

MANAGEMENT PLAN FOR THE MAI PO MARSHES WILDLIFE EDUCATION CENTRE AND NATURE RESERVE

2006 - 2010



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This Plan has taken longer to complete than originally intended so if we have missed your name in the acknowledgements, then accept our apologies.

Last but not least, a big thanks to all the WWF staff at Mai Po for their early input into the Plan and now to implement it!!

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Citation

WWF Hong Kong. 2006. Management Plan for the Mai Po Nature Reserve, WWF Hong Kong, Hong Kong

EXECUTIVE SUMMARY

The 2006 - 2010 Mai Po Management Plan is the third 5-year Plan that has been drafted for the Reserve and was done based on the recommendations of the management plan for the larger Mai Po Inner Deep Bay Ramsar Site, advice from many experts, and the experience that WWF has gained since 1984 when they first became involved in the site's management.

The overall Management Objectives of the Mai Po Nature Reserve (MPNR) are:

- To manage the MPNR so as to maintain and, if possible, increase the diversity of habitats appropriate for south China coastal wetlands, and the richness of native wildlife in the area.
- To promote the use of the area for educational purposes both by students and the general public (including the provision of special facilities and tours for the disabled).
- 3. To realise the training potential of the Reserve as part of the Ramsar Site so as to promote wetland conservation and wise use in the East Asian-Australasian Flyway, in particular China.
- 4. To promote scientific research relevant to the management and conservation of wetlands and their biota.
- 5. To promote, and support measures to reduce and minimise external threats to the habitats and wildlife at the Reserve.

This Management Plan describes the tasks that will be carried out to achieve Goals 1 and 4 since the strategies for achieving Goals 2, 3 and 5 have been drafted as separate strategies by the Education, Training, and Conservation Departments respectively within WWF in consultation with MPNR staff.

To achieve Goal 1, 12 Management Objectives have been identified (Section 2.4.3), with each Objective requiring a number of projects to be undertaken for the Objective to be met. For Goal 4, two Management Objectives have been identified (Sections 3.4).

The main focus of the habitat management work at Mai Po from 2006 – 2010 will be to;

- Monitor the baseline ecology of the Reserve as well as the result of habitat management project in order to assess their success. The results will then feed-back into improving the management of the Reserve.
- Remove the silt and invasive grasses that have built up in the *gei wai* by dredging the perimeters and cross channels, as well as in the central portions of certain *gei wai* (e.g. 17b, 21) to address the long-term problem of the *gei wai* 'drying out',
- Reduce the landscape profile through management of the height and sideway growth of
 selected trees growing along the *gei wai* bunds. This will address the problem of
 declining waterbirds using the shallow water roosts due to tall trees around the roost
 site,
- Enhance the ecological value of the *gei wai* by appropriate habitat management works, some of which may be on a trial basis, e.g. targeted water level management, reprofiling the pond floor (such as by creating new islands or deeper channels, planting of aquatic vegetation, management of the grasses along the pond bunds by a schedule of cutting or grazing by domestic animals etc.. The aim will be to maintain and if possible, increase the diversity and abundance of wildlife using MPNR.

PART 1: DESCRIPTION

CHAPTER 1.1 GENERAL INFORMATION

1.1.1 Location

Country: The People's Republic of China (Hong Kong Special Administrative Region)

Region: New Territories

District: Yuen Long

Site Name: Mai Po Marshes Wildlife Education Centre and Nature Reserve

Location: The Reserve lies in the northwestern New Territories of the Hong Kong SAR on

the eastern shore of Deep Bay. On the opposite side of the Bay, is the Shenzhen Special Economic Zone, Guangdong Province, People's Republic of China

(PRC).

Site Status: SSSI 1976, Mai Po and Inner Deep Bay Ramsar Site 1995, Shorebird Flyway

Network Site 1996, Anatidae Flyway Network Site 2001.

Location: 22°28′N/22°32′N - 113°59′E/114°04′E

Grid Ref.: 49Q JV 957 917 - 49Q JV 951 891

Sheet Number: Hong Kong SAR Government, Series HM20C (Sheet 2)

Total Area: Mai Po Marshes 378.1 ha (272.1 ha [70.35%] ponds,

115.0 ha [29.7%] mangroves)

Site manager: Whilst the Reserve consists of the intertidal mangroves and some twenty-four

gei wai (Figure 1), World Wide Fund For Nature Hong Kong only carries out physical management of gei wai 3, 4, 6-24 within the Closed Area (CA). The administrative work is carried out by the Agriculture, Fisheries and Conservation Department (AFCD) of the Hong Kong SAR Government. Private

individuals manage the ponds outside the CA Fence (gei wai 1, 2 and 5).

Address: Peter Scott Field Studies Centre,

Mai Po Marshes Wildlife Education Centre and Nature Reserve,

Mai Po, Yuen Long,

New Territories, Hong Kong, P.R. China.

Contact: Peter Scott Field Studies Centre, Tel: 2471-8272, 2471-4517, Fax: 2471-0325

Wildlife Education Centre, Tel: 2471-6306, 2471-9722, Fax: 2482-0369

e-mail: <maipo@wwf.org.hk>

1.1.2 Access

Legal rights of access: There are no rights of way in Hong Kong and no legal rights of public access.

Under Schedule 6 of the Wild Animals Protection Ordinance (Cap 170), the Mai Po Nature Reserve is a restricted area and all visitors must first obtain a valid Mai Po Entry Permit issued by the Director of the Agriculture, Fisheries and Conservation Department, Hong Kong SAR Government. Permits are valid for periods of up to 12 months.

There are some 15 households within the restricted area, who do not require permits to enter the Reserve.

Vehicle access: From Castle Peak Road, which runs from Sheung Shui to Yuen Long, turning west at Mai Po village and continuing along the road to the village of Pak Hok Chau.

Pedestrian access: is via (1), the road from Pak Hok Chau Border Police post and then through Pak Hok Chau village and (2), a floating bridge from Lut Chau (to the south of MPNR).

Other access: There are two helicopter-landing sites - at Pak Hok Chau, and at the south end of the Reserve by *gei wai* 22.

Access to Lut Chau is via two bridges, one from the village of Tai Sang Wai (suitable for vehicles), and the other is a floating bridge from the southern end of Mai Po that was constructed in the summer of 1994.

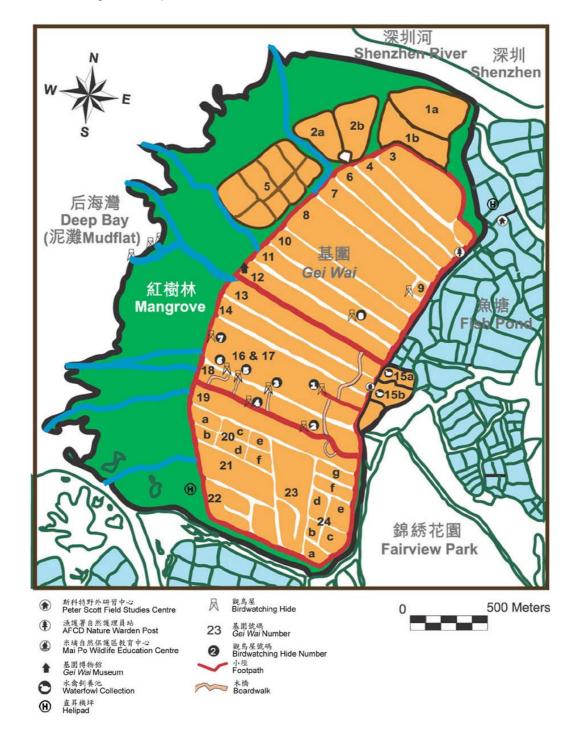


Figure 1: Map of Mai Po Nature Reserve and its facilities

1.1.3 Land tenure

This is not a legal document. Please refer to the original tenure documents before taking any decision or action which may have legal implications.

Owner: Hong Kong SAR Government

Type of Holding: At Mai Po, the land is leased to WWF HK and private individuals.

| Gei wai | Leasee | Date of | Approx. area | Compensation | Remark |
|---------|---------|---------------|--------------|---------------|--|
| No. | | Lease/control | ((ha) | Amount (HK\$) | |
| 1 | Private | - | 16.4 | - | - |
| 2 | Private | - | 11.4 | - | - |
| 3 | WWF HK | 1994 | 9.9 | - | Given to WWF HK by government for |
| | | | | | management |
| 4 | WWF HK | 1994 | 8.3 | - | Given to WWF HK by government for management |
| 5 | Private | - | 18.2 | - | - |
| 6 | WWF HK | 1992 | 9.4 | 1,248,437.5 | Donation by Wharf Holdings |
| 7 | WWF HK | 1992 | 10.7 | 1,240,437.3 | Donation by Wharf Holdings |
| 8 | WWF HK | 1988 | 19.4 | 1,186,130 | Funds raised from BBR |
| 9 | WWF HK | 1987 | 1.1 | 60,000 | Funds raised from BBR |
| 10 | WWF HK | 1989 | 11.2 | 622,869.75 | Funds raised from BBR |
| 11 | WWF HK | 1987 | 11.2 | 682,000 | Funds raised from BBR |
| 12 | WWF HK | 1994 | 11.4 | | Given to WWF HK by government for |
| | | | | ı | management |
| 13 | WWF HK | 1994 | 12.2 | | Given to WWF HK by government for |
| | | | | • | management |
| 14 | WWF HK | 1985 | 11.5 | 561,928 | Funds raised from BBR |
| 15 | WWF HK | 1989 | 6.6 | 977,900 | Funds raised from BBR |
| 16 | WWF HK | 1983 | 12.2 | 569,340 | Funds raised from BBR |
| 17 | WWF HK | 1985 | 12.1 | 1,199,785 | Donation by Jockey Club |
| 18 | WWF HK | 1985 | 11.8 | 1,199,700 | Donation by Jockey Club |
| 19 | WWF HK | 1987 | 12.9 | 720,584 | Funds raised from BBR |
| 20 | WWF HK | 1995 | 8.9 | | Given to WWF HK by government for |
| | | | | • | management |
| 21 | WWF HK | 1995 | 9.2 | _ | Given to WWF HK by government for |
| | | | | <u>-</u> | management |
| 22 | WWF HK | 1995 | 9.7 | _ | Given to WWF HK by government for |
| | | | | | management |
| 23 | WWF HK | 1995 | 12.6 | _ | Given to WWF HK by government for |
| | | | | | management |
| 24 | WWF HK | 1995 | 13.8 | _ | Given to WWF HK by government for |
| | | | | | management |
| | | | Total = | | |
| | | | 272.1ha | | |

^{*} In 1994, the HK Government used HK\$16 million to buy up the remaining *gei wai* within Mai Po which WWF HK had still not acquired (*gei wai* 3, 4, 12, 13, 20-24) and gave their management over to WWF HK.

Total area leased to WWF HK: approx. 226.1 ha, consisting of *gei wai* 3, 4, 6-24 and excluding the area of intertidal mangroves outside the Closed Area Border Fence.

Length of lease: to WWF HK - annually renewable **Cost of lease:** nominal HK\$ 1 per year to WWF HK

Conditions/terms of lease: Each *gei wai* is under either a separate, or group license. Refer to Mai Po office file 'Reserve Management/Land Matters/*Gei Wai* (rm/lm/gw)'. The license can be revoked after 3 months notice is given and no compensation is required - *ex gratia* payment is possible.

Mai Po Management Plan 2006 - 2010

There are general controls on land-use such that the area may "...not be used for any purpose

other than for the purpose of a nature reserve.." Prior written approval is required from the

District Lands Office - Yuen Long for a number of management activities, such as tree felling

and carrying out drainage works, e.g. dredging.

The erection of new structures and replacement of existing structures requires permission from

the Town Planning Board through a Section 16 application under the Town Planning

Ordinance.

1.1.4 Management infrastructure

AFCD controls access into the Reserve and administer the legal aspects of the site. In 1983,

World Wide Fund For Nature Hong Kong began to take over, and actively manage the land

within the Reserve and by October 1998, had taken over 83% (approx. 272 ha) of the gei wai.

This was only made possible by generous funding provided by the Hong Kong SAR

Government, Hong Kong Jockey Club, private companies and individuals.

The WWF HK Mai Po Management Committee provide overall management direction for

MPNR. This committee has representatives from AFCD, academics from the local tertiary

institutes, and local environmental groups. WWF HK's headquarters is located at:

1 Tramway Path,

Tel: 2526-1011

Central.

Fax: 2845-2734

Hong Kong.

e-mail: wwf@wwf.org.hk; website: http://www.wwf.org.hk

5

The following departments of WWF Hong Kong are based at the office in Central: Accounts,

Conservation, Fund Raising, Membership, Trading, Translation, Central Services, Publicity

and Publications. Reserve Management is based at MPNR, and Environmental Education

based at Island House, Tai Po.

The Mai Po Marshes has a Wildlife Education Centre and the Peter Scott Field Studies Centre,

whilst the Conservation Studies Centre is located at:

Island House,

Tel: 2656-1272

Tai Po.

Fax: 2651-0276

New Territories, HK.

e-mail: ihcsc@wwf.org.hk

1.1.4.1 Staffing

The Executive Director oversees the work of all WWF HK departments including that of reserve management. Direct reserve management responsibility is delegated to the Reserve Manager. The staff structure at Mai Po is outlined in <u>Appendix 1</u>. The titles and duties of Mai Po staff are as follows:

Reserve Manager: Overall management of Mai Po Marshes Nature Reserve and staff. Cooperate on specific projects with WWF Hong Kong staff in Central.

Visitor Marketing Manager: Manages services such as bookings, retail sales, accommodation and catering to ensure that visitors have a value for money experience when they visit MPNR.

Assistant Visitor Marketing Manager: Responsible for the promotion, administration and smooth operation of the Mai Po Public Visit Programme.

Assistant Administration Officer: Reports to the Visitor Marketing Manager. Has a wide range of administrative responsibilities for the smooth running of the Reserve.

Reserve Officers: There are two Reserve Officer. One has responsibility for the ecological monitoring and research programmes being conducted at the Reserve whilst the other, has responsibility for assisting in the field work of the Reserve and the various community programmes. Each supervises the work of one of the two Assistant Field Officers. Both the Reserve Officers are based at the Education Centre.

Assistant Reserve Officer:

There are two Assistant Reserve Officers who are based at the Education Centre and assists in the administration and implementation of the community relations, research, training and field work that is carried out at Mai Po Nature Reserve.

Field Officer: Oversees 8 full-time Field Assistants and up to 1 Part-time Field Assistant on the Reserve who are responsible for general habitat and infrastructure management work.

Senior Training Officer: Organizes Wetland Management Training Programmes for wetland Reserve staff and Government officials from across East Asia, particularly China. Oversees one assistant responsible for all duties associated with the smooth operation of the Training Courses.

Training Officer: Assist the Senior Training Officer in all duties associated with the smooth operation of the Training Courses.

Peter Scott Field Studies Centre Housekeeper: Based at the Peter Scott Field Studies Centre, responsible for the cooking and cleanliness of the centres and surroundings.

Part-time staff: One Part-time Field Assistant is employed to assist in various management activities around the Reserve on an as needs basis.

AFCD controls access to the Reserve, and there are AFCD Nature Wardens stationed at the entrance to the Reserve at Pak Hok Chau who enforce this restriction.

Volunteers often assist with a variety of reserve management activities. A number of postgraduate and undergraduate students conduct research on the Reserve and the results of their studies are often relevant to the management of the Reserve (Appendix 2).

Contractors are paid to do work as required. Usually this is on larger construction or habitat management projects.

1.1.4.2 Facilities:

WWF HK has developed the following facilities at Mai Po (Figure 1):

Wildlife Education Centre: The Education Centre, with a building cost of HK\$ 2.9 million donated by the Royal Hong Kong Jockey Club, was opened in October 1986. The building has an exhibition hall with displays concerning the natural and human history of Mai Po designed to suit all levels of visitors, a small research laboratory, toilets, office, workshop and storeroom. The design of this centre incorporates access and facilities for the disabled. There is an outside storage hut used by field staff.

Since the completion of the Education Centre, the original Visitor Information Centre built in 1983, has been used as a bird-ringing station and a resting point for visitors.

Peter Scott Field Studies Centre: The two-storey Field Studies Centre located at Pak Hok Chau, cost HK\$ 4.9 million to build and was opened in February 1990. It provides accommodation and study facilities for staff, visiting scientists, researchers, conservationists and members of the public. The Centre has increased the potential of Mai Po as a regional wetland research and management training station. Regular Wetland Management Training Courses are run for wetland Reserve staff and Government officials from East Asia, particularly Mainland China. A 'Visitors Centre', upgraded in 2002, where visitors on guided tours report on arrival, is situated in the Centre. The Field Studies Centre also provides a paved car park for visitors.

Waterfowl collection: A Waterfowl Collection adjacent to, and landward of the Education Centre was opened in December 1989 at a cost of HK\$ 403,000. Approximately 100 pinioned native ducks and geese were originally kept, and were used to explain basic ecological principles to students and visiting members of the public. In winter, the collection attracts several hundred wintering waterbirds, principally Coots *Fulica atra*, Wigeon *Anas penelope* and Pintail *Anas acuta*, which use the site for feeding and roosting. In addition, up to 2,000 wintering Cormorants *Phalacrocorax carbo* roost on the trees around the collection. By 1997, all the original waterfowl stocked into the Collection had died and there are no plans to replace them. This is because;

- Of concerns over captive waterfowl as a vector for the spread of avian diseases to wild waterfowl, captive waterfowl are no longer kept in the collection,
- Up to 1,000 wintering waterfowl may use the Collection in winter so there is no need to have a captive collection at these times,
- In summer, many of the captive ducks stay in the reeds at the edge of the Collection due to the high temperature, so that they would not be visible to visitors,
- Of the high cost of purchasing captive reared waterfowl from abroad for stocking into the ponds.

Observation Hides: Eleven observation hides have been constructed (three of which are suitable for those with walking disabilities). These include a three-storey Tower Hide (lower floor accessible to wheelchair users) which provides a commanding view over the northern part of the Reserve. A floating boardwalk (540m), built through the mangroves on the seaward side of the marsh, leads to three Floating Hides on the edge of the inter-tidal mangroves facing the Deep Bay mudflats with the city of Shenzhen in the distance.

Other Facilities: Concrete footpaths to a length of 4 km have been constructed from the AFCD Nature Warden Post at Pak Hok Chau to the Education Centre and around the Reserve. A Nature Trail has been established which loops around the Education Centre. There are a number of educational notice boards along this route, which also includes a rain shelter and a piled boardwalk (200m) at the landward end of *gei wai* 19. A *gei wai* Museum has been built by the sluice gate of *gei wai* 12, to demonstrate traditional methods of *gei wai* shrimp farming at Mai Po, and the way of life of *gei wai* fishermen in the past. A second rain shelter has been built near the entrance to the floating boardwalk.

There are a number of huts in the Reserve (*gei wai* 13, 14, 16, 17, 18, 19, 20 and 21) which are used for the storage of equipment and materials.

Extensive landscaping and vegetation management, including the planting of native tree species, has been undertaken by the side of footpaths to provide shade for visitors, and along the eastern and southern boundaries of the Reserve as a visual screen against neighbouring urban development.

1.1.5 Map coverage

Maps of the Reserve and surrounding areas are available from the Map Section, Planning Department located at:

Planning Department, Government Offices, 333 Java Road, North Point, Hong Kong.

1.1.6 Photographic coverage

Aerial photographs of the Reserve and surrounding areas are also available from the Map Section, Planning Department. These photographs are updated on an annual basis.

There are various privately owned aerial photograph collections of relevance to Mai Po. Contacts for these can be made through the Mai Po Reserve Manager.

Other Photographs: At present, photographs are not systematically used as a method of recording at Mai Po - neither aerial nor ground photos. However, generally special projects taking place on the Reserve are recorded and these are kept at the WWF HK office in Central.

Slide Collection: The Communications Manager at the WWF HK office in Central maintains the WWF HK slide collection which includes slides of Mai Po. Several members of staff also keep private slide collections.

CHAPTER 1.2 ENVIRONMENTAL INFORMATION

1.2.1 Physical

1.2.1.1 Climate

Hong Kong has a typically wet, sub-tropical climate tending towards temperate for nearly half the year. The Mai Po area has an annual mean temperature range of $15.5 - 28.7^{\circ}$ C. The mean annual rainfall of 1,400 mm is low compared with the rest of Hong Kong (2,246 mm/year) because Mai Po is situated in the rain shadow of the Tai Mo Shan massif. The mean evaporation rate is around 1,500mm/year.

During November and December there are breezes, sunshine and comfortable temperatures. January to February is cloudier, with occasional cold fronts followed by dry northerly winds.

The lowest temperature recorded at the Hong Kong Observatory is 0°C although sub-zero temperatures and ground frost occur at times on high ground and in the New Territories, including Mai Po. From late April to October, the weather is hot and humid with frequent showers and thunderstorms. Afternoon temperatures often exceed 32°C, whereas at night temperatures generally stay around 26°C with humidity of over 95%.

Tropical cyclones occur from June to October (although gales may occur any time between May and November). Heavy rain from tropical cyclones may last for a few days, and subsequent flooding may cause more damage than the winds.

Data collected by the Hong Kong Observatory's meteorological station in Kowloon from 1999 – 2003 show that on average, the weather in January has been becoming warmer and wetter. Although the temperature in April has also increased, it has done so at a smaller rate. Rainfall in April does not appear to have changed. These climatic changes may impact on the diversity and number of certain species of waterbirds wintering and on passage through Mai Po and Deep Bay (Young 2005).

Table 1: Average temperature and rainfall recorded at the Hong Kong Observatory, in January and April, from 1997 to 2003 (http://www.hko.gov.hk/wxinfo/pastwx/mws.htm)

| | Average temp (°C) | | Rainfall (mm) | |
|-------------|-------------------|---------------|---------------|--------------|
| | January | April | January | April |
| 1997 – 2003 | 16.9 ± 0.2 °C | 23.9 ± 0.4 °C | 37.5 ± 8.2 | 189.3 ± 65.4 |
| 'Normal' | 15.5 | 23.4 | 22.2 | 161.5 |

1.2.1.2 Hydrology

Mai Po is situated on the eastern shore of Deep Bay which has a total catchment area of 112 km². The Bay is nowhere deeper than 6 m and has an average depth of 3 m. With a maximum tidal range of some 2.8 m, extensive mudflats are exposed at low tide. The water retention time in Deep Bay is about 15 days.

Deep Bay is part of the Pearl River estuary, which is the largest river in southern China and drains an area of some 450,000 km². The estimated annual flow is 308 billion cubic metres. The river is characterized by a heavy sediment load as well as various organic and inorganic loadings.

The Pearl River has a significant effect on water quality in Deep Bay, as well as on the general hydrology of Hong Kong's western marine waters. During the summer wet season, it creates a transition from estuarine to oceanic conditions in a northwest to southeast direction (Morton & Wu 1975; Morton 1982). The seasonal occurrence of extremely low salinities in Deep Bay can be attributed to this river discharge (Morton & Wu 1975). Major rivers and tributaries flowing into Deep Bay include:

- The Shenzhen River, which has the river Indus and Ganges as major tributaries from Hong Kong, and the rivers Buji and Shawan as major tributaries arising from the Shenzhen Special Economic Zone, P.R. China.
- The Yuen Long River (Shan Pui River) and the associated Kam Tin River which join to form a common tidal creek (Yuen Long Creek) before entering Deep Bay, 3 km to the south of the Shenzhen River.
- The Dasha River, located in northwestern Deep Bay about 10 km west of the Shenzhen River.

Water quality in Inner Deep Bay has deteriorated during recent years, with dissolved oxygen levels in the bottom waters falling to below 1% for a couple of weeks during the summer of 1996 (Environmental Protection Department 1998). The levels of BOD₅, *E. coli* and nutrients also indicate serious organic pollution. This poor water quality in Inner Deep Bay is a result of the continuous discharge of untreated, or only partially treated organic waste from urban areas and livestock farms in the catchment. There is also some discharge of industrial effluents via rivers and streams into the head of the bay.

Studies have shown that the Deep Bay estuary is moderately contaminated with chromium but is seriously contaminated with copper and zinc, and that these metals are brought down by the Shenzhen River (Anon 1994a, b).

1.2.1.3 Geology

The Mai Po Marshes lie in the Yuen Long Basin. The marble bedrock is the starting point for the marshes' geological history. Sediment was first deposited 300 million years ago during the Carboniferous era. It was then compressed into rock and then further "cooked" by high geological pressures and temperatures converting it into marble during the Jurassic era (150 million years ago). It is described as metamorphosed, sedimentary rock belonging to the Lok Ma Chau formation.

This Lok Ma Chau Formation is widespread between Lo Wu and Tuen Mun, and can be divided on lithology into the Mai Po Member and the Tai Shek Member. The former is older, and mainly consists of metamorphosed siltstone, fine-grained sandstone and carbonaceous siltstone, while the latter is composed of metamorphosed sandstone and conglomerate.

Recent microfossil evidence suggests that the Lok Ma Chau Formation is of a Tournaissian or Namurian-Westphalian age, formed when the area was a neritic swamp. Lower layers are composed of silts, fine sand and carbonaceous horizons, probably deposited in a deltaic floodplain. As the delta built up, the sediment-type gradually changed to medium sand, coarse sand and pebbles (Landford *et al.* 1989).

Colluvium (>20,000 yrs ago)

During the last ice age, sea level was about 120m below today's level. Erosion of the hillsides resulted in the deposition of colluvium, a sandy rocky soil at the bottom of the slopes.

Alluvial Deposits (> 15,000 years ago)

Polar ice caps began to melt and sea level rose. The Yuen Long Basin was transformed into a broad alluvial plain. As the force of the rivers increased, sand and clay alluvium was deposited here. Sand is coarser grained than clay so it is dropped first.

Marine Deposits (3,000 - 4,000 years ago)

Sea levels continued to rise until 3 - 4,000 years ago. At this time sea level was probably up to 4m above that of today. A thick layer of clayey marine deposits was laid down. Evidence of this are the fragile "window pane" oysters (*Placuna placenta*) which can be seen in the marsh soils today.

Mangroves (3,000 years ago - present)

As sea level dropped to its present level, mangroves grew naturally on the broad inter-tidal mudflats. Shrimp and fish ponds were formed by digging up the soil and making bunds. Mangroves continued to grow in the middle of the shrimp ponds.

1.2.1.4 Geomorphology

The Deep Bay landscape at the end of the last Ice Age, (about 15,000 years ago), was very different from that of today. Sea level was then as much as 120 metres lower than at present, and the area around Mai Po was a considerable distance inland. The rocks which underlie this area, comprising metamorphosed limestones and shales of the Lok Ma Chau formation, were exposed at the surface. Eroded by fast flowing streams, the land was formed into a series of valleys which ran into the major river course along the line of present Deep Bay.

After the Ice Age, sea level rose rapidly as the ice melted and retreated. About 6,000 years ago the sea reached its present level and the coastline of Hong Kong assumed its characteristic "drowned" appearance. In other words, former mountain peaks became islands, and river valleys flooded to become rias. This happened in Deep Bay too, where the shore probably reached the line of the present Castle Peak Road. Many hill summits and ridges dividing the former river valleys became isolated islands, breaking the surface of the estuarine waters. The present day names of these rocky outcrops often include the suffix "chau" meaning island.

There is little evidence to indicate that sea level 6,000 years ago was actually higher than it is today, or that geomorphic uplift has occurred in the Deep Bay region to cause the subsequent retreat of the shoreline. Rather, the most likely explanation for the increase in land area is that deposition of sediments from the bay has led to gradual and natural reclamation from the

sea. Such a process is known as shoreline progration, and this continues to be the major agent of natural landscape change in Deep Bay today.

Shoreline progration is further assisted by the mangrove trees fringing Deep Bay which bind silt particles around their root systems. The fact that the mangrove community is steadily extending seawards, especially in the area near Mai Po Marshes, is a clear indication that natural processes are playing an active role in the landscape evolution of Deep Bay.

1.2.1.5 Soils

The Mai Po soils belong to the Mai Po Association, which is found in the Mai Po, San Tin and Sheung Shui districts, and in pockets of agricultural land along the border from Lok Ma Chau to Lo Wu and Ta Kwu Ling.

The Mai Po Association is formed on alluvial and coluvial material derived from rocks of the Lok Ma Chau Formation but affected also by Tai Mo Shan Porphyries.

The soils around Mai Po are poorly drained and frequently highly saline, and thus are not important agriculturally. Signs of salinity can be seen in winter when the existing fish ponds are drained. As the sun dries the mud on the bottom of the pond, it forms hexagonal blocks separated by large cracks, with salt deposits on the surface (Grant 1960).

1.2.2 Biological

1.2.2.1 Flora

An updated plant list for MPNR has been prepared by an intern student, Ms. Maja Willis and is available on the web http://www.stationeast.net/maipo/mappingkey.swf (Appendix 3). A small herbarium has also been established at the Education Centre. However, the distribution of species in the Reserve needs to be mapped, and their significance on a local, national and international level needs to be assessed.

The Mai Po flora was originally dominated by mangroves. Over the past 50 years however, it has been greatly altered by human influence, e.g. from the creation of *gei wai* and fish ponds which have often led to the loss of the original mangrove, to be replaced by other marshland or coastal plants. Tree planting since 1976 (with *Casuarina equisetifolia* to mark the

boundary of the Reserve) and more recently since 1985 (e.g. *Macaranga tanarius* for shelter, and *Ficus microcarpa* as a food source for wildlife), has also affected the natural flora. Such planting has been concentrated along the landward part of the Reserve. However, there has also been extensive natural colonization of the bunds by trees following the cessation of regular burning of vegetation in the early 1980's (D.S. Melville, pers. com.). Native shrubs are now planted instead of trees because they have a smaller impact on the landscape profile of the Reserve.

No trees in the areas licensed to WWF Hong Kong may be "interfered with or removed" without written consent from the District Lands Officer – Yuen Long.

Noteworthy Flora: Mai Po holds 115 ha (42%) of inter-tidal mangroves in Hong Kong which is the largest stand in Hong Kong and together with the other stands around Deep Bay, forms the sixth largest protected area of mangroves in China (Fan 1993). There is another 175 ha of mangroves inside the *gei wai*.

The mangroves in Hong Kong are close to their northerly limit, and so species diversity is less than that in more tropical areas to the south. The main species are;

| Species | Scientific name |
|------------------------|------------------------|
| Spiny Bears Breech | Acanthus ilicifolius |
| | Aegiceras corniculatum |
| Black Mangrove | Avicennia marina |
| | Bruguiera gymnorrhiza |
| Milky Mangrove | Excoecaria agallocha |
| Looking-glass Mangrove | Heritiera littoralis |
| | Kandelia obvata |

The Looking-glass mangrove, *Heritiera littoralis*, was introduced in the Reserve at around 1986. Apart from these species, there are a number of mangrove associates such as *Clerodendrum inerme*, *Derris trifoliata*, *Acrostichum aureum*, *Canavalia maritima* and the planted *Cerbera manghas*.

Local rarities include *Ruppia maritima* which used to be found in the *gei wai* (Melville & Chan 1992) but has not been recorded in recent years.

The stands of reed *Phragmites communis* in Mai Po are the largest in Hong Kong (46 ha), and one of the largest remaining in Guangdong Province, China (Gao, Y.R. pers. comm.).

Plant invaders: Many terrestrial plants have also become "invaders": e.g. *Bidens pilosa*, *Emilia sonchifolia*, *Gynura bicolor*, *Paspalum* spp, *Sonchus oleraceus* and *Achyranthes aspera*. The introduced *Mikania micrantha* and *Lantana camara* are also invasive, but the flowers of the latter are an important food source for butterflies and the fruits are fed on by several bird species.

The inter-tidal mangroves on the estuary side of the *gei wai* are effectively undisturbed by people apart from dredging of the channels. However, the landward mangroves are being "invaded" by climbers, principally *Derris trifoliata*, which will cover and kill the mangroves if left unchecked. It is likely that this spread of *D. trifoliata* in recent years, is related to the silting up of the mangrove floor and eutrophication of Deep Bay.

The mangroves on the seaward side are affected by the colonization by the exotic mangrove, *Sonneratia* spp., which have been planted on the Shenzhen SEZ side of Deep Bay. If left unchecked, there is a concern that this fast growing species will become dominant over the local species. The Agriculture, Fisheries and Conservation Department monitors the mangrove habitat in the Ramsar site and takes precautionary measure to uproot the *Sonneratia* found there where accessible.

All plants at Mai Po are protected under the 1993 amendment to the Forests and Countryside Ordinance (Cap. 96), where it is an offence to fell, cut, burn or otherwise destroy any tree or growing plant on Government land without prior permission from The Director of Agriculture, Fisheries and Conservation.

1.2.2.2 Fauna

Birds: Over 380 bird species have been recorded from Mai Po, the Deep Bay mudflats and surrounding areas (<u>Appendix 4</u>). This forms 89% of the Hong Kong total.

Many experienced birdwatchers visit the site and they help in up-dating records. Regular bird-ringing is also conducted. The Hong Kong Bird Watching Society carries out monthly waterbird counts in the Mai Po and Deep Bay area.

The Deep Bay wetlands offer rich feeding habitats for birds. Of the over 450 species currently recorded in Hong Kong, over 380 have been seen at Mai Po, of which a 100 are rarely, if ever, found elsewhere in Hong Kong. About 80% of the species, however, are

migrants which breed in northern China, Russia, Korea and Japan, and either visit the area for the winter, or pass through in spring and autumn on migration (Melville & Morton, 1982)

Deep Bay supports large numbers of wintering waterfowl, with a peak of over 67,000 in January 1996, but which now averages some 54,000 individuals. During spring passage, up to 10,000 shorebirds may be recorded at any one time, and it is estimated that a total of 20,000 – 30,000 passes through. The area regularly supports 20 threatened bird species (BirdLife 2000) and 28 species (Carey & Young 1999) whose recorded number is greater than 1% of their estimated population along the East Asian-Australasian Flyway.

| Species | Scientific name | Approx. % of flyway population | Status |
|--|---------------------------------|--------------------------------|------------------------|
| Dalmatian Pelican | Pelecanus crispus | 20% | Conservation dependent |
| Great Cormorant | Phalacrocorax carbo | 6.3% | |
| Grey Heron | Ardea cinerea | Up to 5.3% | |
| Great Egret | Egretta alba | Up to 5.3% | |
| Little Egret | Egretta garzetta | 1% | |
| Chinese Egret | Egretta eulophotes | 1% | Vulnerable |
| Chinese Pond Heron | Ardeola bacchus | 1% | |
| Japanese Night Heron | Gorsachius goisagi | | Endangered |
| Oriental Stork | Ciconia boyciana | | Endangered |
| Black-headed Ibis | Threskiornis melanocephalus | | Near-threatened |
| Black-faced Spoonbill | Platalea minor | 25% | Endangered |
| Common Shelduck | Tadorna tadorna | Average 2.9% | |
| Eurasian Wigeon | Anas penelope | Up to 2.4% | |
| Baikal Teal | Anas formosa | | Vulnerable |
| Common Teal | Anas crecca | Up to 4% | |
| Northern Pintail | Anas acuta | Up to 6.5% | |
| Northern Shoveler | Anas clypeata | Up to 7.3% | |
| Baer's Pochard | Aythya baeri | | Vulnerable |
| Ferruginous Duck | Aythya nyroca | | Near-threatened |
| Black Vulture | Aegypius monachus | | Near-threatened |
| Greater Spotted Eagle | Aquila clanga | | Vulnerable |
| Imperial Eagle | Aquila heliaca | | Vulnerable |
| Eurasian Coot | Fulica atra | 1% | |
| Black-winged Stilt | Himantopus himantopus | 3.3% | |
| Pied Avocet | Recurvirostra avosetta | 4.3 – 10.7% | |
| Grey Plover | Pluvialis squatarola | Up to 2.25% | |
| Kentish Plover | Charadrius alexandrinus | 1% | |
| Greater Sand Plover | Charadrius leschenaultii | 1% | |
| Black-tailed Godwit | Limosa limosa | 1.3% | |
| Eurasian Curlew | Numenius arquata | 0.8 – 8% | |
| Far Eastern Curlew | Numenius madagascariensis | 0.00 | |
| Spotted Redshank | Tringa erythropus | 3.5% | |
| Marsh Sandpiper | Tringa stagnatilis | 2-3% | |
| Common Greenshank | Tringa nebularia | 3% | |
| Spotted Greenshank | Tringa nesalana Tringa guttifer | | Endangered |
| Terek Sandpiper | Xenus cinereus | > 1% | |
| Asian Dowitcher | Limnodromus semipalmatus | , , | Near-threatened |
| Dunlin | Calidris alpina | 1% | |
| Mai Do Management Dian 2006 2010: Environmental Information 19 | | | |

| Curlew Sandpiper | Calidris ferruginea | 5% | |
|---------------------|-------------------------|-----------|-----------------|
| Spoon-billed | Eurynorhynchus pygmaeus | | Vulnerable |
| Sandpiper | | | |
| Relict Gull | Larus relictus | | Vulnerable |
| Black-headed Gull | Larus ridibundus | 1.8 – 18% | |
| Saunders' Gull | Larus saundersi | | Vulnerable |
| Styan's Grasshopper | Locustella pleskei | | Vulnerable |
| Warbler | | | |
| Japanese Paradise | Tersiphone atrocaudata | | Near-threatened |
| Flycatcher | | | |
| Yellow Bunting | Emberiza sulphurata | | Vulnerable |

Mai Po and Inner Deep Bay is the only known wintering site for Styan's Grasshopper Warbler. All wild birds and their nests in Hong Kong are protected under the Wild Animals Protection Ordinance (Cap. 170).

Mammals: Mai Po holds 17 (37%) of Hong Kong's terrestrial mammal species but there is a need for further survey and research (<u>Appendix 5</u>). The results may have significant implications for future habitat management.

The following mammals are protected under the Wild Animals Protection Ordinance (Cap. 170) and have been recorded from MPNR:

| Species | Scientific name |
|-------------------------------|-------------------------|
| Leopard Cat | Felis bengalensis |
| Eurasian Otter | Lutra lutra |
| Javan Mongoose | Herpestes javanicus |
| Crab-eating Mongoose | Herpestes urva |
| Small Indian Civet | Viverricula indica |
| | |
| Japanese Pipistrele | Pipistrellus abramus |
| Greater Short-nosed Fruit Bat | Cynopterus sphinx |
| Lesser Yellow Bat | Scotophilus khuli |
| Noctule Bat | Nyctalus noctula |
| Leschenault's Rousette Bat | Rousettus leschenaultii |

Feral dogs are the most common mammal within MPNR (Wildlife Conservation Fund, unpub. data), and are a problem as they have been seen chasing and killing mammals, e.g. Javan Mongooses, and disturbing waterbirds from their roosting sites. WWF staff operate three baited walk-in traps with permission from AFCD, and these trap some 20 dogs per year. This number is low considering that packs of up to five to six dogs are sometimes observed in the Reserve and they have been known to breed in the Reserve as well.

Reptiles and Amphibians: A checklist of the reptiles and amphibians is available (<u>Appendix</u> <u>6</u>). To date, 27 (28%) of Hong Kong's reptile and amphibians species have been recorded

from Mai Po. Specimens (mainly "casualties") are kept in the laboratory at the Education Center.

Species protected in Hong Kong under the Wild Animals Protection Ordinance (Cap. 170), include:

| Species | Scientific name |
|-----------------------------|---------------------|
| Reeves' Terrapin | Chinemys reevesi |
| Chinese Soft-shelled Turtle | Pelodiscus sinensis |
| | |
| Burmese Python | Python molurus |

Athough not protected under Cap. 170, Bennett's Water Snake *Enhydris benetti* is of conservation importance because it is a little known species, with a range restricted to the coastal areas of Hainan Island, Guangdong and Fujian Provinces only.

Fish: In recent years, water pollution has adversely affected fish diversity in the Reserve, which is now dominated mainly by *Oreochromis* spp., *Mugil cephalus* and *Gambusia affinis*. Species lost includes *Sparus latus* and *Scatophagus argus*. The presence of the introduced *Oreochromis mossambicus* and *O. niloticus* is significant in the management of the Reserve since they have no economic value but they prey on *gei wai* prawns and may compete with native fish.

Terrestrial invertebrates: Nearly 400 species of invertebrates were found in the Mai Po reedbeds, with at least 4 species probably being undescribed previously (Reels 1994).

The invasive Red Fire Ant (*Solenopsis invicta*) was first recorded at Mai Po in spring 2005. Whenever colonies are found, a selective insecticide, such as 'Justice' (Spinosad), which has minimal impacts on the other wildlife in the Reserve will be used to control the spread of these ants.

Butterflies and Moths: Some 23 species of butterflies have been recorded at Mai Po (Appendix 7), accounting for 12% of Hong Kong's total. Work on the moths is being carried out and a checklist is currently being prepared. So far, Mai Po is the type locality for two moth species, *Schrankia bilineata* Galsworthy, 1997 and *Thalassodes maipoensis* Galsworthy, 1997. So far, the Reserve is the only known sites where these species can be found.

Mai Po also holds a number of moth species which are characteristic of mangrove and reedbed habitats including *Chasmina candida*, which in Hong Kong, has so far only been recorded at the Reserve so far (R. Kendrick, pers. comm. 1999).

