

Chapter 10

Conflicts in the Management of a Wetland Nature Reserve — Case Study of the Mai Po Nature Reserve, Hong Kong

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Abstract. Objectives are set in the management of any nature reserve and at times, apparent conflicts may arise where the achievement of one objective may impact on another objective. For example, whilst mudflats and coastal mangroves are important conservation habitats, the spread of mangroves over the mudflats may have to be controlled in order to maintain the area of the two habitats in balance. The reasoning behind such apparent conflicts have to be carefully explained to visitors otherwise, they will depart with a negative impression of the reserve. Therefore, education and public awareness about the management of the reserve is just as important as maintaining the ecological and cultural values of the site itself. This chapter uses the Mai Po Nature Reserve (MPNR), Hong Kong SAR to describes some of the apparent conflicts that may arise in the management of a wetland nature reserve.

10.1. Introduction

Nature reserves around the world are subject to some form of management intervention. This ranges from local people who farm, graze their livestock, or harvest resources from the site as part of their livelihood, to government representatives or private individuals who follow a prescribed plan to maintain the site's ecological and cultural significance. In the case of the latter, the reserve staff manage the site in order to meet a number of goals which could, unless the management is done carefully, cause apparent conflicts with each other.

Management of the MPNR, Hong Kong is used as an example to illustrate the types of apparent management conflicts that may occur in a wetland nature reserve, and the steps that can be taken to reduce those conflicts.

10.1.1. Geography

The Inner Deep Bay wetlands are located at the eastern edge of the estuary of the Pearl River, southern China. The Bay is bounded to the north by the Shenzhen Special Economic Zone (SEZ) and to the south, by the Hong Kong Special Administrative Region (SAR). During low tide, 2,700 ha of mudflats are exposed in the Bay, fringed by an area of some 400 ha of inter-tidal mangrove forest. Behind the mangrove, are traditionally operated shrimp ponds (locally called *gei wai*, which support stands of mangroves and reedbeds), and commercial fishponds. Since the mid-1970s, the area of these wetlands have declined due to their gradual in-filling for urban developments.

Protection of these wetlands on the Hong Kong SAR side of Deep Bay began in 1976 when the *gei wai* and mangroves at Mai Po were designated as a Site of Special Scientific Interest (SSSI). Management of this site for conservation and for promoting environmental education began in 1984 when WWF Hong Kong began to take over management of the *gei wai*. Protection was further increased in 1995 when a 1,500 ha area of the wetlands (including the MPNR), was designated a Wetland of International Importance under the Ramsar Convention (Fig. 1). On the Shenzhen SEZ side of the Bay, the Futian National Mangrove Nature Reserve was established in 1984.

10.1.2. Ecological Importance

The wetlands of Inner Deep Bay are best known as a wintering site for up to 68,000 waterbirds, and another 20,000–30,000 shorebirds which use the site as a staging post during spring and autumn migration. In addition, 18 species of these waterbirds are considered threatened and 30 species occur in numbers that are greater than 1% of their estimated population in East Asia (Carey and Young, 2001).

However, the Inner Deep Bay wetlands are also important for supporting other wetland wildlife, such as the Eurasian Otter *Lutra lutra*, as well as a number of rare and endangered invertebrates, e.g. the endangered dragonfly *Mortonagrion hirosei* (Young, 1999).

Apart from wildlife, the wetland habitats at Mai Po and surrounding areas are also important (Table 1).

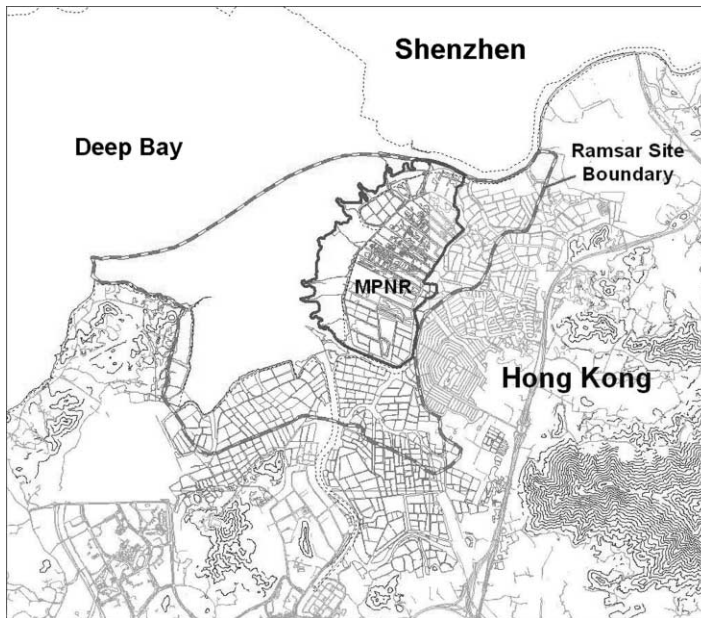


Figure 1: Map showing the Mai Po Inner Deep Bay Ramsar Site (Mai Po Nature Reserve, MPNR).

10.2. Management of the Inner Deep Bay Wetlands

10.2.1. Historical Management

The local people living around the coast of Inner Deep Bay have been managing the area's wetlands since at least the 1200s, when the first settlers established themselves at San Tin. These people mainly depended on the local fisheries for their livelihood, such as fish, shrimps, crabs and oysters.

From the early 1900s, the landscape began to change, with groups of immigrants from mainland China coming down to settle along the southern (Hong Kong) coast of Deep Bay at various times. Each time such people came, they brought with them new techniques of reclaiming and farming the land, such as:

- 1920s — techniques for brackish rice farming;
- 1940s — shrimp farming using tidal ponds called *gei wai*;
- 1960s — pond-fish farming.

Table 1: Importance of the habitats at Mai Po Nature Reserve and surrounding areas.

Habitat	Approximate area (ha)	Importance
Deep Bay mudflats	2,700	The most important feeding habitat for the migratory waterbirds that visit Deep Bay
Inter-tidal mangroves	400	The largest mangrove stand in Hong Kong and the sixth largest protected stand in China.
<i>Gei wai</i> shrimp ponds	240	One of the last remaining areas of traditionally operated shrimp ponds not only in South China, but also in Asia.
Reedbeds	45	The largest area of reeds in Hong Kong, and probably one of the largest stands in Guangdong Province.
Commercial fishponds	1,200	Traditionally operated fishponds are an example of the wise use of wetlands and are of high ecological value.

As a result, the Deep Bay wetlands went through a series of land-use changes, and the remains of each type of these farming practices can still be seen today in the landscape (Irving and Morton, 1988).

10.2.2. Management Plan for the Mai Po Nature Reserve

The Mai Po Marshes have been well known as a place for migratory waterbirds since the late 19th century. Steps to look into the designation of the Marshes as a protected area began in the 1960s but in 1975, the colonial Hong Kong Government approved a large-scale housing development adjacent to the Marshes. This raised the concerns of the conservationists at the time over the impacts from disturbance if residents from the development had unrestricted access to the Marshes. After lobbying from these conservationists, the Government declared the Marshes as a restricted access area the same year. In 1976, the Hong Kong Government further designated the Mai Po Marshes as an SSSI. However, this was only an administrative designation and did not confer any real protection to the site, nor was the site managed for conservation.

The Mai Po Marshes are made up by inter-tidal shrimp ponds (*gei wai*), created in the early 1940s. However, by the late 1970s, they were becoming increasingly unprofitable due to competition from pond-fish farming and the gradual pollution of Deep Bay due to the catchment becoming more urbanised. As a result in 1984,

WWF Hong Kong began to take over the management of these *gei wai* for conservation and for promoting environmental education. A special committee within WWF Hong Kong was formed to oversee the development and management of the MPNR, with members from various government departments, academics, green groups and interested persons. The goals for the Reserve as outlined in the management plan (Young, 1999) are:

1. To manage the MPNR so as to maintain and, if possible, increase the diversity of habitats appropriate for south China lowland 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.