Dragonflies: A list of dragonflies for the Reserve has also been prepared (<u>Appendix 8</u>). Of particular importance, is the presence of the endangered damselfly *Mortonagrion hirosei* in the Mai Po reedbeds.

Marine invertebrates: A literature survey of the marine invertebrate community (excluding insects) at Mai Po has been made (Lee 1993). Some 80 species have been recorded, of which at least 13 were previously undescribed. In recent years, an increasing number of research projects are being carried out on the community ecology of the mudflat invertebrates.

A list of the crabs on the Reserve has been drawn up (Lee & Leung 1999) with *Parasesarma maipoensis* being of particular conservation concern because it has so far only been recorded from Mai Po and Macau. The *gei wai* prawn *Metapenaeus ensis* is of economic importance.

1.2.2.3 Communities

This section is difficult to complete because phytosociological studies in Hong Kong are in their infancy and thus functional communities cannot be easily recognized. There are no vegetation maps nor vegetation classification system for Mai Po, and any information on communities is scattered.

1.2.3 Cultural

1.2.3.1 Archaeology/Past land use

There are no known archaeological remains on the site. However, a certain amount of information is available on the past land use of the entire Deep Bay area including the Mai Po Marshes, which has management implications. The inter-tidal shrimp ponds (*gei wai*) at Mai Po are of great cultural significance as they are the only remaining examples in Hong Kong. They are also one of the few traditionally (extensively) managed shrimp ponds that remain in Asia, and are increasingly being seen as an example of the 'wise use' of wetlands.

The wetlands around the Mai Po Marshes have been used for a wide range of agricultural and other practices including prawn farming, fishing, oyster cultivation, algae collection and salt production. The first settlers around Deep Bay were fishermen who reclaimed the marshes for cultivation. The first such project took place some 1000 years ago near Yuen Long but the most intensive period of reclamation occurred this century, when more than 1,700ha of

former marshland were brought under cultivation. Due to the poorly drained soil which had a high salinity, a salt-tolerant variety of rice known as "red rice" was cultivated. After some years of planting "red rice", areas of former marshland became sufficiently salt-free to allow conversion to fresh water rice cultivation.

After World War II, immigrants from China settled around Deep Bay bringing with them the technique for rearing shrimps using *gei wai*. Around 1940-45, the first *gei wai* at Mai Po were constructed.

In the 1950s, the Agriculture and Fisheries Department began intensive research into improved methods of pond fish culture. As the results were successful, it lead to farmers adopting the method in the 1960s and 1970s and converting the *gei wai* and paddy outside of the present Reserve area into deep water ponds for fish farming. Some of the southern *gei wai* inside Mai Po Nature Reserve were also converted into such deep water fish ponds in the 1970's. Attempts were made to convert the northern ponds into deep water ponds in 1979/1980 but failed due to Government withholding permission. However, the sluice gates of these *gei wai* were blocked up so that they could still be used as permanent ponds, and this caused the mangroves inside to drown and die. In the 1980's, new operators took over the ponds who reinstated traditional *gei wai* management and unblocked the sluice gates to allow water exchange. When the *gei wai* were drained during water exchange, it provided conditions for the reed, *Phragmites australis*, to rapidly colonize. Those *gei wai* in the central part of Mai Po were maintained as traditionally operated shrimp ponds over this period, and now the Reserve holds the last remaining *gei wai* in Hong Kong.

1.2.3.2 Present land use

Prawn and Fish Farming: All the *gei wai* within the Closed Area Fence are under the management of WWF HK and where water quality permits, are still managed traditionally for prawn farming, particularly *gei wai* 12 - 14. The remaining ponds are managed as wildlife habitat. There are a total of 272 ha of prawn and fish ponds in the Reserve.

Education/Recreational: Although visitor numbers are controlled by AFCD, all public visits are under the direct management of WWF HK. Educational visits are subvented by the Education Department. Thus visitor impacts on the site can be monitored and controlled. However, individuals, usually in the form of naturalists, wildlife photographers or AFCD guests, may gain access to Mai Po and thus the site is used for special interest purposes.

1.2.3.3 Past management for nature conservation

The need to conserve the Deep Bay wetlands, particularly Mai Po has been recognized for nearly 50 years. In 1964 Sir Peter Scott, one of the founders of WWF, recommended that a Reserve be established and this was echoed by the Government's Provisional Council for the Use and Conservation of the Countryside in 1968.

In 1974 hunting was prohibited in the Mai Po area and a year later access was restricted to permit holders so reducing disturbance to the area.

In 1975, the Government's Wildlife Protection Advisory Sub-committee considered a proposal to establish a nature reserve and waterfowl collection at Mai Po and in 1977, Prof. Geoffrey Matthews of the Wildfowl Trust visited Hong Kong at the invitation of the Hong Kong Government and prepared an outline proposal for a reserve, but no further action was taken at that time.

The Hong Kong Government declared Mai Po a Site of Special Scientific Interest (SSSI) in 1976 although this did not confer any special protection to the site, nor was there any active management of the site for conservation or education.

In 1982, the Hong Kong Government's Executive Council approved in principle WWF HK's request for permission to develop a nature reserve at Mai Po, and in the autumn of 1983 WWF HK started to develop and manage the Mai Po Marshes Wildlife Education Centre and Nature Reserve with the following aims:

- to manage the entire Mai Po Marshes so as to maintain and, if possible increase the diversity of native wildlife in the area,
- to promote the use of the area for educational purposes both by school pupils and the general public (which includes the provision of special facilities for the disabled),
- to provide facilities for training of overseas personnel in wetland management and research techniques,
- to promote scientific research.

To achieve these objectives, WWF HK has a Mai Po Management Committee. Staff were recruited to manage the *gei wai* and other habitats on the Reserve, and to develop educational programmes. An Education Centre and a Field Studies Centre, the latter with accommodation for overseas personnel, were built in 1986 and 1990 respectively.

The preparation of a management plan in 1993 included a review of these objectives and a strategy for implementing the revised ones.

1.2.3.4 Public interest

The MPNR is of considerable interest to a wide variety of people because:

- it supports a large number of birds and other wildlife, some of which are internationally important,
- of its educational and training value, both for local people in Hong Kong and overseas conservation personnel,
- it is the location of the largest remaining area of mangrove in Hong Kong and one of the largest in China,
- it is the site of the last remaining traditionally operated *gei wai* in Hong Kong, and probably along the coast of Guangdong Province, China.

Management sees the Reserve being used particularly for education and increasing environmental awareness. However, with increased Government support for the Reserve, the management committee is now looking into how the Reserve can "give more back to the community", without compromising the conservation value of the site.

1.2.3.5 Landscape

The MPNR is a long and narrow low-lying, flat area of land lying in a North-South direction bordering Deep Bay. From the air, one can make out the long and narrow rectangular *gei wai*. To the north and south of these, are the more square or irregularly shaped fish ponds.

On the ground it can be seen that within the Reserve there is a network of *gei wai*, mangroves and reed beds with paths along some of the bunds between the *gei wai*.

Looking beyond, one can see urban developments encroaching towards the boundaries of the Reserve. To the north, there is the urban and industrial centre of the Shenzhen Special Economic Zone, while those of Yuen Long and Tin Shui Wai can be seen to the south.

1.2.4 Ecological relationships and implications for management

The habitats within MPNR are very much inter-related. The health of Deep Bay - affected to a large extent by its associated hydrology and the extent of pollution - is ultimately responsible for the productivity in the *gei wai*.

Research has been conducted on how the presence and integrity of the inter-tidal mangroves affects the productivity and health of Deep Bay (Anderson 1994).

Each time that water exchange occurs in the *gei wai*, the incoming water brings in silt which is deposited in the perimeter and cross channels. As a result, the shrimps and fish inside will become more prone to heat stress in the summer because of the shallow water and high temperatures. There is thus a need to carry out frequent small scale dredging of the *gei wai* channels as a regular management practice in order to maintain the wetland habitat.

This silt also deposits in the central portion of the *gei wai*, at the base of the mangrove and reedbeds. As the floor of these areas become higher, invasion by grasses, climbers, trees occur and so the original wetland habitat is gradually lost over time. Therefore, desilting operations also need to be conducted in the central portion of the *gei wai*.

However, the rate of such invasion can be reduced by maintaining high water level in the *gei* wai whenever possible, e.g. in-between periods of water exchange. If the water level is kept low for long periods (several months), such as if the pond is being managed as a high tide shorebird roost, then invasion by other plants, especially invasive climber is certain. Other advantages of maintaining a high water level in the pond, is that it will reduce the problem of heat stress for the shrimp and fish in the pond, and that it will discourage reed invasion from the pond edge into the central, shallower part of the pond. However, if the water level is kept high for long periods (e.g. more than 3-months), then this will drown and kill the mangroves in the pond. High water levels will also make feeding conditions in the pond difficult for waterbirds. During spring and autumn passage, at least one *gei* wai needs to be with low water level at all times.

PART 2: EVALUATION AND OBJECTIVES

CHAPTER 2.1 CONSERVATION STATUS OF THE SITE

2.1.1 Historic

The need to conserve the Mai Po area has been recognized for over 50 years, and has been repeatedly brought to the attention of the Hong Kong Government since the early 1960's. Prior to that time, the area was used for agriculture and fisheries purposes.

mid-1800's

The Deep Bay mudflats were used for oyster culture, being licensed out to villagers from both sides of the Bay. In the mid-1970's, the mudflat was still licensed out to Shek Ha villagers from Shenzhen.

1941-1945

Intertidal gei wai shrimp ponds were dug out from the original mangroves.

1964

Sir Peter Scott, then Director of the Wildfowl Trust and a founder of WWF International, visited Hong Kong in October 1964 and wrote a report to the Hong Kong Government recommending that a reserve be established in the Deep Bay area. This report noted that:

"Recommendation 5.7: An area of the biologically rich mudflats and mangrove swamps should be set aside as a scientific and educational study area, but it might be desirable to link it with a group of fish ponds in the *Mai Po marshes thereby adding a substantial ornithological interest to the reserve." (* Mai Po - a fairly large village complex nearest to the particular part of Deep Bay marsh area outstandingly abundant in wild bird life, for which Strict Nature Reserve status is recommended.)

1965

Drs. L.M. and M.H. Talbot, consultants for the Agriculture and Fisheries Department, produced a report in April 1965 entitled "Conservation of the Hong Kong Countryside". Through the report, they wrote (Ch.2 [2].) "Mai Po Marshes and the associated fish ponds

contain a rich bird life. An area of mudflat and mangrove swamp should be protected as a strict nature reserve, and an adjacent and large area of the fish pond could be a limited access, no-hunting reserve."

1966

Prof. S.D. Ripley, President of the International Council for Bird Preservation (ICBP), wrote to the Governor of Hong Kong in October, requesting that government do everything rationally possible to preserve the Mai Po Marshes area for the preservation of birds and wildlife, and with the suggestion that it might be possible to set aside this area as a no-hunting reserve.

1968

In June, the Hong Kong Government's Provisional Council for the Use and Conservation of the Countryside produced their report which, amongst other recommendations, suggested the conservation of the primary natural resources (flora/fauna, water, productive soils and areas of scenic value) of the Deep Bay area and proposed strict reserve status for Mai Po. The report covered "...a total land area of about 10,058 acres (457 ha) and a total sea area of about 4,526 acres (2057 ha)". It also delineated the principal economic activities and land-use within the area, which were classified into: agricultural, small-scale industrial activities, settlements, mudflats, mangroves, 'tembak' or *gei wai*, and illegal activities.

1971

Following its inception in 1971, the area was under consideration by the Nature Conservation Sub-Committee and by the Advisory Committee on Recreational Development and Nature Conservation in the New Territories (No. 20 - "Report of the Nature Conservation Sub-Committee on Deep Bay Marshes).

1973

Gei wai 2 dug by villagers from Shek Ha commune.

1974

Hunting and carrying of firearms was prohibited in the Mai Po area through designation under the Fourth Schedule of the Wild Birds and Wild Animals Protection Ordinance (Cap. 170).

At the XVIth World Conference of ICBP in Canberra, M.A. Webster presented a paper based on the report by the PCUCC in 1968 entitled "Conservation of the Deep Bay Marshes, Hong Kong". It gave details concerning the establishment of a nature reserve, bird park and research

centre at Mai Po and also mentioned "a smaller area approximately 2,500 acres (1136 ha) for which strict nature reserve status would be proposed, the area which would then be referred to as the Mai Po Marshes". This report brought Mai Po to the attention of a wider audience and as a result, a resolution was passed at the meeting which strongly urged the Hong Kong Government to initiate adequate conservation measures in the area.

Canadian Overseas Development Company applied for permission to build Fairview Park.

At this time, D.S. Melville also wrote an overall management plan for Mai Po, and put forward the idea of a Wildfowl Park, but this was not put into action. This report covered an area of about 940 acres (427 ha), of which about 515 acres (234 ha) were *gei wai* and bunds, the latter area being the proposed area for the Nature Education Area and Wildfowl Park.

1975

The Nature Conservation Sub-Committee presented a paper in April which considered the Mai Po Marshes in detail, and which was partly a synthesis of what had been written previously.

The Secretary for Environment approved the Fairview Park Development but there was opposition from the HKBWS (F.O.P. Hechtel) and the Conservancy Association (M.A. Webster).

Under the Wild Animals Protection Ordinance, access to and presence in the Mai Po Marshes was restricted to local inhabitants and persons holding written permits issued by The Director, Agriculture and Fisheries Department only.

The three Mai Po land licenses were changed, whereby all mangrove removal and the construction of new cross-bunds made illegal. This was to prevent *gei wai* being converted to fish ponds. The three land licenses were a), *gei wai* 3–19 that were on license to a Hong Kong agent reportedly representing Shek Ha Commune b), *gei wai* 20-22 and c), *gei wai* 23-24 which were both on license to Hong Kong people.

Gei wai 5 was dug out by Shek Ha villagers who also laid claim to the pond because it was alleged that the site was part of Oyster Bed No. 5. The work was stopped by the Hong Kong Government at the present boundary of the pond.

1976

The Mai Po Marshes was listed and declared a Site of Special Scientific Interest (SSSI) by the Hong Kong Government, although this was an administrative designation and did not confer

any special protection to the site.

Horsetail trees (*Casuarina equisetifolia*) and a number of bamboo clumps were planted along the AFD footpath. AFD set up two [Game] Warden Posts at Mai Po. One Post was at the

present site and the other at the bridge by Pond 24c (now dismantled) to Tai Sang Wai.

1977

Prof. G. Mathews, then Deputy Director of the Wildfowl Trust, compiled a report on the Mai Po Marshes for the Hong Kong Government. The report was done after a feasibility study on the Wildfowl Park to consider further measures to establish a formal nature reserve. However, no further action was taken but it did initiate correspondence between H.E. The Governor, the

Agriculture and Fisheries Department and interested people.

1978

Construction work began at Fairview Park, where the fish ponds had been filled in over the previous three years.

1979

Mai Po Village Egretry was listed as an SSSI.

1980

The sub-contract for managing the northern *gei wai* at Mai Po came up for renewal (at about \$5,000/year), and the leaders from Shek Ha commune were alleged to have tricked local people into taking over the management of these *gei wai* as deep water fish ponds. As no cross bunds could be made nor ponds deepened, the new operators flooded the ponds to turn them into fish ponds. This drowned nearly all the mangroves inside and their place was taken by

reeds. These ponds were re-opened in the mid-1980's.

All hunting banned in Hong Kong.

1981

World Wildlife Fund Hong Kong was founded, later to changed its name to World Wide Fund for Nature Hong Kong. As there was little local awareness of the need for conservation at the

time, WWF HK looked for a local project to adopt which could be used for promoting environmental education. It was eventually decided to undertake a project at Mai Po.

When the FCA Border Fence Road was built at this time, bridges were placed over the sluice gates rather than blocking them up, so saving the reserve. As a result of the new Border Road, *gei wai* operators no longer needed to use the bunds for access, but used the road instead. Trees and other vegetation then slowly grew up along these bunds.

1982

S.M. Goodall of the Wildfowl Trust, Slimbridge, wrote an assessment of the Wildlife Education Centre, and also put forward proposals for its management. WWF HK submitted a proposal to the Hong Kong Government to take over management of Mai Po at no cost to the government.

1982/83

The Hong Kong Government approved in principle, the establishment of the Mai Po Marshes Nature Reserve.

Acquisition and management of the first *gei wai* by WWF HK began (16, 17 and 18) with funds from the Royal Hong Kong Jockey Club, and those parts of the marsh were then developed as a nature reserve. These funds were used to make *ex-gratia* payments to the operator who in many cases, had been illegally sub-leasing out the management of the pond. These payments were made to the DLO Yuen Long, who would then pay the license holder (30%) and the operator (70%). New licenses (for conservation and education) were then given to WWF HK.

1983

H.E. Axell, formerly of the Royal Society for the Protection of Birds and was responsible for the development and management of the Minsmere Reserve, U.K., compiled a detailed report with a proposal for the setting up of a Mai Po Nature Reserve and Education Centre based on WWF HK's guidelines.

A Visitor Information Centre and a 1.2km concrete footpath were constructed.

1984

WWF Hong Kong appoints a Mai Po Project Manager.

1985

Establishment of the Futien Nature Reserve on the north shore of Deep Bay in the Shenzhen Special Economic Zone, China.

Report by R.O. Dolk and D.S. Melville which consolidated earlier reports, with the specific aim of using it to approach Government, charitable organizations and financial institutions to support conservation at Mai Po. The report also recommended support for strict management, including the establishment of suitable facilities to maximise the public use of the area.

WWF HK appointed the first Education Officer and Field Staff for Mai Po. The first guided visits for schools and the general public were also organized.

Gei wai 16 was drained in summer for earthmoving that winter to turn ponds 16/17 into a high tide roosting site for shorebirds.

1986

The Mai Po Marshes Wildlife Education Centre was opened. Earthmoving began in the former *gei wai* 16 and 17 to construct 'The Scrape', the Floating Boardwalk and Hide were completed, as well as a return footpath.

Inner Deep Bay listed as a SSSI.

1988

Futien Nature Reserve was granted status as a National Nature Reserve.

The Hong Kong Government commissioned a Deep Bay Environmental Review to assess the cumulative impacts of developments in the Deep Bay catchment.

1990

Opening of the Peter Scott Field Studies Centre.

Start of Wetland Reserve Management Training Courses for reserve staff in East Asia, particularly Mainland China.

Formation of the Hong Kong - Guangdong Environmental Protection Liaison Group, with a Technical Sub-Group to oversee environment management in the Deep Bay area and its catchment.

The Mai Po Marshes SSSI was formally listed on the Interim Development Permission Area (IDPA) Plan under the Town Planning Ordinance, which allowed Government to control landuse in the area.

The Deep Bay Water Control Zone was established.

1991

The Livestock Waste Control Ordinance in the Deep Bay area was enforced.

The Town Planning Ordinance (Amendment) was extended to the New Territories, giving limited legal protection to SSSIs.

The draft Mai Po and Fairview Park DPA Plan No. DPA/YL-MP/1 including land previously within the Mai Po and Fairview Park IDPA Plan was exhibited for public inspection under section 5 of the Town Planning Ordinance.

1992

WWF HK had established, and was managing a "core nature reserve", holding 37% (100ha) of the available *gei wai* at Mai Po.

China became a signatory to the Ramsar Convention, and placed Futien NNR on the shadow list of reserves to be designated.

Primary school education programme began at Mai Po.

Widening of the Yuen Long Creek begins

Town Planning Board approved the recognition of two "buffer zones" around Deep Bay and Mai Po as part of a series of guidelines to control land-use changes when considering development applications.

1993

H.E. the Governor, during a visit to Mai Po, announced that Government would make funds available (HK\$ 16 million) for WWF HK to take over the remaining *gei wai* at Mai Po.

Formation of the Government ad hoc Ramsar Working Group.

Sponsored visits for disabled groups to Mai Po formally begin.

The Sunnyville Estate development at Nam Sang Wai goes before the Town Planning Appeal Board.

1994

EIA on the Shenzhen River Widening Project begins.

WWF HK produces the first Mai Po Management Plan covering all *gei wai* with the Frontier Closed Area Border Fence..

In June, the draft Mai Po and Fairview Park Outline Zoning Plan No. S/YL-MP/1 was exhibited under section 5 of the Town Planning Ordinance to replace the DPA/YL-MP/1. The new OZP designated Mai Po as SSSI.

Nam Sang Wai development approved by the Town Planning Appeal Board.

1995

In February, Government hands over southern *gei wai* (20-24) to WWF HK to manage. WWF HK now manages all the *gei wai* with the FCA Border Fence at Mai Po.

After ExCo approves designating Mai Po and Inner Deep Bay as a Wetland of International Importance under the Ramsar Convention in March, the Hong Kong Government formally announced the decision in September.

Widening of the Shenzhen River begins.

1996

Consultancy studies begin on a), drafting a management plan for the Mai Po and Inner Deep Bay Ramsar Site and b), on the ecological value of fish ponds.

The Privy Council in the UK judges that the TPAB was correct in approving the development at Nam Sang Wai.

The Agriculture and Fisheries Department begins subventing the habitat management works at Mai Po.

Defaunation of the mudflat in the summer due to sudden worsening of the water quality.

1997

After resumption of the exercise of sovereignty over Hong Kong by the P. R. China, Mai Po and Inner Deep Bay is recognized as China's 7th Ramsar Site

Enhancement works begin in the southern *gei wai* at Mai Po (15c, 16c, 20a-f, 24f-g), as mitigation for the temporary loss of fish ponds due to the Shenzhen River widening project.

Release of the management plan for the Mai Po Inner Deep Bay Ramsar Site.

1998

The Winter Waterfowl Count showed an approx. 20% in the decline of waterbirds wintering in Deep Bay.

Release of the results of the 'Deep Bay Water Quality Regional Control Strategy Study'.

The AFD sponsored consultancy study on Wetland Compensation begins.

Formation of the Wetland Advisory Committee.

1999

First meeting of the Wetland Advisory Committee and its various sub-committees.

Town Planning Board promulgates new guidelines to control land-use changes around the Mai Po Inner Deep Bay Ramsar Site. The new 'Wetland Conservation Area' and 'Wetland Buffer Area' replaces the old Buffer 1 and Buffer 2 concept.

Finalization of the Management Plan for the Shenzhen Futien Mangrove Nature Reserve.

2000

January. Initiation of the study in *gei wai* 8, to develop a long-term management strategy for the Mai Po reedbeds, in conjunction with the Hong Kong Bird Ringing Group.

2001

Jul 2001 – Feb 2002. Earthmoving in gei wai 16/17 to lower the height of the central island.

Dec 2001 – *Mar* 2002. AFCD sponsored study on the ecology and habitat use of the Anatidae wintering in Deep Bay. Birds were caught and fitted with either radiotransmitters or colour nasal tags.

December. Initiation of the AFCD sponsored baseline monitoring of the ecology of the Mai Po Inner Deep Bay Ramsar Site.

2002

Dec 2002 – Mar 2003. AFCD sponsored study on habitat use by the Black-faced Spoonbills wintering in Deep Bay. New peak count of 253 Spoonbills recorded during this study.

2003

Dredging of the channel outside the sluice gate of *gei wai* 17 as partial mitigation of the impacts from the Shenzhen Western Corridor construction project.

First 'Management agreement' signed with a pond-fish farmer close to Mai Po Nature Reserve.

2004

Mai Po was closed for seven weeks between February and March as a result of the outbreak of avian influenza in China and Asia.

AFCD funded study begins on;

- habitat use by the wintering waterfowl in Pond 20a-f and 24g-f,
- shorebird use of newly created high-tide roosting sites in gei wai 16/17.

2005

In February, the CE in C, under section 9(1)(a) of the Town Planning Ordinance, approved and gazetted the draft Mai Po and Fairview Park OZP, which was subsequently renumbered as S/YL-MP/6.

Rotary Centennial Wetland Institute launched.

Shenzhen Government decides not to proceed with the project to pump water from Mirs Bay into the Shenzhen River in order to dilute the pollution loading.

2.1.2 Present

Restricted access: In 1975, entry to the Mai Po Marshes became restricted under the 6th Schedule of the Wild Birds and Wild Animals Protection Ordinance (Cap. 170), where visitors must hold valid Mai Po Entry Permit issued in writing by The Director of Agriculture and Fisheries (now the Director of Agriculture, Fisheries and Conservation).

SSSI status: Mai Po was designated a Site of Special Scientific Interest (SSSI) in 1976. The concept of an SSSI was "... primarily a planning measure to ensure that due account is taken of the scientific importance of particular sites when changes to land use or other developments are being considered." Being an SSSI, "... implies no legal restriction on owners, tenants or occupiers and will not, by itself, ensure protection of the Site against antipathetic activities or forms of development." (Agriculture and Fisheries Department 1984).

IDPA: In 1990, Interim Development Permission Area (DPA) plans were produced by the Planning Department under the Town Planning Ordinance, which aimed to set out the types of developments which would be allowed within the different Development Permission Areas. Mai Po falls under Plan No. DPA/YL-MP/1 (Mai Po and Fairview Park), where it was zoned as an SSSI and where "... strict control will be imposed within SSSI and only development which will support the conservation of the area's special interest will be permitted."

OZP: In June 1994, the Mai Po and Fairview Park DPA plan was replaced by the draft Outline Zoning Plan (OZP Plan No. S/YL-MP/1). The Reserve was still zoned as an SSSI where in the 'Schedule of Uses', no use of the site is given automatic right ('Column 1' uses). However, a selected number of uses could be considered if an application for permission is first submitted to the Town Planning Board (TPB). These ('Column 2') uses include 'Agricultural Use, Field Study Centre. Sitting Out Area and Tree Plantation'. The 'Explanatory Statement' for this plan states that the planning intention of the SSSI zone is to '...deter human activity or urban development..(other than those which are necessary to sustain the site or to serve educational purpose) and to conserve the feature of special scientific interest.'

In February 2005, the draft OZP was renumbered to S/YL-MP/6. The Reserve was still zoned as an SSSI, where in the 'Schedule of Uses', 'Wild Animals Protection Area' is listed in 'Column 1' for uses always permitted. A selected number of uses could be considered if an application for permission is first submitted to the TPB. These ('Column 2') uses include 'Agricultural Use, Field Study/Education/visitor Centre, Government Use, Nature Reserve, Nature Trail, On-Farm Domestic Structure, Public Convenience, Public Utility Installation,

and Utility Installation for Private Project'. The planning intention stated in the 'Explanatory Statement' of this zone is to conserve and protect the features of special scientific interest such as rare or particular species of fauna and flora and their habitats, corals, woodlands, marshes or areas of geological, ecological botanical/biological interest. There is a general presumption against development in this zone. No developments are permitted unless they are needed to support the conservation of the features of special scientific interest in the SSSI, to maintain and protect the existing character of the SSSI, or for educational and research purposes.

Buffer Zones: In November 1994, the Town Planning Board put out a set of revised guidelines setting out two Buffer Zones around the wetlands of Mai Po and Inner Deep Bay (TPB PG-NO. 12A). The aims of these buffer zones were to '...give MPNR and the areas around Inner Deep Bay added protection and to prevent them from becoming isolated islands of natural habitat encroached by urban type developments.'

MPNR lies within Buffer Zone 1 where the planning intention is '...primarily to protect the special ecological value of the wetland habitat in the Inner Deep Bay area, in particular, the MPNR. New development within this zone should not be allowed unless it is required to support the conservation of the area's natural features and scenic qualities...'

Furthermore, appropriate land uses for Buffer Zone 1 include conservation ('...conservation management of the wetland areas...'), and environmental education ('...research and educational uses which will facilitate the public understanding of the ecology of the area...').

Revised Buffer Zones: In April 1999, the Town Planning Board promulgated a revised set of guidelines for land use around Mai Po and Inner Deep Bay (TPB PG-No. 12B), where the two buffer zones are replaced with a Wetland Conservation Area (WCA), and a Wetland Buffer Area (WBA).

The planning intention of the WCA is to conserve the ecological value of the Deep Bay fish ponds. Certain activities may be considered by the Town Planning Board in the WCA subject to the submission of an ecological impact assessment. These activities include conservation, environmental education and essential infrastructural projects.

The planning intention of the WBA is to protect the ecological integrity of the fish ponds and wetlands within the WCA. Therefore, a buffer area of 500m alongside the landward boundary of the WCA has been designated WBA. Within the WBA, certain activities may be considered

by the Town Planning Board subject to the submission of an ecological impact assessment. These activities include wetland restoration, recreation and residential developments.

In considering applications for development or changes in land use which may impact on the WCA or WBA, the Town Planning Board will consider certain concepts. These include the 'precautionary approach' in conserving the ecological value of fish ponds and the principle of 'no-net-loss in wetland'. Where appropriate, the Town Planning Board will also consider the approach of a 'private-public partnership' in conserving the wetlands in the WCA and WBA.

Ramsar designation: In September 1995, the Hong Kong Government listed Mai Po and Inner Deep Bay on the list of Wetlands of International Importance under the Ramsar Convention. Under this convention, the Hong Kong SAR Government has an international obligation to '...formulate and implement their planning so as to promote the conservation of wetlands included in the List, and as far as possible the wise use of wetlands in their territory...' After the resumption of the exercise of sovereignty over Hong Kong by the P.R. China in July 1997, Mai Po and Inner Deep Bay was recognized as China's 7th Ramsar Site. In 1997, a management plan for the Ramsar Site was released which designated Mai Po Nature Reserve as a 'Biodiversity Management Zone', being made up of smaller compartments. Each compartment was a group of *gei wai* each with its own broad management intention but without any detailed management prescription.

2.1.3 Site definition and boundaries

Site boundaries are shown on the site map (Figure 1).

Initially, funds for WWF HK to take over management of the *gei wai* in Mai Po came from the Royal Hong Kong Jockey Club, Big Bird Race donations and corporate sponsors. In such a way, WWF HK was able to take over 12 of the 21 *gei wai* inside the FCA Border Fence at Mai Po for management. In February 1995, WWF HK took over management of the remaining *gei wai* due to generous support (HK\$ 16 million) from the Hong Kong Government. This excludes the three *gei wai* (1, 2 and 5) outside the Closed Area border fence where there is dispute over the land status.

CHAPTER 2.2 EVALUATION OF FEATURES

2.2.1 Evaluation

2.2.1.1 Size

Size of Site: The MPNR covers an area of 380ha. In 1967 the "Deep Bay Marshes" (natural and man-made) covered an area of some 4,000 ha. Today it only has an area of some 2,000 ha. This is the most extensive wetland area left in Hong Kong. In recent decades, there has been a substantial loss of fish pond habitat due to the reclamation of Tin Shui Wai (450 ha) and filling in of other areas, principally for open storage and low-rise residential development.

In 1996, the Agriculture and Fisheries Department (now known as the Agriculture, Fisheries and Conservation Department) designated the Mai Po mudflats as a restricted access area under the Wild Animals Protection Ordinance (Cap. 170) which, in effect, has increased the size of the Reserve.

Size of Populations: The number of wintering wildfowl that use the wetlands of Deep Bay (including Mai Po), has increased since counts first began in 1979, with some 68,000 being present in mid-January 1996. However, this number dropped to some 54,000 in January 1999 and has since stabilized at around that level. This fall is being related to the poor water quality in Deep Bay. During spring, up to 10,000 migratory shorebirds can be present at one time and the seasonal turnover accounts for probably around 20,000 – 30,000.

The area regularly supports 20 threatened bird species (BirdLife 2000) and 28 species (Carey & Young 1999) whose recorded number is greater than 1% of their estimated population along the East Asian-Australasian Flyway.

The Inner Deep Bay mangroves are one of the most extensive remaining along the coast of Mainland China. They support a rich invertebrate fauna, including over 17 species new to science, most of which are currently known from nowhere else.

Mai Po Nature Reserve (including Deep Bay), is of a "manageable" size and supports populations of sizes significant enough to justify management. Compared with many other wetland sites in Asia, however, for example elsewhere in China, Mai Po is a very small unit.

2.2.1.2 Diversity

One of WWF Hong Kong's objectives in managing Mai Po, is to "to increase the diversity of native wildlife wherever possible". The natural state would have been inter-tidal mudflat and mangroves but development and reclamation over the past century has resulted in new habitats being created, e.g. *gei wai*, fish ponds, reedbeds and dry vegetated bunds. In turn, this has lead to a greater diversity of feeding and breeding habitat for wildlife. Wildlife diversity is expected to increase as further habitats are created within the Reserve. Increased habitat diversity will also provide a greater selection of habitats for use as an educational resource.

It is recognised, however, that habitats important for significant species and the general integrity of the site should not be compromised just for the sake of increasing diversity.

Pollution in Deep Bay has caused a decline in invertebrate diversity and biomass on the mudflat, particularly indicator species such as *Dendronereis* sp. However, the number of more pollution tolerant species has increased.

2.2.1.3 Naturalness

Apart from the inter-tidal mangroves which may be considered as being in a nearly natural state (succession is truncated at the landward side), the remainder of the Mai Po Nature Reserve is essentially man-made. The landscape of *gei wai*, reedbeds and fish ponds is a result of nearly 60 years of human influence, and other factors such as eutrophication and the introduction of exotic species add to this impression.

The traditional management of the *gei wai* mimics, but does not follow the natural tidal cycle, and this has a direct effect on the species that thrive in them.

The fish ponds, freshwater pools, reedbeds and the vegetated bunds that run along the borders of the *gei wai* although "unnatural " habitats to the area, are nevertheless being maintained and developed to improve species diversity within the Reserve. There are many species within the Reserve which rely entirely on these habitats for their survival e.g. birds which are associated with reedbeds, butterflies and moths which rely on the vegetated bunds and shrubs growing on them. Thus these man-made habitats are also of value.

It is important that although the natural habitats within the Reserve are conserved, e.g. mangroves, the man-made habitats, e.g. *gei wai* and fish ponds are also of ecological value and require conservation management.

2.2.1.4 Rarity

Habitat: On a local scale (i.e. within Hong Kong), both *gei wai* and mangroves are extremely rare habitats. This is significant for wildlife but also in cultural terms for the Hong Kong community. The mangrove stand here is the largest in Hong Kong, and is the sixth largest protected stand in China (Fan 1993). Although there may be better examples of mangroves in other parts of China and mangrove habitats may not yet be regarded as being "rare", they are nevertheless a threatened habitat.

The reedbeds within the Reserve are probably one of the largest remaining stands in Guangdong Province (Gao, Y.R., South China Institute for Endangered Species, pers. comm.).

Species: Several rare or globally threatened species occur at Mai Po, notably invertebrates and birds. The latter includes some 20% of the wintering population of the endangered Blackfaced Spoonbill, *Platalea minor*, of which the total world population is only around 1,400 individuals (HKBWS 2005).

The main reason for the rarity of these species is due to a number of factors impacting singly, or in combination on the birds (e.g. egg collecting at the breeding site) and the wetland habitats on which they depend (e.g. excessive disturbance to, or loss of the wetland habitat). For example, many of its staging grounds for the Black-faced Spoonbill along the coast of China are being threatened by reclamation.

Many of the rare Mai Po invertebrates, e.g. the amphipods and oligochaetes depend on the mudflat habitat (Sec 2.2.2). Increasing water pollution in Deep Bay will thus lead to species loss.

2.2.1.5 Fragility

The Mai Po environment has withstood a century of human manipulation, and is still of conservation value. Since the existing system is man-made, it requires continued management in order to maintain its conservation value. For example, water levels in the *gei wai* must be

controlled within limits for both prawns and feeding/roosting waterbirds. Their channels must also be dredged regularly to counteract siltation.

Although the northern and southern *gei wai* are seriously affected by water pollution to the point where *gei wai* prawn production is unprofitable, those *gei wai* still support pollution tolerant species, e.g. certain invertebrates and fish which, in turn, are food for higher predators, e.g. waterbirds. These areas are thus, still valuable wildlife habitats.

Overall, Mai Po is a robust system which has withstood human interference. However, studies are required to investigate how close the site is to its limit of interference or disturbance before it is seriously affected.

2.2.1.6 Typicalness

Traditionally managed *gei wai* used to be a typical feature of coastal South China but now, are only found at Mai Po.

Mangroves were also once the typical habitat of the area although they too have now declined dramatically due to direct destruction and coastal reclamation.

Most of the bird species are typical of tidal mudflats but their numbers in Deep Bay have increased. It is suspected that this is due to a combination of factors, including habitat loss elsewhere around the Pearl River Estuary and southern China; improved feeding conditions resulting from initial effects of eutrophication; habitat creation within the Mai Po Nature Reserve to provide regular roosting sites.

Reedbeds were an uncommon habitat in the original *gei wai* in the Reserve, but may have been more common further inland. The presence of this 'new' habitat has management implications.

2.2.1.7 Recorded history

Information on the flora and fauna in Mai Po are organised in the office filing system. However, most of these records originated in the mid-1980s as checklists to produce educational leaflets for Mai Po.

Systematic surveys have not yet taken place at Mai Po due to a lack of resources, and a lot more research and scientific study is required to survey and monitor the populations of flora and fauna. Most surveys and records to date are scanty and of a general nature.

A lot of information is available on the birds of Mai Po but has never been organised into a format of records for Mai Po. This management plan aims to facilitate a better recording system.

Monitoring currently being undertaken includes:

- the AFCD sponsored monitoring of the baseline ecological conditions of the Mai Po Inner Deep Bay Ramsar Site (Anon 2000),
- the Hong Kong Bird Watching Society conducts winter waterfowl counts in mid-January (since 1979), monthly winter waterfowl counts (since November 1992, Nov – Mar), and monthly waterfowl counts throughout the year since May 1998,
- weekly/monthly bird ringing,
- a variety of waterbird monitoring programmes by WWF staff within the Reserve.

2.2.1.8 Position in an ecological unit

The Mai Po Nature Reserve may be regarded as an ecological sub-unit of the larger Deep Bay ecological unit, and management of the former cannot be considered in isolation from the latter. From the mid-1980s, the Reserve has become more isolated as an ecological unit by the extensive reclamation and urbanization that has taken place around it. Although the boundaries of the Reserve are clearly defined and protected, there is an increasing threat of pollution from neighbouring housing and industrial estates.

The boundary between the Hong Kong SAR and the Shenzhen SEZ serves to further fragment the overall wetland unit in terms of management and control.

The health of the entire ecological unit will significantly affect the welfare of Mai Po. Important factors to consider are:

- effective land-use control in the Wetland Buffer Area (WBA) and Wetland Conservation Area (WCA);
- pollution control in the Deep Bay catchment;
- management of the Futian National Nature Reserve, Shenzhen SEZ.

Designation of the Mai Po Inner Deep Bay Ramsar Site has helped protect Mai Po as part of the larger ecological unit.

2.2.1.9 Relationship of species to local/ National / International populations

Deep Bay supports significant portions of the world and/or regional populations of certain bird species which increases the international obligation to preserve the site (see Section 2.2.2).

2.2.1.10 Potential value

Mai Po is already of very high value, both for wildlife and as an educational resource. However, the site may be affected and degraded by external influences, such as pollution. Also, the overall size and position of the site puts a limit on its potential value.

2.2.1.11 Intrinsic appeal

The MPNR is somewhat of an oasis amongst what is rapidly becoming an 'unnatural desert'. The route to the Reserve is littered with container parks and chaotic scrapyards. All around are sprawling housing developments and noisy, dusty motorways. Although the mountains provide a pleasant backdrop to the Reserve, the tall towers of industrial development and housing estates are never out of sight.

Nevertheless, immediately upon entering the boundaries of the Reserve, a sense of quiet and tranquillity descends. The presence of water all around is instantly calming. Walking along the paths at the edge of the *gei wai*, with water and mangrove swamp all around, there is a sense of 'nearness to nature', highlighted by the very obvious presence of birds, not to mention the abundant dragonflies and butterflies. The wonderful sounds of the birds greatly contribute to this.

2.2.1.12 Public access

Mai Po is an important resource for increasing the environmental awareness of Hong Kong people, and of great importance to students and scientists. Access is controlled by AFCD through the Wild Animals Protection Ordinance (Cap. 170) and is restricted to those in possession of a valid Mai Po Entry Permit, issued mainly to naturalists and scientists. In addition, WWF Hong Kong has been issued with group permits. WWF Hong Kong works closely with the Department thus ensuring that reasonable numbers of students and the public

can visit Mai Po without compromising its conservation value. To date, emphasis has been on providing facilities for primary and secondary school students and the general public. The demand for visits by both educational institutes and the general public has stabilized at around 40,000 visitors per year, with most coming during the winter months (Figure 2).

AFCD issues local birdwatchers with their own annual Mai Po Entry Permits, and also issues group permits to WWF and the Hong Kong Birdwatching Society to organize group tours into the reserve. In addition, AFCD may, at their discretion, issue one-day permits to VIPs. WWF has a system to monitor the number of people entering the reserve each day and can only control numbers through a voluntary system by informing other group permit holders who may also want to visit on the day that is already busy.

Although WWF can control the number of visit using their permits, they cannot control access by other permit holders. As a result, there have been a few cases of overcrowding in the birdwatching hides.

On-site accommodation is provided for visiting scientists, researchers and overseas conservation personnel.

2.2.1.13 Education

The site is of great educational value and this was one of the prime objectives with which WWF Hong Kong took over its management (indicated by the title - The Mai Po Marshes Wildlife Education Centre and Nature Reserve). WWF Hong Kong is committed to environmental education and this is reflected in the resources allocated to educational staff and facilities (see Management Infrastructure 1.1.4). At present, some 300 secondary and 100 primary school groups visit Mai Po annually. The numbers and type of schools visiting Mai Po are essentially dictated by the Education Department of the Hong Kong SAR Government which provides subvention for such visits.

2.2.1.14 Monitoring and Research

Although there is an extensive literature on the ecology of Deep Bay and Mai Po (<u>Appendix 9</u>), and many research studies have been conducted at the Reserve (<u>Appendix 2</u>), there is an urgent need for more work to be done. Such future work not only includes baseline surveys on the flora and fauna of the site but also, whether habitat management projects by WWF Hong Kong help to maintain and, if possible, increase the biodiversity of the site.

The Hong Kong Birdwatching Society (HKBWS) has been monitoring the birds at Mai Po and around Deep Bay since the 1958 (Carey *et al* 2001), and AFCD began baseline monitoring of the ecology of the Ramsar Site in 2001 (Anon 2000). In the early 2000's, WWF began general waterbird monitoring at Mai Po, including the numbers roosting and breeding in and around the Reserve.

Monitoring has also begun of the effectiveness of various habitat management projects, so that the success of these projects can be assessed and management fine-tuned if necessary. The projects where monitoring has been carried out include the creation of new islands in *gei wai* 16/17 for roosting shorebird, and vegetation management along the bunds of the rain-fed freshwater ponds for wintering waterfowl.

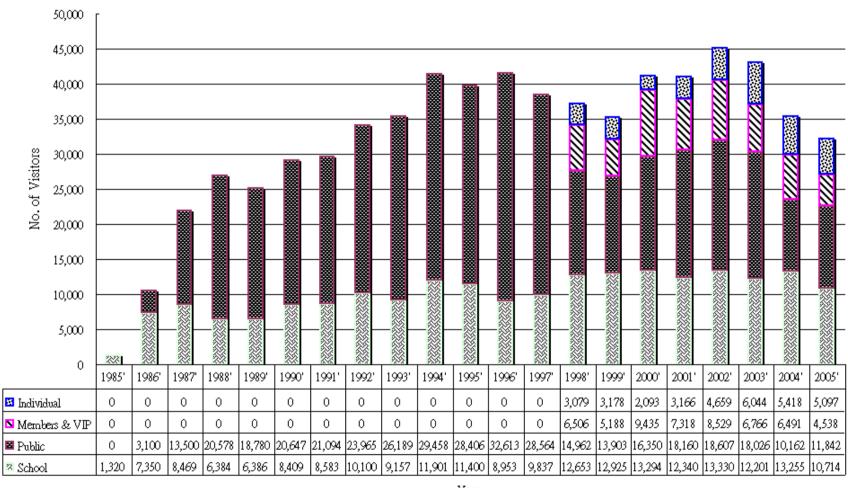


Figure 2: Visitor numbers to Mai Po Nature Reserve (1985 - 2005)

Year

2.2.2 Identification/Confirmation of important features

Whilst it is necessary to identify the relative importance of the habitats and species at Mai Po on an international, regional (southern China) and local (Hong Kong) level so that a priority list of habitats and species can be drawn up for management attention, there is however insufficient data available for this to be done quantitatively. Therefore, the assessment below has been made using the best information from experts in the relevant fields. Over the course of this Plan, baseline studies will continue to be conducted on the wildlife within the Reserve and the areas of the different habitats monitored from aerial photographs, so as to better identify and confirm the Reserve's importance and the management regime required to maintain that importance. These studies will be conducted in cooperation with relevant experts.

1. Habitat/Vegetation types

| Habitat | Importance | | |
|--------------------|---------------|----------|-------|
| | International | Regional | Local |
| Intertidal mudflat | High | High | High |
| Mangroves | Moderate | High | High |
| Reedbeds | | Moderate | High |
| Gei wai | | High | High |
| Fish ponds | | Moderate | High |

2. Plants

| Species Scientific name | | Importance | | |
|-------------------------|------------------------|---------------|----------|-------|
| | | International | Regional | Local |
| Wigeon Grass | Ruppia maritima | | Moderate | High |
| Reedgrass | Phragmites australis | | Moderate | High |
| | Acanthus ilicifolius | | Moderate | High |
| | Aegiceras corniculatum | | Moderate | High |
| | Avicennia marina | | Moderate | High |
| | Bruguiera gymnorrhiza | | Moderate | High |
| | Excoecaria agalloca | | Moderate | High |
| | Heritiera littoralis | | Moderate | High |
| | Kandelia obvata | | Moderate | High |

3. Invertebrates

| Species Importance | | | |
|---|---------------|-----------|-----------|
| | International | Regional | Local |
| Mortonagrion hirosei (Odonata) Endangered ¹ | High | High | High |
| | | | |
| Thalassodes maipoensis (Geometridae) | High (Ns) | High (Ns) | High (Ns) |
| Schrankia bilineata (Noctuidae) | High (Ns) | High (Ns) | High (Ns) |

| Chasmina candida (Noctuidae) | | | High |
|---------------------------------------|-----------|-----------|-----------|
| | | | |
| Perisesarma maipoensis (Grapsidae) | High (Ns) | High (Ns) | High (Ns) |
| Uca spp. (Ocypodidae) | | | High |
| | | | |
| Phoxocephalidae oculatus (Amphipoda) | | | High |
| Synchelidium nonmiraculum (Amphipoda) | | | High |
| Grandidierella sp. nov. (Amphipoda) | High (Ns) | High (Ns) | High |
| Kamaka sp. nov. (Amphipoda) | High (Ns) | High (Ns) | High |
| Melita sp. nov. (Amphipoda) | High (Ns) | High (Ns) | High |
| Victoriopisa sp. nov. (Amphipoda) | High (Ns) | High (Ns) | High |
| Talorchestia sp. nov. (Amphipoda) | High (Ns) | High (Ns) | High |
| Discapseudes sp. nov. (Tanaidacea) | High (Ns) | High (Ns) | High (Ns) |
| Dometorina rostrata (Acarina) | | | High |
| Limnodriloides biforis (Oligochaeta) | High (Ns) | High (Ns) | High (Ns) |
| L. fraternus (Oligochaeta) | High (Ns) | High (Ns) | High (Ns) |
| Rhizodrilus russus (Oligochaeta) | High (Ns) | High (Ns) | High (Ns) |
| Pseudopythina maipoensis (Bivalvia) | High (Ns) | High (Ns) | High (Ns) |
| Procephalothrix orientalis (Nemertea) | High (Ns) | High (Ns) | High (Ns) |

¹ = IUCN threatened category; Ns = new species to science.

4. Reptiles

| Species | Scientific name | Importance | | |
|-------------|-------------------|---------------|----------|-------|
| | | International | Regional | Local |
| Bennett's | Enhydris benettis | | Moderate | High |
| Water Snake | | | | |

5. Mammals

| Species | Scientific name | Importance | | |
|----------------|---------------------|-------------------------|----------|--------|
| | | International | Regional | Local |
| Javan | Herpestes javanicus | | | Medium |
| Mongoose | | | | |
| Crab-eating | Herpestes urva | | High | High |
| Mongoose | | | | |
| Eurasian Otter | Lutra lutra | Vulnerable ¹ | High | High |

¹ = IUCN threatened category

6. Birds

| Species | Scientific name | Importance | | |
|----------------------------|---------------------|---------------|----------|-------|
| | | International | Regional | Local |
| Dalmatian Pelican (Vu) | Pelecanus crispus | High | High | High |
| Great Cormorant | Phalacrocorax carbo | Moderate | High | High |
| Grey Heron | Ardea cinerea | | High | High |
| Great Egret | Egretta alba | | High | High |
| Little Egret | Egretta garzetta | | High | High |
| Chinese Egret (Vu) | Egretta eulophotes | Moderate | High | High |
| Chinese Pond Heron | Ardeola bacchus | | High | High |
| Japanese Night Heron | Gorsachius goisagi | | Moderate | High |
| Oriental Stork (En) | Ciconia boyciana | | Moderate | High |
| Black-headed lbis (Nt) | Threskiornis | | Moderate | High |
| , , | melanocephalus | | | |
| Black-faced Spoonbill (En) | Platalea minor | High | High | High |

| Eurasian Wigeon Ana Baikal Teal (Vu) Ana Common Teal Ana Northern Pintail Ana Northern Shoveler Ana Baer's Pochard (Vu) Ayth Ferruginous Duck (Nt) Ayth Black Vulture Aeg Greater Spotted Eagle (Vu) Aqu Imperial Eagle (Vu) Aqu Eurasian Coot Fulio Black-winged Stilt Him hims Pied Avocet Rec Grey Plover Pluv Kentish Plover Cha | orna tadorna s penelope s formosa s crecca s acuta s clypeata nya baeri nya nyroca ypius monachus ila clanga ila heliaca ca atra antopus antopus urvirostra avosetta riadrius | Moderate Moderate | High Moderate High High High High Moderate Moderate Moderate High High High | High High High High High High High High |
|--|---|----------------------|--|---|
| Baikal Teal (Vu) Common Teal Ana Northern Pintail Ana Northern Shoveler Baer's Pochard (Vu) Ferruginous Duck (Nt) Black Vulture Greater Spotted Eagle (Vu) Imperial Eagle (Vu) Eurasian Coot Black-winged Stilt Pied Avocet Grey Plover Kentish Plover Ana Ana Ana Ana Ana Ana Ana An | s formosa s crecca s acuta s clypeata nya baeri nya nyroca ypius monachus ila clanga ila heliaca ca atra antopus antopus urvirostra avosetta vialis squatarola | | High High High High High Moderate Moderate Moderate High High | High High High High High High High High |
| Common Teal Ana Northern Pintail Ana Northern Shoveler Ana Baer's Pochard (Vu) Ayth Ferruginous Duck (Nt) Ayth Black Vulture Aeg Greater Spotted Eagle (Vu) Aqu Imperial Eagle (Vu) Aqu Eurasian Coot Fulia Black-winged Stilt Him hims Pied Avocet Rec Grey Plover Plux Kentish Plover Cha | s crecca s acuta s acuta s clypeata nya baeri nya nyroca ypius monachus ila clanga ila heliaca ca atra antopus antopus urvirostra avosetta vialis squatarola | | High High High Moderate Moderate Moderate High High High | High High High High High High High High |
| Northern Pintail Ana Northern Shoveler Ana Baer's Pochard (Vu) Ayth Ferruginous Duck (Nt) Ayth Black Vulture Aeg Greater Spotted Eagle (Vu) Aqu Imperial Eagle (Vu) Aqu Eurasian Coot Fulid Black-winged Stilt Him hims Pied Avocet Rec Grey Plover Plux Kentish Plover Cha alex | s acuta s clypeata nya baeri nya nyroca ypius monachus ila clanga ila heliaca ca atra antopus antopus urvirostra avosetta vialis squatarola | | High High High Moderate Moderate Moderate High High High | High High High High High High High High |
| Northern Shoveler Baer's Pochard (Vu) Ferruginous Duck (Nt) Black Vulture Greater Spotted Eagle (Vu) Imperial Eagle (Vu) Aqu Eurasian Coot Black-winged Stilt Pied Avocet Grey Plover Kentish Plover Ann Ayth Aqu Aqu Fulid Fied Avocet Rec Grey Plover Kentish Plover Cha alex | s clypeata nya baeri nya nyroca ypius monachus ila clanga ila heliaca ca atra antopus antopus urvirostra avosetta vialis squatarola | | High High High Moderate Moderate Moderate High High | High High High High High High High High |
| Baer's Pochard (Vu) Ferruginous Duck (Nt) Black Vulture Greater Spotted Eagle (Vu) Imperial Eagle (Vu) Aqu Eurasian Coot Black-winged Stilt Pied Avocet Grey Plover Kentish Plover Aeg Aeg Aeg Aeg Aeg Aeg Aeg A | nya baeri nya nyroca nya nyroca nypius monachus ila clanga ila heliaca ca atra antopus antopus urvirostra avosetta vialis squatarola | | High High Moderate Moderate Moderate High High | High High High High High High |
| Ferruginous Duck (Nt) Black Vulture Greater Spotted Eagle (Vu) Imperial Eagle (Vu) Aqu Eurasian Coot Black-winged Stilt Pied Avocet Grey Plover Kentish Plover Agu Aqu Eurasian Coot Fulio Pied Avocet Crey Plover Cha alex | nya nyroca ypius monachus ila clanga ila heliaca ca atra antopus antopus urvirostra avosetta vialis squatarola | | High Moderate Moderate Moderate High High | High High High High High |
| Black Vulture Aeg Greater Spotted Eagle (Vu) Aqu Imperial Eagle (Vu) Aqu Eurasian Coot Fulio Black-winged Stilt Him hima Pied Avocet Rec Grey Plover Pluv Kentish Plover Cha alex | ypius monachus ila clanga ila heliaca ca atra antopus antopus urvirostra avosetta vialis squatarola | | Moderate Moderate Moderate High High | High High High High |
| Greater Spotted Eagle (Vu) Imperial Eagle (Vu) Aqu Eurasian Coot Black-winged Stilt Pied Avocet Grey Plover Kentish Plover Aqu Aqu Eurasian Coot Fulio Him hima Pied Avocet Crey Plover Cha alex | ila clanga ila heliaca ca atra antopus antopus urvirostra avosetta vialis squatarola | | Moderate Moderate High High | High High High |
| Imperial Eagle (Vu) Eurasian Coot Black-winged Stilt Pied Avocet Grey Plover Kentish Plover Chaalex | ila heliaca ca atra antopus antopus urvirostra avosetta vialis squatarola | | Moderate High High | High High |
| Eurasian Coot Fulid Black-winged Stilt Him hima Pied Avocet Rec Grey Plover Pluv Kentish Plover Cha alex | ca atra antopus antopus urvirostra avosetta vialis squatarola | | High High | High |
| Black-winged Stilt Pied Avocet Grey Plover Kentish Plover Cha alex | antopus antopus urvirostra avosetta rialis squatarola | | High | |
| Pied Avocet Rec Grey Plover Pluv Kentish Plover Cha alex | urvirostra avosetta vialis squatarola | | | |
| Grey Plover Pluv Kentish Plover Cha alex | rialis squatarola | | | |
| Kentish Plover Cha alex | | | High | High |
| alex | radrius | | High | High |
| | radrius randrinus | | High | High |
| | radrius henaultii | | High | High |
| | osa limosa | | High | High |
| | nenius arquata | | High | High |
| | nenius | | Moderate | High |
| | lagascariensis | | | |
| | ga erythropus | | High | High |
| | ga stagnatilis | | High | High |
| | ga nebularia | | High | High |
| Spotted Greenshank (En) Trin | ga guttifer | High | High | High |
| | us cinereus | | High | High |
| | nodromus iipalmatus | Moderate | High | High |
| | dris alpina | | High | High |
| | dris ferruginea | | High | High |
| | norhynchus | Moderate | Moderate | High |
| | maeus | Moderate | Wioderate | Підії |
| | ıs relictus | | | High |
| | ıs saundersi | High | High | High |
| | ıs ridibundus | | High | High |
| Styan's Grasshopper Local Warbler (Vu) | ustella pleskei | High | High | High |
| | siphone | | Moderate | Moder |
| | caudata | | | ate |
| | periza sulphurata | | Moderate | High |

(Key: En = Endangered; Vu = Vulnerable; Nt = Near-threatened)

7. Education and public awareness

The site is also very important as an educational resource, with 40,000 visiting the site annually on specially guided tours (Section 2.2.1.12).

2.2.3 The site in wider perspective and implications for management.

Mai Po is used as a stop-over and/or wintering site from autumn to spring by regionally significant numbers of migratory birds, some of which are globally threatened. This gives the site an importance on a wider scale than just Hong Kong, and means that WWF Hong Kong,

on behalf of the Hong Kong SAR Government, has an international obligation to manage the site with a view to the conservation of these species.

As the areas of mangrove at Mai Po and surrounding areas of Inner Deep Bay are one of the largest stands remaining in China, this means that the site is important in a regional perspective. Similarly the areas of reedbeds, is probably one of the largest remaining in Guangdong Province, China.

Likewise, a considerable number of invertebrate species new to science have been found at Mai Po and Inner Deep Bay. Whilst it is unlikely that many of these will be endemic but the fact that Mai Po and Inner Deep Bay is the type locality for many of them is of significance.

2.2.4 Ideal management objectives

- (1) To safeguard all threatened habitats and species occurring on the Reserve.
- (2) To maintain, and where appropriate, increase the value of all other natural and man-made habitats occurring on the Reserve without compromising Objective 1.
- (3) To maximize the diversity of habitats and associated diversity of native species on the reserve without compromising Objective 1.
- (4) To maintain features of historical and cultural value.
- (5) To provide education and training facilities, and actively promote and encourage education at all levels on-site without compromising Objectives 1, 2 and 3.
- (6) To accommodate visitor access to the Reserve without compromising its conservation value.
- (7) To promote research, particularly where it will help realise Objectives 1 and 2.
- (8) To regularly review the management plan in the light of results from monitoring programmes and research.

2.2.5 Specified limits

Mai Po Nature Reserve has in place an on-going baseline ecological monitoring programme that acts as an early warning system to detect any adverse change to the Reserve, or if the Performance Indicators are not being met (see Section 3). If it is necessary, the Reserve can use the results of the monitoring programme to take appropriate actions to remediate those changes.

Ideally, acceptable limits of change should also be established to detect changes to the ecological character of the Reserve in terms of the size, numbers or quality of specific parameters, which may be habitat or species based. Unfortunately, there is insufficient baseline data on many of the parameters for meaningful limits to be set. This situation will be improved by carrying out baseline studies on the ecological requirements of the key habitats and species in collaboration with relevant experts and groups.

In future, it is hoped that limits of change can be established for habitat parameters such as:

- an upper limit on the area of reedbed, mangrove and freshwater habitats without compromising other important habitats;
- a lower limit on the area of open water;
- a lower limit on the area used for traditional *gei wai* operation.

For species, examples of limits to their change include:

- a lower limit on the numbers of a particular species that uses the Reserve, or some specific habitat in it, for example egret/gei wai, before action is taken to change management of that habitat;
- lower limits on the numbers of rare/threatened species, upper limits on the numbers of people using the Reserve/educational visits etc..

For environmental factors, examples of limits to their change include upper limits on levels of pollution in the *gei wai*.

As Mai Po is a wetland nature reserve, it is essential to maintain the area of open water for wildlife, particularly waterbirds. In 1973, there was approximately 120 ha of open water at Mai Po but due to encroachment by reeds, this area declined to 39 ha in 2001. Over the course

| of the $2006 - 2010$ Management Plan, the aim will be to increase this to 117 ha and will be achieved by removal of the reeds that have invaded the water channel in past years. |
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CHAPTER 2.3 FACTORS INFLUENCING MANAGEMENT

2.3.1 Natural trends

Although man has influenced the Mai Po landscape for at least 50 years, natural trends still play a significant role in the management of the site.

Siltation

A large quantity of silt and organic material is brought down from the Pearl River and other sources in the Deep Bay catchment area, and this silt slowly accumulates on the mudflats.

Between 1989 and 1949, the accretion rate in Deep Bay was estimated to be some 8 mm/year and by 1987, this rate had increased to between 1.4 - 1.5 cm/year (Wong et al. 1987). In the 1990s, the accretion rate speeded up and between 1990 and 2000, was around 3 cm/year (pers. obs.). This quickening was probably due to soil runoff from deforested hillsides and runoff from coastal reclamation project, particularly on the Shenzhen side of the catchment. The rate is lower in the *gei wai*, around 1.2 cm per year (Lee 1988).

As a result, the inter-tidal mangroves have been estimated to be advancing into the Bay at approximately 5m per year (Anderson 1994; Anon 1994a, b). Those mangrove seedlings which establish in front of the Floating Hides have to be removed every autumn, so that they do not obstruct the view from the hides.

As for the *gei wai*, silt is brought into the pond during water exchange and the rate of accretion is estimated to be around 1.2 cm per year (Lee 1988). This means that the channel around the edge of each pond has to be dredged every 10-15 years, so that a water column of approximately 1-1.5 m is maintained for shrimp production. If not, then the reared prawns will be more prone to summer heat stress.

Silt accumulation in the central part of the *gei wai* causes the stands of mangroves to dry out, leading to invasion by climbers, e.g. *Derris trifoliata*, which can eventually smother the mangrove trees. Unlike the perimeter channels, this accumulated silt cannot be removed without seriously damaging the mangroves stands.

It also means that shallow open areas of water may be invaded by the reed grass *Phragmites communis*. Between 1973 and 2001, there has been an increase of 69.8% in the area of reed, and a 67.4% decrease in the area of open water (AEC unpublished data). If the area of open water is allowed to decline unchecked, then the value of MPNR for roosting and feeding waterbirds would decline dramatically. One traditional solution to controlling the spread of reeds has been to flood the *gei wai* as high as possible in summer. However, this may have implications for *gei wai* use by waterbirds.

2.3.2 Man-induced trends

Most of the habitats and processes at Mai Po have anthropogenic origins and are still being managed. The dominant man-induced trends on the Reserve, which have significant management implications, include;

- A cautious move towards greater habitat diversity (and thus of the species using those habitats), e.g. ponds with different salinities, vegetation and water depths,
- A wider range of management objectives for the different *gei wai*, e.g. for commercial prawn production or as wildlife habitat,
- Increasing eutrophication of the water from Deep Bay and siltation rate due to input from the catchment areas.

The effects of human disturbance on wildlife habitat use and behaviour have yet to be studied.

2.3.3 External factors

Local: Water quality

Deep Bay is the most polluted part of the Hong Kong coastline, especially in its bacterial and nutrient loads. The problem is due mainly to organic waste from livestock farms, unsewered villages and urban developments produced in the catchment being discharged into the Bay, especially from the Shenzhen River. This problem is threatening the oyster and fishing industry at Lau Fau Shan, and *gei wai* shrimp production at Mai Po.

In the summer of 1996, Environmental Protection Department data showed that the levels of dissolved oxygen in the water of Inner Deep Bay fell to <1mg/l for around 3 weeks.

Afterwards, the density of mudflat animals, e.g. crabs and mudskippers declined some tenfold. Although the densities of certain mudskipper species are recovering, the crab population has still to recover. There was a knock-on effect on the wintering waterbird numbers, which declined from a peak of 68,000 in January 1996 to 54,000 in January 1999 and numbers have since stabilized at that level.

The effect of oil runoff from the increasing number of scrapyards built over filled-in fish ponds has not been adequately studied. The effect of urban-runoff has also been inadequately studied.

Local: Exotic species

Although there are a range of exotic species that could potentially have adverse impacts on the Deep Bay wetlands, e.g. *Spartina* sp. along the coast by Pak Nai, and the climber *Mikania micrantha*, the species of particular concern at present is the mangrove *Sonneratia* sp. It was introduced to Futian Mangrove National Nature Reserve in the early 1990 where it has since established and has spread along the Shenzhen coastline and to mouth of the Shenzhen River, at Tsim Bei Tsui and inland to the Fairview Nullah. There are also *Sonneratia* along the Kam Tin Main Drainage Channel by Nam Sang Wai but these were accidentally introduced as part of a planting programme.

As a flood prevention measure, the Drainage Services Department (DSD) removes vegetation along the Hong Kong side of the Shenzhen River at regular intervals and in doing so, also remove any *Sonneratia* trees that happen to be growing there.

In 2004, the Highways Department have removed *Sonneratia* from the Deep Bay mudflat as an additional enhancement measure under the Shenzhen Western Corridor project. So far, *Sonneratia* sp. has not yet been recorded within MPNR. If any trees are found then they will be removed at once. AFCD is currently collaborating with local academics to investigate the impacts of *Sonneratia* on the Deep Bay ecosystem and ways to eradicating the trees.

Local: Management of the landscape profile within Mai Po

Prior to the construction of the Closed Area Fence road in the early 1980s, the *gei wai* bunds were the main route for the *gei wai* fishermen to access their huts built next to the *gei wai* sluice gates. With the completion of the road, the *gei wai* bunds were no longer used and so slowly became vegetated. This process was hastened by the placing of silt dredged up from the *gei wai* channels which made the bunds higher and wider. Wild birds helped spread the seeds of trees along these bunds so that many now support a line of trees, consisting mainly of

Melia azedarach, Ficus spp., Macarangia tanarius and Sapium spp.. These trees have helped in attracting a greater variety of woodland bird species into the Reserve, e.g. thrushes and flycatchers, and so will be retained on the landward side of the Reserve.

However, the spread of tall trees throughout the Reserve will increase the landscape profile and make the *gei wai* less attractive to waterbirds for which MPNR is important. This has been recognized in the management plan for the Ramsar Site (Anon 1997) and in previous Mai Po Management Plans (Young 1999). As a result, small-scale trimming of the trees at the landward side of the *gei wai* will be carried out to manage their height and sideward growth (Figure 3, 4). Saplings with diameter at breast height (dbh) < 30 cm will be removed. It is also proposed that exotic trees, especially *Eucalyptus robusta*, will be removed and shrubs, such as *Rhaphiolepis indica* planted in their place.

It is expected that such tree management work will small-scaled so as to minimize any impacts.

Figure 3: Tree management along the *gei wai* bunds

indicates bunds where tree trimming will occur.

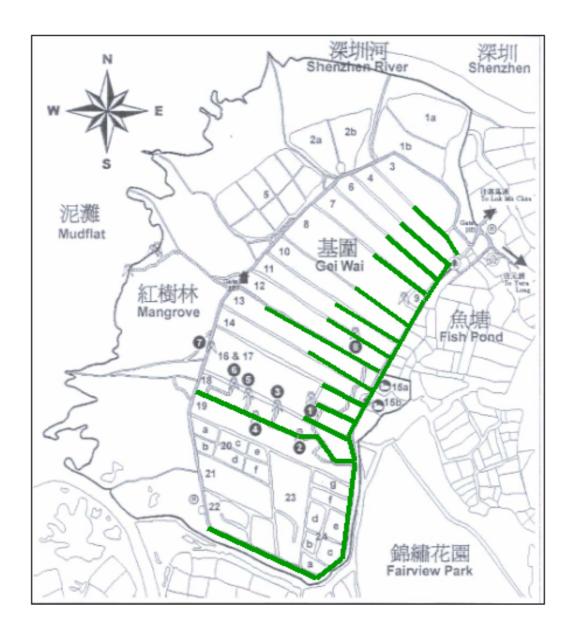
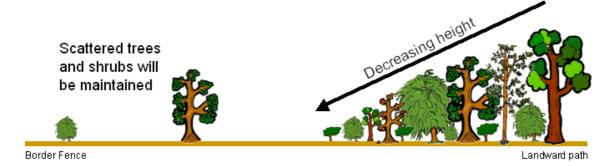


Figure 4: Diagram showing a typical vegetation profile along selected *gei wai* bunds at Mai Po Nature Reserve



Local: Urban development

On the landward side of Mai Po, there is constant pressure for reclamation of the fish ponds for urban developments. Specific threats include:

- Proposals for residential developments. Many of these application sites straddle the
 Wetland Conservation Area and Wetland Buffer Area set up by the Town Planning
 Board in autumn 1999 to control urban encroachment into the Deep Bay wetlands. A
 number of these developers have come up with innovative proposals following the
 'Private Public Partnership' approach which attempts to balance both development and
 wetland conservation on their sites.
- The Shenzhen SEZ Government is carrying out reclamation of the coastline adjacent to the landing point of the Shenzhen Western Corridor bridge. However, due to a lack of information from the Shenzhen SEZ Government on the possible impacts of the reclamation, the exact scale of the impact is unknown.

Local: Habitat destruction

The construction of the Binhai Causeway along the northern shore of Inner Deep Bay has lead to the loss of some 20% of the Bay's inter-tidal mudflat area. However, the Shenzhen SEZ Government is proposing further reclamation at the landing site of the Shenzhen Western Corridor at Shekou, and on the northern side of Deep Bay.

Global: Acid precipitation

Acid rain is primarily associated with the emission of sulphur and nitrogen oxides from the burning of fossil fuels. Rain is said to be acidic if its pH is < 5.6.

Wet and dry deposition was monitored at six sites, and the weighed mean pH of rain was 4.8, with little spatial variation throughout Hong Kong (Anon 1993). Thus, there is evidence for acid precipitation in Hong Kong, but little is known about the effects of it on the natural environment. Acid precipitation can be modified by vegetation, soils and rocks, such that it need not necessarily acidify surface waters (Peart 1993).

Global: Climate change

On a global level, climate changes is expected to cause a mean rise in annual surface temperatures of around 1.0 - 3.5°C by 2100 and a sea-level rise of 1.0 - 2.5 mm per year. However, it is difficult to determine similar impact for Asia because of limited historical data on climate and sea-levels (IPCC 1997; http://www.grida.no/climate/ipcc/regional/index.htm).

Despite this however, it is expected that climate change will have the following qualitative impacts:

- Exacerbate the impacts of typhoons/cyclones, droughts, and floods,
- Large deltas and low-lying coastal areas of Asia would be inundated by sea-level rise,
- Increased precipitation intensity, particularly during the summer monsoon, could increase flood-prone areas in temperate and tropical Asia (IPCC 2001; http://www.grida.no/climate/ipcc_tar/wg2/index.htm).

In Hong Kong, it has been difficult to measure the effect of global warming and the resulting changes in future sea-levels because of several confounding factors. Hong Kong is situated in the southwestern corner of the Pearl River Delta, which, as with many deltaic regions, has large quantities of sediment being deposited around its mouth. This increase in loading due to the weight of sediment, results in subsidence which may be mistaken for sea-level rise. In addition, the tide-gauge stations in Hong Kong used for measuring sea-level changes are not located on bedrock, but on newly reclaimed land which are liable to ground settlement, thus giving unreliable readings for sea-level rise (Yim 1993).

If the international predications of sea-level rise are correct, then a smaller area of the Deep Bay mudflat would be exposed each time at low tide and for a shorter period as well. This would result in the mudflat becoming less available as a feeding habitat for migratory waterbirds. The seaward mangroves would also be prone to longer periods of inundation, which would slow down, or even reverse their advance out into the Bay along the mudflat.

As a precaution, the Government has suggested that coastal construction projects should prepare for a 0.5 m sea-level rise in the next 50 years.

2.3.4 Obligations

The successful management and safeguarding of this site will depend upon compliance with the following list of legal and other, non-legal obligations, both locally and internationally:

Local

Under the Wild Animals Protection Ordinance Cap. 170, access to Mai Po Marshes is restricted to those in possession of a Mai Po Entry permit issued by the Director of Agriculture, Fisheries and Conservation.

Mai Po is zoned as a Site of Special Scientific Interest under the Outline Zoning Plan, where there are strict guidelines on the uses which are permitted in the site.

International

There is a need to adhere to international conventions and other agreements to which Hong Kong is Party. The former includes the Ramsar Convention, Bonn Convention on Migratory Species, and the London Convention on dumping at sea, whilst the latter includes the Shorebird Site Network and Anatidae Site Network in the East Asian - Australasian Flyway. At the time of writing, the Central Peoples' Government has agreed-in-principal to extend the application of the Convention of Biodiversity to the Hong Kong SAR but it has yet to come into being.

2.3.5 Legal constraints

Each *gei wai* is under either a separate, or group license which can be revoked after 3 months notice is given and no compensation is required. However, *ex gratia* payment is possible. Under the land license, there are general controls on land-use such that the area may ".. not be used for any purpose other than for the purpose of a nature Reserve.." Prior written approval is required from the District Lands Office - Yuen Long for a number of management activities, such as carrying out drainage works (e.g. dredging) and tree felling.

The erection of new structures and replacement of existing structures requires permission from the Town Planning Board through a Section 16 application under the Town Planning Ordinance.

2.3.6 Resources

In 1984, when WWF Hong Kong first became involved in the management of Mai Po, WWF would also raise the necessary funds to cover the annual costs of their operation in the Reserve. In 1996 however, AFCD began granting an annual subvention to WWF Hong Kong towards the cost of the habitat and infrastructure management work at the Reserve.

It now requires some HK\$2.6 million to cover the annual habitat management costs of Mai Po and this money comes from the following sources;

- HK\$ 1.2 million (46%) from the Hong Kong Government through the AFCD,
- HK\$ 0.5 million (20%) from a subvention provided by the Education and Manpower Bureau to cover the cost of organizing and running tours for school groups to Mai Po Nature Reserve.
- HK\$ 0.9 million (36%) from major annual fundraising events such as the Big Bird Race.

Of the total, some HK\$ 2.2 million (85%) goes towards recurrent projects, e.g. grass cutting, water exchange in the *gei wai* and climber management, whilst HK\$ 0.4 million (15%) is for capital project, e.g. those that will improve the habitats or facilities. In view of the challenges that the Reserve now faces, e.g. accretion and the decline in area of open water, a greater amount of funds will have to be raised so that a greater proportion of the money raised can be used in resolving those problems.

2.3.7 Impact assessment

The impact of WWF Hong Kong's management of Mai Po will be covered by improved targeted monitoring of the habitat management projects undertaken in the Reserve, as well as by baseline monitoring undertaken as part of the regular programme of works in the Ramsar Site under the auspices of the AFCD.

External factors are now most likely to place a constraint in achieving the management objectives of the site, and these have been discussed above. Basically, since the health of the habitats and species within the Reserve are dependent to a large extent on water quality in Deep Bay, the factor which will have most impact on the fate of the Reserve is the extent of the continuing urbanization and development within the Deep Bay catchment, and the effect that this will have in terms of pollution to the site. The future rate of sedimentation of the Deep Bay mudflat and of the *gei wai* is also of concern, in view of the fact that little action appears to be taken to address the problem.

CHAPTER 2.4 RATIONALE, MANAGEMENT GOALS AND MANAGEMENT OBJECTIVES

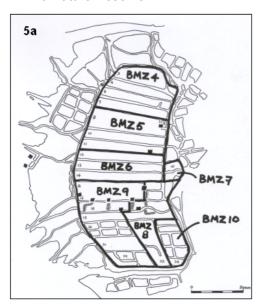
2.4.1 Introduction

The Mai Po and Inner Deep Bay Ramsar Site was listed in 1995 and a management plan was produced two years later (Anon 1997). This plan sets out the broad conservation and management objectives for the Ramsar Site and WWF Hong Kong's own Mai Po Management Plan complements it, by detailing how those broad objectives will be achieved practically within the Reserve.

The Management Plan lists MPNR within the Biodiversity Management Zone (BMZ) of the Ramsar Site, where the broad purpose of the BMZ is to '...provide a refuge for waterfowl (including a high tide roost) and a focus for biodiversity conservation, education and training in a relatively intensively managed environment' (Anon 1997).

The Mai Po 'BMZ' is divided into seven compartments (from BMZ 4 to BMZ10), each with its own management intention (Anon 1997). The designation of these compartments has been very useful in allowing target specific management actions to be undertaken within each of them. However, with the experience gained since the production of the Management Plan for the Ramsar Site, there is a need to review the intention and boundaries of each of the compartments (<u>Table 2</u>; <u>Figure 5</u>).

Figure 5: Present (5a) and proposed (5b) revision to the BMZ compartments at Mai Po Nature Reserve



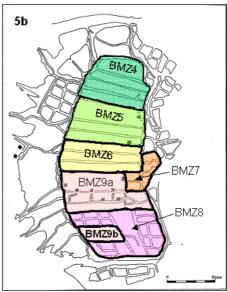


Table 2: Management intention of the seven compartments (BMZ 4 – 10) at Mai Po Nature Reserve and proposed revision to their boundaries.

| No. | Compartment |
|-----|--|
| 1 | BMZ 4 (gei wai 3, 4, 6, 7) |
| | Management intention: In the medium term, to adjust conditions in favour of supporting higher numbers of the Black-faced Spoonbill. Tasks include; Maintaining the existing embankments for the time being, Consider planting a vegetation screen along the northern boundary. Manage the height and sideway growth of tall vegetation to reduce landscape profile. |
| | Issue: None |
| | Proposed change: None |
| 2 | BMZ 5 (<i>gei wai</i> 8, 9, 10, 11) |
| | Management intention: In the medium term, to adjust conditions in favour of supporting a substantial block of reedbed habitat (plus the small existing patch of bulrush vegetation). Tasks include; Maintaining the existing embankments for the time being, Lower internal embankments, Manage the height and sideway growth of tall vegetation to reduce landscape profile. |
| | Issue: None |
| | Proposed change: None |
| 3 | BMZ 6 (<i>gei wai</i> 12, 13, 14) |
| | Management intention: In the long term, to maintain traditionally managed production |

gei wai with areas of mangrove vegetation. Tasks include managing the height and sideway growth of tall vegetation to reduce landscape profile.

Issue: It was suggested that *gei wai* 14 be converted into a settling pond to trap silt in water before it is discharged into *gei wai* 16/17 (Anon 1997). As the floor of *gei wai* 16/17 is higher than that in *gei wai* 14, this suggestion would not be feasible since water would not be able to flow naturally from *gei wai* 4 to 16/17 without major earthmoving works.

Proposed change: It is proposed that *gei wai* 14 will not be used as a sedimentation pond for water entering *gei wai* 16/17.

4 BMZ 7 (gei wai 15a, b)

Management intention: In the long-term, maintain and improve the Education Centre and its associated waterfowl collection.

Issue: In recent years, Pond 16b has been developed as an additional facility to enhance the education and awareness programmes conducted in the Education Centre, and there are plans to enhance the habitat in Pond 17b in a similar way. Furthermore, as it is proposed that treated wastewater will now not be discharged from Fairview Park into MPNR, and the boundary of BMZ 8 are be changed (see below), it is further proposed that the boundary of BMZ 7 be extended to include Ponds 15c, 16b and 17b.

Proposed change: It is proposed that the boundary of BMZ 7 be enlarged to include Ponds 15c, 16b and 17b.

5 BMZ 8 (gei wai 15c, 16/17 (east), 18 and 19 (east), 23)

Management intention: In the medium term, adjust conditions in favour of creating an open freshwater roosting area with fringing reeds and mangroves, shingle or tree-topped islands and pools/channels with varying sizes, heights and depths. Tasks include:

- Retain existing embankments for time being,
- Manage the height and sideway growth of tall vegetation to reduce landscape profile.
- Heighten southernmost embankment to prevent overtopping during floods.

Issue: In order to create an open freshwater area in BMZ 8, it was proposed in the Ramsar Site Management Plan (Anon 1997), that treated wastewater from the Fairview Park sewage treatment plant can be discharged into Pond 15c from where, it would be passed to Pond 17b, then the landward halves of *gei wai* 18 and 19, before entering *gei wai* 23 to be discharged through its sluice gate into the Fairview Nullah. However, the treated effluent has a high level of phosphate making it unsuitable for discharge into MPNR.

Proposed change: It is suggested that treated wastewater will not be discharged from Fairview Park into MPNR unless the phosphate load in the water is reduced. Therefore, earthmoving will not be required in *gei wai* 18 and 19 to divide these two *gei wai* into a 'seaward' and a landward half. As a result, it is further suggested that the boundary of BMZ 8 may be revised to include *gei wai* 20, 21 – 24 so as to maintain the original intention of creating an open freshwater area.

6 BMZ 9 (gei wai 16/17 (west), 18 and 19 (west), 20, 21, 22)

Management intention: In the medium term, adjust conditions in favour of creating an open, tide-influenced area with fringing reeds and mangroves, shingle or tree-topped islands and pools/channels with varying sizes, heights and depths that can act as a secure high-tide roost. Tasks include;

- Restrict visitor access to the southern two-thirds of the compartment.
- Retain existing embankments for time being,
- · Lower existing internal embankments,
- Manage the height and sideway growth of tall vegetation to reduce landscape
- Clear internal vegetation unless required for islands,
- Heighten southernmost outer embankments to prevent overtopping during floods.

Issues: As BMZ 8 will now not include the landward ends of gei wai 18 and 19 (see section on BMZ 8), there is no need to carry out earthmoving work to divide these two gei wai into a seaward and a landward portion. No earthmoving works will be conducted to convert these two ponds into shorebird high-tide roost sites because of the mangroves still inside the pond and the proposal to improve gei wai 21 as an alternative high-tide roost (see below)

Pond 20 is being successfully managed as a rain-fed pond for wintering waterfowl, instead of being managed as a tidal influenced area that will serve as a high tide roosting site for waterbirds.

In recent years, gei wai 21 has been successfully managed as a tidal pond to provide both feeding and roosting habitat for waterbirds, including shorebirds. It is proposed that this will continue and that the dead mangrove in the pond removed so that a larger area of shallow water, mud and low islands can be created for roosting waterbirds. This will then provide two large ponds that can act as waterbirds roosts (gei wai 16/17 and 21) so that if one is disturbed by habitat management works (e.g. drained), an alternative roost is available.

Proposed changes: It is suggested that there is no need to carry out earthmoving works to divide *gei wai* 18 and 19 into a seaward and a landward portion.

Continue management of Pond 20 as rain-fed freshwater ponds,

Earthmoving works carried out in gei wai 21 to create an open high-tide roosting site as an alternative to gei wai 16/17.