In order to achieve Goal 1, a number of Management Objectives were set out in the management plan:

- 1.1 To provide suitable roosting and feeding habitats for Black-faced Spoon-bills.
- 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 ensure suitable habitats for key species.
- 1.5 To maintain and manage the mangrove habitats.
- 1.6 To maintain and manage the reedbed habitats.
- 1.7 To develop a series of freshwater habitats within the reserve.
- 1.8 To maintain the traditional operation and landscape of the *gei wai* habitats.
- 1.9 To maximise biodiversity without compromising the above objectives.
- 1.10 To monitor the progress of all habitat management on the reserve.
- 1.11 To encourage research projects that will achieve the above objectives.
- 1.12 To review regularly the management plan in the light of results from the monitoring programme, research and changing circumstances.
- 1.13 To abide by local legislations and meet obligations under agreed international conventions and relevant inter-governmental agreements.

In 1995, the Hong Kong Government designated a 1,500 ha area of wetlands around Deep Bay as a Wetland of International Importance under the Ramsar Convention (Convention on Wetlands), and the MPNR was incorporated as part of the Ramsar Site.

A year later in 1996, the Hong Kong Government began providing annual subvention to WWF Hong Kong for the wetland habitat management they were carrying out at Mai Po. With the completion of a management plan for the Mai Po Inner Deep Bay Ramsar Site in 1997, WWF Hong Kong had to ensure that the work programme laid out in the Mai Po Management Plan complemented that in the management plan for the larger Ramsar Site. With the formation of a Wetlands Advisory Committee (WAC, with a separate Scientific sub-committee and a Management sub-committee) under the Agriculture, Fisheries and Conservation Department (AFCD) in 1998, it meant that the habitat management work at the Reserve would be scrutinised by both the WWF Hong Kong Mai Po Management Committee as well as the WAC Management sub-committee.

10.2.3. Management Plan for the Ramsar Site

The 1997 management plan for the Mai Po Inner Deep Bay Ramsar Site (Anon., 1997) divided the Site into five zones:

Core Area to provide an undisturbed, largely natural reference area. Maintenance of natural processes has priority and access is generally limited to essential management, monitoring and research purposes.

Biodiversity Management Zone 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.

Wise Use Zone To allow ecologically sustainable use of wetland and other natural resources to be carried out in a way compatible with the Ramsar Site management goals and objectives and, where appropriate, to be encouraged and promoted.

Public Access Zone To enable people to have unrestricted (but managed) access to a part of the Ramsar Site in order to appreciate its special values and enjoy contact with wildlife.

Private Land Zones To recognise the existing legal status of the land.

Each of the above zones is divided into smaller compartments, including the “Biodiversity Management Zone” which includes the MPNR. At Mai Po, each of the compartments consists of a group of *gei wai*, each with its own broad management intention but without any detailed management prescription (Fig. 2; Table 2).

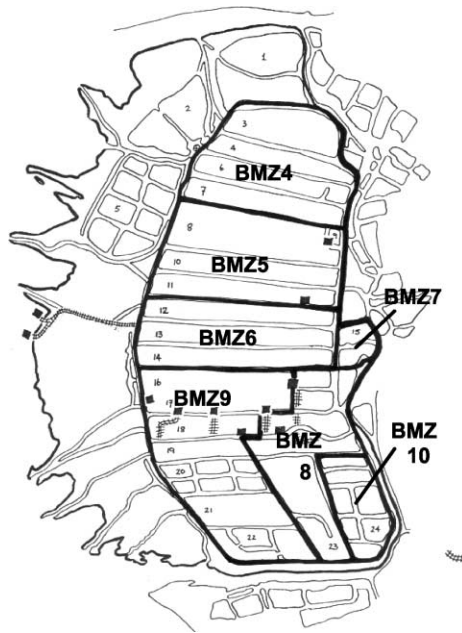


Figure 2: Management compartments within Mai Po Nature Reserve.