It is suggested to revise the boundary of BMZ 9 to include the 'Scrape' (gei wai 16a/17a), gei wai 18, 19 and 21. As the former three gei wai are adjacent, they will be called BMZ 9a whist gei wai 21 which is more isolated, will be called BMZ 9b.

BMZ 10 (gei wai 24)

Management intention: In the medium term, to adjust conditions in favour of creating a series of freshwater lakes of varying depth with surrounding areas of marsh. Tasks include:

- Retain existing embankments.
- Lower and grade the internal embankments to create shallows and bays,
- Manage the height and sideway growth of tall vegetation to reduce landscape
- Clear internal vegetation unless required for islands.
- Heighten southernmost outer embankments to prevent overtopping during floods.

Issue: As the intention of BMZ 10 is similar to that of BMZ 8, i.e. to create a freshwater habitat and that the management tasks are similar, it is suggested that these two BMZ should be merged to improve efficiency.

Proposed change: BMZ 10 to be merged within the boundary of the revised BMZ 8.

2.4.2 Management Goals for Mai Po Nature Reserve

- (1) To manage the MPNR so as to maintain and, if possible, increase the diversity of habitats appropriate for south China coastal wetlands, and the richness of native wildlife in the area.
- (2) To promote the use of the area for educational purposes both by students and the general public (including the provision of special facilities and tours for the disabled).
- (3) To realise the training potential of the Reserve as part of the Ramsar Site so as to promote wetland conservation and wise use in the East Asia/ Australasian Flyway, in particular China.
- (4) To promote scientific research relevant to the management and conservation of wetlands and their biota.
- (5) To promote, and support measures to reduce and minimise external threats to the habitats and wildlife at the Reserve.

2.4.3 Management Objectives to achieve Goal 1

The order in which the objectives are listed below does not imply any order of priority.

- 1.1 To provide suitable roosting and feeding habitats for Black-faced Spoonbills.
- 1.2 To provide suitable high tide roosting sites for a significant population of the shorebirds in Deep Bay.
- 1.3 To provide suitable roosting and feeding sites for a significant population of the wintering waterfowl in Deep Bay.
- 1.4 To maintain and manage the mangrove habitats.
- 1.5 To maintain and manage the reedbed habitats.
- 1.6 To develop and manage a diversity of freshwater habitats within the Reserve.
- 1.7 To maintain the traditional operation and landscape of the *gei wai* habitats in BMZ6.
- 1.8 Identify and maintain habitats for other focal key species and species groups.
- 1.9 To carry out additional management to support achievement of the above objectives.
- 1.10 To develop monitoring programmes and encourage research projects that will contribute to the above objectives.
- 1.11 To review regularly the management plan in the light of results from the monitoring programme, research and changing circumstances.
- 1.12 To abide by local legislations and meet obligations under agreed international conventions and relevant inter-governmental agreements.

Actions on how to achieve these objectives are detailed in Part 3.

2.4.4 Management Objectives to achieve Goal 2

The Education Strategy is a separate document and can be made available from the Education Department of WWF Hong Kong.

2.4.5 Management Objectives to achieve Goal 3

The Training Strategy is a separate document and can be made available from the Training Department of WWF Hong Kong.

2.4.6 Management Objectives to achieve Goal 4

The order in which the objectives are listed below does not imply any order of priority.

- To investigate the distribution and habitat use by the damselfly *Mortonagrion hirosei*;
- To investigate the distribution and habitat use by the Eurasian Otter *Lutra lutra*.

Other projects may be identified during annual reviews of the Management Plan conducted by WWF through their Mai Po Management Committee.

2.4.7 Management Objectives to achieve Goal 5

The Conservation Strategy is a separate document and is available from the Conservation Department of WWF Hong Kong.

PART 3: PRESCRIPTIONS TO ACHIEVE MANAGEMENT GOALS

CHAPTER 3.1 PERSCRIPTIONS TO ACHIEVE MANAGEMENT GOAL 1

The following prescriptions take into account the proposals included in the Management Plan for the Mai Po and Inner Deep Bay Ramsar Site (Anon 1997). This places Mai Po into the Biodiversity Management Zone (BMZ) of the Ramsar Site, with the different *gei wai* of the Reserve being placed into one of a number of management compartments (Figure 5).

Whilst the Ramsar Site Management Plan uses the terms 'short-', 'medium-' and 'long-term' to indicate the time scale over which different activities should be carried out, the actual time which these periods represent is not indicated. Therefore, in the following, it is assumed that "short-", medium-" and "long-term" indicates 1-5, 6-10 and >11 years respectively.

Throughout this management plan, the term 'gei wai' is used synonymously with 'pond'. Whilst the former refers to a 'pond' which has a an operational sluice gate, the latter does not have a sluice gate, or has a sluice gate that is blocked and is non-functional.

3.1.1 Goal 1.1 - To provide suitable roosting and feeding habitats for Black-faced Spoonbills

Background

The endangered Black-faced Spoonbill is restricted to East Asia, breeding on small islands off the west coast of the Korean peninsular and the coast of Liaoning Province (P.R. China), and wintering in coastal Japan, China, and Vietnam (BirdLife International 2000). With an estimated world population of some 1,475 individuals (Yu 2005), a peak of 340 individuals has been recorded wintering in Deep Bay in December 2005 (J. Allcock, pers. com. 2005). This represents some 23% of the species' world population.

During the day, most of these birds roost in the shallow water and bunds of $gei\ wai\ 3-7$ (BMZ 4) at Mai Po but at night, the birds make use of the islands at the landward end of gei

wai 8 (AEC 2004; Yu 2002). During the later part of the winter, the birds may also roost in *gei* wai 16/17 and the shallow water and islands of the ponds in the southern part of the Reserve.

The Reserve also provides feeding habitat for the wintering Black-faced Spoonbills by slowly draining a number of the Mai Po $gei\ wai\ (8,\ 10-19)$ on rotation from November to March. The Black-faced Spoonbills coming in to feed on the small fish and shrimps in the shallow water at the bottom of the pond.

As a result, Goal 1.1 will be achieved mainly in BMZ 4 (Anon 1997), but also in BMZ 5-6, 8-10.

Compartment BMZ 4

The medium term intention of this compartment is to support higher numbers of Black-faced Spoonbills (Anon 1997). Management of this compartment for roosting Black-faced Spoonbills will therefore mainly involve;

- lowering the water level in *gei wai* 6 from October April so that this gei wai can act as a roost for the wintering Black-faced Spoonbills,
- lowering the water level and stocking fish into *gei wai* 3 from November March to provide a feeding habitat for the wintering Black-faced Spoonbills,
- raising the water level in all the gei wai of this compartment May to September, to prevent reed encroachment into the areas of open water,
- maintaining the side and cross channels open by dredging when necessary,
- controlling reed encroachment into the open areas of water in all the gei wai of this compartment when necessary,
- cutting the grass along the bund between *gei wai* 3 4 and 4 6 in late September, prior to the arrival of the wintering Black-faced Spoonbills.

Compartments BMZ 5 - 6, 8 - 10

In late winter, there is a tendency for Black-faced Spoonbills to loaf in *gei wai* 16/17 (BMZ 9). As a result, the water level in this pond needs to be lowered from February to accommodate these birds.

At nights, Black-faced Spoonbills use the shallow water areas and islands on the landward part of *gei wai* 8 (BMZ 5) in front of the Tower Hide. As a result, the water level in this *gei wai* also has to be carefully managed so that the pond continues to be available to Black-faced Spoonbills at night.

The provision of feeding sites for Black-faced Spoonbills is done by sequentially draining *gei* wai # 8, 10-14, 18-19 on a 2-week rotation from November to March, so that these birds can feed on fish and shrimps in the shallow water. Records will be kept of the diversity and abundance of shrimps and fish in each of the *gei* wai at the end of winter draining. Records will also be kept of the frequency of water exchange.

All BMZ Compartments

The following tasks will take place in all BMZ Compartments:

- native shrubs and grasses (e.g. Panicum maximum), will be encouraged along the side
 of the ponds adjacent to the Closed Border Area Fence to screen the relevant
 Compartments from disturbances along the Border Road.
- the tall vegetation along the western 2/3 of the bunds will be cleared to reduce the landscape profile. The vegetation along the eastern 1/3 of the bunds will be retained (Figure 3, 4).

3.1.2 Goal 1.2 - To provide high tide roosting sites for the shorebirds in Deep Bay

Background

Mai Po and Inner Deep Bay is a regionally important site for migratory shorebirds and was listed as a Shorebird Network Site in the East Asian – Australasian Flyway in 1996. Some 17,000 shorebirds migrate through Deep Bay during Spring northward passage and over 13,000 shorebirds may winter in the Bay. Smaller numbers (about 2,000) pass through during Autumn southward passage. Over the course of the year, it is estimated that a minimum of some 30,000 shorebirds utilise the Deep Bay wetlands and if turnover over the course of the year is considered, then Deep Bay may support some 54,000 – 81,000 shorebirds (Carey *et al.* 2001). Of these shorebirds species, three are threatened and another 14 occur in regionally important numbers (see Sections 1.2.2.2 and 2.2.2).

Whilst these shorebirds feed on the intertidal mudflats of Deep Bay at low tide, they require suitable areas of shallow water and mud to roost at high tide. In 1986, WWF began creating a number of high-tide roosting sites at Mai Po with the main one being in *gei wai* 16/17. Management of these sites involve lowering the water level at time of shorebirds passage and creating small shallow islands where the birds can roost, and clearing vegetation encroaching into the open water areas.

Although the Ramsar Site Management Plan intends for Goal 1.2 to be achieved in BMZ 9 (*gei wai* 16, 20 - 22, and the western halves of *gei wai* 18 – 19; Anon 1997), WWF Hong Kong has also been achieving this goal at the landward part of *gei wai* 8 and 11 (Compartment BMZ 5).

Compartment BMZ 9

The intention of BMZ 9 is, in the medium term, to adjust conditions in favour of creating an open, tide influenced area with fringing reed or mangroves according to local salinity gradients; grass- or shingle-topped islands and pools/channels with varying sizes, heights and depths (Anon 1997). Management of this Compartment will also involve:

- managing the water levels according to an agreed programme (<u>Figure 6</u>). This will ensure that at any one time, there will be at least one pond with shallow areas of water and mud which can act as a high tide roosting site for shorebirds;
- lowering the internal bunds and clearing tall vegetation to reduce the landscape profile,
- clearing existing stands of internal vegetation;
- maintaining the side and cross channels by dredging;
- heightening the perimeter bunds of the southernmost compartments to prevent overtopping during storm/floods by water from Fairview Nullah;
- restricting group access to the southern part of this (gei wai 20 24) and adjacent
 Compartments so that this part of MPNR can provide a relatively undisturbed area for wildlife:
- encouraging native shrubs and grasses (e.g. *Panicum maximum*), along the side of the ponds adjacent to the Closed Border Area Fence to screen the relevant Compartments from disturbances along the Border Road.

Gei wai 16/17

This *gei wai* lies within BMZ 9 and is presently the main high-tide roosting site for migratory shorebirds and wintering waterbirds within MPNR. During the course of this Plan, a second site will be created in *gei wai* 21 (see below, this section) and the two sites will be operated to compliment each other. Management of *gei wai* 16/17 as a roosting site will involve:

maintaining the areas of open water and controlling encroachment by reeds and grasses
 (e.g. *Paspalum* sp.) by a combination of cutting, flooding and spraying with glyphosate or similar;

- lowering the water level in mid-March before the arrival of the first northward migrating shorebirds at the end of March, in order to provide suitable shorebirds roosting habitat;
- maintaining a low water level from mid-March to mid-May for the migrating shorebirds;
- continue to maintain a low water level from mid-May to mid-July to provide shallow islands for breeding waterbirds, especially Black-winged Stilts;
- carry any necessary vegetation management on the islands and perimeter bunds from mid-July,
- continue to maintain a low water level from mid-July to September in order to provide roosting sites for shorebirds on southward migration;
- carry out any necessary vegetation management on the islands and perimeter bunds from September and raise the water level by mid-October to provide roosting sites for wintering waterfowl. This water level will be maintained until mid-March when the cycle of water level management is repeated (Figure 6);
- removing tall vegetation along the bunds to lower the landscape profile;
- construct an earth bund along the side of *gei wai* 16/17 by the 'dirt track' to act as a screen against disturbance (e.g. works vehicles) for the waterbirds using the scrape.

Figure 6: Illustration of the management of water levels in different *gei wai* for waterbirds

| <i>Gei wai</i> no. | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------------------------|
| 0-1104 | | | | | | | | | | | | | A in all a star |
| Gei wai 21 | | | | | | 3 | | | | | | | ↑ indicates |
| | | | | _ | | | | | | | | | increasing |
| | 1 | | | 2 | | | | | | | 1 | | water level |
| | | | | | | | | | | | | | |
| Gei wai 16/17 | | | | | | | | | | 5 | | | |
| | | | | | | 4 | | | | | | | |
| | | | | 2 | | | | 2 | | | | | |
| | | | | | | | | | | | | | |
| Gei wai 11 | | | | | | 3 | | | | | | | |
| | 2 | | | | | | | 2 | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Gei wai 8 | | | | | | 3 | | | | 5 | | |] |
| | | | | 2 | | | | | | | | | 1 |
| | | | | | | | | | | | | | Ī |
| | | | | | | | | | | | | | |
| Gei wai 6 | | | | | 3 | | | | | | | | |
| | | | | | | | | | | | | | 1 |
| | 6 | | | | | | | | | | 6 | | ĺ |

Key:

- 1 Pond managed as an inter-tidal pond to provide feeding site for waterfowl and other waterbirds.
- 2 Water level lowered to provide shallow water roosting site for shorebirds on passage
- 3 Water level raised to control the spread of grasses into the open areas of the pond
- 4 Water level slightly raised for breeding waterbirds, e.g. Black-winged Stilts
- 5 Water level raised to provide roosting habitat for wintering waterbirds, such as ducks
- 6 Water level lowered to provide roosting habitat for wintering Black-faced Spoonbills.

One side effect of the managing *gei wai* 16/17 as a high tide roosting site for migratory shorebirds in spring, is that invasive climbers (e.g. *Strophanthus divaricatus*) have colonised the landward side of *gei wai* #17 (pond 17b) and have covered, and killed many of the mangrove trees in that section of the pond. As a result, consideration will be given to removing the dead mangrove and climbers and converting the area into a rain-fed freshwater pond (see Section 3.1.6).

Gei wai 18

The western end of this *gei wai* lies within BMZ 9 and the two small open areas of shallow water in front of birdwatching hides 2 and 4 (<u>Figure 1</u>) will not be managed as additional high-tide shorebirds roosting sites because:

- there is already a larger roosting sites for shorebirds that is adjacent, e.g. *gei wai* 16/17, and
- that lowering water levels during the spring will encourage the growth of climbers that will smother and kill the mangroves in the central portion of the pond.

Other works to be carried out include:

- maintaining the walkways to the existing birdwatching hides that overlook *gei wai* 16/17;
- monitoring the spread of invasive climbers in the mangroves and control when and where necessary;
- maintaining the side and cross channels open by dredging to remove the accumulated silt.

Gei wai 19

The western end of this *gei wai* lies also within BMZ 9 but as there is a large area of mangroves in this pond and creating a high-tide roosting sites for shorebirds in this pond will involve the removal of large area of these mangroves, there will not be any near-term plan to create the roost site and manage the pond for roosting shorebirds. There is also no medium-term plan to divide this *gei wai* into a seaward portion and a landward portion as suggested in the Ramsar Site Management Plan (Anon 1997) (see Section 2.4.1, <u>Table 2</u>).

Invasive climbers are increasingly covering the mangroves in this *gei wai*. The immediate aim will be to control the spread of these climbers and to remove them from the mangroves.

Removal may involve one, or a combination of spraying, hand weeding and/or cutting the climbers close to their base followed by prolonged flooding.

Pond 20a-f

The eight ponds that make up pond 20 also fall within BMZ 9. However, with the success of the management of pond 20 as a rain-fed freshwater habitat that supports large numbers of roosting waterfowl in winter (Anon 2000b), it is proposed that this management be continued (see Section 3.1.3) rather than the pond being managed for shorebirds.

If there were to be a prolonged period of drought, then water may be pumped into Pond 20a-from a number of reservoirs of freshwater available other parts of the Reserve, e.g. *gei wai* 23 or Pond 24. However, if the drought is severe, then there is the risk that these reservoirs may also dry up.

Gei wai 21

Since the mid-1990s, this *gei wai* has been successfully managed as an inter-tidal pond from October – April to provide feeding opportunities for ardeids, waterfowl and spoonbills. Then from May – September, the *gei wai* is flooded to prevent vegetation encroachment into the open areas of water. However, invasive climbers have almost completely covered the mangroves in this *gei wai*. It is proposed that these mangroves be allowed to die after which, the level of the pond floor will be lowered using a bulldozer and backhoe, and the dead mangroves removed. The earthmoving works will also create islands and pools/channels with varying sizes, heights and depths and the pond will then continue to be managed as:

- an inter-tidal area in winter for waterbirds (November mid- March);
- a high-tide roosting site for shorebirds in Spring (late March mid-May) and Autumn (September October) to complement the high-tide roosting site in *gei wai* 16/17;
- and be flooded in summer to prevent the spread of grasses (mid-May August).

As a result, this *gei wai* would serve a similar purpose to, and would complement the management of *gei wai* 16/17 as a high-tide waterbird roosting site. The advantage is that if one roost is disturbed, e.g. by earthmoving works, then waterbirds can still fly and use the second roost.

Gei wai 22

In line with the proposal to manage this pond as a rain-fed freshwater pond (see Section 3.1.3), this pond will not be managed as a high-tide roosting site for shorebirds.

Compartment BMZ 5

Gei wai 8

Whilst this pond does not lie in BMZ 9, the 'scrape' at the landward end of this pond has previously been managed as a high-tide roosting site for migratory shorebirds in Spring. It is proposed that this function be continued. The water level in this *gei wai* will be kept high in winter and summer, but lowered in spring and autumn to provide shallow areas of water and exposed mud for roosting shorebirds at high tide.

The stand of sedge (*Schoenoplectus* spp.) in front of the Tower Hide at the landward end of the *gei wai* #8 will require management in order to control its spread over the area of open water.

Gei wai 11

Whilst this *gei wai* also does not lie in BMZ 9, the landward end has also previously been managed as a high-tide roosting site for shorebirds during spring and autumn passage and it is proposed that this function be continued. The water depth at the landward end will be kept no deeper than about 4 cm during spring passage (late-March to mid-May) and autumn passage (late July to October) so that there are shallow areas of water and exposed wet mud.

3.1.3 Goal 1.3 – To provide suitable roosting and feeding sites for the wintering waterfowl in Deep Bay.

Background

Mai Po and Inner Deep Bay is a regionally important site for wintering waterfowl and was listed as an Anatidae Network Site in the East Asian – Australasian Flyway in 2001. On average, some 20,000 waterfowl winter in Deep Bay and of the 26 species that have been recorded, three are threatened (see Sections 1.2.2.2 and 2.2.2). These waterfowl would roost at nights in *gei wai* 8, 11 and 16/17. However, in the late 1990s after WWF began creating a number of rain-fed freshwater ponds within Mai Po, these waterfowl became particularly attracted to these new freshwater ponds and these ponds have since become valuable waterfowl habitats. For example, pond 20 has supported over 3,500 roosting waterfowl.

This goal will mainly be achieved in BMZ 7 (pond 15), BMZ 9 (pond 20) and BMZ 10 (pond 24) where freshwater ponds have been created but also in *gei wai* 16/17 and 21 which are brackish water ponds.

Compartment BMZ 7

This Compartment currently consists of ponds 15a and b, whose long-term intention is to 'maintain and improve the Education Centre and its associated wildfowl collection' (Anon 1997). In future, it is proposed that the boundary of this Compartment will be extended to include pond 16b and 17b.

The aim of the captive waterfowl was to be an educational tool for visiting students and the public but they were also successful in attracting up to around 1,000 wild waterfowl to use the collection in winter. However, due to concerns over captive waterfowl as a vector for the spread of avian diseases to wild waterfowl, captive waterfowl are no longer kept in the collection. The last captive waterfowl died around 1997 but feeding of the wild wintering waterfowl still continues from October to April in order to attract a small number of these birds for educational purposes.

Future management of pond 15a and b will include:

- limited feeding of the wild wintering waterfowl which use pond 15a-b from October to March, as these wild birds act as an important educational resource for students and other visitors to the Reserve;
- if water quality deteriorates, flush water from the adjacent freshwater ponds 15c to maintain adequate water quality;
- checking for, and taking all sick and dead birds to the Kadoorie Farm and Botanic
 Garden for medical treatment or post-mortem examination respectively;
- controlling grasses and invasive climbers along the bunds and islands;
- draining the ponds in May after the wintering waterfowl have departed, and keeping a low water level for breeding waterbirds, especially Black-winged Stilts;
- refilling the ponds with rainwater in August and September prior to the return of the wintering waterbirds.

Pond 15c will be managed as a reservoir of rainwater for refilling ponds 15a-b or 16b, especially in winter when there is less rainfall and the water levels in those ponds fall due to evapo-transpiration and natural leakage.

Compartment BMZ 9

The management objective of *gei wai* 16/17 is principally to provide a roosting site for waterfowl. In spring and autumn when there are shorebirds on passage through Deep Bay,

then the water level in *gei wai* 1617 will be lower to provide shallow areas of water and wet mud for the shorebirds to roost at high tide. In summer, the islands in *gei wai* 16/17 have been used for breeding by Black-winged Stilts and Painted Snipe and so the water level must be maintained low so as not to flood the nests. Then in winter, when there are relatively fewer shorebirds in Deep Bay, the water level in *gei wai* 16/17 will be raised to provide deeper areas of water with low islands that have shallow edges. This will provide habitat for wintering waterfowl as well as any shorebirds that may also be wintering in Deep Bay.

Although pond 20 lies within BMZ 9, it has been successfully managed as a rain-fed freshwater pond for wintering waterfowl. As a result, it is proposed that this management be continued and will involve:

- storing the rainwater that falls from August to September and maintaining a high water level from October April, in order for the site to attract roosting waterfowl. From May July, the ponds will be drained in sequence to oxidise the mud floor and to carry out any repairs to the bunds and other features of the pond. Afterward, the pond will be re-filled with rainwater. In case of a drought, the water level in these ponds would drop but experience since 1997 has shown that the pond would still hold sufficient water. In the long term however, the possibility of importing tertiary treated wastewater from Fairview Park as a source of freshwater will be investigated. This idea will be further developed during the course of the proposed Plan.
- cut the grasses along the bunds of the pond on at least a 6-8 weekly basis from May to
 November in order to provide areas of short grass for wintering waterfowl, especially
 Wigeon. Whilst certain vegetation, such as the grass, *Paspalum disticlum* will be
 maintained, other invasive species (e.g. *Phragmites australis*) and weeds will be
 removed;
- native shrubs and grasses (e.g. *Panicum maximum*), will be encouraged along the side of the ponds adjacent to the Closed Border Area Fence to screen the pond from disturbances along the Border Road;
- the landscape profile around the pond will be by managing all tall vegetation;
- unless for research and management purposes, visitor access to this pond will be restricted to that along the Closed Border Area Border Fence road to prevent disturbance to wildlife using the ponds.

Gei wai 21

As this *gei wai* has been managed as a tidal pond in winter to provide both feeding and roosting habitat for waterbirds, including waterfowl. This has proved to be successful and it is

proposed that this will continue. This will not conflicts with the proposed work to turn *gei wai* 21 it into a high-tide roosting site in Spring and Autumn (see Section 3.1.2). It is also proposed to remove the dead mangrove in *gei wai* 21 so that a larger area of shallow water, mud and low islands can be created for roosting waterbirds. This will then provide two large ponds at Mai Po that can act as waterbirds roosts (*gei wai* 16/17 and 21) so that if one is disturbed by habitat management works (e.g. drained), an alternative roost can be available for waterbirds.

Gei wai 22

As this *gei wai* lies within the block of ponds at the southern side of Mai Po which are proposed to be converted to freshwater habitat (Section 2.4.1, Figure 5), it is proposed that the medium-term intention of this *gei wai* will be changed to providing additional freshwater habitat for waterbirds. This will initially be done by blocking the sluice gate and allowing the pond to fill with rainwater.

Compartment BMZ 10

BMZ 10 is made up of the seven ponds that make up pond 24a-f. The intention is to create a series of freshwater lakes of varying depth with surrounding areas of marsh by:

- Retaining existing embankments;
- Linking the ponds by using L-pipes to coordinate hydrological control;
- Lower and grade the internal embankments to create shallows and bays;
- Clear tall vegetation to reduce the landscape profile;
- Clear internal vegetation unless required for an island;
- Cut vegetation along all the ponds bunds every 1-2 months from March to November;
- Heighten southernmost outer embankments to prevent overtopping during floods.

Whilst no target species were identified in the Ramsar Site Management Plan (Anon 1997) for this compartment, vegetation control along the pond bunds by regular cutting from May to November has made the pond (particularly 24f and g) attractive for wintering waterfowl. It is proposed that this management continues.

3.1.4 Goal 1.4 - To maintain and manage the mangrove habitats

Background

The Mai Po Inner Deep Bay Ramsar Site supports the largest stand of mangroves in Hong Kong, and the sixth largest protected stand in P.R. China (Sections 1.2.2.1 and 2.2.2). These mangroves support a unique community of wildlife that adds to the ecological value of the Ramsar Site.

Due to their large size, diversity and quality, the mangroves in BMZ 6 (*gei wai* 12-14) have been singled out for conservation management (Anon 1997). BMZ 6 supported 10.35 ha of mangroves in 2001 and the aim is to increase that to 10.54 ha by 2010. This will be done through the removal of invasive reed grasses by a combination of herbicide treatment, mechanical cutting and de-silting of the pond using machinery, and then the planting (both natural and manual) of young mangroves into the gaps produced by the removal of the reeds. Management activities to be carried out to maintain the mangroves in BMZ 6 are detailed below.

Compartment BMZ 6

This goal will be achieved in BMZ 6 ($gei\ wai\ 12-14$) where the long-term intention is to maintain traditionally managed production $gei\ wai$ with areas of mangrove vegetation (Anon 1997). Management will involve:

- include the regular flushing of the water in the gei wai to prevent the mangroves from 'drowning', and removal of invasive climbers (e.g. *Derris trifoliata* and *Mikania micrantha*).
- The natural spread of mangroves in BMZ 6 will also be encouraged. Furthermore, any stands of reeds growing within the mangroves in the central portions of *gei wai* 12-14 will be removed and the colonisation by mangrove of the gap created will be allowed. Artificial planting of mangrove seedlings in these gaps will also be considered.
- maintaining the traditional *gei wai* landscape (<u>Figure 7</u>), as well as features of cultural interest, e.g. sluice gates, and huts;
- keeping updated records of the frequency of water exchange, as well as the diversity and abundance of shrimps and fish in the *gei wai* at the end of winter draining;
- maintain the water depth in the side and cross channels by dredging when necessary;
- managing tall vegetation along the western 2/3 of the bunds to reduce the landscape profile. The vegetation along the eastern 1/3 of the bunds will be retained as well as

- the vegetation along the landward bund and by the side of the footpaths between *gei* wai 12/13 (Figure 3, 4);
- encourage the growth of native shrubs and grasses (e.g. *Panicum maximum*), along the side of the ponds adjacent to the Closed Border Area Fence to screen the relevant compartments from the Border Road.

Mangroves can also found in the *gei wai* outside of those in BMZ 6. However, the mangrove stands in these *gei wai* are often small and scattered and in certain cases, the quality of the mangroves is deteriorating because of siltation of the *gei wai* and subsequent invasion by climbers. Furthermore, the management intentions of the Compartments where these mangrove stands are found are not compatible with mangrove conservation. For example, mangrove trees can be found in BMZ 5 where the intention of the Compartment is to support a substantial block of reeds. In these compartments therefore, mangrove removal will be necessary to achieve the intention of the compartment. However, as there may be a few (< 20) isolated, small mangrove trees (< 3m in height) within the experimental reed block in *gei wai* 8 (Section 3.1.5) attempts will be made to identify these trees and remove them. No compensation will be carried for the loss of these trees as they are growing in an area designated for reedbed conservation. These trees will be removed when cutting of the reeds, or de-silting of the reedbed using heavy machinery needs to take place. The loss of these few trees will be more than made up for by the planting of young mangroves in BMZ 6 (Section 3.1.4).

Mudflat

Apart from the mangroves inside the Mai Po *gei wai*, some 33 hectares of mangroves on the inter-tidal mudflat in front of the floating hides have been managed since 1986. The aim of this is to maintain an area of open mudflat for waterbirds to roost and feed. Each August – October, permission is obtained from the DLO – Yuen Long to occupy this area of mudflat to remove a pre-agreed number of mangrove seedlings over a set area.

Any grasses (e.g. *Paspalum* spp. or *Spartina* spp.) or sedges (e.g. *Schoenoplectus* spp.) encroaching onto the same area of mudflat will be removed.

Figure 7: Photographs showing the landscape at Mai Po Nature Reserve in the 1980s (7a) and in 2003 (7b).





There is concern about the spread of the exotic *Sonneratia caseolaris* and *S. apetala* and Highways Department have carried out work to clear this species from the open mudflat during autumn 2004 as part of the off-site mitigation for the construction of the Shenzhen Western Corridor. The Drainage Services Department are also clearing *Sonneratia* spp. from the southern bank of the Shenzhen River. However, the latter is part of a larger project to clear vegetation from the banks of the river so as not to impede the flow of storm water down the river.

AFCD and the City University of Hong Kong are studying the ecology of *Sonneratia* spp. as well as investigating way to eradicate the species from Deep Bay.

3.1.5 Goal 1.5 - To maintain and manage the reedbed habitats

Background

The stand of reeds, *Phragmites australis*, at Mai Po Nature Reserve is probably the largest remaining in Guangdong Province and supports nearly 400 species of invertebrates, as well as a number of reedbed dependent bird species, as well as the endangered damselfly *Mortonagrion hirosei* (see Sections 1.2.2.2 and 2.2.2).

Goal 1.5 will principally be achieved in BMZ 5 (*gei wai* 8 – 11) where the medium term intention is to adjust conditions in favour of supporting a substantial block of reed (and sedge) habitat (Anon 1997). The target is to have 15.4 ha of reedbeds in BMZ 5 by 2010.

Compartment BMZ 5

Reedbed management will include;

- raising the water level in *gei wai* 8-11 as high as possible from May to September to control reed encroachment into the areas of open water. Reed encroachment will also be controlled by cutting and by spraying with herbicide, e.g. glyphosate,
- dredging the side and cross channels in order to maintain the water depth. The spoil
 will be placed on the bunds and after drying, will be levelled to provide a smooth
 surface for access and vegetation management,
- clearing tall vegetation along the western 1/2 of the bunds to reduce the landscape profile. The vegetation along the eastern 1/2 of the bunds will be retained as well as the vegetation along the landward bund,
- encouraging native shrubs and grasses (e.g. *Panicum maximum*), along the side of the ponds adjacent to the Closed Area Fence road to screen the compartments from sources of disturbance along the road, e.g. vehicles,
- carrying out water exchange in these ponds as and when water quality in Deep Bay allows.
- continue cooperation with the Hong Kong Bird Ringing Group in the reedbeds of *gei* wai 8, to complete the study to develop a management strategy for the Mai Po reedbeds. In the long-term, consideration should be given to rejuvenating the reedbeds by lowering the floor of the ponds with a bulldozer,
- as part of the on-going study to compare bird use of different types of reed stands in *gei wai* 8, the experimental blocks of reed in Blocks 2 and 3 will be de-silted in summer 2006. Once the reeds have regrown in these two blocks, this will then allow

- comparison of bird use in the reed blocks that have been de-silted (Blocks 2 and 3), and the Blocks that have not (Blocks 4 and 5).
- As there may be a few isolated, small mangrove trees within the experimental reed block in *gei wai* 8, attempts will be made to identify these trees and remove them. As the numbers of these trees are expected to be low, and that they are growing in an area designated for reedbed conservation, no compensation will be carried for the loss of these trees in summer 2006. The loss of these few trees will be more than made up for by the planting of young mangroves in BMZ 6 (see Section 3.1.4).

Although reedbed occur in other Compartments, these Compartments have other priorities that may conflict, e.g. BMZ 8 and BMZ 9 aims to encourage areas of open water. In these cases, encroaching areas of reedbeds will need to be removed. This is because the area of reedbeds has almost doubled since 1973 at the expense of areas of open water that are used by waterbirds. There is thus also an urgent need to control the continued expansion of reeds, particularly into the perimeter water channels of the *gei wai*. Dredging of these silted up channels is now needed. The timetable for these works is follow the timetable below (<u>Table 3</u>)

Table 3: Timetable for reed management works

| Year | Proposed Work (Compartment no.) |
|------|---|
| 2006 | Dredge channels in <i>gei wai</i> 3, 4, 6 and 7 (BMZ 4) |
| 2007 | Dredge channels in gei wai 10, 11 (BMZ 5), 18 and 19 (BMZ 9) |
| 2008 | Remove reeds in ponds 24a – d (BMZ 10) |
| 2009 | Remove reeds in central portion of <i>gei wai</i> 12 – 13 (BMZ 6) |
| 2010 | Dredge channels in <i>gei wai</i> 22 (BMZ 9) |

3.1.6 Goal 1.6 - To develop and manage a diversity of freshwater habitats.

Background

The site over which the present Fairview Park housing estate now stands, used to be a freshwater marsh that was of particular interest because it was the last know breeding site for the Pheasant-tailed Jacana *Hydrophasianus chirurgus* in Hong Kong, as well as being a breeding site for the now scarce Watercock *Gallicrex cinerea* (Webster 1979).

In the late-1990s, a project was initiated within Mai Po Nature Reserve to recreate similar (rain fed) 'freshwater' habitat in an attempt to attract freshwater associated species into the Reserve.

Goal 1.6 will be achieved in *gei wai* 15, 16b, 17b, 20, 22-24.

Compartment BMZ 7

During the summer of 2004, the Waterfowl Collection (*gei wai* 15a and 15b; BMZ 7) was drained to remove the nutrient rich waters caused by the dropping from hundreds of waterfowl that used the pond during the previous winter. As the ponds were drained, shallow freshwater areas were created that attracted a number of waterbirds to breed inside the ponds, particularly Black-winged Stilts *Himantopus himantopus*. As a result, this practise of summer draining will continue from May onwards and the pond will be allowed to refill with the rains from late summer (Section 3.1.3).

Compartment BMZ 8

The Ramsar Site Management Plan states that this compartment should include the landward end of *gei wai* 15c - 19 and all of *gei wai* 23 (Anon 1997). The medium term intention of the Compartment being to adjust conditions in favour of creating an open freshwater area with fringing reeds according to the local salinity gradients; grass-, shingle- or tree-topped islands and pools/channels with varying sizes, heights and depths in order to provide open freshwater roosting areas for waterbirds (Anon 1997).

Management would involve:

- storing rainwater and using it as the main source of freshwater;
- shaping the bunds so that they have gentle slopes;
- reducing the landscape profile by clearing the tall vegetation within the compartment;
- raise the height of the perimeter bund of the southern part of *gei wai* 23 to prevent overtopping during storm/flood by water from the Fairview Nullah.

To create this Compartment, Anon (1997) proposed that minor bund creation would have to be carried out to divide both *gei wai* 18 and 19 into a western and eastern half, with the former being placed in BMZ 9 and the latter in BMZ 8. Furthermore, treated effluent from Fairview Park, as an additional source of freshwater, would be pumped into pond 15c and from there, allowed to circulate into pond 17b, the landward (Eastern) end of *gei wai* 18 and 19, and finally into *gei wai* 23 before being discharged out through the sluice gate into the Fairview Nullah (Anon 1997). However, there is no short- to medium-term plan to carry out the bund creation works or to pump treated effluent into pond 15c because the quality of the effluent from Fairview Park is not of a high enough standard to be discharged into MPNR (Table 2).

Pond 17b

Invasive climbers (e.g. *Strophanthus divaricatus*), have killed the mangroves at the landward side of *gei wai* 17 and the pond has generally become invaded by grasses and terrestrial plants. In the medium-term, consideration will be given to removing the dead mangrove and climbers, deepening the pond, and converting the area into a rain-fed freshwater pond.

Compartment BMZ 9

A primary objective of this compartment is to provide a secure high tide roosting area for waterbirds (Anon 1997). However, pond 20 which lies in this compartment has been successfully managed as a rain-fed freshwater habitat supporting large numbers of roosting waterfowl in winter. It is therefore proposed, that this management of pond 20 be continued and to replace the previous objective of providing a roosting area for waterbirds (see Section 3.1.2).

Compartment BMZ 10

This Compartment consists of *gei wai* 24a-g, and the intention is, in the medium term, to create a series of freshwater lakes of varying depths with surrounding areas of marsh (Anon 1997). Seven ponds make up *gei wai* 24, with only 24a having an operating sluice gate. The ponds are hydrologically separated from each other except that plastic pipes have been in the bund separating ponds 24e and 24f, and between ponds 24f and 24g, to allow water to flow from one to the other when required.

Management of these seven ponds will involve:

- creating rain-fed habitats for freshwater fauna and flora, especially odonates;
- managing 24c and 24e on a trial basis as a buffalo grazing marsh;
- managing the remaining ponds as a variety of freshwater marshes by introducing
 plants such as Barnyard millet (*Echinochloa crus-galli*) Water spinach (*Ipomoea aquatica*) and Knotgrass (*Paspalum disticlum*) to act as food, or cover for wintering
 waterbirds, particularly waterfowl;
- reduce the landscape profile by clearing tall vegetation along the bunds;
- cut the grasses along the pond bunds on a 6-8 week basis from March to November in order to provide roosting sites for waterbirds;
- encourage the growth of native shrubs and grasses (e.g. *Panicum maximum*), by the side of the ponds adjacent to the Fairview Nullah, to act as a screen against disturbance along the footpath that runs round the southern part of MPNR.

Earthmoving works will also be carried out to:

- remove the invading reed grasses in ponds 24a-d
- form areas of deep and shallow water in the ponds, and to increase the height of the
 external bund to prevent overtopping during storm and floods by water from the
 Fairview Nullah;
- lowering and grading the internal bunds to create shallows and bays.

3.1.7 Goal 1.7 - Maintain the traditional operation and landscape of the gei wai habitat

Background

The commercial shrimp ponds at Mai Po (locally called 'gei wai'), are of historical, cultural and ecological importance. This is because they were created from the coastal mangroves in the mid-1940s and now are probably the only shrimp ponds still being managed traditionally in China. The artefacts (e.g. gei wai huts, sluice gates for draining and flooding the ponds etc.) and landscape associated with gei wai shrimp farming are still very evident in the Reserve, and an important part of the experience by visitors to the Reserve. Traditional gei wai management has also maintained the ecological value of Mai Po by maintaining large areas of mangroves within the ponds, and by providing feeding, roosting and breeding habitat for many species of wildlife, particularly waterbirds.

Compartment BMZ 6

This goal will be achieved in BMZ 6 (*gei wai* 12 – 14) where the long-term intention is to maintain traditionally managed production *gei wai* with areas of mangrove vegetation (Anon 1997). Management will involve:

- maintaining the traditional *gei wai* landscape (<u>Figure 7</u>; Section 3.1.4), as well as features of cultural interest, e.g. sluice gates, and huts;
- monitoring the spread of climbers, e.g. *Derris trifoliata* and *Mikania micrantha*, in the mangroves and controlling them when necessary;
- promoting the spread of mangroves in the *gei wai* by active planting when necessary;
- keeping updated records of the frequency of water exchange, as well as the diversity and abundance of shrimps and fish in the *gei wai* at the end of winter draining;
- maintain the water depth in the side and cross channels by dredging when necessary;
- managing tall vegetation along the western 2/3 of the bunds to reduce the landscape profile. The vegetation along the eastern 1/3 of the bunds will be retained as well as

the vegetation along the landward bund and by the side of the footpaths between *gei* wai 12/13 (Figure 3, 4);

• encourage the growth of native shrubs and grasses (e.g. *Panicum maximum*), along the side of the ponds adjacent to the Closed Border Area Fence to screen the relevant compartments from the Border Road.

3.1.8 Goal 1.8 - Identify and maintain habitats for other focal key species and species groups.

Background

The key species for which Mai Po Nature Reserve is important has been listed in Sections 1.2.2.1 and 2.2.2. For a number of these species (e.g. Black-faced Spoonbills) and species groups (e.g. shorebirds and waterfowl), it is possible to manage the Reserve to provide feeding and roosting habitats for them. However, this is not possible for other species because their survival is not directly dependent on how the Reserve is managed, e.g. e.g. Dalmatian Pelicans *Pelecanus crispus* that feeds and roosts mainly out in Deep Bay. For a third group of key species, e.g. Eurasian Otter *Lutra lutra chinensis*, there is insufficient information on their requirement in order to manage the Reserve to provide suitable habitat for them.

Over the course of this Plan therefore, work will focus on two species in order to understand their distribution and habitat use within Mai Po, so that appropriate management strategies can be developed for them. The species selected and the rationale for selecting them are:

- (1) *Mortonagrion hirosei*. This is an endangered species of damselfly with a limited distribution in Hong Kong but which has been found in the reedbeds of the Mai Po *gei* wai.
- (2) Eurasian Otter *Lutra lutra*. This mammal is declining in China and as a result, is listed as a Class II National Protected Species. Although Otters have been recorded in past unpublished mammal surveys carried out at Mai Po by the Agriculture, Fisheries and Conservation Department and the Wildlife Conservation Fund, a Hong Kong based environmental NGO, there is very little information on their distribution and abundance.

With further research on these species, it may be possible to produce plans for their conservation within MPNR. Such research will be encouraged over the duration of this management plan, 2006 - 2010.

Overall, as this management plan includes strategies for the conservation management of the major habitats at MPNR, i.e. mangroves, reedbeds, *gei wai* and rain-fed freshwater marshes, it should be possible to conserve many of the key species through appropriate management of their habitats.

3.1.9 Goal 1.9 - Carry out additional management to support achievement of the above objectives.

Tree management

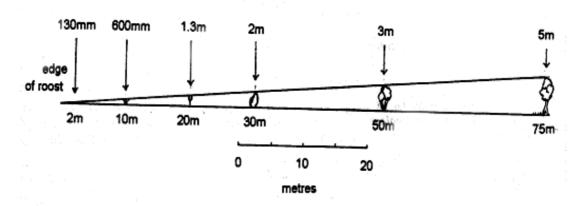
After the construction of the Closed Border Area Fence Road in the early 1980s, *gei wai* fishermen were able to drive along the new road to reach their *gei wai* sluice gate for shrimp harvesting, rather than having to walk along the *gei wai* bunds. As a result, the bunds became more forested without the regular cutting and burning that the fishermen used to carry out to keep open the footpaths along the bunds.

Planting of native trees on the landward side of MPNR since 1976, has also contributed to the Reserve becoming forested. The reasons for this planting were:

- to mark the landward boundary of the Reserve;
- to provide shade for visitors;
- to act as a visual screen against adjacent developments;
- to provide food for frugivorous birds.

The new-forested landscape has an unanticipated adverse impact on the migratory waterbirds that use MPNR. For example, observation of shorebirds using *gei wai* 16/17 (the 'scrape'), showed that as the pond bunds became more forested in the early 1990s, fewer shorebirds began to use the 'scrape' to roost at high tide. When the tall trees were removed in 1996, the shorebirds returned again. The adverse impact of tall vegetation on the number of waterbirds using roost sites has also been found in Australia, where Lawler (1995) stated that "...roosts need to be open areas...with 30m buffer to visual obstructions of 2m height (wider if obstructions are higher)..." (Figure 8).

Figure 8: Relationship between distance to and height of visual barriers at a wader roost, expressed as an angle. Useful in prescribing buffer distances to different heights of obstructions (From: Lawler, W. 1995. Wader roost construction in Moreton Bay. Ecopix, Australia)



As a result, there is a need to reduce the landscape profile of the Reserve and this is supported by the management plan for the Ramsar Site (Anon 1997). Therefore, management of the height and lateral growth of the trees will continue along the western two thirds of the bunds of the central and northern $gei\ wai\ (\#3-19)$. However, the trees along the eastern third of these bunds will not be managed, nor the trees on either side of the main footpaths (Figure 3, 4) This includes the footpath from the AFCD Nature Warden Post to the Wildlife Education Centre, between $gei\ wai\ 12$ and 13, and between $gei\ wai\ 18$ and 19. In the southern part of MPNR ($gei\ wai\ 20-24$), the landscape profile will be reduced along all the pond bunds in order to create an open landscape. Furthermore, any saplings found along the bunds with a diameter breast height of < 30 cm will be removed.

If any trees need to be felled as part of the tree management programme, then permission for the work will first be obtained from the District Lands Office – Yuen Long, and compensation replanting undertaken using shrubs, such as *Rhaphiolepis indica*, in order to maintain a low landscape profile.

Earthmoving works

There has been a history of earthmoving projects at MPNR, dating back to the construction of the *gei wai* in the mid-1940s. Since then, the *gei wai* operators have carried out dredging of the channels in their *gei wai*, as well as sub-dividing a number of their *gei wai* into smaller ponds for fish cultivation in the 1970s. After WWF Hong Kong began taking over management of MPNR, a number of earthmoving projects were carried out, including:

- 1986, to combine gei wai 16 and 17 into a single gei wai;
- winter of 1991/92, to deepen the section of gei wai 8 in front of the Tower Hide;
- 1997, lowering the internal bunds of pond 20 and turning it into a rain-fed freshwater marsh;
- winter of 2000/01, earthmoving works in *gei wai* 23 to create shallow islands at the southern end of the pond for roosting and breeding waterbirds;
- 2001, deepening pond 16b to convert it into a rain-fed freshwater marsh;
- 2004, lowering Island No. 3 in *gei wai* 16/17 and the creation of a number of smaller, lower islands;
- 2005, removing invasive grasses and desilting the northern edge of *gei wai* 16/17.

All of these projects involve draining the *gei wai* or pond, and then using heavy earthmoving machinery. As a result, the projects were all carried out in the dry season (October – March), in order to avoid the heavy rains that would otherwise cause serious delays. However, there have been comments that draining such *gei wai* or ponds for earthmoving works over the whole of the dry season may impact the wintering waterbirds that use the *gei wai* or pond. Therefore, all future earthmoving projects will only be carried out in the first half of the dry season; i.e. from September to October.

3.1.10 Goal 1.10 - To develop monitoring programmes that will contribute to the above objectives.

In order to determine the success or otherwise of all management interventions, there is a need for comprehensive monitoring of the baseline ecology of the Reserve as well as to monitor the success of any large-scale habitat management works, e.g. earthmoving works. The results of these monitoring projects will be reported back to the Mai Po Management Committee and fed back to improve the management of Mai Po.

One of the Mai Po Reserve Officers has been tasked with coordinating the baseline ecological monitoring of selected physical and biological parameters under an agreed programme at MPNR, as well as monitoring the success of all habitat intervention projects.

3.1.11 Goal 1.11 - To review regularly the management plan in the light of results from the monitoring programme, research and changing circumstances.

From the ecological information collected by the Mai Po Reserve Officer, the Reserve Manager will then make adaptive changes, where necessary, to the Management Plan.

A detailed review of the Mai Po Management Plan will be conducted every 5-year, whilst WWF's Mai Po Management Committee will conduct annual reviews of the progress on implementing the Management Plan and they will also approve any changes to the Plan.

3.1.12 Goal 1.12 - To abide by local legislations and meet obligations under agreed international conventions and relevant inter-governmental agreements.

To abide by all legislation that affects the management of Mai Po, such as:

- the conditions stated within the Land Licenses for each *gei wai*;
- the provisions of the Wild Animals Protection Ordinance (Cap. 170), and the Forestry and Countryside Ordinance (Cap. 96);
- the permitted uses and conditions under the Outline Zoning Plan, Town Planning Ordinance and EIAO;
- the Articles, recommendations and resolutions of the Ramsar Convention and the Bonn Convention on Migratory Species;
- and any other legal obligations.

3.1.13 Work Programme

The projects that will be undertaken to fulfil Management Objectives 1.1 to 1.12 are summarized in <u>Table 4</u>, and a priority rating and timetable for carrying out each of the projects is given in <u>Table 5</u>

3.2 PRESCRIPTIONS TO ACHIEVE MANAGEMENT GOAL 2

Prescriptions to achieve the Management Goals of the Education Strategy will be drafted by the Education Department of WWF Hong Kong.

3.3 PRESCRIPTIONS TO ACHIEVE MANAGEMENT GOAL 3

Prescriptions to achieve the Management Goals of the Training Strategy will be drafted by the Training Department of WWF Hong Kong.

3.4 PRESCRIPTIONS TO ACHIEVE MANAGEMENT GOAL 4

The Reserve Officer with responsibility for monitoring and research at Mai Po will keep close contact with government departments, other organisations, researchers, visitors, academics, consultants and people with experience or knowledge about the Reserve, about any monitoring or research projects they are carrying out within the Reserve. The Reserve Officer will also keep an updated list of the monitoring and research projects being undertaken at the Reserve, and the results of those projects.

A review of the 'Mai Po Monitoring Programme and Strategy' is now in progress and will be appended to the Mai Po management Plan as a separate document.

Table 4: Management Objectives serving Goal 1

| | Management Objectives | | Rationale and Specified Limits | Cross- reference | | Performance indicator (1) |
|-----|--|---|--|---------------------|---|---|
| 1.1 | roosting and feeding | BMZ 4 [but also BMZ 5 – 6, 8 – 10] | Mai Po provides roosting and feeding habitats for more than 20% of the wintering population of this endangered species. The Reserve thus has a responsibility to maintain suitable habitats for this species and to maintain and if possible, increase the numbers wintering at the Reserve. | 3.1.1 | Tasks will include; 1) Provision of roosting habitat by management of water levels and vegetation management in selected <i>gei wai</i> , particularly gei wai 6, 8 and 16/17. 2) Provision of feeding habitat by sequential draining of <i>gei wai</i> 8, 10, 11, 12, 13, 14, 18 and 19 in winter | Roosting habitat provided in BMZ4 for an average of 50% or more of the Black-faced Spoonbill wintering in Deep Bay, and feeding habitat for 20% of the same population in the <i>gei wai</i> during winter drain down. |
| 1.2 | roosting sites for the | BMZ 9 and selected ponds in BMZ 4 and 5 | Mai Po provides a high-tide roosting site for up to 10,000 shorebirds during passage. Whilst some of these species are globally threatened, others are present in significant numbers for the East Asian region. The Reserve thus has a responsibility to maintain suitable roosting sites for these species and to maintain and if possible, to increase the numbers roosting in the Reserve. | 3.1.2 | Manage water levels and remove tall vegetation in and along the bunds of the following <i>gei wai</i> to provide high-tide roosting sites for shorebirds; 1) <i>Gei wai</i> 8 2) <i>Gei wai</i> 11 3) <i>Gei wai</i> 16/17 4) Provide baseline for the number of shorebirds roosting in these ponds 5) Monitor the number of shorebirds roosting in <i>gei wai</i> 8, 11 and 16/17, and in the Reserve as a whole (with assistance from the HKBWS) | Roosting habitat provided in BMZ9 and <i>gei wai</i> 6, 8 and 11 for an average of 60% of the shorebirds in Deep Bay during spring and autumn passage. |
| 1.3 | feeding sites for the wintering waterfowl in Deep Bay. | BMZ 7-10 | Mai Po provides a roosting and feeding site for up to 20,000 wintering waterfowl. Whilst some of these species are globally threatened, others are present in significant numbers for the East Asian region. The Reserve thus has a responsibility to maintain suitable habitats for these species. | | Tasks will include; Management of water levels Reduce the landscape profile along the bunds of BMZ8 – 10 by managing the height of the trees Maintenance of a healthy population of wild waterfowl in the Waterfowl Collection (pond 15a and 15b) Monitor the number of waterfowl in the Reserve. | Roosting habitat provided in <i>gei wai</i> 15a-b, 16/17, Pond 20 and 24 for an average of 20% of the waterfowl wintering in Deep Bay. |
| 1.4 | To maintain and manage the mangrove habitats. | BMZ6, 9, CZ 1 | Deep Bay supports the largest area of mangroves in Hong Kong and sixth largest protected area in China. As such, the Reserve has an obligation to maintain the present area and diversity of mangroves. However, the area of mangroves on the Deep Bay mudflat has to be managed to maintain a balance between mangrove and mudflat. | | Tasks will include: Monitoring the area of mangroves in the Reserve; Encourage research on effective ways of removing invasive climbers from affected mangrove areas; Mangrove planting in degraded areas in BMZ6; Monitor and control the spread of the invasive <i>Sonneratia</i> spp. | By 2010, an area of 10.5 ha of mangroves in BMZ6 maintained through appropriate management, such as removal of invasive vegetation (e.g. reeds and climbers) and water level control. The total area of mangroves within MPNR in 2010 will be 24 ha. |

| | Management Objectives | Compartment(s) | Rationale and Specified Limits | Cross- reference | Project Group | Performance indicator (1) |
|-----|---|--|---|---------------------------|---|--|
| 1.5 | habitats. | in BMZ5 but control expansion into open water in | Mai Po supports the largest area of reedbeds in Hong Kong and probably the largest in Guangdong Province. As such, the Reserve has an obligation to maintain the present area of reedbeds. However, there is a need to control the spread of reeds in open areas of water throughout the Reserve. | 3.1.5 | Tasks will include; 1) Monitoring the area of reedbed in the Reserve, 2) Complete the study in <i>gei wai</i> 8 to develop a long-term management strategy for the Mai Po reedbeds, 3) Prevent reed encroachment into open areas of water | By 2010, an area of 15.4 ha of reedbeds in BMZ5 maintained through appropriate management, such as the removal of invasive vegetation, and excavating and removing the accumulated silt from the pond floor. The total area of reedbed within MPNR in 2010 will be 37 ha. |
| 1.6 | To develop and manage a diversity of freshwater habitats. | BMZ 7, 8, 10 and selected ponds in BMZ 9 | The creation of freshwater habitats will complement the existing brackish water habitats at Mai Po (i.e. gei wai), by attracting a greater diversity of wildlife, particularly odonates, into the Reserve. These new habitats will also in part, make up for the freshwater marshes close to Mai Po that had been destroyed in the past decades. | 3.1.6 | Creation of freshwater habitat in; 1) Pond 15a-c, 16b and 17b, 20, 22 -24 2) Monitor abundance and diversity of odonates in the freshwater habitats. | An area of 40 ha of rain-fed freshwater habitat developed and maintained, particularly in ponds 15, 16b, 17b and 20, and <i>gei wai</i> 23 – 24, through appropriate management, such as through the periodic draining and re-filling of the pond with fresh rainwater every 1-3 years. The total area of freshwater habitat within MPNR in 2010 will be 35 ha. |
| 1.7 | operation and landscape | BMZ 6 but also throughout the Reserve | Mai Po supports the last area of traditionally managed tidal shrimp ponds (<i>gei wai</i>) in Hong Kong, and one of the last in Asia. This system is seen as an example of sustainable shrimp production despite many of the ponds being seriously affected by water pollution in Deep Bay. The traditional system of <i>gei wai</i> operation helps maintain the ecological value of Mai Po. The regular draining and reflooding of the pond is required to maintain a healthy stands of mangroves within the <i>gei wai</i> , and the sequential winter drain down creates feeding habitats for ardeids and other piscivorous birds. | 3.1.7 | Management tasks will involve: 1) Maintain traditional <i>gei wai</i> water levels and frequency of exchange. Maintenance tasks will involve: 1) Dredge channels at frequent interval to remove the accumulated silt; 2) maintenance of structures associated with traditional <i>gei wai</i> , such as the sluice gates, huts, sampans and bunds | Traditional operation and landscape of the <i>gei wai</i> habitats in BMZ6 maintained by appropriate water level control and management of the vegetation in the ponds and along the bunds. |
| 1.8 | Identify and maintain habitats for other focal key species and species groups. | All compartments | To provide habitat for the other key habitats and species that Mai Po is important for (other than those listed in 1.1 – 1.3), so that their numbers can be maintained and if possible, increased. These include: 1) <i>Mortonagrion hirosei</i> ; 2) Eurasian Otter <i>Lutra lutra</i> ; 3) Ardeids | 3.1.8 3.4.1 – 3.4.3 | Task will include; 1) Surveys for the abundance and distribution of these groups within MPNR; 2) Identify the habitat requirements for these species; 3) Draft strategies for the management of the habitats that these species depend upon. | The survival of these key species and species group ensured through implementation of monitoring programmes and research projects, as well as through appropriate habitat management works. |

| | Management Objectives | Compartment(s) | Rationale and Specified Limits | Cross- reference | Project Group | Performance indicator (1) |
|------|--|------------------|---|---------------------|--|---|
| 1.9 | Carry out additional management to support achievement of the above objectives. | All compartments | Where opportunities arise but without compromising the above objectives, additional management will be carried out to achieve the above objectives. | 3.1.9 | Tasks will include; Tree management along the western two thirds of the bunds separating gei wai # 3-19 Manage mangrove seedlings in front of the floating hides Native tree planting along the southern and eastern perimeter bunds Encourage tall grasses along the northern and western perimeter bunds as a barrier to disturbance along the Border Fence road | The objectives above achieved through scheduled and adaptive management works. |
| 1.10 | To develop monitoring programmes that will contribute to the above objectives. | All compartments | Maintain and when required, expand the baseline ecological monitoring programme at Mai Po. Then as the opportunities arise, cooperate with partners (e.g. government departments and tertiary institutes) to conduct monitoring and research projects that will contribute to the above objectives. | | Tasks will include; 1) Maintaining the present baseline ecological monitoring programme 2) Expand the monitoring programme where and when appropriate 3) Explore opportunities with government departments and tertiary institutes to initiate additional monitoring and research programmes at Mai Po. | The objectives above achieved through implementation of appropriate monitoring programmes. |
| 1.11 | To review regularly the management plan in the light of results from the monitoring programme, research and changing circumstances. | All compartments | To ensure that the Mai Po Management Plan is being implemented according to plan and to incorporate any new information from monitoring and research projects that will help in the management of the Reserve. | 3.1.11 | Review progress on the Management Plan on a quarterly basis | Management Plan is reviewed annually at the January meeting of the Mai Po Management Committee. |
| 1.12 | To abide by local legislation and meet obligations under agreed international conventions and relevant intergovernmental agreements. | - | This is to ensure that management is in line with local legislation and international obligations. | 3.1.12 | Maintain close contacts with: 1) AFCD, ACE Conservation Subcommittee, DLO-YL and other relevant government Departments and bodies; 2) Government officials and departments on the Mainland, P.R.China; 3) East Asian/Australasian Flyway Programme; 4) Shorebird Site Network; 5) Anatidae Site Network; 6) Ramsar Bureau and the offices of other relevant international conventions. | Local legislations and obligations under agreed international conventions and relevant intergovernmental agreements followed. |

⁽¹⁾ These performance indicators are based on previous data and are subject to adjustment when more ecological information can be obtained.

Table 5: Timetable for projects to achieve Management Goal 1

Key to priorities

- (1) Core projects that should be implemented from Mai Po's budget.
- (2) Projects that ought to be implemented if funding becomes available. These projects are normally dependent on the successful achievement of priority 1 projects, and may progress onto being priority 1 projects in future.
- (3) Projects of lower priority that may be carried out if resources allow, or increase in priority if circumstances change.

| | Projects to achieve Management Goal 1 | Priority Rating (Year) | | | | | |
|-----|--|------------------------|------|------|------|------|--|
| | Project Title | 2006 | 2007 | 2008 | 2009 | 2010 | |
| 1.1 | To provide suitable roosting and feeding habitats for Black- | | | | | | |
| | faced Spoonbills | | | | ' | | |
| | Provision of roosting habitat | 1 | 1 | 1 | 1 | 1 | |
| | Provision of feeding habitat | 1 | 1 | 1 | 1 | 1 | |
| | | | | | | | |
| 1.2 | To provide suitable high tide roosting sites for a significant | | | | | | |
| | population of the shorebirds in Deep Bay | | | | | | |
| | Provide high-tide roosting site in gei wai 6 | 1 | 1 | 1 | 1 | 1 | |
| | Provide high-tide roosting site in gei wai 8 | 1 | 1 | 1 | 1 | 1 | |
| | Provide high-tide roosting site in <i>gei wai</i> 11 | 1 | 1 | 1 | 1 | 1 | |
| | Provide high-tide roosting site in <i>gei wai</i> 16/17 | 1 | 1 | 1 | 1 | 1 | |
| | Removal of tall vegetation close to roost sites | 1 | 1 | 1 | 1 | 1 | |
| | De-silt gei wai 21 and reprofile the pond floor | | | | 1 | 1 | |
| | | | | | | | |
| 1.3 | To provide suitable roosting and feeding sites for a | | | | | | |
| | significant population of the wintering waterfowl in Deep Bay | | | | | | |
| | Management of water levels(gei wai #20 - 24) | 1 | 1 | 1 | 1 | 1 | |
| | Removal of tall vegetation close to roost sites | 1 | 1 | 1 | 1 | 1 | |
| | Waterfowl Collection maintainence – bunds | | | | 3 | 3 | |
| | Waterfowl Collection maintainence – islands | | | | 3 | 3 | |
| | | | | | | | |
| 1.4 | To maintain and manage the mangrove habitats | | | | | | |
| | Maintain the present area of mangroves at Mai Po | 3 | 3 | 3 | 3 | 3 | |
| | Monitor the distribution and 'health' of key species, e.g | 3 | 3 | 3 | 3 | 3 | |
| | Avicennia marina and Bruguiera conjugata | | | | | | |
| | Mangrove planting in degraded areas | 2 | 2 | 2 | 2 | 2 | |
| | Climber management - intertidal mangroves | 1 | 3 | 3 | 1 | 3 | |
| | Climber management - gei wai mangroves | 1 | 2 | 1 | 1 | 2 | |
| | | | | | | | |
| 1.5 | To maintain and manage the reedbed habitats | | | | | | |
| | Monitoring the area of reedbeds in the Reserve | 3 | 3 | 3 | 3 | 3 | |
| | Use herbicides to control reed encroachment into the | 1 | 1 | 1 | 1 | 1 | |
| | perimeter <i>gei wai</i> channel | | | | | | |
| | De-silt Blocks 2 and 3 in the experimental reedbeds in gei | 1 | | | | | |
| | wai 8 | | | | | | |
| | Dredge channels in <i>gei wai</i> 3, 4, 6, and 7 | 1 | 2 | | | | |
| | Dredge channels in <i>gei wai</i> 10, 11 and 18, 19 | | 1 | 2 | | | |
| | Remove reeds from ponds 24a-d | | | 1 | 2 | | |
| | Remove reeds from central portion of gei wai 12 and 13 | | | | 1 | 2 | |
| | Dredge channels in <i>gei wai</i> 22 | | | | | 1 | |
| | | | | | | | |
| 1.6 | To develop and manage a diversity of freshwater habitats | | | | | | |
| | Remove colonizing vegetation in <i>gei wai</i> 9 | | 2 | | | | |
| | Remove colonizing vegetation in <i>gei wai</i> 17b | | | 2 | | | |

| | Maintain freehwater habitat in goi wai 20 | 1 | 1 | 1 | 1 | 1 |
|------|--|---|---|---|---|---|
| | Maintain freshwater habitat in <i>gei wai</i> 20 | | 1 | | - | |
| | Maintain freshwater habitat in <i>gei wai</i> 24 | 1 | 1 | 1 | 1 | 1 |
| | De-silt pond 17b and conversion into a freshwater pond | | I | 1 | 1 | |
| 1.7 | Maintain the traditional operation and landscape of the <i>gei</i> wai habitats | | | | | |
| | Management - gei wai water levels | 1 | 1 | 1 | 1 | 1 |
| | Maintainence - dredge channels gei wai 3 and 4 | 1 | | | | |
| | Maintainence - dredge channels gei wai 19 | | 1 | | | |
| | Maintainence - dredge channels <i>gei wai</i> 23 | | | 1 | | |
| | Maintainence - gei wai sluice gates | 1 | 1 | 1 | 1 | 1 |
| | Maintainence - leaks in the <i>gei wai</i> bunds | 1 | 1 | 1 | 1 | 1 |
| | Maintainence - gei wai huts | 1 | 1 | 1 | 1 | 1 |
| | | | | | | |
| 1.8 | Identify and maintain habitats for other focal key species and species groups | | | | | |
| | Develop and carry out management plans for key species | 2 | 2 | 2 | 2 | 2 |
| 1.9 | To carry out additional management to support achievement of the above objectives | | | | | |
| | Manage mangrove seedlings in front of the floating hides | 1 | 1 | 1 | 1 | 1 |
| | Maintain the present area of sedge habitat | 2 | 2 | 2 | 2 | 2 |
| | Tree management along the western two thirds of the bunds separating <i>gei wai</i> 3-19 | 2 | 2 | 2 | 2 | 2 |
| | Encourage tall grasses along the northern and western perimeter bunds | 1 | 1 | 1 | 1 | 1 |
| | Remove tall vegetation from in front of the hides | 1 | 1 | 1 | 1 | 1 |
| 1.10 | To develop monitoring programmes that will contribute to the above objectives | | | | | |
| | Black-faced Spoonbill use of feeding and roosting sites | 1 | 1 | 1 | 1 | 1 |
| | Shorebird use of high-tide roosting sites | 1 | 1 | 1 | 1 | 1 |
| | Waterfowl use of habitats inside the Reserve | 1 | 1 | 1 | 1 | 1 |
| | Distribution and abundance of key species | 2 | 2 | 2 | 2 | 2 |
| | Area of mangrove habitat | 3 | | | | 3 |
| | Distribution of invasive climbers | 3 | | 3 | | 3 |
| | Area of reedbed habitat | 3 | | | | 3 |
| | Wildlife recolonization into newly created freshwater habitats | 1 | 1 | 1 | 1 | 1 |
| | Gei wai shrimp production | 1 | 1 | 1 | 1 | 1 |
| | | | | | | |
| 1.11 | To review regularly the management plan in the light of results from the monitoring programme, research and changing circumstances | | | | | |
| | Review progress on the Management Plan on an annual basis | 1 | 1 | 1 | 1 | 1 |
| 1.12 | To abide by local legislations and meet obligations under agreed international conventions and relevant intergovernmental agreements | | | | | |
| | Relevant Hong Kong SAR Government Departments and bodies | 1 | 1 | 1 | 1 | 1 |
| | Mainland P.R. China Government officials and departments | 2 | 2 | 2 | 2 | 2 |
| | East Asian/Australasian Flyway Programme | 2 | 2 | 2 | 2 | 2 |
| | Offices of relevant international conventions, e.g. Ramsar | 2 | 2 | 2 | 2 | 2 |
| | | | | | | |

This management Plan has identified three main research projects that the Reserve will focus on during the course of the 2006 – 2010 Mai Po Management Plan. These are as follows:

3.4.1 To investigate the distribution and habitat use by the endangered damselfly Mortonagrion hirosei.

Mortonagrion hirosei is an endangered species of damselfly with a limited distribution in Hong Kong but which has been found in the reedbeds of the Mai Po gei wai. A study will be carried out on the distribution and abundance of this species at Mai Po and at the same time, similar data on the other species of odonates present at Mai Po will be recorded. It is hoped that the results will provide an indication on the habitat preferences of Mortonagrion hirosei and other species of odonates so that particular areas in the Reserve can then be specially managed to provide habitat for these species.

3.4.2 To investigate Distribution and habitat use by the Eurasian Otter Lutra lutra.

The Eurasian Otter *Lutra lutra* is declining in China and as a result, is listed as a Class II National Protected Species. Although Otters have been recorded in past unpublished mammal surveys carried out at Mai Po by the Agriculture, Fisheries and Conservation Department and the Wildlife Conservation Fund (a Hong Kong based environmental NGO), there is very little information on their distribution, abundance and habitat preference within MPNR. As a result, a survey using automatic camera traps placed in a grid system across the Reserve will be carried out, to collect baseline information on their distribution. It is hoped that the data collected will give an indication of the habitat preferences of the Otters at Mai Po so that management can be geared to provide appropriate habitat for the species. This study will also likely provide valuable information on the distribution and habitat preference of other mammals within MPNR, e.g. Leopard Cats, so that the conservation management of these species in the Reserve can be improved.

3.4.4 Work Programme

The projects that will be undertaken to fulfil Management Objectives 2.1 to 2.3 is summarized in Table 6, and a priority rating and timetable for carrying out each of the projects is given in Table 7.

Table 6. Management Objectives serving Goal 4

| | Management Objectives | Compartments | Rationale and Specified Limits | Cross- reference |
|-----|---|------------------|---|---------------------|
| 2.1 | To investigate the distribution and habitat use by the endangered damselfly <i>Mortonagrion hirosei</i> . | BMZ 5 - 10 | The endangered damselfly Mortonagrion hirosei is a key species for the freshwater habitats at Mai Po and such a study will provide baseline information on other odonates species within MPNR so that a management strategy can be developed for this group of wildlife. | 3.4.1 |
| 2.2 | To investigate the distribution and habitat use by the Eurasian Otter <i>Lutra lutra</i> . | All compartments | Most records of this uncommon mammal is from the Deep Bay wetlands, including the MPNR. A study on this species will gather baseline information for understanding their habitat requirements and thus, allow for the development of a management strategy for this species. It is hoped that the study will yield information on other species of mammals, e.g. Leopard Cat. | 3.4.2 |

Table 7. Timetable for projects to achieve Management Goal 4

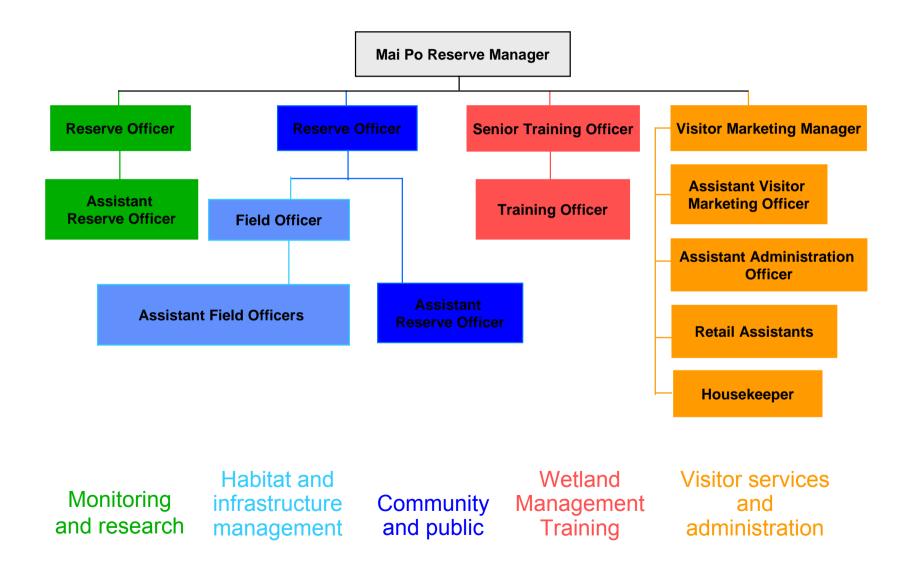
Key to priorities

- 1. Core projects that should be implemented from Mai Po's budget.
- 2. Projects that ought to be implemented if resources become available. These projects are normally dependent on the sucessful achievement of priority 1 projects, and may progress onto being priority 1 projects in future.

 3. Projects of lower priority that may be carried out if resources allow, or increase in priority if circumstances change.

| Projects to achieve Management Goal 4 | | Priority rating (Year) | | | |
|---|------|------------------------|------|------|------|
| Project Title | 2006 | 2007 | 2008 | 2009 | 2010 |
| To investigate the distribution and habitat use by the endangered damselfly <i>Mortonagrion hirosei</i> . | 1 | 1 | 1 | 2 | 2 |
| To investigate Distribution and habitat use by the Eurasian Otter <i>Lutra lutra</i> . | 2 | 2 | 1 | 1 | 1 |

Appendix 1: Staff Structure at Mai Po Nature Reserve



Appendix 2: Mai Po Researches

1957

Poon, S.C. 1957. *Land utilization of the marshes north of Tung Tau Tsuen*. Unpub. B.A. thesis, University of Hong Kong, Hong Kong.

1970

Chan, S.Y. 1970. The changing landuse pattern in Tin Shui Wai - and example of the reclamation of swamps and marshes for agricultural purposes in the New Territories. Unpub. B.A. thesis. University of Hong Kong, Hong Kong.

1986

- Leung, K.W. 1986. *Landuse and landuse changes in the Deep Bay area*. Unpub. B.A. thesis. University of Hong Kong, Hong Kong.
- Pong, M.W. 1986. *The marketing of oysters and gei wai shrimps in Deep Bay*. Unpub. B.A. thesis. University of Hong Kong, Hong Kong.
- Wong, C.M. 1986. Shrimp farming in Deep Bay The evolution and present situation of a traditional industry. Unpub. B.A. thesis. University of Hong Kong, Hong Kong.

1988

Lee, S.Y. 1988. The ecology of a traditional tidal shrimp pond in Hong Kong, the production and fate of macrodetritus and implications for management. Unpub. Ph.D. thesis. University of Hong Kong, Hong Kong.

1989

- Anderson, C. 1989. The effects of sexual selection on the feeding ecology of <u>Uca arcuata</u> (Decapoda, Brachyura, Ocypodidae), a fiddler crab of a Hong Kong mangrove ecosystem. Unpub. final year B.Sc. project. University of Southampton, U.K.
- Chan, K.Y. 1989. The ecology of mudskippers (Pisces: Periophthalmidae) at the Mai Po Marshes Nature Reserve, Hong Kong. Unpub. M.Phil. thesis. University of Hong Kong, Hong Kong, Hong Kong.

1990

Wong, F.K.O. 1990. *Habitat utilization by Little egrets breeding at Mai Po egretry*. Summer project. Chinese University of Hong Kong, Hong Kong.

1991

- Britton, A.R.C. 1991. *Feeding behaviour in the Little egret*. Unpub. final year B.Sc. project. University of Leeds, U.K.
- Choi, K.C. 1991. The ecology of fiddler crabs (Crustacea: Ocypodidae) at the Mai Po Marshes Nature Reserve, Hong Kong. Unpub. M.Phil. thesis. University of Hong Kong, Hong Kong.
- Leung, S.F. 1991. The population dynamic of <u>Metapenaeus ensis</u> (Penaeidae) and <u>Exopalaemon styliferus</u> (Palaemonidae) in a traditional tidal shrimp pond at the Mai Po Marshes Nature Reserve, Hong Kong. Unpub. Ph.D. thesis. University of Hong Kong, Hong Kong.

1992

- Chan F.M. 1992. Heavy metals in the tissues of <u>Oreochromis mossambicus</u> and <u>Coutierella tonkinensis</u> at Mai Po. Unpub. final year B.Sc. project. Baptist College, Hong Kong.
- Chiu Kin-tung. 1992. An assessment of the water pollution status of the Mai Po Marshes Nature Reserve, Hong Kong. Unpub. Ph.D. thesis, University of Hong Kong, Hong Kong.

1993

- Keung, M.K. 1993. A study on the behaviours of Comorants in Mai Po. Unpub. final year B.Sc. project. City Polytechnic of Hong Kong, Hong Kong.
- Kwok, K. 1993. Effect of water level fluctuation of gei wai on distribution of waders in the Mai Po Marshes. Unpub. final year B.Sc. project. City Polytechnic of Hong Kong, Hong Kong.
- Ma, K.K. 1993. A study on the behaviours of Cormorant in Mai Po. Unpub. final year B.Sc. project, City Polytechnic of Hong Kong, Hong Kong.
- Pearson, S. 1993. A comparison of the use of habitats for feeding by Chinese pond herons and Little egrets in 1989, 1990 and 1993, with special emphasis on commercial fishponds in Hong Kong. Extended essay Environmental Systems. Li Po Chuen College, Hong Kong.
- Tsang, S.C. 1993. To monitor the heavy metal content in the polychaeta <u>Dendronereis</u> <u>pinnaticirrus</u> in Mai Po mudflat. Unpub. final year B.Sc. project. City Polytechnic of Hong Kong, Hong Kong.
- Wong, Y.M. 1993. *Comparison of mudflat invertebrate densities in different parts of the Deep Bay mudflats*. Unpub. final year B.Sc. project. City Polytechnic of Hong Kong, Hong Kong.
- Young, L. 1993. The ecology of Hong Kong Ardeidae (Aves) with special reference to the Chinese Pond Heron at the Mai Po Marshes Nature Reserve, Hong Kong. Unpub. Ph.D. thesis, University of Hong Kong, Hong Kong.

1994

- Anderson, C. 1994. The production ecology of the mangrove at the Mai Po Marshes Nature Reserve, Hong Kong. Unpub. Ph.D. thesis, University of Hong Kong, Hong Kong.
- Chan, C.K. 1994. Effect of nutrient enrichment on macroinvertebrates in a Mai Po gei wai. Unpub. final year B.Sc. project, City Polytechnic of Hong Kong, Hong Kong.
- Hui, S.H. 1994. Species composition and abundance of benthic macroinvertebrates in Mai Pogei wai. Unpub. final year B.Sc. project. City Polytechnic of Hong Kong, Hong Kong.
- Hui, S.H. 1994. The distribution of the invertebrates in three different regions of gei wai 3 in different seasons and the factors affecting their abundance. Unpub. final year B.Sc. project. City Polytechnic of Hong Kong, Hong Kong.
- Kwok, Y.W. 1994. *Study of benthic invertebrates in Mai Po gei wai*. Unpub. final year B.Sc. project. City Polytechnic of Hong Kong, Hong Kong.
- Leung, C.Y. 1994. Spatial and temporal variations in species composition and abundance of zooplankton in Mai Po gei wai. Unpub. final year B.Sc. project. City Polytechnic of Hong Kong, Hong Kong.
- Reels, G.T. 1994. Management strategies for the reed (Phragmites australis) (Cav.) Steud. at Mai Po Marshes Nature Reserve, Hong Kong, with observations on the associated insect fauna.. Unpub. M.Phil. thesis. University of Hong Kong, Hong Kong.
- Sun, W.N. 1994. *Study of benthic invertebrates in Mai Po gei wai*. Unpub. final year B.Sc. project. City Polytechnic of Hong Kong, Hong Kong.
- Wong, K.W. 1994. Species composition and abundance of benthic macroinvertebrates in Mai Po gei wai. Unpub. final year B.Sc. project. City Polytechnic of Hong Kong, Hong Kong.
- Yung, H.T. 1994. *Study of benthic invertebrates in a Mai Po gei wai*. Unpub. final year B.Sc. report. City Polytechnic of Hong Kong, Hong Kong.

1995

- Kwok, P.W. 1995. The ecology of two sesarmine crabs, *Perisesarma bidens* (de Haan) and *Parasesarma plicata* (Latreille) at the Mai Po Marshes Nature Reserve, Hong Kong. Ph.D. Thesis. University of Hong Kong, Hong Kong.
- Lee, W.H. 1995. Distribution and structure of reedbeds community in *gei wai* 14 of Mai Po Marshes. Unpub. final year B.Sc. project. City University of Hong Kong, Hong Kong.
- Lok, Y.L. 1995. The effect of herbicide on Phragmites australis and the associated fauna in a gei wai of Mai Po Nature Reserve. Unpub. final year B.Sc. project. City Polytechnic of Hong Kong, Hong Kong.

- Picton, E.L. 1995. The stratigraphic record of heavy metals preserved in the Mai Po Marshes, Hong Kong. Unpub. B.Sc. thesis, University of Leeds, United Kingdom.
- Tsang, C.L. 1995. The distribution and structure of *Phragmites communis* in *gei wais* 4, 6, 8 and 10 in Mai Po. Unpub. final year B.Sc. project. City University of Hong Kong, Hong Kong.

1996

- Chan, C.W., Chan, K.F., Lee, W.L., Wong, S.W. and Wong, Y.K. 1996. The benthic community in Mai Po Marshes (gei wai 20-24). Unpub. final year project. Hong Kong Technical College (Chai Wan), Hong Kong.
- Chan, V. and Dawes, V. 1996. Survey on the guided visit program of Mai Po Marshes July to August 1996. Unpublished report. WWF Hong Kong, Hong Kong.
- Cheung, W.L., Lee, K.C., Sia, S.F. and Tong, S.T. 1996. Determination of the heavy metal concentration in *Metapenaeus ensis*, *Eriocheir chinensis* and sediment from four Mai Po gei wais (8, 11, 16/17, 19). Unpub. final year project. Hong Kong Technical College (Chai Wan), Hong Kong.
- Fung, C.N. 1996. Sediment characteristics on the Mai Po mudflats. Unpub. final year B.Sc. project. City University of Hong Kong, Hong Kong.
- Leung, H.W. 1996. The water quality and soil characteristic of four fish ponds in Mai Po. Unpub. final year B.Sc. project. City University of Hong Kong, Hong Kong.
- Lui, T.H. 1996. Effcets of nitrogen enrichment on the mangrove *Kandelia candel* (L.) Druce. Unpub. final year B.Sc. project. University of Hong Kong, Hong Kong.
- Sadaba, R.B. An ecological study of fungi associated with the mangrove associate *Acanthus ilicifolius* L. in Mai Po, Hong Kong. Unpub. Ph.D. thesis. University of Hong Kong, Hong Kong.
- Wong, W.L. 1996. The physical and chemical characteristics of the sediment and water in Mai Po gei wai. Unpub. final year B.Sc. project. City University of Hong Kong, Hong Kong.
- Yang, K.Y. 1996. The feeding ecology of the mudskipper: *Boleophthalmus pectinirostris* (Pisces: periophthalmidae) at the Mai Po Marshes Nature Reserve, Hong Kong. M.Phil. Thesis. University of Hong Kong, Hong Kong.