10.3. WWF Hong Kong Management of Mai Po

10.3.1. Vegetation Management

Although the plant communities at Mai Po are ecologically important in their own right (i.e. mangroves and reedbeds), they also provide shelter, nesting and feeding sites for wildlife. However, these plants need to be managed and their spread controlled whenever they begin to encroach into other habitats of importance. Examples include:

- reeds encroaching into open areas of water within the *gei wai* that are used by waterbirds,
- reeds into designated mangrove habitats,
- mangroves into designated reedbed habitat, and
- mangroves over the mudflat which is the most important habitat for waterbirds in the Ramsar Site.

Apart from the above examples, other types of vegetation may have to be removed because they are exotic or invasive species, and their spread will also reduce the diversity of habitats and species in the wetland. Such species include

Table 2: Management intentions of the compartments of the Biodiversity Management Zone at Mai Po Nature Reserve.

Compartment	<i>Gei wai</i> #	Management intention
BMZ 4	3,4,6,7	In the medium term, to adjust conditions in favour of supporting higher numbers of Black-faced Spoonbills.
BMZ 5	8,9,10,11	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).
BMZ 6	12,13,14	In the long term, to maintain traditionally managed production <i>gei wai</i> with areas of mangrove vegetation.
BMZ 7	15a, b	The long-term intention is to maintain and improve the Education Centre and its associated wildfowl collection.
BMZ 8	15c, 16/17 (east), 18 and 19 (east), 23	In the medium term, to adjust conditions in favour of creating an open freshwater area.
BMZ 9	16/17 (west), 18 and 19 (west), 20, 21, 22	In the medium term, to adjust conditions in favour of creating an open, tide-influenced area, whose primary objective is to provide a secure high tide roosting area for waterbirds.
BMZ 10	24	In the medium term, to adjust conditions in favour of creating a series of freshwater lakes of varying depth with surrounding areas of marsh.

the exotic invasive climber *Mikania micrantha*, the grass *Spartina* spp., and the mangrove *Sonneratia* spp.

Vegetation Control. Vegetation control has been carried out using one or more of the following techniques:

- Physical clearing with or without machinery.
- Controlled burning. This can be used to prevent colonization by certain plants (e.g. heat sensitive trees and shrubs) and to rejuvenate grasslands and reedbeds. Fire is a powerful management tool but needs to be used carefully. This is not only for safety reasons, but also for public relations reasons as many people have a negative impression of fires in the countryside and would initially consider that fire should not be used as a management tool within nature reserves.

- **Herbicide.** The herbicide chosen must be carefully selected to have minimal impact on the environment. Again, many members of the public have a negative impression over the use of chemicals in a nature reserve so care must be taken used in their use. Ideally, the reserve should carry out their own tests on the toxicity of the chemicals, and be able to discuss the benefits and potential harm that they may cause.
- **Controlled grazing** by domestic stock or control harvesting of plant products can sometimes be used to maintain desired vegetation such as grassland. If closely controlled, they can also be used to produce a uniform stand of vegetation that can provide feeding or nesting sites for wildlife. However, there may be a problem of the spread of diseases and parasites between domestic stock and wildlife. The stock should therefore be carefully monitored to ensure that the protected area does not lose any of its original values due to their presence.

Tree Management. Prior to the early 1980s, the landscape within the present MPNR used to be open, with very few trees growing along the *gei wai* bunds. This was because the local fishermen regularly used the bunds as footpaths to access the sluice gates at the seaward end of the pond where they had their homes and where they would harvest *gei wai* shrimps. Each winter, the fishermen would cut and/or burn the vegetation along the bunds in order to stop them from being overgrown.

With the completion of the Frontier Closed Area (FCA) Border Fence Road at Mai Po around 1982, fishermen stopped using the bunds as footpaths and instead, would drive along the new road to access their shrimp ponds. As a result, trees began to grow up along these bunds so that today we have a well-vegetated landscape. However, many of the waterbirds for which Mai Po is important (e.g. ducks and shorebirds), prefer to use open areas with few tall trees, in order to more easily detect predators. One example of the benefits of tree management is from *gei wai* #16/17 which between the late 1980s and early 1990s, was used by up to 10,000 migratory shorebirds in Spring as a high tide roosting site. From 1994 however, a decreasing number of shorebirds began to use this pond, and by 1997 shorebirds completely abandoned the pond. The main reason for this problem was suspected to have been because of tall trees having grown up along the bunds of the pond. When these trees were removed in early spring 1997/98, shorebirds began using the pond again.

As a result, WWF Hong Kong has a programme to manage the tall trees along the sides of the Mai Po *gei wai*, especially those ponds that are managed as waterbird habitat. However, there will likely be negative public opinion about the removal of trees from within a nature reserve. Therefore, this programme needs to be carried out carefully, by removing any tall trees in small blocks or selectively

along different *gei wai* bunds, rather than removing a long line of tall trees along a bund in one single operation. This is so as to minimise any sudden, negative visual impact to visitors from the removal of large blocks of trees from the reserve.

Tree Planting. Whilst there is a programme of tree removal from the bunds at Mai Po, there is also a programme of tree planting next to footpaths and around the landward edge of the reserve. This is mainly so that the trees can provide shade for visitors and act as a visual screen against nearby developments. In selecting the tree species for planting, priority will be given to species which are native, are associated with lowland wetlands, and can provide fruit for frugivorous birds. These have included species such as *Ficus superba* and *Sapium sebiferum*.

However, as discussed in “Tree Management” it is considered that there is now sufficient tree cover within Mai Po, and so shrubs are planted instead of trees. Examples of shrubs include *Rhaphiolepis indica* and *Schefflera octophylla*, which are also fruit bearing species.

Invasive Climbers. There are a number of invasive climbers at Mai Po which if left unchecked, will smother and kill the mangroves and other plants at the reserve. These species include *Derris alborubra*, *Ipomoea* spp., *Mikania micrantha*, *Paederia scandens*, *Passiflora foetida* and *Strophanthus divaricatus*.

Trials have been undertaken to identify the most effective way of controlling the most harmful of these species, *Mikania micrantha*. These trials involve clearing the *Mikania* by mechanical cutting, spraying with herbicide, burning and a combination of these techniques in autumn. So far, the results indicate that removal is most effective by using a combination of spraying and then burning.

Reedbed Management. The 46 ha of reed grass *Phragmites australis* at Mai Po is the largest area of this habitat remaining in Hong Kong, and probably the largest area in Guangdong Province. Over the years, the area of reedbeds at Mai Po has increased as the *gei wai* have silted up.

Apart from being an important ecological habitat that supports a diversity of wildlife, reeds also have a commercial value. In many parts of Mainland China, reeds are harvested for thatching the roof of houses, paper production and for making traditional Chinese herbal medicine. Harvesting and removal of the reeds also has the benefit of reducing leaf litter build up, and thus the rate of siltation.

A number of strategies have been successfully developed by nature reserves around the world for managing reedbeds for wildlife. This includes managing the water levels in the reedbed, or by managing the reed itself by a mixture of spraying, cutting and burning at different times of year, on rotation varying from 1–15 years (Fry and Londale, 1991; Kirby, 1992; Burgess et al., 1995; Hawke and Jose, 1996).

In January 2001, a long-term study was initiated in the Mai Po reedbeds in co-operation with the Hong Kong Bird Banding Group, to develop a management strategy for the Mai Po reedbeds. This involves cutting and removing the reeds in four 1 ha experimental blocks on an annual rotation, and monitoring the use by birds of the different aged blocks through mist netting. A fifth block of reeds is maintained as a control block. The initial results show that the first block of reeds that was cut in January 2001 and has since regrown, attracted a greater diversity and abundance of birds after 1 year of growth, than compared with the other blocks that had not been cut for over 20 years.