1997

- Lam, V.S.K. 1997. Survey on the effectiveness of guided visit program of Mai Po Marshes. Unpub. final year B.Sc. project. City University of Hong Kong, Hong Kong.
- Lau, S.S.S. 1997. Pollution status and assimilative potential of the wetlands at the Mai Po Marshes Nature Reserve, Hong Kong. Unpub. M.Phil. thesis. Chinese University of Hong Kong.
- Lee, W.H. 1997. Ecological value of reedbeds (*Phragmites australis*) at Mai Po Marshes Nature Reserve. Unpub. M.Phil. thesis. City University of Hong Kong.
- Leung, Y.H. 1997. Water quality of Mai Po Marshes. Unpub. final year B.Sc. project. University of Hong Kong, Hong Kong.
- Li, P.S. 1997. Water quality of Mai Po Marshes. Unpub. final year B.Sc. project. University of Hong Kong, Hong Kong.
- McChesney, S. 1997. The benthic invertebrate community of the intertidal mudflat at the Mai Po Marshes Nature Reserve, with special reference to resources for migrant shorebirds. Unpub. M.Phil. thesis, University of Hong Kong.
- Ma, K.W. 1997. Foraging behaviour, patch use and use of drain down *gei wai* by Little Egret *Egretta garzetta* at Mai Po, Hong Kong. Unpub. final year B.Sc. project. University of Hong Kong, Hong Kong.

2002

Tsui, M.T.K. 2002. Aquatic toxicity and environmental fate of glyphosate-based herbicides. Unpub. M.Phil thesis. Chinese University of Hong Kong, Hong Kong.

2004

- Lai, Y.F. 2004. A study of physical and chemical properties of pond water and bottom soil in fishponds of Hong Kong. Unpublished B.Sc. undergraduate project. Chinese University of Hong Kong, Hong Kong.
- Lee, K.W.K. 2004. Species assemblages of traditional shrimp ponds (*gei wai*) at Mai Po Marshes Nature Reserve Hong Kong, with special reference to post-larval shrimps and fish. Unpublished B.Sc thesis. University of Hong Kong, Hong Kong.
- Miao, M.Y.M. 2004. Heavy metal contamination and metalloid contamination at Mai Po Marshes. Unpublished B.Sc. thesis. Hong Kong Baptist University, Hong Kong.
- Tse, M.F. 2004. Polycyclic aromatic hydrocarbon contamination at Mai Po Marshes. Unpublished B.Sc. thesis. Hong Kong Baptist University University, Hong Kong.

Appendix 3: Mai Po Plants

| FEDNIC | | Water Crimes | l |
|---|---|---------------------------|---|
| FERNS | A | Water Spinace | Ipomoea aquatica |
| Leather Fern | Acrostichum aureum Blechnum orientale | Sweet Potato | Ipomoea batatas |
| Oriental Blechnum | On and and a size that Patrick has | Beach Morning-glory | Ipomoea pes-caprae |
| Water Fern | Ceratopteris thalictroides | - | lpomoea triloba |
| Hairy Wood-fern | Cyclosorus acuminatus Cyclosorus interruptus | Lesser Duck-weed | Lemna minor |
| Interrupted Tri-vein Fern Linear Forked Fern | Dicranopteris linearis | Brittle False Pimpernel | Lindernia crustacea |
| | · | Lily Turf | Liriope spicata |
| Climbing Fern | Lygodium japonicum | Water-dragon | Ludwigia adscendens |
| Scansorial Climbing Fern Rough Sword Fern | Lygodium scandens Nephrolepis hirsutata | Jute-leaved Melochia | Melochia corchorifolia |
| - | Nephrolepis sp. | Sensitive Plant | Mimosa pudica |
| Nodding Clubmoss | Palhinhaea cernua | Naked Flower Murdannia | Murdannia nudiflora |
| Silver Fern | Pityrogramma calomelanos | Common Banana | Musa paradisiaca |
| | , , | India Poberry | Phytolacca acinosa |
| HEDDO | | Chinese Knotweed | Polygonum chinense |
| HERBS | A 1 4 | Spiny Knotweed | Polygonum perfoliatum |
| Common Achyranthes | Achyranthes aspera | Purslane | Portulaca oleracea |
| Billygoat-weed | Ageratum conyzoides | - | Ruellia brittoniana |
| Alligator-weed | Alternanthera philoxeroides | Toothed-fruited Dock | Rumex dentatus |
| Sessile Alternanthera | Alternanthera sessilis | - | Senecio scandens |
| Alyce Clover | Alysicarpus vaginalis | Java Sesbania | Sesbania javanica |
| Green Amaranth | Amaranthus viridis | Sida Hemp | Sida rhombifolia |
| Water hyssop | Bacopa monnieri | Black Nightshade | Solanum nigrum |
| Malabar-Nightshade | Basella alba | Tetrongan | Solanum torvum |
| <u>-</u> | Bidens alba | Sow-Thistle | Sonchus oleraceus |
| Hairy Bur-marigold | Bidens pilosa | Gold Button | Spilanthes paniculata |
| Malay Blumea | Blumea lacera | South Sea-Blite | Suaeda australis |
| Canna Lily | Canna Hybride | African Evergreen | Syngonium podophyllum |
| Indian Canna | Canna indica | Rose Mallow | Urena lobata |
| Sickle Senna | Cassia tora | Procumbent Indian Mallow | Urena procumbens |
| Moneywort | Centella asiatica | Iron Weed | Vernonia cinerea |
| Lamb's Quarters | Chenopodium album | - | Wedelia triloba |
| Taro | Colocasia esculenta | Common Zeuxine | Zeuxine strateumatica |
| - | Conyza bonariensis | | |
| Mock Jute | Corchorus aestuans | GRASSES / SEDGES | Apluda mutica |
| - | Crassocephalum crepidioides | Glutene-rice Grass | Bothriochloa bladhii |
| | Crinum spp. | Australian Bluestem | Brachiaria mutica |
| Smooth Crotalaria | Crotalaria pallida | Blunt Signal-grass | Cynodon dactylon |
| Dianella | Dianella ensifolia | Couch Grass | Cyperus imbricatus |
| Eclipta | Eclipta prostrata | Imbricate Galingale | Cyperus iria |
| Tassel-Flower | Emilia sonchifolia | Rice Galingale | Cyperus malaccensis |
| - | Eupatorium odoratum | Malacca Galingale | Cyperus rotundus |
| Red-involure Euphorbia | Euphorbia cyathophora | Nut-grass Galingale | Crytococcum patens |
| Garden spurge | Euphorbia hirta | - | Dichanthium annulatum |
| Wild Globe Amaranth | Gomphrena celosioides | Two-flowered Golden-beard | Digitaria microbachne |
| - | Gynura bicolor | Hispid Crabgrass | • |
| - | Gynura divaricata Eleusine indica | Common Crabgrass | Digitaria sanguinalis Toxocarpus wightianus |
| Goose Grass | LIGUSING INUICA | Wight's Toxocarpus | rozocarpus wignilanus |

| | Eragrostis zeylanica | | Zehneria indica |
|--------------------------|----------------------------------|-----------------------|---------------------------|
| Elongated Lovegrass | Fimbristylis dichotoma | Indian Zehneria | Zormona maioa |
| Dichotomous Fimbristylis | Imperata koenigii | | |
| Lalang Grass | Ischaemum aristatum var | SHURBS | Acanthus ilicifolius |
| Duck-beak Grass | Ischaemum indicum | Spiny Bears Breech | Aegiceras corniculatum |
| India Duck-beak | Kyllinga aromatica | - | Aglaia odorata |
| Aromatic Kyllinga | Leptochloa chinensis | Mock Lime | Allamanda cathartica |
| Chinese Sprangletop | Neyraudia reynaudiana | Allamanda | Ardisia elliptica |
| Burma-reed | Panicum maximum | - | Aucuba chinensis |
| Guinea Grass | | Chinese Aucuba | |
| Panic Grass | Panicum repens | Black Mangrove | Avicennia marina |
| Hilo Grass | Paspalum conjugatum | Waxy Leaf | Breynia fruticosa |
| Knot Grass | Paspalum paspaloides | Many-petaled Mangrove | Bruguiera gymnorhiza |
| Ditch Millet | Paspalum orbiculare | Pink Power Puff | Calliandra haematocephala |
| India Paspalum | Paspalum scrobiculatum | - | Cansjera rheedii |
| Mission Grass | Pennisetum polystachyum | Double-fruited Cassia | Cassia bicapsularis |
| Napier Grass | Pennisetum purpureum | - | Clerodendrum inerme |
| Common Reedgrass | Phragmites australis | Garden Croton | Codiaeum variegatum |
| Reed | Phragmites karka | Thick-leaved Croton | Croton crassifolius |
| Golden-hair Grass | Pogonatherum crinitum | Demos | Demos chinensis |
| Branch Pycreus | Pycerus polystachyus | Small Persimmon | Diospyros vaccinioides |
| Redtop | Rhynchelytrum repens | Oval Kumquat | Fortunella margarita |
| Reed-like Sugarcane | Saccharum arundinaceum | Cape Jasmine | Gardenia jasminoides |
| Coastal Bulrush | Scirpus littoralis | Chinese Hibiscus | Hibiscus rosa-sinensis |
| Australian Smut-grass | Sporobolus fertilis | Rough-leaved Holly | llex asprella |
| Seashore Dropgrass | Sporobolus virginicus | Chinese Ixora | Ixora chinensis |
| Chinese Lawn Grass | Zoysia sinica | - | Kandelia obovata |
| Offinese Lawii Orass | | Lantana | Lantana camara |
| CLIMBERS | | White Popinac | Leucaena leucocephala |
| Two-flowered Aniseia | Aniseia biflora | Chinese Privet | · |
| | Benincasa hispida | | Ligustrum sinense |
| White Gourd | Benincasa hispida var. chieh qua | Round-leaved Litsea | Litsea rotundifolia |
| Hairy Gourd | Bougainvillea spectabilis | Matrimony Vine | Lycium chinense |
| Brazil Bougainvillea | Canavalia maritima | Turk's Cap | Malvaviscus arboreus |
| Sea Sword Bean | Cardiospermum halicacabum | Common Melastoma | Melastoma candidum |
| Balloon Vine | Cassytha filiformis | Blood-red Melastoma | Melastoma sanguineum |
| Cassytha | Cocculus orbiculatus | Orange-jessamine | Murraya paniculata |
| Snail Seed | Derris alborubra | Thorny Wingnut | Paliurus ramosissimus |
| White-flowered Derris | Derris trifoliata | Marsh Fleabane | Pluchea indica |
| Derris | Ficus pumila | Wild Coffee | Psychotria asiatica |
| Creeping Fig | Gymnanthera oblonga | Hong Kong Hawthorn | Rhaphiolepis indica |
| Oblong Gymnanthera | Gymnanthera obionga | Red Azalea | Rhododendron simsii |
| Cairo Morning Glory | Ipomoea cairica | Sumac | Rhus chinensis |
| Ivy-like Merremia | Merremia hederacea | Hedge Sageretia | Sageretia thea |
| Mile-a-minuted Weed | Mikania micrantha | Chinese Scolopia | Scolopia chinensis |
| Common Indian-mulberry | Morinda umbellata | Box-leaved Atalantia | Severinia buxifolia |
| Chinese Feverine | Paederia scandens | Yellow Oleander | Thevetia peruviana |
| Passion Flower | Passiflora foetida | Triumfetta | Triumfetta rhomboidea |
| - | Philodendron spp. | Indian Wikstroemia | Wikstroemia indica |
| Goat Horns | Strophanthus divaricatus | | |

| TREES | | UNSURE SPECIES | |
|------------------------|---------------------------------|---------------------------|-----------------------|
| Ear-leaved Acacia | Acacia auriculiformis | Common Caladium | Caladium bicolor |
| Taiwan Acacia | Acacia confusa | | Cyperus oderatus |
| Lebbeck Tree | Albizia lebbeck | Thyme-leaved Spurge | Euphorbia thymifolia |
| Formosan Alder | Alnus japonica | | Mikania guaco |
| Sugar-apple | Annona squamosa | Many-flowered Silvergrass | Miscanthus floridulus |
| Bamboo | Bambusa sp. | Night-closing Leaf | Phyllanthus urinaria |
| Purple Camel's Foot | Bauhinia purpurea | | |
| Autumn Maple | Bischofia javanica | | |
| Tree Cotton | Bombax ceiba | | |
| Pop-gun Seed | Bridelia tomentosa | | |
| Fishtail Palm | Caryota ochlandra | | |
| Horsetail Tree | Casuarina equisetifolia | | |
| Chinese Hackberry | Celtis sinensis | | |
| Cerbera | Cerbera manghas | | |
| Camphor Tree | Cinnamomum camphora | | |
| - | Citrus sp. | | |
| Lidded Cleistocalyx | Cleistocalyx operculatus | | |
| Obtuse-leaved Crateva | Crateva trifoliata | | |
| Flame Tree | Delonix regia | | |
| Ivory Coral Tree | Erythrina speciosa | | |
| Swamp Mahogany | Eucalyptus robusta | | |
| Milky Mangrove | Excoecaria agallocha | | |
| Chinese Banyan | Ficus microcarpa | | |
| Big-leaved Fig | Ficus virens var. sublanceolata | | |
| Water Pine | Glyptostrobus pensilis | | |
| Coastal Heritiera | Heritiera littoralis | | |
| Cuban Bast | Hibiscus tiliaceus | | |
| Chinese Holly | llex rotunda | | |
| Sweet Gum | Liquidambar formosana | | |
| Pond Spice | Litsea glutinosa | | |
| Elephant's Ear | Macaranga tanarius | | |
| Turn-in-the-wind | Mallotus paniculatus | | |
| China-berry | Melia azedarach | | |
| Microcos | Microcos paniculata | | |
| White Mulberry | Morus alba | | |
| Guava | Psidium guajava | | |
| Weeping Willow | Salix babylonica | | |
| Mountain Tallow Tree | Sapium discolor | | |
| Chinese Tallow Tree | Sapium sebiferum | | |
| Ivy Tree | Schefflera heptaphylla | | |
| Lance-leaved Sterculia | Sterculia lanceolata | | |
| Box-leaved Syzygium | Syzygium buxifolium | | |
| Rose Apple | Syzygium jambos | | |

Appendix 4: Birds of Mai Po and Inner Deep Bay

Key:

- (C): Critical species is facing an extremely high risk of extinction in the wild in the immediate future.
- (E): Endangered species is facing a very high risk of extinction in the wild in the near future.
- (V): Vulnerable species is facing a high risk of extinction in the wild in the medium-term future.
- (CD) Conservation dependent species which are the focus of a continuing species-specific or habitat-specific conservation programme, the cessation of which would result in the species qualifying for one of the threatened categories above within a period of five years.
- (N): Near-threatened does not qualify for Conservation Dependent, but which are close to Vulnerable.

| Category A: Species whic apparently wild state in Hong | h have been recorded in an | Black-headed lbis (NT) | Threskiornis melanocephalus |
|--|----------------------------|-----------------------------|-----------------------------|
| apparently wild state in Florig | Rong. | Glossy Ibis | Plegadis falcinellus |
| GREBES | | Eurasian Spoonbill | Platalea leucorodia |
| Little Grebe | Tachybaptus ruficollis | Black-faced Spoonbill (E) | Platalea minor |
| Great Crested Grebe | Podiceps cristatus | | |
| Black-necked Grebe | Podiceps nigricollis | DUCKS AND GEESE | |
| Horned Grebe | Podiceps auritus | Whooper Swan | Cygnus Cygnus |
| Homed Grebe | r odiceps duritus | Lesser Whistling Duck | Dendrocygna javanica |
| PELICANS | | Greylag Goose | Anser anser |
| Dalmatian Pelican (V) | Pelecanus crispus | Greater White-fronted Goose | Anser albifrons |
| Daimatian Felican (V) | r ciccanas crispas | Ruddy Shelduck | Tadorna ferruginea |
| CORMORANTS | | Common Shelduck | Tadorna tadorna |
| Great Cormorant | Phalacrocorax carbo | Cotton Pygmy-goose | Nettapus coromandelianus |
| ordat comorant | Thalacrocorax carbo | Mandarin Duck | Aix galericulata |
| FRIGATEBIRDS | | Eurasian Wigeon | Anas penelope |
| Christmas Island Frigatebird | Fregata andrewsi | Falcated Duck | Anas falcata |
| Lesser Frigatebird | Fregata ariel | Gadwall | Anas strepera |
| | , rogata a.ro. | Baikal Teal (V) | Anas formosa |
| BITTERNS, HERONS AND E | EGRETS | Common Teal | Anas crecca |
| Grey Heron | Ardea cinerea | Green-winged Teal | Anas carolinensis |
| Purple Heron | Ardea purpurea | Mallard | Anas platyrhynchos |
| Great Egret | Egretta alba | Spot-billed Duck | Anas poecilorhyncha |
| Intermediate Egret | Egretta intermedia | Northern Pintail | Anas acuta |
| Little Egret | Egretta garzetta | Garganey | Anas querquedula |
| Swinhoe's Egret (V) | Egretta eulophotes | Northern Shoveler | Anas clypeata |
| Pacific Reef Egret | Egretta sacra | Common Pochard | Aythya ferina |
| Cattle Egret | Bubulcus ibis | Baer's Pochard | Aythya baeri |
| Chinese Pond Heron | Ardeola bacchus | Ferruginous Duck | Aythya nyroca |
| Striated Heron | Butorides striatus | Tufted Duck | Aythya fuligula |
| Black-crowned Night Heron | Nycticorax nycticorax | Greater Scaup | Aythya marila |
| Yellow Bittern | Ixobrychus sinensis | Velvet Scoter | Melanitta fusca |
| Schrenck's Bittern | lxobrychus eurythmus | Common Goldeneye | Bucephala clangula |
| Cinnamon Bittern | Ixobrychus cinnamomeus | Smew | Mergus albellus |
| Black Bittern | Ixobrychus flavicollis | Red-breasted Merganser | Mergus serrator |
| | Botaurus stellaris | | |
| | | EAGLES AND HAWKS | |
| STORKS | | Osprey | Pandion haliaetus |
| Black Stork | Ciconia nigra | Black Baza | Aviceda leuphotes |
| Oriental Stork (E) | Ciconia boyciana | Crested Honey Buzzard | Pernis ptilorhynchus |
| | | Black-winged Kite | Elanus caeruleus |
| IBISES AND SPOONBILLS | | Black Kite | Milvus migrans |

Brahminy Kite

Haliastur indus

| White-bellied Sea Eagle | Haliaeetus leucogaster | AVOCETS AND STILTS | |
|----------------------------|--------------------------|---------------------------------------|---------------------------|
| Eurasian Black Vulture | Aegypius monachus | Black-winged Stilt | Himantopus himantopus |
| Crested Serpent Eagle | Spilornis cheela | Pied Avocet | Recurvirostra avosetta |
| Grey-faced Buzzard | Butastur indicus | | |
| Pied Harrier | Circus melanoleucos | PRANTINCOLES | |
| Eastern Marsh Harrier | Circus spilonotus | Oriental Pratincole | Glareola maldivarum |
| Crested Goshawk | Accipiter trivirgatus | | |
| Chinese Goshawk | Accipiter soloensis | PLOVERS | |
| Japanese Sparrowhawk | Accipiter gularis | Northern Lapwing | Vanellus vanellus |
| Besra | Accipiter virgatus | Grey-headed Lapwing | Vanellus cinereus |
| Eurasian Sparrowhawk | Accipiter nisus | Pacific Golden Plover | Pluvialis fulva |
| Common Buzzard | Buteo buteo | Grey Plover | Pluvialis squatarola |
| Greater Spotted Eagle (V) | Aquila clanga | Common Ringed Plover | Charadrius hiaticula |
| Imperial Eagle (V) | Aquila heliaca | Little Ringed Plover | Charadrius dubius |
| Bonelli's Eagle | Hieraaetus fasciatus | Kentish Plover | Charadrius alexandrinus |
| | | Lesser Sand Plover | Charadrius mongolus |
| FALCONS | | Greater Sand Plover | Charadrius leschenaultii |
| Common Kestrel | Falco tinnunculus | Oriental Plover | Charadrius veredus |
| Eurasian Hobby | Falco subbuteo | | |
| Peregrine Falcon | Falco peregrinus | SANDPIPERS, SNIPES, CUI | RLEWS AND ALLIES |
| | | Black-tailed Godwit | Limosa limosa |
| FRANCOLINS AND QUAILS | 5 | Bar-tailed Godwit | Limosa lapponica |
| Japanese Quail | Coturnix japonica | Little Curlew | Numenius minutus |
| | | Whimbrel | Numenius phaeopus |
| BUTTONQUAILS | | Eurasian Curlew | Numenius arquatus |
| Yellow-legged Button-quail | Turnix tanki | Far Eastern Curlew (N) | Numenius madagascariensis |
| Barred Button-quail | Turnix suscitator | Spotted Redshank | Tringa erythropus |
| | | Common Redshank | Tringa totanus |
| CRANES | | Marsh Sandpiper | Tringa stagnatilis |
| Siberian Crane | Grus leucogeranus | Common Greenshank | Tringa nebularia |
| Common Crane | Grus grus | Nordmann's Greenshank (E) | Tringa guttifer |
| | _ | Lesser Yellowlegs | Tringa flavipes |
| RAILS, CRAKES AND |) | Green Sandpiper | Tringa ochropus |
| Slaty-breasted Rail | Rallus striatus | Wood Sandpiper | Tringa glareola |
| Water Rail | Rallus aquaticus | Terek Sandpiper | Xenus cinereus |
| White-browed Crake | Porzana cinerea | Common Sandpiper | Actitis hypoleucos |
| Baillon's Crake | Porzana pusilla | Grey-tailed Tattler | Heteroscelus brevipes |
| Ruddy-breasted Crake | Porzana fusca | Ruddy Turnstone | Arenaria interpres |
| White-breasted Waterhen | Amaurornis phoenicurus | Red-necked Phalarope | Phalaropus lobatus |
| Watercock | Gallicrex cinerea | Red Phalarope | Phalaropus fulicarius |
| Common Moorhen | Gallinula chloropus | Eurasian Woodcock | Scolopax rusticola |
| Eurasian Coot | Fulica atra | Pintail Snipe | Gallinago stenura |
| | | Swinhoe's Snipe | Gallinago megala |
| JACANAS | | Common Snipe | Gallinago gallinago |
| Pheasant-tailed Jacana | Hydrophasianus chirurgus | Long-billed Dowticher | Limnodromus scolopaceus |
| | | Asian Dowitcher | Limnodromus semipalmatus |
| PAINTED SNIPE | | Red Knot | Calidris canutus |
| Greater Painted-snipe | Rostratula benghalensis | Great Knot | Calidris tenuirostris |
| | 3 | Sanderling | Calidris alba |
| | | · · · · · · · · · · · · · · · · · · · | |

| Red-necked Stint | Calidris ruficollis | Horsfield's Cuckoo | Cuculus Horsfieldi |
|------------------------|----------------------------|---------------------------|---------------------------|
| Little Stint | Calidris minuta | Plaintive Cuckoo | Cacomantis merulinus |
| Temminck's Stint | Calidris temminckii | Common Koel | Eudynamis scolopacea |
| Long-toed Stint | Calidris subminuta | | |
| Pectoral Sandpiper | Calidris melanotos | COUCALS | |
| Sharp-tailed Sandpiper | Calidris acuminata | Greater Coucal | Centropus sinensis |
| Dunlin | Calidris alpina | Lesser Coucal | Centropus bengalensis |
| Curlew Sandpiper | Calidris ferruginea | | |
| Spoon-billed Sandpiper | Eurynorhynchus pygmaeus | OWLS | |
| Broad-billed Sandpiper | Limicola falcinellus | Eastern Grass Owl | Tyto longinembris |
| Ruff | Philomachus pugnax | Oriental Scops Owl | Otus sunia |
| | | Asian Barred Owlet | Glaucidium cuculiodes |
| SKUAS | | Short-eared Owl | Asio flammeus |
| Long-tailed Jaeger | Stercorarius longicaudus | | |
| | | NIGHTJARS | |
| GULLS AND TERNS | | Grey Nightjar | Caprimulgus indicus |
| Black-tailed Gull | Larus crassirostris | Savanna Nightjar | Caprimulgus affinis |
| Mew Gull | Larus canus | | |
| Heuglin's Gull | Larus heuglini | SWIFTS | |
| Brown-headed Gull | Larus brunnicephalus | Himalayan Swiftlet | Collocalia brevirostris |
| Yellow-legged Gull | Larus cachinnans | White-throated Needletail | Hirundapus caudacutus |
| Slaty-backed Gull | Larus schistisagus | Silver-backed Needletail | Hirundapus cochinchinesis |
| Glaucous Gull | Larus hyperboreus | Common Swift | Apus apus |
| Glaucous-winged Gull | Larus glaucescens | Pacific Swift | Apus pacificus |
| Pallas's Gull | Larus icthyaetus | Little Swift | Apus affinis |
| Relict Gull | Larus relictus | | |
| Black-headed Gull | Larus ridibundus | KINGFISHERS | |
| Slender-billed Gull | Larus genei | Pied Kingfisher | Ceryle rudis |
| Little Gull | Larus minutus | Common Kingfisher | Alcedo atthis |
| Saunders' Gull (V) | Larus saundersi | White-throated Kingfisher | Halcyon smyrnensis |
| Black-legged Kittiwake | Rissa tridactyla | Black-capped Kingfisher | Halcyon pileata |
| Whiskered Tern | Chlidonias hybridus | Collared Kingfisher | Halcyon chloris |
| White-winged Tern | Chlidonias leucopterus | | |
| Gull-billed Tern | Gelochelidon nilotica | BEE-EATERS | |
| Caspian Tern | Sterna caspia | Blue-throated Bee-eater | Merops viridis |
| Common Tern | Sterna hirundo | Blue-tailed Bee-eater | Merops philippinus |
| Little Tern | Sterna albifrons | | |
| Greater Crested Tern | Sterna bergii | ROLLERS | |
| | | Dollarbird | Eurystomus orientalis |
| DOVES | | | |
| Oriental Turtle Dove | Streptopelia orientalis | HOOPOES | |
| Red Turtle Dove | Streptopelia tranquebarica | Eurasian Hoopoe | Upupa epops |
| Spotted Dove | Streptopelia chinensis | | |
| Emerald Dove | Chalcophaps indica | WOODPECKER | |
| | . , | Eurasian Wryneck | Jynx torquilla |
| CUCKOOS | | • | , , |
| Chestnut-winged Cuckoo | Clamator coromardelianas | LARKS | |
| Large Hawk Cuckoo | Hierococcyx sparverioides | Eurasian Skylark | Alauda arvensis |
| Indian Cuckoo | Cuculus micropterus | Oriental Skylark | Alauda gulgula |
| | | | J J |

| | | Scaly Thrush | Zoothera dauma |
|--|---------------------------------------|--|---|
| SWALLOWS AND | | Japanese Thrush | Turdus cardis |
| MARTING Sand Martin | Riparia riparia | Common Blackbird | Turdus merula |
| Barn Swallow | Hirundo rustica | Grey-backed Thrush | Turdus merula Turdus hortulorum |
| Red-rumped Swallow | Hirundo rustica | Pale Thrush | Turdus pallidus |
| Asian House Martin | | | Turdus pallidus Turdus obscurus |
| Asian House Martin | Delichon dasypus | Eyebrowed Thrush | |
| PIPITS AND WAGTAILS | | Dusky Thrush | Turdus naumanni |
| | Dendronanthus indicus | BABBLERS | |
| Forest Wagtail | Motacilla flava | Masked Laughing-thrush | Carrulay paranjaillatus |
| Yellow Wagtail | | 3 3 | Garrulax perspicillatus |
| Citrine Wagtail | Motacilla citreola | Hwamei Striated Yuhina | Garrulax canorus |
| Grey Wagtail | Motacilla cinerea Motacilla alba | Striated Furnita | Yuhina castaniceps |
| White Wagtail | Anthus novaeseelandiae | OLD WORLD WARBLERS, O | PICTICOL AC AND DDINIAC |
| Richard's Pipit | | • | |
| Olive-backed Pipit | Anthus hodgsoni | Asian Stubtail Warbler | Urosphena squameiceps |
| Red-throated Pipit | Anthus cervinus | Pale-footed Bush Warbler | Cettia pallidipes |
| Pechora Pipit | Anthus gustavi | Japanese Bush Warbler Brownish-flanked Bush | Cettia diphone |
| Buff-bellied Pipit | Anthus rubescens | Marhlar | Cettia fortipes |
| OHOKOO OHDIKEO AND M | NIN/ETO | Russet Bush Warbler | Bradypterus seebohmi |
| CUCKOO-SHRIKES AND M | | Lanceolated Warbler Pallas's Grasshopper | Locustella lanceolata |
| Black-winged Cuckoo-shrike | | Marhler Middendorff's Grasshopper | Locustella certhiola |
| Swinhoe's Minivet | Pericrocotus cantonensis | Marhlar | Locustella ochotensis |
| Ashy Minivet | Pericrocotus divaricatus | Styan's Grasshopper Warbler | · |
| DI II DI II O | | Black-browed Reed Warbler | Acrocephalus bistrigiceps |
| BULBULS | December (see a see | Manchurian Reed Warbler | Acrocephalus tangorum |
| Red-whiskered Bulbul | Pycnonotus jocosus | Paddyfield Warbler | Acrocephalus agricola |
| Chinese Bulbul | Pycnonotus sinensis | Blunt-winged Warbler | Acrocephalus concinens |
| Sooty-headed Bulbul | Pycnonotus aurigaster | Blyth's Reed Warbler | Acrocephalus dumetorum |
| Chestnut Bulbul | Hemixos castanonotus | Oriental Reed Warbler | Acrocephalus orientalis |
| CUDIKEC | | Thick-billed Warbler | Acrocephalus aedon |
| SHRIKES | La mina diamina | Zitting Cistcola Yellow-bellied Prinia | Cisticola juncidis |
| Tiger Shrike | Lanius tigrinus | | Prinia flaviventris Prinia inornata |
| Bull-headed Shrike | Lanius bucephalus | Plain Prinia | |
| Brown Shrike | Lanius cristatus | Common Tailorbird | Orthotomus sutorius |
| Long-tailed Shrike | Lanius schach | Mountain Tailorbird | Orthotomus cuculatus |
| CHATS AND THRUSHES | | Chiffchaff Dusky Warbler | Phylloscopus collybita Phylloscopus fuscatus |
| Rufous-tailed Robin | Luscinia sibilans | Yellow-streaked Warbler | Phylloscopus armandii |
| Siberian Rubythroat | Luscinia calliope | Radde's Warbler | Phylloscopus schwarzi |
| Siberian Rubytilloat Siberian Blue Robin | Luscinia cyane | Pallas's Leaf Warbler | Phylloscopus proregulus |
| Bluethroat | Luscinia cyane Luscinia svecica | Yellow-browed Warbler | Phylloscopus inornatus |
| Red-flanked Bluetail | | Arctic Warbler | Phylloscopus borealis |
| Oriental Magpie Robin | Tarsiger cyanurus Copsychus saularis | Greenish Warbler | Phylloscopus trochiloides |
| <u>.</u> | • • | | • • |
| Daurian Redstart Plumbeous Redstart | Phoenicurus auroreus | Pale-legged Leaf Warbler | Phylloscopus tenellipes Phylloscopus boroaloidos |
| Common Stonechat | Rhyacornis fuliginosus | Sakhakin Leaf Warbler Eastern Crowned Warbler | Phylloscopus porealoides |
| | Saxicola torquata | | Phylloscopus rogulaidos |
| Grey Bushchat | Savicola ferrea | Blyth's Leaf Warbler | Phylloscopus reguloides |
| White-throated Rock Thrush | Monticola gularis | ELVEATCHERS | |
| Blue Rock Thrush | Monticola solitarius | FLYCATCHERS | |

Grey-streaked Flycatcher Muscicapa griseisticta Dark-sided Flycatcher Muscicapa sibirica Asian Brown Flycatcher Muscicapa dauurica Ferruginous Flycatcher Muscicapa ferruginea Verditer Flycatcher Eumvias thalasina Yellow-rumped Flycatcher Ficedula zanthopygia Narcissus Flycatcher Ficedula narcissina Mugimaki Flycatcher Ficedula mugimaki Red-throated Flycatcher Ficedula albicilla Blue-and-white Flycatcher Cyanoptila cyanomelana Hainan Blue Flycatcher Cyornis hainana

MONARCHS

Grey-headed Flycatcher

Black-naped Monarch Hypothymis azurea

Asian Paradise Flycatcher Terpsiphone paradisi
Japanese Paradise Terpsiphone atrocaudata

Culicicapa ceylonensis

PENDULINE TITS

Chinese Penduline Tit Remiz consobrinus

TITS

Yellow-bellied Tit Parus venustulus
Great Tit Parus major

FLOWERPECKER

Scarlet-backed Flowerpecker Dicaeum cruentatum

WHITE-EYES

Chestnut-flanked White-eye Zosterops erythropleurus

Japanese White-eye Zosterops japonica

BUNTINGS

Crested Bunting Melophus lathami Grey-necked Bunting Emberiza buchanani Tristram's Bunting Emberiza tristrami Chestnut-eared Bunting Emberiza fucata Little Bunting Emberiza pusilla Yellow-browed Bunting Emberiza chrysophrys Yellow-breasted Bunting Emberiza aureola Emberiza melanocephala Black-headed Bunting Emberiza rutila

Chestnut Bunting Emberiza rutila

Japanese Yellow Bunting (V) Emberiza sulphurata

Black-faced Bunting Emberiza spodocephala

Common Reed Bunting Emberiza schoeniclus

FINCHES

Brambling Fringilla montifringilla
Grey-capped Greenfinch Carduelis sinica

Eurasian Siskin Carduelis spinus

Common Rosefinch Carpodacus erythrinus

Yellow-billed Grosbeak Eophona migratorius

MUNIAS

White-rumped Munia Lonchura striata
Scaly-breasted Munia Lonchura punctulata

SPARROWS

Russet Sparrow Passer rutilans
Eurasian Tree Sparrow Passer montanus

STARLINGS AND MYNAS

Red-billed Starling Sturnus sericeus Chestnut-cheeked Starling Sturnus philippensis Purple-backed Starling Sturnus sturninus Rose-coloured Starling Srurnus roseus Common Starling Sturnus vulgaris White-cheeked Starling Sturnus cineraceus Black-collared Starling Sturnus nigricollis White-shouldered Starling Sturnus sinensis Crested Myna Acridotheres tristis

ORIOLES

Black-naped Oriole Oriolus chinensis

DRONGOS

Ashy Drongo Dicrurus leucophaeus
Black Drongo Dicrurus macrocercus
Hair-crested Drongo Dicrurus hottentottus

CROWS

Eurasian Jay

Blue Magpie

Common Magpie

Pica pica

Daurian Jackdaw

Corvus dauricus

Carrion Crow

Corvus corone

Garrulus glandarius

Large-billed Crow Corvus macrorhynchus
Collared Crow Corvus torquatus

Category B: Species that are considered to have probably occurred in Hong Kong in a wild state, but for which the possibility of escape or release from captivity cannot be satisfactorily excluded.

Chestnut-tailed Starling Sturnus malabaricus

Category C: Southeast China breeding species, the established or formerly established Hong Kong populations of which are considered to be derived from captive stock, but which probably occurred in Hong Kong prior to anthropo habitat changes.

Vinous-throated Parrotbill Paradoxornis webbianus

Category D: Extralimital species that, although originally introduced to Hong Kong by man, maintains or did maintain, a regular feral breeding stock without necessary recourse to further introduction.

Yellow-crested Cockatoo Cacatua sulphurea
Rose-ringed Parakeet Psittacula krameri
Chestnut Munia Lonchura malacca
Baya Weaver Ploceus philippinus

Category E: Species for which all published Hong Kong records are considered likely to relate to birds that have escaped or have been released from captivity.

Great White Pelican Pelecanus onocrotalus

Wood Duck Aix sponsa

Common Pheasant Phasianus colchicus
Purple Swamp-hen Porphyrio porphyrio

Red Lory Eos bornea

BudgerigarMelopsittacus undulatusAlexandrine ParakeetPsittacula eupatriaPied BushchatSaxicola caprata

Brown-breasted Bulbul Pycnonotus xanthorrhous

European Goldfinch Carduelis carduelis

Yellow-fronted Canary Serinus mozambicus

Red Avadavat Amandava amandava

White-headed Munia Lonchura maja
Java Sparrow Padda oryzivora
Pin-tailed Whydah Vidua macroura
Golden Bishop Euplectes afer

White-vented Myna Acridotheres javanicus
Azure-winged Magpie Cyanopica cyanus
House Crow Corvus splendens

<u>Category F</u>: Species for which all published Hong Kong records must be regarded as doubtful because of the possibility of mistaken identification.

Saker Falcon Falco cherrug

Amur Falcon Falco amurensis

Vega Gull Larus vegae

Eurasian Oystercatcher Haematopus ostralegus
Paradise Whydah Vidua paradisaea
Red Bishop Euplectes orix

Appendix 5: Mai Po Mammals

Wild boar (3 record in winter 2002) Sus scrofa Feral dog Canis familiaris

Javan Mongoose Herpestes javanicus Crab-eating Mongoose Herpestes urva **Small Indian Civet** Viverricula indica **Eurasian Otter** Lutra lutra

Leopard Cat Felis bengalensis

Ryuku Mouse Mus caroli House Mouse Mus musculus

Black Rat Rattus rattus flavipectus

Large Bandicoot Rat Bandicota indica **Brown Rat** Rattus norvegicus

Brown House Shrew Suncus murinus

Japanese Pipistrelle Greater Short-nosed Fruit Bat

Lesser Yellow Bat **Noctule Bat**

Cynopterus sphinx Scotophilus khuli Nyctalus noctula

Pipistrellus abramus

Appendix 6. Mai Po Reptiles and Amphibians

Brown Tree Frog
Asian Common Toad
Chinese Bullfrog
Gunther's Frog
Asiatic painted Frog
Ornate Pigmy Frog
Polypedates leucomystax
Bufo melanostictus
Rana rugulosa
Rana guentheri
Kaloula pulchra
Microhyla ornata
Paddy Frog
Rana limnocharis

Reeves' Terrapin Chinemys reevesi
Chinese Soft-shelled Turtle Pelodiscus sinensis

Red-eared Terrapin Trachemys scripta elegans

Four-clawed Gecko

Bowring's Gecko

Reeves' Smooth Skink

Chinese Skink

Grass Lizard

Common Blind Snake

Gehyra mutilata

Hemidactylus bowringi

Leiolopisma reevesi

Eumeces chinensis

Takydromus sexlineatus

Ramphotyphlops braminus

Burmese Python Python molurus
Copperhead Racer Elaphe radiata
Common Rat Snake Ptyas mucosus
Indo-Chinese Rat Snake Ptyas korros

Taiwan Kukri Snake
Checkered Keelback
Bennett's Water Snake
Chinese Water Snake
Many-banded Snake

Oligodon formosanus
Xenochrophis piscator
Enhydris bennetti
Enhydris chinensis
Bungarus multicinctus

Chinese Cobra Naja naja

King Snake Ophiophagus hannah

Appendix 7: Mai Po Butterflies

ORDER: LEPIDOPTERA

Family: Papilionidae (Swallowtails, Birdwings)

Common mime Chilasa clytia clytia Common Mormon Papilio polytes polytes **Great Mormon** Papilio memnon agenor Paris Peacock Papilio paris paris Red Helen Papilio helenus helenus Common Bluebottle Graphium sarpedon sarpedon Common Jay Graphium doson axion

Tailed Jay Graphium agamemnon agamemnon

Family: Pieridae (Whites, Yellows)

Lemon Emigrant Catopsilia pomona pomona Mottled Emigrant Cataopsilia pyranthe pyranthe Common Grass Yellow Eurema hecabe hecabe Painted Jezebell Delias hyparete hierte Red-base Jezebell Delias pasithoe pasithoe Indian Cabbage White Pieris canidia canidia **Great Orange Tip** Hebomoia glaucippe

Family: Danaidae (Tigers, Crows)

Common Tiger Danus genutia genutia Blue Tiger Tirumala limniace limniace Ceylon Blue Glassy Tiger Ideopsis similis similis Common Indian Crow Euploea core amymone Blue-spotted Crow Euploea midamus midamus

Family: Satyridae (Browns) Common Evening Brown

Dark Evening Brown Melanitis phedima muskata Banded Tree Brown Lethe confusa confusa Dark Brand Bush Brown Mycalesis mineus mineus

Melanitis leda leda

Family: Amathusiidae (Duffer, Faun) Faunis eumeus Large Faun

Family: Nymphalidae (Nymphs)

Red Ring Skirt Hestina assimilis assimilis Rustic Cupha erymanthis erymanthis Blue Admiral Kaniska canace canace **Grey Pansy** Junonia atlites atlites Common Sailer Neptis hylas hylas

Short-banded Sailor Phaedyma columella columella Great Egg-fly Hypolimnas bolina kezia Lemon Pansy Junonia lemonias lemonias

Peacock Pansy Junonia almana almana

Family: Ridinidae (Metalmarks)

Plum Judy Abisara echerius echerius

Family: Lycaenidae (Blues)

Purple Sapphire Heliophorus epicles phoenicoparphus

Silver Streak Blue Iraota timoleon timoleon Long-banded Silverline Spindasis Iohita formosana Long-tailed Blue / Pea Blue Lampides boeticus

Zizeeria karsandra Dark Grass Blue Pale Grass Blue Zizeeria maha serica Tailed Cupid Everes lacturnus rileyi Common Hedge Blue Acytolepis puspa gisca Gram Blue Euchryspos cnejus cnejus

Family: Hesperiidae (Skippers)

Banana Skipper Erionota torus Common Redeye Matapa aria

Chinese Dart Potanthus confucius confucius

Common Straight Swift Parnara guttata Little Branded Swift Pelopidas agna agna

Contiguous Swift Polytremis lubricans lubricans

Appendix 8. Mai Po Odonates

| SUBORDER: ZYGOPTE | RA (Damselfilies) | Superfamily: Libelluloidea | | |
|--|-----------------------------------|----------------------------|-------------------------------------|--|
| Superfamily: Coenagric | onoidea | Family: Corduliidae | | |
| Family: Coenagrionidae | • | Regal Pond Cruiser | Epopthalmia elegans | |
| Orange-tailed Midget | Agriocenemis femina oryzae | | | |
| Wandering Midget | Agriocenemis pygmaea | Family: Libellulidae | | |
| Four-spot Midget | Mortonagrion hirosei | Blue Dasher | Brachydiplax chalybea flavovittata | |
| Marsh Dancer | Onychargia atrocyana | Forest Chaser | Lyriothemis elegantissima | |
| Asian Bluetail | Ischnura asiatica | Coastal Glider | Macrodiplax cora | |
| Common Bluetail | Ischnura senegalensis | Blue Chaser | Potamarcha congener | |
| Orange-tailed Sprite | Ceriagrion aurantiacum ryukyuanum | Red-faced Skimmer | Orthetrum chrysis | |
| Orange-faced Sprite | Pseudagrion rubriceps rubriceps | Common Blue Skimmer | Orthetrum. glaucum | |
| Blue Sprite | Pseudagrion microcephalum | Marsh Skimmer | Orthetrum luzonicum | |
| Eastern Lilysquatter | Cercion melanotum | Common Red Skimmer | Orthetrum pruinosum neglectum | |
| | | Green Skimmer | Orthetrum sabina sabina | |
| Family: Platycnemididae | | Greater Blue Skimmer | Orthetrum melania | |
| Black-kneed Featherlegs | Copera ciliata | Asian Pintail | Acisoma panorpoides panorpoides | |
| Yellow Featherlegs | Copera marginipes | Asian Amberwing | Brachythemis contaminata | |
| | | Crimson Darter | Crocothemis servilia servilia | |
| SUBORDER: ANISOPTI | ERA (Dragonflies) | Black-tipped Percher | Diplacodes nebulosa | |
| Superfamily: Aeshnoid | ea | Blue Percher | Diplacodes trivalis | |
| Family: Aeshnidae | | Pied Percher | Neurothemis tullia tullia | |
| Common Evening Hawer | Anaciaeschna jaspidea | Russet Percher | Neurothemis fulvia | |
| Pale-spotted Emperor | Anax guttatus | Pied Skimmer | Pseudothemis zonata | |
| Lesser Emperor | Anax parthenope julius | Crimson Dropwing | Trithemis aurora | |
| Little Dusk-hawker | Gynacantha saltatrix | Indigo Dropwing | Trithemis festiva | |
| Blue-spotted Dusk-hawk | er Gynacantha japonica | Asian Widow | Palpopleura sexmaculata sexmaculata | |
| Dingy Dusk-hawker | Gynacantha subinterrupta | Variegated Flutterer | Rhyothemis variegata arria | |
| | | Amber-winged Glider | Hydrobasileus croceus | |
| Family: Gomphidae | | Wandering Glider | Pantala flavescens | |
| Common Flangetail Ictinogomphus pertinax | | Saddlebag Glider | Tramea virginia | |
| Golden Flangetail | Sinictogomphus clavatus | Evening Skimmer | Tholymis tillarga | |
| Tawny Hooktail | Paragomphus capricornis | Dingy Dusk-darter | Zyxomma petiolatum | |

Appendix 9: Bibliography for Mai Po Nature Reserve and the surrounding parts of Deep Bay

- Abdel-Wahab, M.A. Jones, E.B.G. and Vrijmoed, L.L.P. 1999. *Halosarpheia kandeliae* sp. nov. on intertidal bark of the mangrove tree *Kandelia candel* in Hong Kong. *Mycological Research* 103(11): 1500-1504.
- AEC 2004. Focal study of Black-faced Spoonbills in northwest New Territories, in particular Mai Po and Inner Deep Bay areas. Unpublished report for the Agriculture Fisheries and Conservation Department, Hong Kong SAR Government. Asia Ecological Consultants, Hong Kong.
- Anderson, C. 1994. The production ecology of the mangrove at the Mai Po Marshes Nature Reserve, Hong Kong. Unpublished Ph.D. thesis, University of Hong Kong.
- Anderson, C. and Lee, S.Y. 1995. Defoliation of the mangrove Avicennia marina in Hong Kong: cause and consequences. Biotropica 27(2), 218-226.
- Anderson, C. and McChesney, S. 1999. Composition and zoznation of benthic macrofauna in the Mai Po Marshes mangrove forest. pp. 45-56. In: Lee, S.Y. (ed.) The mangrove ecosystem of Deep Bay and the Mai Po Marshes, Hong Kong. Hong Kong University Press, Hong Kong.
- Anon. 1968. Case Study: B. Report on the Deep Bay Marshes and surrounding countryside. pp. 31-37 in The Countryside and the people. Report of the Provisional Council for the Use and Conservation of the Countryside. Government Printer, Hong Kong.
- Anon. 1975. Report on the Mai Po Marshes. Paper prepared for Nature Conservation Sub-committee.
- Anon. 1980. Our first Chinese recovery letter. BTO News 111: 8.
- Anon. 1983. Preliminary status report and conservation priorities Storks, Ibises and Spoonbills. World Working Group on Storks, Ibises and Spoonbills Report 1: 3-5.
- Anon. 1984. Checklist of the birds of Mai Po Nature Reserve. World Wildlife Fund Hong Kong, Hong Kong.
- Anon. 1987a. WWF Hong Kong Mai Po Marshes Wildlife Education Centre and Nature Reserve: the way ahead. Duplicated Report in WWF Hong Kong files.
- Anon. 1987b. Tin Shui Wai Development. Land formation Working Paper No. 15. Biological reconnaissance Survey, May 1987. Binnes & Partners (Hong Kong).
- Anon. 1987. Pledge to save Hong Kong's threatened wetlands. New Scientist 6 August 1987: 22.
- Anon. 1988a. Deep Bay Integrated Environmental Management. Volume 1: The management strategy. Environmental Resources Limited, Hong Kong.
- Anon. 1988b. Deep Bay Integrated Environmental Management. Working paper 2: Project profiles. Environmental Resources Limited, Hong Kong.
- Anon. 1988c. Deep Bay Integrated Environmental Management. Working paper 3: Mitigation and Monitoring. Environmental Resources Limited, Hong Kong.
- Anon. 1988d. Deep Bay Integrated Environmental Management. Key issues. Environmental Resources Limited, Hong Kong.
- Anon. 1988e. Deep Bay Integrated Environmental Management. Executive summary. Environmental Resources Limited, Hong Kong.
- Anon. 1994a. Stage one EIA. Environmental impact assessment study on Shenzhen River Regulation Project. Peking University, Peking.
- Anon. 1994b. Final EIA Study Report (1). Environmental impact assessment study on Shenzhen River Regulation Project. Peking University, Peking.
- Anon. 1997a. Development of a comprehensive conservation strategy and a management plan in relation to the listing of Mai Po and Inner Deep Bay as a Wetland of International Importance under the Ramsar Convention. Final report: Part A Summary of Study. Report by Aspinwall Clouston to the Agriculture, Fisheries and Conservation Department, Hong Kong Government, Hong Kong.
- Anon. 1997b. Development of a comprehensive conservation strategy and a management plan in relation to the listing of Mai Po and Inner Deep Bay as a Wetland of International

- Importance under the Ramsar Convention. Final report: Part B Management Plan. Report by Aspinwall Clouston to the Agriculture, Fisheries and Conservation Department, Hong Kong Government, Hong Kong.
- Anon. 1997c. Study on the ecological value of fishponds in Deep Bay area. Report by Aspinwall & Company Hong Kong Limited to the Planning Department, Hong Kong Government, Hong Kong.
- Anon. 1999. Strengthening the role of farmers preserving traditional shrimp farming in Hong Kong. Case studies on the role of major groups in sustainable oceans and seas. Background paper #6. Presented to the seventh session of the United Nations' Commission on Sustainable Development, New York, April 1999 by WWF International.
- Anon. 2000a. Development of an ecological monitoring programme for the Mai Po and Inner Deep bay Ramsar Site. Final technical manual. Report by Hyder Consulting Ltd. to the Agriculture, Fisheries and Conservation Department, Hong Kong SAR Government, Hong Kong.
- Anon 2000b. Regulation of the Shenzhen River, Stage II, Phase I works. Monitoring off-site compensation works Ma Po. Unpublished report to the Drainage Services Department, Hong Kong SAR Government. WWF Hong Kong, Hong Kong.
- Anon 2004. Focal study of Black-faced Spoonbills in northwest New Territories, in particular Mai Po and Inner Deep Bay Areas. Unpublished report to the Agriculture, Fisheries and Conservation Department, Hong Kong SAR Government. Asia Ecological Consultants Ltd., Hong Kong.
- Axell. H. 1983. Mai Po Marshes proposals for development as a nature reserve and education centre. Report to World Wildlife Fund Hong Kong.
- Axell. H. 1992. Of birds and men. The Book Guild. Lewes.
- "Aymas". 1930. Local game birds. The snipe. Hong Kong Naturalist 1: 112-113.
- BirdLife International. 2000. Threatened birds of the world. Lynx Edicions and BirdLife International, Barcelona and Cambridge.
- Bradford, D. 1974. A good day for duck. Hong Kong Bird Report 1973: 36-37.
- Berlijn, M., van der Burg, E., Ebels, E. and Schrijvershof, P. Hong Kong 1989. (duplicated).
- Blackmore, G. 1998 An overview of trace metal pollution in the coastal waters of Hong Kong. Science of the Total Environment 214(1-3): 21-48.
- Britton, A.R.C. 1993. Feeding behaviour of the Little Egret at Mai Po, Hong Kong. Hong Kong Bird Report 1992: 176-184.
- Bromhall, J.D. 1958. On the biology of the native oyster of Deep Bay, Hong Kong, *Crassostrea* sp. Hong Kong University Fisheries Journal 2: 93-107.
- Burger J, Gochfeld M (1993). Heavy metal and selenium levels in feathers of young egrets and herons from Hong Kong and Szechuan, China. *Arch. Environ. Contam. Toxicol.* 25:322-7.
- Carey, G.J. 1993. Hybrid male Wigeon in East Asia. Hong Kong Bird Report 1992: 160-166.
- Carey, G.J. 1994. Winter Waterfowl Counts 1992-93. Hong Kong Bird Report 1993: 91-97.
- Carey, G.J. 1994. Smew at Mai Po: the first record for Hong Kong. Hong Kong Bird Report 1993: 115-116.
- Carey, G.J. 1995. Winter Waterfowl Count. Hong Kong Bird Report 1994: 92-97.
- Carey, G.J. 1996. Winter Waterfowl Counts 1994-95. Hong Kong Bird Report 1995: 92-97.
- Carey, G.J. 1998. Winter Waterfowl Counts 1995-96. Hong Kong Bird Report 1996: 88-93.
- Carey, G.J. 1998. Winter Waterfowl Counts 1996-97. Hong Kong Bird Report 1996: 94-99.
- Carey, G.J. 1998. Horned Grebe at Mai Po: the first record for Hong Kong. Hong Kong Bird Report 1996: 114-115.
- Carey, G.J. 1998. Eastern Marsh Harrier drowning Mallard. Hong Kong Bird Report 1996: 171.
- Carey, G.J. 1999. Winter Waterfowl Counts 1997-98. Hong Kong Bird Report 1997: 93-99.
- Carey, G.J. 2002. Mai Po and Inner Deep Bay Ramsar Site Waterbird Monitoring Programme. Winter 1998-99 Report. Hong Kong Bird Report 1998: 96-105.

- Carey, G.J. and Kennerley, P.R. 1996. Mew Gull: the first record for Hong Kong and the identification and systematics of Common Gull forms in East Asia. Hong Kong Bird Report 1995: 134-149.
- Carey, G.J. and Melville, D.S. 1996. Spot-billed ducks in Hong Kong. Hong Kong Bird Report 195: 224-230.
- Carey, G.J. and Young, L. 1999. The importance to waterfowl of the Mai Po Marshes and Inner Deep Bay Ramsar Site. Hong Kong Bird Report 1997: 141-149.
- Carey, G.J., Yu, Y.T. and Ying H.K. 2001. Shorebird Monitoring at the Mai Po Marshes and Inner Deep Bay Ramsar Site: 2001-2002 Report. The Hong Kong Bird Watching Society Limited. Hong Kong.
- Carey, G.J., Diskin, D.A., Lewthwaite, R.W. and M. Turnbull. 2002. Systematic list. Hong Kong Bird Report 1998: 18-95.
- Carey, G.J., Kennerley, P.R., Cheung, H.F., Lewthwaite, R.W. and Chalmers, M.L. 1999. Systematic list. Hong Kong Bird Report 1997: 15-92.
- Carey, G.J., Chalmers, M.L., Diskin, D.A., Kennerley, P.R., Leader, P.J., Leven, M.R., Lewthwaite, R.W., Melville, D.S., Turnbull, M. and Young, L. 2001. The avifauna of Hong Kong. Hong Kong Birdwatching Society, Hong Kong.
- Carvalho, S. de E. 1973. Duck at Deep Bay. Hong Kong Bird Report 1972: 45-46.
- Cha, M.W. 1999. A survey of mudflat gastropods in Deep Bay, Hong Kong. pp. 33-44. In: Lee, S.Y. (ed.) The mangrove ecosystem of Deep Bay and the Mai Po Marshes, Hong Kong. Hong Kong University Press, Hong Kong.
- Cha, M.W. 2004. Steps to minimize the water qulaity impact from the Shenzhen Western Corridor Project in Deep Bay. In Proceedings of the International Conference on Coastal Infrastructure Development Challenges in the 21st Centry, 22-24 November 2004, Coastal-073. Hong Kong.
- Cha, M.W. and Young, L. 1991. Food of the Spoon-billed Sandpiper in Hong Kong. Hong Kong Bird Report, 1990, 192-193.
- Cha, M.W., L. Young, and K.M. Wong. 1997. The fate of traditional extensive (*gei wai*) shrimp farming at the Mai Po Marshes Nature Reserve, Hong Kong. Hydrobiologica, 352, 295-303.
- Chalmers, M.L. 1984. Waterfowl counts in Deep Bay (1979-1983). Hong Kong Bird Report 1981/1982: 98-113.
- Chalmers, M.L. 1985a. International Waterfowl Count in Deep Bay: 12th and 13th January 1985. Hong Kong Bird Watching Society (duplicated).
- Chalmers, M.L. 1985b. Mai Po warbler study. Hong Kong Bird Report 1983: 37-39.
- Chalmers, M.L. 1986. Annotated checklist of the birds of Hong Kong. Hong Kong Bird Watching Society, Hong Kong.
- Chalmers, M.L. 1987. Waterfowl Counts in Deep Bay 1984 and 1985. Hong Kong Bird Report 1984/85: 54-64.
- Chalmers, M.L. 1987. International Waterfowl Count in Deep Bay, Hong Kong 1986. Hong Kong Bird Report 1986: 36-40.
- Chalmers, M.L. 1988. International Waterfowl Count in Deep Bay, Hong Kong 1987. Hong Kong Bird Report 1987: 35-40.
- Chalmers, M.L. 1989. International Waterfowl Count in Deep Bay, Hong Kong 1988. Hong Kong Bird Report 1988: 37-42.
- Chalmers, M.L. 1990. International Waterfowl Count in Deep Bay, Hong Kong 1989. Hong Kong Bird Report 1989: 34-38.
- Chalmers, M.L. 1992. Report on the birds 1991. Hong Kong Bird Report 1991: 4-7.
- Chalmers, M.L. 1992. Hong Kong International Waterfowl Count 1991. Hong Kong Bird Report 1991: 72-78.
- Chalmers, M.L. 1993. Hong Kong International Waterfowl Count 1992. Hong Kong Bird Report 1992: 75-80.
- Chalmers, M.L. 1998. Black-faced Spoonbill nest-building at Mai Po. Hong Kong Bird Report 1996: 170.

- Chalmers, M.L. 2002. A review of Frigatebird records in Hong Kong. Hong Kong Bird Report 1998: 128-142.
- Chan, C.S. 1997. The future of the Deep Bay Wetlands, Hong Kong. M.Sc. Thesis. University of Hong Kong, Hong Kong.
- Chan F.M. 1992. Heavy metals in the tissues of *Oreochromis mossambicus* and *Coutierella tonkinensis* at Mai Po. Baptist College Project report.
- Chan, K.W., Cheung, R.Y.H., Leung, S.F., Wong, M.H. 1999. Depuration of metals from soft tissues of oysters (*Crassostrea gigas*) transplanted from a contaminated site to clean sites. Environmental Pollution 105(3): 299-310.
- Chan, K.Y. 1989. The ecology of mudskippers (Pices: Periophthalmidae) at the Mai Po Marshes Nature Reserve, Hong Kong. Unpublished thesis. University of Hong Kong, Hong Kong.
- Chan, S.Y. 1970. The changing landuse pattern in Tin Shui Wai and example of the reclamation of swamps and marshes for agricultural purposes in the New Territories. B.A. thesis. University of Hong Kong, Hong Kong.
- Chan, S.Y. 1993. Report on the result of water quality at the WWF Hong Kong Mai Po Marshes Nature Reserve. Duplicated. World Wide Fund for Nature Hong Kong, Hong Kong.
- Chan, S.Y., Au, J. and Young, L. 1992. A new species of mammal for Hong Kong: The Javan Mongoose (*Herpestes javanicus*). Memoirs of the Hong Kong Natural History Society 19: 137-138.
- Chan, V. and Dawes, V. 1996. Survey on the guided visit program of Mai Po Marshes July to August 1996. Unpublished report. WWF Hong Kong, Hong Kong.
- Chan, C.W., Chan, K.F., Lee, W.L., Wong, S.W. and Wong, Y.K. 1996. The benthic community in Mai Po Marshes (*gei wai* 20-24). Hong Kong Technical College (Chai Wan), Hong Kong.
- Che, R.G.Ong. 1999. Concentration of 7 Heavy Metals in Sediments and Mangrove Root Samples from Mai Po, Hong Kong. *Marine Pollution Bulletin* 39(1-12): 269-279.
- Che, R.G.O. and Cheung, S.G. 1998. Heavy metals in *Metapenaeus ensis*, *Eriocheir sinensis* and sediment from the Mai Po marshes, Hong Kong. Science of the Total Environment 214(1-3): 87-97.
- Cheng, L. & Hill, D.S. 1982. Marine insects of Hong Kong. In: Morton, B. and Tseng, C.K. (eds), The marine flora and fauna of Hong Kong and Southern China. pp 173-183. Hong Kong University Press, Hong Kong.
- Cheung, W.L., Lee, K.C., Sia, S.F. and Tong, S.T. 1996. Determination of the heavy metal concentration in Metapenaeus ensis, Eriocheir chinensis and sediment from four Mai Po gei wais (8, 11, 16/17, 19). Hong Kong Technical College (Chai Wan), Hong Kong.
- Cheung, Y.M. 1999. The socio-economics of fish pond farming and implications for future land use in and around the Mai Po and Inner Deep Bay Ramsar Site. M.Sc. thesis, University of Hong Kong, Hong Kong.
- Chiu K.T. 1992. An assessment of the water pollution status of the Mai Po Marshes Nature Reserve, Hong Kong. Ph.D. thesis, University of Hong Kong, Hong Kong.
- Choi, K.C. 1991. The ecology of Fiddler crabs (Crustacea: Ocypodidae) at the Mai Po Marshes Nature Reserve, Hong Kong. Unpublished thesis. University of Hong Kong, Hong Kong.
- Chow, T. 1958a. The bionomics of pondfish culture in the New Territories, Hong Kong. Hong Kong University Fisheries Journal 2: 130-132.
- Chow, T. 1958b. A study of water quality in the fish-ponds of Hong Kong. Hong Kong University Fisheries Journal 2: 7-28.
- Chu, H.F. 1995. Planning considerations for conservation and development within Deep Bay Buffer Zones in North West New Territories Hong Kong. University of Hong Kong, Hong Kong.
- Chung, H.F. 2000. An investigation of the role of Mai Po Nature Reserve from a conservation and education perspective. M.Sc. Thesis. University of Hong Kong, Hong Kong.

- Connell, D.W., Wong, B.S.F., Lam, P.K.S., Poon, K.F., and Lam, M.H.W. 2002. Risk to Breeding Success of Ardeids by Contaminants in Hong Kong: Evidence from Trace Metals in Feathers. *Ecotoxicology*, 11(1): 49-59.
- Connell, D.W., Fung, C.N., Minh, T.B. and Tanabe, S. *et al.* 2003. Risk to breeding success of fish-eating Ardeids due to persistent organic contaminants in Hong Kong: evidence from organochlorine compounds in eggs. *Water Research* 37(2): 459-467
- Corlett, R.A. 1992. Two additions to the naturalized flora of Hong Kong. Memoirs of the Hong Kong Natural History Society, 19, 119.
- Corlett, R.A. 1992. The impact of cold and frost on terrestrial vegetation in Hong Kong. Memoirs of the Hong Kong Natural History Society, 19, 133-135.
- Corlett, R.A. 1992. Taxonomic notes on some common Hong Kong weeds. Memoirs of the Hong Kong Natural History Society, 19, 136.
- Cornish, A.S. 1996. Habitat utilisation by feeding Little Egrets from a Tsim Bei Tsui egretry. Hong Kong Bird Report 1995: 238-244.
- Crivelll, A. and Vizi, O. 1981. The Dalmatian Pelican, (*Pelecanus crispus* Bruch 1832), a recently world-endangered bird species. Biological Conservation 20:
- Dahmer, T.D. and Felley. M.L. 1994. Census and population status of Black-faced Spoonbills during winter 1993-1994. Hong Kong Bird Report 1993: 177-183.
- De Luca-Abbott SB, Wong BSF, Peakall DB, Lam PKS, Young L, Lam MHW, Richardson BJ (2001). Review of effects of water pollution on the breeding success of waterbirds, with particular reference to Ardeids in Hong Kong. *Ecotoxicology* 10:327-349.
- Dolk, R.O and Meville, D.S. 1985. Conservation of Mai Po. Unpub. report.
- Duke, N.C. and Khan, A. 1999. Structure and composition of the seaward mangrove forest at the Mai Po Marshes Nature Reserve, Hong Kong. pp. 83-104. In: Lee, S.Y. (ed.) The mangrove ecosystem of Deep Bay and the Mai Po Marshes, Hong Kong. Hong Kong University Press, Hong Kong.
- Erseus, C. 1984. The marine Tubificidae (Oligochaeta) of Hong Kong and southern China. Asian Marine Biology 1: 135-175.
- de Frias Martins, A.M. 1994. The anatomy of Auriculastra subula (Quoy and Gaimard, 1832) (Pulmonata: Ellobiidae) from Hong Kong, with a comment on the systematic position of *Auriculastra Martes*, 1880. Asian Marine Biology 11: 79-88.
- Fan, H.Q. 1993. Necesity of establishing China Mangrove Research Centre and its tasks. Journal of the Guangxi Academy of Sciences, 9(2), 122-129.
- Fellowes, J.R. 1999. Preliminary observations of ants in Hong Kong mangroves. pp. 131-134. In: Lee, S.Y. (ed.) The mangrove ecosystem of Deep Bay and the Mai Po Marshes, Hong Kong. Hong Kong University Press, Hong Kong.
- Fong, T.Y. 1956. Oyster industry of Hong Kong. Undergraduate essay presented in the Dept. of Geography & Geology. University of Hong Kong, Hong Kong.
- Foo, P.M. 1996. An introduction of Mai Po Marshes Nature Reserve: Geography of the Mai Po Marshes. pp.184-212. In Ecotone VI, Regional Seminar for Southeast and East Asia on zoning and multiple resource use schemes for integrated coastal resources development planning and management.
- Fung, C.N. 1996. Sediment characteristics on the Mai Po mudflats. Unpub. B.Sc. dissertation. City University of Hong Kong, Hong Kong.
- Fung, T. 1997. Mapping land cover changes in the Inner Deep Bay area of Hong Kong. pp: 83-92. In: Kam, N.A. and K. Lulla (eds.) Hong Kong and the Pearl River Delta as seen from space images. Geocarto International Centre, Hong Kong.
- Galsworthy, A.C. 1997. New and revised species of macrolepidoptera from Hong Kong. Memoirs of the Hong Kong Natural History Society 21: 127-150.
- Goodall, S.E.M. 1982. Report on the feasibility of Mai Po Marshes as a Wildlife Education Centre. Report to the World Wildlife Fund Hong Kong.
- Goodyear, N.J. 1992. Notes on land mammals of Hong Kong. Memoires of the Hong Kong Natural History Society. 19: 71-78.
- Grant, C.J. 1969. Development of soil acidity in operating fish ponds. Agricultural Science 1: 136-140.

- Grant, C.J. 1971. Fish farming in Hong Kong. In: Dwyer, D.J. (ed.) The changing face of Hong Kong. Ye Olde Printerie, Hong Kong.
- Hale, M. and Kennerley, P.R. Swiflets in Hong Kong. Hong Kong Bird Report 1994: 181-195.
- Herklots, G.A.C. 1934. Notes and comments. Ornithology. Hong Kong Naturalist 5: 320-322.
- Herklots, G.A.C. 1937. Notes and comments. Ornithology. Hong Kong Naturalist B: 54-56.
- Herklots, G.A.C. 1940. Notes and comments. Ornithology. Hong Kong Naturalist 10: 63-70.
- Herklots, G.A.C. 1940. Notes and comments. Ornithology. Hong Kong Naturalist 10: 122-127.
- Herklots, G.A.C. 1940. The birds of Hong Kong. Part XXXIV. Family Scolopacidae, subfamily Tringinae. (Curlews and large sandpipers). Hong Kong Naturalist 10: 5-10.
- Hirayama, A. 1992. Phoxocephalidae and Urothoidae (Crustacea: Amphipoda: Phoxocephaloidea) from Hong Kong. Asian Marine Biology 9: 117-138.
- Hirayama, A. 1992. Oedicerotidae (Crustacea: Amphipoda) from Hong Kong. Asian Marine Biology 9: 139-166.
- Ho, Y.B. 1999. Metal concentrations in shrimp and mantis shrimps from Deep Bay, Hong Kong and the esatern waters of the Pearl River estuary. pp. 153-164. In: Lee, S.Y. (ed.) The mangrove ecosystem of Deep Bay and the Mai Po Marshes, Hong Kong. Hong Kong University Press, Hong Kong.
- Hodgkiss, I.J. 1986. Aspects of mangrove ecology in Hong Kong. Memoirs of the Hong Kong Natural History Society 17, 107-116.
- Hodgkiss, I.J. 1992. Species new to Hong Kong. Memoirs of the Hong Kong Natural History Society 19, 139.
- Hodgkiss, I.J. 1995. Species new to Hong Kong. Memoirs of the Hong Kong Natural History Society 20, 237.
- Hodgkiss, I.J. & Morton, B. 1978. Halophila beccarii Ascherson (Hydrocharitaceae) a new record for Hong Kong with notes on other Halophila species. Memoirs of the Hong Kong Natural History Society 13: 28-32.
- Holmes, J. 1992. Blue-throated Bee-eater at Mai Po. A new species for Hong Kong. Hong Kong Bird Report 1991: 110-111.
- Huggins, R.M. and Yip, P.S.F. 1999. Estimation of the size of an open population from capture-recapture data using weighted martingale methods. Biometrics 55 (2): 387-395.
- Hui, S.H. 1994. The distribution of the invertebrates in three different regions of gei wai 3 in different seasons and the factors affecting their abundance. City Polytechnic of Hong Kong, Hong Kong.
- Hsu, W. and Melville, D.S. 1994. Seabirds of China and adjacent seas: status and conservation. Pp. 210-218. In: Nettleship, D.N., Burger, I. and Gochfield, M. (eds.) Seabirds on islands: threats case studies and action plans. BirdLife Conservation Series 1. Birdlife International, Cambridge.
- Hui, S.H. 1994. The species composition and distribution of the invertebrates in three different regions of *gei wai* 3 and the factors affecting their abundance. Unpub. B.Sc. dissertation. City Polytechnic of Hong Kong, Hong Kong.
- Hutson, H.P.W. 1930. Notes and comments. Ornithology. Hong Kong Naturalist 1: 190-193.
- Inderbitzin, Abdel-wahab, M.A. Jones, E.B.G. and Vrijmoed, L.P. 1999. A new species of Cryptovalsa from Mai Po mangrove in Hong Kong. *Mycological Research* 103(12): 1628-1630.
- Irving, R.T.A. 1992. Landuse and landuse change in the reclaimed coastal areas of Deep Bay. In: Sinn, E. (ed.) Between east and west. University of Hong Kong, Hong Kong.
- Irving, R.T.A. and Leung, K.W. 1987. Land-use and land-use changes in the reclaimed coastal areas of Deep Bay. MS. Geography Department, Hong Kong University.
- Irving, R. & Morton, B. 1988. A Geography of the Mai Po Marshes. World Wide Fund for Nature Hong Kong, Hong Kong.
- Jones, D.S. and Morton, B.S. 1994. The Fiddler Crabs (Ocypodidae: Uca) of Hong Kong. Asian Marine Biology: 9-40.
- Kathiresan, K. 1999. Observations on the mangrove community at the Mai Po Marshes, Hong Kong: implications for conservation. pp. 179-189. In: Lee, S.Y. (ed.) The mangrove

- ecosystem of Deep Bay and the Mai Po Marshes, Hong Kong. Hong Kong University Press, Hong Kong.
- Kennerley, P.R. 1987. Little Stint *Calidris minuta* at Tsim Bei Tsui. A new species for Hong Kong. Hong Kong Bird Report 1986: 69-71.
- Kennerley, P.R. 1987. Lesser Yellowlegs *Tringa flavipes* at Tsim Bei Tsui and Mai Po. The first record for Hong Kong and China. Hong Kong Bird Report 1986: 72-74.
- Kennerley, P.R. 1987. Black-necked **Grebe** *Podiceps nigricollis* at Tsim Bei Tsui. A new species for Hong Kong. Hong Kong Bird Report 1986: 80.
- Kennerley, P.R. 1992. Ferruginous Duck at Mai Po. The first record for Hong Kong. Hong Kong Bird Report 1991: 104-105.
- Kennerley, P.R. 1992. White-browed Crake at Mai Po. The first record for Hong Kong and China. Hong Kong Bird Report 1991: 108-109.
- Kennerley, P.R. 1992. Paddyfield Warbler at Mai Po. The first record for Hong Kong. Hong Kong Bird Report 1991: 123-126
- Kennerley, P.R. and Bakewell, D.N. 1987. Nordmann's Greenshank in Hong Kong: a review of the identification and status. Hong Kong Bird Report 1986: 83-100.
- Kennerley, P.R. and Leader, P.J. 1992. The identification, status and distribution of small *Acrocephalus* warblers in Eastern China. Hong Kong Bird Report 1991: 143-187.
- Kennerley, P.R., Hoogendoorn, W. and Chalmers, M.L. 1995. Identification and systematics of large white-headed gulls in Hong Kong. Hong Kong Bird Report 1995: 127-156.
- Kennish, J. 2002. Environmental threats and environmental future of estuaries. *Environmental Conservation* 29(01): 78-107.
- Kent, S.P.M. 1963. The Marshes. Hong Kong Bird Report 1962: 48-54.
- Kilburn, E.M.S. and Lam, C.Y. 1999. Monthly summaries. Hong Kong Bird Report 1997: 8-14.
- Kong, M.F. et al. 1985. A hydrological and sediment transport survey in Deep Bay during the dry season, 1984. Technical Report No. 8501. Department of Civil and Structural Engineering, Hong Kong Polytechnic. Hong Kong.
- Kueh, C.S.W. and Chui, H.K. 1996. Integrated catchment management of Deep Bay, Hong Kong. Water Science Technology, 34(12), 1-8.
- Kwok, H.K. 1993. Comparison of feeding efficiencies between adult and juvenile Little Egrets. Hong Kong Bird Report 1992: 185-187.
- Kwok, K. 1993. Effect of water level fluctuation of gei wai on distribution of waders in the Mai Po Marshes. Unpub. report. City Polytechnic of Hong Kong.
- Kwok, P.W. 1995. The ecology of two sesarmine crabs, *Perisesarma bidens* (de Haan) and *Parasesarma plicata* (Latreille) at the Mai Po Marshes Nature Reserve, Hong Kong. Ph.D. Thesis. University of Hong Kong, Hong Kong.
- Kwok, P.W. 1999. Time activity budget of *Perisesarma bidens* and *Parasesarma affinis* (Brachyura: Sesarminae) at the Mai Po Marshes mangrove, Hong Kong. pp. 137-152. In: Lee, S.Y. (ed.) The mangrove ecosystem of Deep Bay and the Mai Po Marshes, Hong Kong. Hong Kong University Press, Hong Kong.
- Kwok, Y.W. 1994. To investigate the factors affecting the biodiversity and abundance of the benthic invertebrates in Mai Po. Unpub. B.Sc. dissertation. City Polytechnic of Hong Kong, Hong Kong.
- Kwong, A.W.K., Chan, C.Y. and Renneberg, R. 1998. Monitoring biodegradable substances with high molecular content with a microbial sensor. Analytical Letters 31(14): 2309-2325.
- Lai, Y.F. 2004. A study of physical and chemical properties of pond water and bottom soil in fishponds of Hong Kong. Unpublished B.Sc. undergraduate project. Chinese University of Hong Kong, Hong Kong.
- Lam, C.Y. 1987. Bull-headed Shrike *Lanius bucephalus* at Mai Po. Hong Kong Bird Report 1986: 75.
- Lam, P.K.S. and Lam M.H.W. 2001. Study on the effect of water pollution on the breeding success of Ardeids: Unpublished report to the Agriculture, Fisheries and Conservation Department, Hong Kong SAR Government, Hong Kong.

- Lam, V.S.K. 1997. Survey on the effectiveness of guided visit programme of Mai Po Marshes. Unpub. final year B.Sc. project. City University of Hong Kong, Hong Kong.
- Lam, C.Y. and Williams, M. 1994. Weather and bird migration in Hong Kong. Hong Kong Bird Report 1993: 139-169.
- Lam, M.H.W. and Lam, P.K.S. 2000. Study on the impact of sediment porewater quality on the benthic infauna of the Mai Po mudflats. City University of Hong Kong, Hong Kong.
- Lam PKS, Lam MHW (2001). Study on the effect of water pollution on the breeding success of Ardeids: Final report. Submitted to the Agriculture, Fisheries and Conservation Department, Hong Kong SAR Government.
- Lam, C.W., Shinsuke, T., Lam, M.H.W. and Lam P.K.S. 2005. Risk to breeding success of waterbirds by contaminants in Hong Kong: evidence from trave elements in eggs. Environmental Pollution 135: 481 490.
- Lansdown, R.V., Mundkur, T. and Young, L. 2000. Status of herons in East and South-east Asia. pp. 73 98. In: Kushlan, J.A. and H. Hafner (eds.), Heron Conservation. Academic Press.
- Lau, L.K. 2000. Effectiveness of planning and management on Ramsar site in Hong Kong. M.Sc. Thesis. University of Hong Kong, Hong Kong.
- Lau, M. and Melville, D.S. 1992. Notes on the feeding of *Enhydris bennetti*. Memoires of the Hong Kong Natural History Society. 19: 117.
- Lau, M.W. and Dudgeon, D. 1999. Composition and distribution of Hong Kong Amphibian fauna. Memoirs of the Hong Kong Natural History Society 22: 1-80.
- Lau, S.S.S. 1997. Pollution status and assimilative potential of the wetlands at the Mai Po Marshes Nature Reserve, Hong Kong. M.Phil. thesis. Chinese University of Hong Kong.
- Lau, S.S.S. 2000. The significance of temporal variability in sediment quality for contamination assessment in a coastal wetland. *Water Research* 34(2): 387-394.
- Lau, S.S.S. and Chu, L.M. 1999. Contaminant release from sediments in a coastal wetland. Water Research, 33, 909-918.
- Lau, S.S. and Chu, L.M. 1999. Water quality degradation at the Mai Po Marshes Nature Reserve (Hong Kong) with reference to nutrient enrichment. Hydrobiologia 403: 195-203.
- Lau, S.S. and Chu, L.M. 2000. Nutrient and faecal contamination and retention in wetland enclosures (*gei wai*) in the Mai Po Marshes, Hong Kong. Hydrobiologia 431(1): 81-92.
- Lau, S.S.S. and Chu, L.M. 2000. The significance of sediment contamination in a coastal wetland, Hong Kong, China. *Water Research* 34(2): 379-386.
- Law, T. P. 1994. Planning for conservation in inner Deep Bay and its hinterland: a strategic choice approach: workshop report. University of Hong Kong, Hong Kong.
- Leader, P.J. 1992. Blunt-winged Warbler. A new species for Hong Kong. Hong Kong Bird Report 1991: 120-122.
- Leader, P.J. 1994. Middendorff's Grasshopper Warbler: the first record for Hong Kong. Hong Kong Bird Report 1993: 123-131.
- Leader, P.J. 1994. Eurasian Reed Bunting: a brief review of its identification. Hong Kong Bird Report 1993: 193-194.
- Leader, P.J. 1995. Field identification of Dusky, Radde's and Yellow-streaked Warblers. Hong Kong Bird Report 1994: 170-180.
- Leader, P.J. 1996. Black-headed Bunting: the first records for Hong Kong. Hong Kong Bird Report 1995: 129-133.
- Leader, P.J. 1996. Field identification of Yellow, Schrenck's and Chestnut Bitterns. Hong Kong Bird Report 1995: 218-223.
- Leader, P.J. 1998. Preliminary observations on the winter ecology of Black-faced Spoonbill in Hong Kong. Hong Kong Bird Report 1996: 143-157.
- Leader, P.J. 1998. The winter status and conservation of Styan's Grasshopper Warbler. Hong Kong Bird Report 1996: 158-161.
- Leader, P.J. 1999. Little Gull: the first record for Hong Kong. Hong Kong Bird Report 1997: 118-119
- Leader, P.J. 1999. Social and migratory behaviour in Great Bittern. Hong Kong Bird Report 1997: 156-158.