One issue that has come up from this study so far, is that of the disposal of the 1 ha area of cut reeds. The initial block that was cut in January 2002 was burnt on-site after standard safety measures had been carried out. However, there was opposition to this as burning was seen as being “inappropriate” in a nature reserve. As a result, the second block of reed that was cut in January 2003 had to be removed off-site by volunteers and reserve staff, and would later be taken to a land-fill site for disposal. Discussion is continuing as to whether the block of reeds that will be cut in January 2004 will be burnt on-site or taken off site for disposal.

Lastly, management of the reeds at Mai Po also involves controlling their spread into open areas of water by either dredging or spraying with an approved herbicide (e.g. glyphosate; see Section: *Vegetation control*).

10.3.2. *Gei wai Management*

Gei wai Shrimp Harvesting. A wave of immigrants from China came to Hong Kong in the early 1940s, and they brought with them the idea of impounding the coastal mangrove forests to make intertidal shrimp ponds, locally known as *gei wai*. Although these *gei wai* were mainly managed for shrimp production, fish oysters, algae and brackish water sedges were also harvested.

Each *gei wai* has an area of approximately 10 ha and are examples of how coastal wetlands can be managed sustainably, i.e. so that they can be of benefit to local communities with minimal adverse impact to the environment. This is because traditional *gei wai* shrimp production relies on the natural productivity in the adjacent bay. The ponds are stocked by flushing in young shrimps from the bay in autumn, and the shrimps feed on organic matter, e.g. dead mangrove leaves on the bottom of the pond. As a result, the fishermen maintained the stands of mangroves inside the pond as a source of food for the shrimps and fish. The shrimp of main commercial importance is *Metapenaeus ensis* but fish, such as *Mugil cephalus* (Grey mullet) are also present.

Each *gei wai* has a single sluice gate that allows water exchange with Deep Bay via a channel through the coastal mangroves. The sluice gate is some 1.0–1.5 m wide, has concrete walls and wooden sluice boards which are slotted into grooves

in the walls. Placing or removing the boards will prevent or allow water to flow through the sluice gate. The sluice boards have to be replaced every few years and the edges of any new boards have to be planed very carefully to ensure a watertight fit between boards.

Apart from a 10 m channel around the inner edge of each *gei wai*, there are also channels running the width of the pond to facilitate water exchange, and to allow a greater area for shrimp production.

Shrimp larvae are flushed into each *gei wai* from August-December on nights when there is a high tide in Deep Bay. The young shrimps feed on naturally occurring detritus on the *gei wai* floor. Shrimp harvesting takes place from the end of April until October or November and is done by opening the sluice gate when there is a low tide in Deep Bay, and placing a funnel net across the sluice gate to catch the outgoing shrimps. In the morning, water from Deep Bay is allowed back into the pond to maintain the water level, and to prevent heat stress which may cause the shrimps to die. Due to the high sediment load of the Pearl River, the water flushed into the *gei wai* from Deep Bay carries a high silt load. The sedimentation rate in the *gei wai* has been estimated to be 1.7 cm yr^{-1} (Lee, 1988). In order to maintain the channel at a suitable depth for shrimp production, dredging has to be conducted every 10 years.

After the end of the shrimp harvesting season, the *gei wai* are completely drained in turn for harvesting the fish inside. At this time, up to 1,600 wintering birds, such as herons, egrets and the endangered Black-faced Spoonbill *Platalea minor*, may be attracted into a single draining *gei wai* (Leader personal communication, 2000). There, they feed on the non-commercial fish and shrimp trapped in the pools of water at the bottom of the pond.

Ma (1997) studied the pattern of use of a draining *gei wai* by Little Egrets *Egretta garzetta*, and found that their numbers gradually increased as the pond was drained until numbers reached a peak on around the fourth or fifth day after draining began. Such peak in a single *gei wai* may represent as much as over 70% of the Little Egrets wintering in Deep Bay at that time (868 Little Egrets in *gei wai* 16/17 in November 1996).