- Leader, P.J. and Carey, G.J. 1992. Identification of Japanese Sparrowhawk and Besra. Hong Kong Bird Report 1994: 157-169.
- Leader, P.J. and Lewthwaite, R.W.1996. Manchurian Reed Warbler: the first records for Hong Kong. Hong Kong Bird Report 1995: 119-122.
- Leader, P.J. and Turnbull, M. 1992. Monthly summaries. Hong Kong Bird Report 1991: 8-20.
- Leano, E.M. 1998. Zoospore chemotaxis of two mangrove strain of *Halophytophthora vesicula* from Mai Po, Hong Kong. Mycologia 90: 1001-1008.
- Leano, E.M., Vrijmoed, L.L.P. and Jones, E.B.G. 1998. Physiological Studies on *Halophytophthora vesicula* (Straminipilous Fungi) Isolated from Fallen Mangrove Leaves from Mai Po, Hong Kong. Botanica Marina 41(4): 411-419.
- Leano, E.M., Vrijmoed, L.L.P. and Jones, E.B.G. 1998. Zoospore chemotaxis of two mangrove strains of *Halophytophthora vesicula* from Mai Po, Hong Kong. Mycologia 90(6): 1001-1008.
- Lee, K.W.K. 2004. Species assemblages of traditional shrimp ponds (*gei wai*) at Mai Po Marshes Nature Reserve Hong Kong, with special reference to post-larval shrimps and fish. Unpublished B.Sc thesis. University of Hong Kong, Hong Kong.
- Lee, S.Y. 1988. The ecology of a traditional tidal shrimp pond in Hong Kong, the production and fate of macrodetritus and implications for management. Unpublished Ph.D. thesis. University of Hong Kong, Hong Kong.
- Lee, S.Y. 1989. The importance of sesarminae crabs *Chiromanthes* spp. and inundation frequency on mangrove (*Kandelia candel* [L.] Druce) leaf litter turnover in a Hong Kong tidal shrimp pond. Journal of Experimental Marine Biology and Ecology 131: 23-43.
- Lee, S.Y. 1990a. Primary productivity and particulate organic matter flow in an estuarine mangrove-wetland in Hong Kong. Marine Biology 106: 453-463.
- Lee, S.Y. 1990b. Net aerial primary productivity, litter production and decomposition of the reed Phragmites communis in a nature reserve in Hong Kong: management implications. Marine Ecology Progress Series 66: 161-173.
- Lee, S.Y. 1990c. The intensity and consequences of of herbivory on the mangrove *Kandelia candel* (L.) Druce at the Mai Po Marshes, Hong Kong. pp. 717-725. In: Morton, B.S. (ed.) The marine flora and fauna of Hong Kong and south China II. Hong Kong University Press, Hong Kong.
- Lee, S.Y. 1991. Herbivoury as an ecological process in a *Kandelia candel* (Rhizphoraceae) mangal in Hong Kong. Journal of Tropical Ecology 7: 337-348.
- Lee, S.Y. 1992. The management of traditional tidal ponds for aquaculture and wildlife conservation in southeast Asia: problems and prospects. Biological Conservation 63: 113-118.
- Lee, S.Y. 1993. Invertebrate species new to science recorded from the Mai Po Marshes, Hong Kong. pp 199-210. In: Morton, B.S. (ed.). The Marine Biology of the South China Sea. Vol.1. Hong Kong University Press, Hong Kong.
- Lee, S.Y. (ed.) 1999. The Mangrove ecosystem of Deep Bay and the Mai Po marshes, Hong Kong: proceedings of the International Workshop on the Mangrove Ecosystem of Deep Bay and Mai Po Marshes, Hong Kong, 3-20 September 1993. Hong Kong University Press, Hong Kong.
- Lee, S.Y. 2000 Carbon dynamics of Deep Bay, eastern Pearl River estuary, China. 2: Trophic relationship based on carbon and nitrogen stable isotopes. Marine Ecology Progress Series 205: 1-10.
- Lee, S.Y. and Leung, V. 1999. The brachyuran fauna of the Mai Po Marshes Nature Reserve and Deep Bay, Hong Kong. pp. 57-82. In: Lee, S.Y. (ed.) The mangrove ecosystem of Deep Bay and the Mai Po Marshes, Hong Kong. Hong Kong University Press, Hong Kong.
- Lee, W.H. 1995. Distribution and structure of reedbeds community in *gei wai* 14 of Mai Po Marshes. City University of Hong Kong, Hong Kong.
- Lee, W.H. 1997. Ecological value of reedbeds (*Phragmites australis*) at Mai Po Marshes Nature Reserve. M.Phil. thesis. City University of Hong Kong.
- Leung C., Shortridge, K.F., Morton, B., Wong, P.S. 1975. The seasonal incidence of faecal bacteria in the tissues of the commercial oyster *Crassostrea gigas* Thunberg 1793 correlated

- with the hydrology of Deep Bay, Hong Kong. Proceedings of the Pacific Science Association, Symposium on Marine Sciences, Hong Kong 1973.
- Leung, C.Y. 1994. Population-dynamics of zooplankton in Mai Po, with emphasis on Copepoda. Unpub. B.Sc. dissertation. City Polytechnic of Hong Kong, Hong Kong.
- Leung, H.W. 1996. The water quality and soil characteristic of four fish ponds in Mai Po. Unpub. B.Sc. dissertation. City University of Hong Kong, Hong Kong.
- Leung, K.W. 1986. Landuse and landuse changes in the Deep Bay area. B.A. thesis. University of Hong Kong, Hong Kong.
- Leung, S.F. 1991. The population dynamic of *Metapenaeus ensis* (Penaeidae) and *Exopalaemon styliferus* (Palaemonidae) in a traditional tidal shrimp pond at the Mai Po Marshes Nature Reserve, Hong Kong. Unpublished thesis. University of Hong Kong, Hong Kong.
- Leung, S.F. 1993. The species composition of penaeid prawns and caridean shrimps in a *gei* wai at the Mai Po Marshes Nature Reserve, Hong Kong. pp. 65-76. In: Morton, B.S. (ed.). The Marine Biology of the South China Sea. Vol.1. Hong Kong University Press, Hong Kong.
- Leung, S.F. 1994. The population dynamics of *Exopalaemon styliferus* H. Milne-Edwards (Palaemonidae) in a traditional tidal shrimp pond at the Mai Po Marshes Nature Reserve, Hong Kong. Asian Marine Biology 11: 55-78.
- Leung, S.F. 1999. The species composition of penaeid prawns in the north-western waters of Hong Kong. pp. 3-12. In: Lee, S.Y. (ed.) The mangrove ecosystem of Deep Bay and the Mai Po Marshes, Hong Kong. Hong Kong University Press, Hong Kong.
- Leung, W.H. 1996. The conservation of coastal wetlands, especially the Mai Po marshes, in Hong Kong: problems and prospects. M.Sc. Thesis. University of Hong Kong, Hong Kong.
- Leung, Y.H. 1997. Water quality of Mai Po Marshes. Unpub. B.Sc. dissertation, University of Hong Kong, Hong Kong.
- Leven, M.R. 1994. Yellow-bellied Bush Warbler in Hong Kong. Hong Kong Bird Report 1993: 212-214.
- Li, M.S. 1997. Nutrient dynamics of a Futian mangrove forest in Shenzhen, South China. Estuarine, Coastal and Shelf Science, 45, 463-472.
- Li, M.S. and Lee, S.Y. 1996. Mangroves of China. Forest Ecology and Management, 96, 241-259.
- Li, M.S. and Lee, S.Y. 1998 Carbon dynamics of Deep Bay, eastern Pearl River Estuary, China.

 1: A mass balance budget and implications for shorebird conservation Marine Ecology Progress Series 172: 73-87.
- Li, P.S. 1997. Water quality of Mai Po Marshes. Unpub. B.Sc. dissertation, University of Hong Kong, Hong Kong.
- Li, Y.S. and Lee, J.H.W. 1995. Hydraulics of Deep Bay and Tolo Harbour. pp 1-5. In: Symposium on hydraulics of Hong Kong Waters, Civil Engineering Department, Hong Kong.
- Li, M.S., Lan, C.Y., Chen, G.Z., Li, S.H., Wong, Y.S., Tam, N.F.Y. and Chen X.R. 1999. Litter production and return of nutrient elements in Futian mangrove swamp, Shenzhen, China. pp. 165-178. In: Lee, S.Y. (ed.) The mangrove ecosystem of Deep Bay and the Mai Po Marshes, Hong Kong. Hong Kong University Press, Hong Kong.
- Liang Y. and Wong M.H. 2003. Heavy metal mobility and aquatic biogeochemical processes at Mai Po Marshes Nature Reserve, Hong Kong. In: MH Wong (ed.) *Wetland Ecosystems in Asia Function and Management* (in preparation).
- Liang Y. and Wong M.H. 2003. Spatial and temporal organic and trace metal pollution at Mai Po Marshes Nature Reserve, Hong Kong. *Chemosphere* 52: 1647-1658.
- Liang, Y., Wong, M.H., Shutes, R.B.E. and Revitt, D.M. 1999. Ecological risk assessment of polychlorinated biphenyl contamination in the Mai Po Marshes Nature Reserve, Hong Kong. *Water Research* 33(6): 1337-1346.
- Lin, C.Y. 2001. The relationship between land use change and water quality degradation and impacts on wetland ecosystem. A case study of Mai Po Marshes Natural Reserve. Unpub. B.Sc. dissertation. Baptist University of Hong Kong.

- Lin, S.Y. 1940. Salt manufacture in Hong Kong. Hong Kong Naturalist 10: 138-151.
- Lui, T.H. 1999. Macrobenthic faunal assemblages of a traditional tidal shrimp pond at Mai Po Marshes Nature Reserve, Hong Kong. M.Phil. Thesis. University of Hong Kong, Hong Kong.
- Lok, Y.L. 1995. The effect of herbicide on *Phragmites australis* and the associated fauna in a *gei wai* of Mai Po Nature Reserve. Unpub. B.Sc. dissertation. City Polytechnic of Hong Kong, Hong Kong.
- Lui, T.H. 1996. Effcets of nitrogen enrichment on the mangrove *Kandelia candel* (L.) Druce. Unpub. B.Sc. dissertation, University of Hong Kong, Hong Kong.
- Lui, T.H. 1999. Macrobenthic faunal assemblages of a traditional tidal shrimp pond at Mai Po Marshes Nature Reserve, Hong Kong. M.Phil. Thesis. University of Hong Kong, Hong Kong.
- Lui, T., Lee, S. and Sadovy, Y. 2002. Macrobenthos of a tidal impoundment at the Mai Po Marshes Nature Reserve, Hong Kong. *Hydrobiologia* 468(1-3): 193-211.
- McChesney, S. 1997. The benthic invertebrate community of the intertidal mudflat at the Mai Po Marshes Nature Reserve, with special reference to resources for migrant shorebirds. Unpublished M.Phil. thesis, University of Hong Kong.
- McClure, H.E. and Leelavit, P. 1972. Birds banded in Asia during the MAPS program by locality, from 1963 through 1971. US Army R and D Group Far East, San Francisco.
- Ma, K.K. 1993. A study on the behaviours of Cormorant in Mai Po. City Polytechnic of Hong Kong, Hong Kong.
- Ma, K.W. 1997. Foraging behaviour, patch use and us eof drain down gei wai by Little Egret *Egretta garzetta* at Mai Po, Hong Kong. Unpub. final year B.Sc. project. University of Hong Kong, Hong Kong.
- Massie, D. and Massie, N. 1998. Common Swift at Mai Po: the first record for Hong Kong. Hong Kong Bird Report 1996: 125-127.
- Marshall, P.M. and Phillips, J.G. 1965. Plans for conserving the wildlife of Hong Kong. Oryx 8: 107-112.
- Matthews, G.V.T. 1978. Report on the Mai Po Marshes, Hong Kong. Report to the Agriculture and Fisheries Department, Hong Kong.
- Maxwell, G.S. and Chope, O. 1995. Propagule variation in *Kandelia candel* (L.) Druce at three Hong Kong locations. Memoirs of the Hong Kong Natural History Society 20, 215-220.
- Melisch, R., Young, L. and Y. Sadovy. 1998. Eurasian Otter (*Lutra lutra*) still present in Hong Kong. IUCN Otter Specialist Group Bulletin, 15(1), 44-46.
- Melville, D.S. 1979a. Gulls and terns perching on wire. British Birds 72: 344.
- Melville, D.S. 1980a. Waterfowl count 14 January 1979. Hong Kong Bird Report 1978: 48-50. Melville, D.S. 1980b. Mai Po Marshes information sheets. Agriculture and Fisheries Department, Hong Kong.
- Melville, D. 1980c. Unexplained shorebird mortality San Tin, May 1979. Agriculture and Fisheries Department, Hong Kong, Occasional Paper M11.
- Melville, D.S. 1981a. Bird ringing in Hong Kong. Hong Kong Bird Report 1979: 44-46.
- Melville, D.S. 1981b. Spring measurements, weights and plumage status of *Calidris ruficollis* and *C. ferruginea* in Hong Kong. Wader Study Group Builetin 33: 18-21.
- Melville, D.S. 1982a. Notes on 'disabled' waders in East Asia. Wader Study Group Bulletin. 36: 14-15.
- Melville, D.S. 1982b. Birds in the Deep Bay area and the potential birdstrike hazard at a replacement airport at Deep Bay. Report to the Director of Civil Aviation.
- Melville, D.S. 1984a. Seabirds of China and the surrounding seas. ICBP Technical Publication 2: 501-511.
- Melville, D.S. 1984b. Notes on intertidal flats and mangroves in southern China. Unpublished report to IUCN.
- Melville, D.S. 1986a. Gulls and terns. Mai Po Nature Reserve. WWF Hong Kong, Hong Kong. Melville, D.S. 1986b. Spoonbills and ibises, Mai Po Nature Reserve. WWF Hong Kong, Hong Kong.

- Melville, D.S. 1986. Report to IUCN on a visit to Fu Tien Reserve, Shenzhen, Guangdong Province, People's Republic of China. 26th/27th May. 1986. MS.
- Melville, D.S. 1987. Three species new to Hong Kong and (Eastern) China. Hong Kong Bird Report 1986: 58-68.
- Melville, D.S. 1987. Chinese Pond Herons *Ardeola bacchus* eating flies. Hong Kong Bird Report 1986: 104-106.
- Melville, D.S. 1987a. Saunders' Gull *Larus saundersi*. Paper presented at International Crane Workshop, May 1987, Qiqihar.
- Melville, D.S. 1987b. Report on bird ringing 1985 and 1986. Hong Kong Bird Report 1986: 55-57.
- Melville, D.S. 1987c. Airport, dump threaten prime Asian wetland. WWF News No. 50 November-December 1987: 1.
- Melville, D.S. 1988. Report on bird ringing in Hong Kong in 1987. Hong Kong Bird Report 1987: 56-63.
- Melville, D.S. 1988. Does the Great Reed Warbler *Acrocephalus arundinaceus orientalis* breed in Hong Kong. Hong Kong Bird Report 1987: 56-63.
- Melville, D.S. 1989a. Wintering waterfowl in Deep Bay, Hong Kong. pp 180-187. Proceedings of a Conference on Wetlands and Waterfowl Conservation in Asia. Malacca, Malaysia, 23-28 February 1987. Asian Wetland Bureau/ IWRB, Kuala Lumpur.
- Melville, D.S. 1989b. Report on bird ringing in Hong Kong in 1988. Hong Kong Bird Report 1988: 63-72.
- Melville, D.S. 1989c. Hong Kong. pp. 283-294. In: Scott, D.A. (ed.) A Directory of Asian wetlands. IUCN, Gland.
- Melville, D.S. 1990a. Report on bird ringing in Hong Kong in 1989. Hong Kong Bird Report 1989: 65-76.
- Melville, D.S. 1990b. Waders roosting in mangrove. British Birds 83: 289.
- Melville, D.S. 1991a. Report on bird ringing in Hong Kong in 1990. Hong Kong Bird Report 1990: 86-99.
- Melville, D.S. 1991b. Potential impacts of development on waterfowl using the Internationally important Inner Deep Bay wetland, Hong Kong. pp. 869-833. In: Boxall, J. (ed.) Polmet '91: Pollution in the metropolitan and urban environment. Hong Kong Institution of Engineers, Hong Kong.
- Melville, D.S.1994. Report on bird ringing in Hong Kong in 1993. Hong Kong Bird Report 1993: 98-111.
- Melville, D.S.1995. Report on bird ringing in Hong Kong in 1994. Hong Kong Bird Report 1994: 98-109.
- Melville, D.S.1995. Chinese Pond Heron eating a Swallow. Hong Kong Bird Report 1994: 216.
- Melville, D.S.1996. Report on bird ringing in Hong Kong in 1995. Hong Kong Bird Report 1995: 98-111.
- Melville, D.S. 1997. Threats to waders along the East Asian-Austrlasian Flyway. pp. 15-34. In Straw, P. (ed.) Shorebird Conservation in the Asia-Pacific Region. The Australasian Wader Study Group, Brisbane.
- Melville, D.S. 1999. Apparent hybrid Mallard x Spot-billed Ducks. Hong Kong Bird Report 1997: 150-155.
- Melville, D. 2002. Little Grebe feeding on chironomids. Hong Kong Bird Report 1998: 160-161.
- Melville, D.S. and Chan, S.Y. 1992. The discovery of *Ruppia maritima* L. (Ruppiaceae) at Mai Po, Hong Kong. Memoirs of the Hong Kong Natural History Society, 19, 123-125.
- Melville, D.S. and Galsworthy, A.C. 1992. Report on bird ringing in Hong Kong in 1991. Hong Kong Bird Report 1991: 87-103.
- Melville, D.S. and Galsworthy, A.C. 1993. Report on bird ringing in Hong Kong in 1992. Hong Kong Bird Report 1992: 81-99.
- Melville, D.S. and Leven, M.R. 1998. Report on bird ringing in Hong Kong in 1996. Hong Kong Bird Report 1996: 100-113.

- Melville, D.S. and Leven M.R. 1999. Report on bird ringing in Hong Kong 1997. Hong Kong Bird Report 1997: 100-113.
- Melville, D.S. & Morton, B. 1983. Mai Po Marshes. World Wildlife Fund Hong Kong, Hong Kong.
- Melville, D.S., Lee, S.Y. & Cheng, W.W. 1989. Some aspects of the management of the Mai Po Marshes, Deep Bay, Hong Kong. Proceedings of a Conference on Wetlands and Waterfowl Conservation in Asia. Malacca, Malaysia, 23-28 February 1987. Asian Wetland Bureau.
- Melville, D.S., Young, L. and P.J. Leader. 1994. Fish ponds around Deep Bay their importance to wildlife, especially waterbirds. Unpublished report, WWF Hong Kong, Hong Kong.
- Melville, D.S., McChesney, S., Anderson, C. and Leader, P.J. 1997. Predicted impacts of the Shenzhen River regulation project on waterfowl in Deep Bay, Hong Kong. pp. 86-92. In Goss-Custard, J.D., Rufino, R. and Luis A. (eds.) Effects of habitat loss and change on waterbirds. Institute of Ecology, The Stationery Office, London.
- Miao, M.Y.M. 2004. Heavy metal contamination and metalloid contamination at Mai Po Marshes. Unpublished B.Sc. thesis. Hong Kong Baptist University, Hong Kong.
- de Moes, D. 1990. Hong Kong. 8-21 April, 1990. An ornithological report. (duplicated).
- Mok. T.K. 1973. Studies on spawning and setting of the oyster in relation to seasonal environmental changes in Deep Bay, Hong Kong. HK Fisheries Bull. 3:89-101.
- Mok, T.K. 1974. Observations on the growth of the oyster, *Crassostrea gigas* Thunberg, in Deep Bay, Hong Kong. Hong Kong Fisheries Bull 4: 45-67.
- Morton, B. and Morton, J. 1983. The sea shore ecology of Hong Kong. Hong Kong University Press, Hong Kong.
- Morton, B. 1975. Pollution of Hong Kong's commercial oyster beds. Marine Pollution Bulletin 6: 117-122.
- Morton, B. and Wong, P.S. 1975. The Pacific Oyster industry in Hong Kong. Journal of the Hong Kong Branch of the Royal Asiatic Society 15: 139-149.
- Müller, Jochen F., Gaus, Caroline, Prange, Joelle A. and Päpke, Olaf *et al.* 2002. Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzo-furans in sediments from Hong Kong. *Marine Pollution Bulletin* 45(1-12): 372-378.
- Murton, R.K. 1972. The ecology and status of Swinhoe's Egret, with notes on other herons in southeastern China. Biological Conservation 4: 89-96.
- Nature Conservation Sub-committee. 1975. Report on the Mai Po Marshes. Unpub. report.
- Nauta, T.A., Lee, H.S., Kwok, A. and Gmitrowicz, E. 1998. 3D water quality modelling of Deep Bay. Pp. 23-30. *In:* Environmental-Hydraulics. Lee, J.H.W., Jayawardena, A.W. and Wang,-Z.Y. (eds.) Balkema-Publishers.
- Ni, J. and Qin, H. 2001. Impact of River Realignment and Land Reclamation on Flood Control and Ecological Habitat in River Estuary Bay System. Water International 26(2): 206-214.
- New Territories Development Consultants. 1981. Development Investigation of the North Western New Territories. Appendix 1 (Vol.2). Planning Studies (continued).
- Nisbet, I.C.T. and Medway, Lord 1972. Dispersal, population ecology and migration of Eastern Great Reed Warblers *Acrocephalus orientalis* wintering in Malaysia. Ibis 114:451-494.
- Ong Che, R.G. 1998. Concentration of seven heavy metals in sediment and mangrove root samples from Mai Po, Hong Kong. Programme and Abstracts of the 2nd International Conference on Marine Pollution and Ecotoxicology, 10 14 June, 1998. Department of Biology and Chemistry, City University of Hong Kong, Hong Kong.
- Pang, L.F. 1994. An appraisal of the existing environmental protection policies and its implications on land use planning. M.Sc. Thesis. University of Hong Kong, Hong Kong.
- Pearson, P. 1993. A comparison of the use of habitats for feeding by Chinese Pond Herons and Little Egrets in 1989, 1990 and 1993, with special emphasis on commercial fish ponds in Hong Kong. Extended Essay, Li Po Chun United World College, Hong Kong.
- Pereira, R.A. 1935. Notes and comments. Ornithology. Hong Kong Naturalist 6: 294-295.

- Pereire, R.A. 1936. The snipe. Hong Kong Naturalist 7: 5-10.
- Pereira, R.A. 1936. Notes and comments. Ornithology. Hong Kong Naturalist 7: 203-206.
- Pereira, R.A. 1938. Notes and comments. Ornithology. Hong Kong Naturalist 7: 290-293.
- Picton, E.L. 1995. The stratigraphic record of heavy metals preserved in the Mai Po Marshes, Hong Kong. Unpub. B.Sc. dissertation, University of Leeds, United Kingdom.
- Planning Department. 1995. *Register of Sites of Special Scientific Interest (SSSIs)*. (Looseleaf) Pong, M.W. 1986. The marketing of oysters and gei wai shrimps in Deep Bay. B.A. thesis. University of Hong Kong.
- Poon, S.C. 1957. Land utilization of the marshes north of Tung Tau Tsuen. B.A. thesis. University of Hong Kong, Hong Kong.
- Poon, S. M. 1997. Dredging and reclamation impact on marine environment in Deep Bay. M.Sc. Thesis. University of Hong Kong, Hong Kong.
- Poon, M.O.K. and Hyde, K.D. 1998. Biodiversity of intertidal estuarine fungi on Phragmites at Mai Po marshes, Hong Kong. Botanica Marina 41(2): 141-155.
- Poon, M.O.K. and Hyde, K.D. 1998. Evidence for the Vertical Distribution of Saprophytic Fungi on Senescent *Phragmites australis* Culms at Mai Po Marshes, Hong Kong. Botanica Marina 41(3): 285-292.
- Provisional Council for the Use and Conservation of the Countryside. 1968. Report on the Deep Bay Marshes and surrounding countryside. Unpub. report, Hong Kong Government.
- Qin, P., Wong, Y.S. and Tam, N.F.Y. 2000. Emergy evaluation of Mai Po mangrove marshes. *Ecological Engineering* 16(2): 271-280.
- Qiu, J.W. 1999. Composition, structure and distribution of polychaete assemblages in Deep Bay, Hong Kong. pp. 13-22. In: Lee, S.Y. (ed.) The mangrove ecosystem of Deep Bay and the Mai Po Marshes, Hong Kong. Hong Kong University Press, Hong Kong.
- Reels, G.T. 1994. Management strategies for the reed *Phragmites australis* (Cav.) Steud. at Mai Po Marshes Nature Reserve, Hong Kong, with observations on the associated insect fauna. M.Phil. thesis. University of Hong Kong.
- Resurreccion Bito-On Sadaba. 1996. An ecological study of fungi associated with the mangrove associate *Acanthus ilicifolius* L. in Mai Po, Hong Kong. Ph.D. Thesis. University of Hong Kong, Hong Kong.
- Richardson, B.J., Lam. P.K.S. and Wu, R.S.S. 2000. Hong Kong. pp. 535-546. *In* Sheppard, C.R.C. (ed.) Seas at the millennium: an environmental evaluation. Volume II. Pergammon Press, Amsterdam.
- Romer, J.D. 1975. Report on mosquito breeding near Tai Shang Wai. MS report.
 - Sadaba, R. B. 1996. An ecological study of fungi associated with the mangrove associate *Acanthus ilicifolius* L. in Mai Po, Hong Kong . Ph.D. Thesis. University of Hong Kong, Hong Kong.
- Shi, Z.R., Thouless, C.R. and Melville, D.S. 1988. The discovery of the breeding grounds of Saunders' Gull *Larus saundersi*. Ibis 130: 445-446.
- Shutes R.B.E. 2001. Artificial wetlands and water quality improvement. *Environment International* 26(5-6): 441-447.
- Sin, A.W. 1976. Development and management of tambaks in Hong Kong. Paper presented at Symposium on Development and Utilization of Inland Fishery Resources, Colombo, Sri Lanka, 27-29 October 1976.
- Soh, C.L. 1978. On a collection of Sesarmine crabs (Decapoda, Brachyura, Grapsidae) from Hong Kong. Memoirs of the Hong Kong Natural History Society 13: 9-22.
- Stott, R.D.E. and Chalmers, M.L. 1993. Carrion Crow: a new species for Hong Kong. Hong Kong Bird Report 1992: 131-133.
- Sun, W.N. 1994. Preliminary study of benthic macro-invertebrates in the gei wai 12 of Mai Po Nature Reserve. Unpub. B.Sc. dissertation. City Polytechnic of Hong Kong, Hong Kong.
- Talbot, L.M. and Talbot, M.H. 1965. Conservation of the Hong Kong Countryside. Summary report and recommendations. Report to the Hong Kong Government.
- Tam, N.F.Y. and Wong, Y.S. 1998. Spatial variation of heavy metal concentration in mangrove sediment from Hong Kong. Programme and Abstracts of the 2nd International

- Conference on Marine Pollution and Ecotoxicology, 10 14 June, 1998. Department of Biology and Chemistry, City University of Hong Kong, Hong Kong.
- Tam, N.F.Y. and Wong, Y.S. 2000. Spatial variation of heavy metals in surface sediments of Hong Kong mangrove swamps. Environmental Pollution 110(2): 195-205.
- Tam, N.F.Y., Ke, L., Wang, X.H. and Wong Y.S. 2001. Contamination of polycyclic aromatic hydrocarbons in surface sediments of mangrove swamps. *Environmental Pollution* 114(2): 255-263.
- Tam, N.F.Y., Wong, Y.S., Lu, C.Y. and Berry, R. 1997. Mapping and characterization of mangrove plant communities in Hong Kong. Hydrobiologia 352, 25-37.
- Thrower, L.B. (ed.). 1975. The vegetation of Hong Kong. Royal Asiatic Society, Hong Kong. Thrower, L.B. and Cheng, D.W.K. 1975. Mangroves. pp. 64-77. In: Thrower, L.B. (ed.), The vegetation of Hong Kong. Royal Asiatic Society, Hong Kong.
- Tipper, R. 1988. Far East staging post. Bird Watching, April 1988: 56-57.
- Tipper, R. 1992. Spotted Eagle scavenging on prey of Imperial Eagle. Hong Kong Bird Report 1991: 195-196.
- Tong, L.K.Y. (1986) The microgastropods of Hong Kong mangroves. pp. 437-448. In Morton, B.S. (ed.) Proceedings of the Second International Mariine Bioloigcal Workshop: The Marine Flora and Fauna of Hong Kong and Southern China, China. Hong Kong University Press, Hong Kong.
- Tsang, C.L. 1995. The distribution and structure of *Phragmites communis* in *gei wais* 4, 6, 8 and 10 in Mai Po. City University of Hong Kong, Hong Kong.
- Tsang, S.C. 1993. Project report to monitor the heavy metal contents in the Polychaeta *Dendronereis pinnaticirrus* in Mai Po mudflats. Higher Diploma in Applied Science Project Report, City Polytechnic of Hong Kong, Hong Kong.
- Tse, M.F. 2004. Polycyclic aromatic hydrocarbon contamination at Mai Po Marshes. Unpublished B.Sc. thesis. Hong Kong Baptist University University, Hong Kong.
- Tsim, S.T. and Lock, N.Y. 2002. Knowing Ramsar Wetland. Cosmos Books Ltd. Friends of the Country Parks, Hong Kong.
- Tsui, M.T.K. 2002. Aquatic toxicity and environmental fate of glyphosate-based herbicides. Unpublished M.Phil Thesis. Chinese University of Hong Kong, Hong Kong.
- Tsui, M.T.K., Wang, W.-X. Wang & Chu, L.M. (2005) Influence of glyphosate and its formulation (RoundupR) on the toxicity and bioavailability of metals to Ceriodaphnia dubia. Environmental Pollution (in press).
- Tsui, M.T.K. & Chu, L.M. (2004) Comparative toxicity of glyphosate-based herbicides: Aqueous and sediment porewater exposures. Archives of Environmental Contamination and Toxicology 46: 316-323.
- Turnbull, M. and Lam, C.Y. 2002. Monthly summaries. Hong Kong Bird Report 1998: 11-17. Vance, D. 1999. Distribution of shrimp and fish associated with the mangrove forest of Mai Po Marshes Nature Reserve, Hong Kong. pp. 23-32. In: Lee, S.Y. (ed.) The mangrove ecosystem of Deep Bay and the Mai Po Marshes, Hong Kong. Hong Kong University Press, Hong Kong.
- Walker, F.J. 1958. Field observations on birds in the Colony of Hong Kong. Hong Kong Bird Watching Society, Hong Kong. (duplicated).
- Waring, P., Thomas, R.C. and Li, K.H.K. 1994. Hawk-moths in Hong Kong, April 1993, with ecological notes. British Journal of Entomology and Natural History 7: 181-191.
- Waring, P., Thomas, R.C. and Li, K.H.K. 1997. Lepidoptera in Hong Kong, April 1993. British Journal of Entomology and Natural History 10: 77-100.
- Webster, M.A. 1967. Ringing in Hong Kong. Hong Kong Bird Report 1966: 31-32.
- Webster, M.A. 1975a. The Deep Bay Marshes: an introduction. SOS Environment 3(2): 3-5.
- Webster, M.A. 1975b. Conservation of the Deep Bay Marshes, Hong Kong. Hong Kong Bird Report 1974: 41-53.
- Webster, M.A. 1979. Chairman's Report. Hong Kong Bird Report 1977: 1-3.
- Webster, M.A and Melville, D.S. 1984. Report on wetlands and wildfowl conservation in Hong Kong. Paper presented at the 10th Regional Conference Asian Section ICBP, Kandy, April 1984.

- Wetlands International. 2002. Waterbird population estimates third edition. Wetlands International Global Series No. 12. Wageningen, Netherlands.
- Williams, M. 1987. The birds of the Mai Po Marshes. Golden Dragon 1: 21-23.
- Wilson, K.D.P. 1995.Dragonflies, diversity and fish ponds. 'Porcupine' Newsletter of the Department of Ecology and Biodiversity, Hong Kong University. No. 12.
- Wilson, K.D.P. 1995. Dragonflies. Urban Services Council, Hong Kong.
- Wilson, K.D.P. 1997. An annotated checklist of the Hong Kong dragonflies with recommendations for their conservation. Memoirs of the Hong Kong Natural History Society 21: 1-68.
- Wong, C.K.C., Cheung, R.Y.H. and Wong, M.H. 1999. Toxicological assessment of coastal sediments in Hong Kong using a flagellate, *Dunaliella tertiolecta*. Environmental Pollution 105(2): 175-183.
- Wong, C.K.C., Cheung, R.Y.H. and Wong, M.H. 2000. Induction of cytochrome P4501A1 genes and metallothionein gene expression in tilapia exposed to coastal sediments in Hong Kong. Marine Environmental Research 50(1-5): 549-550.
- Wong, C.K.C., Yeung, H.Y., Cheung, R.Y., Yung, K.K. and Wong, M.H. 2000. Ecotoxicological Assessment of Persistent Organic and Heavy Metal Contamination in Hong Kong Coastal Sedimen. *Archives-of-Environmental-Contamination-and-Toxicology* 38(4): 486-493.
- Wong, C.K.C., Yeung, H.Y., Woo, P.S. and Wong, M.H. 2001. Specific expression of cytochrome P4501A1 gene in gill, intestine and liver of tilapia exposed to coastal sediments. Aquatic-Toxicology 54(1-2): 69-80.
- Wong, C.M. 1986. Shrimp farming in Deep Bay The evolution and present situation of a traditional industry. B.A. thesis. University of Hong Kong, Hong Kong.
- Wong, K.C., Yeung, H.Y., Woo, P.S. and Wong, M.H.. 2001. Specific expression of cytochrome P4501A1 gene in gill, intestine and liver of tilapia exposed to coastal sediments. *Aquatic Toxicology* 54(1-2): 69-80.
- Wong, K.W. 1994. Factors affecting the distribution and abundance of benthic macro-invertebrates in Mai Po *gei wais*. Unpub. B.Sc. dissertation. City Polytechnic of Hong Kong, Hong Kong.
- Wong, C.L.C. 2002. Summer 2002. Report on Egretry Counts in Hong Kong, with particular reference to the Mai Po Inner Deep Bay Ramsar Site. The Hong Kong Bird Watching Society Limited. Hong Kong.
- Wong, L.C., Corlett, R.T., Young, L. and Lee, J.S.Y. 2000. Comparative Feeding Ecology of Little Egrets on Intertidal Mudflats in Hong Kong, South China. Waterbirds 23(2): 214-225.
- Wong, L.C., Corlett. R.T., Young, L. and J.S.Y. Lee. 2002. A preliminary assessment of the food habits of nesting Cattle Egrets and other egrets and herons in three Hong Kong egetries. Hong Kong Bird Report 1998: 110-119.
- Wong, M.K.M., Poon, M.O.K. and Hyde, K.D. 1998. *Phragmitensis marina* gen. et sp. nov., an Intertidal Saprotroph from Phragmites australis in Hong Kong. Botanica Marina 41(4): 379-382.
- Wong S.H. and Li, Y.S. 1988. Hydrographic surveys and sedimentation in Deep Bay, Hong Kong, Marine Bulletin.
- Wong, S.H., Li, Y.S. and Wong, K.K. 1987. Sedimentation in Deep Bay. Technical Report. Department of Civil and Structural Engineering, Hong Kong Polytechnic. Hong Kong.
- Wong, S.K. 2001. A critical review of wetland protection in Hong Kong. M.Sc. Thesis. University of Hong Kong, Hong Kong.
- Wong, W.L. 1996. The physical and chemical characteristics of the sediment and water in Mai Po gei wai. Unpub. B.Sc. dissertation. City University of Hong Kong, Hong Kong.
- Wong, Y.M. 1993. Comparison of mudflat invertebrate densities in different parts of the Deep Bay mudflat. Unpub. B.Sc. dissertation. City Polytechnic of Hong Kong, Hong Kong.
- Wu, S.H. and Lee, W.T.C. 2000. Pteridophytes of Hong Kong. Memoirs of the Hong Kong Natural History Society 23: 5-20.
- Xing, F.W., Ng, S.C. and Chau L.K.C. 2000. Gymnosperms and Angiosperms of Hong Kong. Memoirs of the Hong Kong Natural History Society 23: 21-136.

- Xu, W. and Purchase, D. 1983. On the migration of banded waders between China and Australia. Memoirs of the Beijing Natural History Museum 23: 1-12. (In Chinese).
- Yang, K.Y. 1996. The feeding ecology of the mudskipper: *Boleophthalmus pectinirostris* (Pisces: periophthalmidae) at the Mai Po Marshes Nature Reserve, Hong Kong. M.Phil. Thesis. University of Hong Kong, Hong Kong.
- Ye, Z.H., Wong, M.H., Baker, A.J.M. and Willis, A.J. 1998. Comparison of biomass and metal uptake between two populations of *Phragmites australis* grown in flooded and dry conditions. Annals of Botany London 82 (1): 83-87.
- Ye, Z.H., Baker, A.J.M., Wong, M.H. and Willis, A. J.. 2003. Copper tolerance, uptake and accumulation by Phragmites australis, *Chemosphere* 50(6): 795-800.
- Yip, M.W., Hau, C.H. and Walthew, G. 1995. Conservation evaluation of nine Hong Kong mangals. Hydrobiologia, 295, 323-333.
- Yu, Y.T. 2002. Summer 2002. Report on Waterbird monitoring at the Mai Po Inner Deep Bay Ramsar Site. The Hong Kong Bird Watching Society Limited. Hong Kong.
- Yung, H.T. 1994. Study of benthic invertebrates in a Mai Po gei wai. Unpub. final year report. City Polytechnic of Hong Kong.
- Young, L. 1989. Black Drongo taking wren-warbler sp. at Mai Po. Hong Kong Bird Report, 1988, 118 119.
- Young, L. 1990. The leech and the Yellow Bittern. Hong Kong Bird Report, 1989, 139.
- Young, L. 1991. Conservation of wildlife in the Deep Bay area: with particular reference to heron species. pp. 813-822. In: Boxall, J. (ed.) Polmet '91; Pollution in the metropolitan and urban environment. Hong Kong Institution of Engineers, Hong Kong.
- Young, L. 1992. Conservation of wildlife in the Deep Bay area: with particular reference to heron species. pp. 813-822. In: Boxall, J. (ed.). Polmet '91: Pollution in the metropolitan environment. Hong Kong Institute of Engineers, Hong Kong.
- Young, L. 1993. Habitat use by herons and egrets (Ardeidae) at the Mai Po Marshes Nature Reserve, Hong Kong. Unpub. Ph.D. thesis, University of Hong Kong.
- Young, L. 1993. Conservation activities at the Mai Po Marshes Wildlife Education Centre and Nature Reserve. Paper presented at the International Symposium on "The future of Cranes and Wetlands", 3-4 June 1993, Tokyo.
- Young, L. 1994. Environmental education at the WWF Hong Kong Mai Po Nature Reserve. pg. 140-148. In: Kusler, J. and L. Krantz (eds.). Improving wetland public outreach, training and education, and interpretation. The Association of State Wetland Managers, Berne.
- Young, L. 1994. Conservation activities at the Mai Po Marshes Wildlife Education Centre and Nature Reserve, Hong Kong. pp. 166-175. In: Higuchi, H. and J. Minton (eds.). The future of Cranes and wetlands. Wild Bird Society of Japan, Tokyo.
- Young, L. 1997. Mai Po. In: Katz, M. (ed.) Biodiversity and wetland conservation. Ramsar Convention Bureau, Gland.
- Young, L. 1997. Mai Po wetlands: an ecological jewel in South China. China? Biosphere Reserves, 4(2), 9 22 (In Chinese).
- Young, L. 1997. Mangrove conservation and shrimp aquaculture. In: Darvell, B.W. (ed.). Challenges in a Crowded World. Proc. First International Symposium on Marine Conservation. Hong Kong. 26-27 October, 1996. Hong Kong Marine Conservation Society.
- Young, L. 1998. The importance to ardeids of the Deep Bay fish ponds, Hong Kong. Biological Conservation, 84, 293-300.
- Young, L. 1999. Mangrove distribution in the *gei wais* at the Mai Po Marshes Nature Reserve. Pp. 105-117. In: Lee, S.Y. (ed.) The mangrove ecosystem of Deep Bay and the Mai Po Marshes, Hong Kong. Hong Kong University Press, Hong Kong.
- Young, L. 1999. Distribution of mangrove species in the intertidal zone at the Mai p Marshes Nature Reserve. pp. 117-130. In: Lee, S.Y. (ed.) The mangrove ecosystem of Deep Bay and the Mai Po Marshes, Hong Kong. Hong Kong University Press, Hong Kong.
- Young, L. 2005. Review of the 1999 2003 Mai Po Management Plan. Unpublished report. WWF Hong Kong, Hong Kong.

- Young, L. and Cha, M.W. 1995. The history and status of the egretries in Hong Kong, with notes on those in the Pearl River Delta, Guangdong Province, China. Hong Kong Bird Report, 1995, 196-215.
- Young, L. and Chan, G. 1997. The importance of draining down fish ponds for wintering Little Egrets. Ibis, 139, 694-698.
- Young, L. and Melville, D.S. 1993. Conservation of the Deep Bay environment. pp. 211-231. In: Morton, B.S. (ed.). The Marine Biology of the South China Sea. Vol.1. Hong Kong University Press, Hong Kong.
- Young, L. and Melville, D.S. 1995. Environmental research at the WWF Hong Kong Mai Po Marshes Nature Reserve. pp.58-69. In: Wong, C.K., Chu, K.H., Chen, Q.C. and X.L. Ma (eds.) Environmental research in Pearl River and coastal areas. Guangdong Higher Education Press, Guangzhou.
- Young, L. and Melville, D.S. 1996. Fish ponds a diisappearing resource for waterbirds in Hong Kong. Wader Study Group Bulletin 79: 35
- Yu, Y.T. 2002. Oriental Reed Warblers at Mai Po Marshes Nature Reserve, Hong Kong, during Autumn 1997. Hong Kong Bird Report 1998: 120-127.
- Yu, Y.T. 2002. *Ecology of the Black-faced Spoonbill Platalea minor in the non-breeding period*. Unpublished M.Sc. thesis. University of Hong Kong, Hong Kong.
- Yu, Y.T. and Swennen, C. 2004. Habitat use of the Black-faced Spoonbill. *Waterbirds* 27(2): 129-134.
- Yu, Y.T. and Swennen, C. 2004. Feeding of wintering Black-faced Spoonbills in Hong Kong: when and how long? *Waterbirds* 27(2): 135-140.
- Yu, K.T., Lam, M.H.W., Yen, Y.F. and Leung, A.P.K. 2000. Behavior of trace metals in the sediment pore waters of intertidal mudflats of a tropical wetland. Environmental Toxicology and Chemistry 19(3): 535-542.
- Yung, H.T. 1994. Study of benthic invertebrates in a Mai Po gei wai. Unpub. final year report. City Polytechnic of Hong Kong.
- Zheng, G.J., Lam, H.W., Lam, K.S. and Richardson, J. *et al.* 2000. Concentrations of Persistent Organic Pollutants in Surface Sediments of the Mudflat and Mangroves at Mai Po Marshes Nature Reserve, Hong Kong. *Marine Pollution Bulletin* 40(12): 1210-1214.
- Zheng, Gene J., Man, K.W., Lam, C.W. and Lam, H.W. *et al.* 2002. Distribution and sources of polycyclic aromatic hydrocarbons in the sediment of a sub-tropical coastal wetland. *Water Research* 36(6): 1457-1468.
- Zhou, H.Y., Cheung, R.Y.H. Chan, K.M. and Wong, M.H. 1998. Metal concentrations in sediments and Tilapia collected from inland waters of Hong Kong. Water Research 32(11): 3331-3340.

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WWF Hong Kong

No. 1 Tramway Path Central Hong Kong

Tel: +852 2526 1011