Water Level Management. Under the Management Plan for the Mai Po Inner Deep Bay Ramsar Site (Anon., 1997) and the Mai Po Management Plan (Young, 1999), only *gei wai* 12–14 are to be operated as traditional *gei wai* shrimp ponds. The other *gei wai* are managed for wildlife and the ecological habitats (e.g. reedbed) that they may support.

Management of the *gei wai* water level for shrimp production has already been discussed in the previous section. For the other ponds, water level management depends on the conservation objective of that pond. For example, the management objective for *gei wai* #11 and 16/17, is to provide a high-tide roosting site for

migratory shorebirds during spring and autumn passage. As a result, the water level is lowered during these two seasons. During summer when few shorebirds are present, the water level is raised so as to prevent vegetation growth on the areas of exposed mud. It is also to prevent the encroachment by reeds and other vegetation from the edge of the pond into the central open areas of water. In the case of *gei wai* #16/17 the water level is kept high during winter, so this pond acts as a night-time roosting site for wintering waterfowl.

The *gei wai* bunds occasionally leak, and if these are small they can be repaired by hand. Sometimes, a large section of the bund may collapse because of wave action during storms, and repairs would then have to be undertaken by machinery, such as a backhoe digger or a dredger on pontoons.

10.3.3. Freshwater Pond Management

Prior to the mid-1970s, there was a large freshwater marsh at the site of a present housing estate adjacent to Mai Po, which was known to support the last breeding population of Pheasant-tailed Jacanas *Hydrophasianus chirurgus* in Hong Kong (Carey et al., 2001). As this marsh has now been lost, it was recommended in the Management Plan for the Ramsar Site (Anon., 1997) and the Mai Po Management Plan (Young, 1999), that a series of freshwater marshes be established at the southern end of MPNR (*gei wai* #20–24).

Work on setting up such a freshwater marsh began in 1997 in *gei wai* #20. This *gei wai* consist of six ponds which were commercially operated as fish ponds until 1995, when the government resumed the land and handed it over to WWF Hong Kong for conservation management. The ponds were first drained to remove the brackish water inside and to repair any leaks in the bunds using a bulldozer and backhoe. As one of the objectives of the ponds was to attract amphibians and odonates, fish were not restocked into the ponds as these may be potential predators. After refilling with rainwater, a number of the ponds soon developed a plant community which was previously uncommon at Mai Po, with species such as the grasses *Paspalum distichum* and *Echinochloa crus-galli*, which are a food source for a number of grazing and granivorous waterbirds respectively. At nights, these ponds were able to attract large number of wintering waterfowl that would return to roost, especially amongst the grasses. In summer, these rain-fed ponds supported a large number of odonates (Young, 2001).

As these rain-fed ponds were created for the first time at Mai Po, learning how to manage these ponds for wildlife was initially very much on a trial-and-error basis. Just 1–2 years after the ponds had been created, it was noticed that the grasses which the waterfowl were often seen grazing and roosting amongst, were being invaded by weeds and climbers. As a result, a programme was initiated to control

the problem. Another problem was that after 3–4 years, Catfish *Clarias fuscus* colonised the pond, and began to graze out the grasses that the waterfowl themselves grazed and roosted amongst. To resolve this problem, the ponds had to be drained and the fish removed.

10.3.4. Mangroves

The Deep Bay mudflat is the main feeding area for up to 68,000 migratory waterbirds that either spend the winter in the Bay, or pass through on migration in spring and autumn. Recent studies have found over 80 species of polychaete worms, snails, bivalves, crabs, mudskippers etc. on the mudflat (McChesney, 1997), with about 20 species that were either new to science or new to Hong Kong (Lee, 1993).

It is a natural part of succession for coastal mudflats to silt up and increase in height, whilst the vegetation on the landward side of the mudflats, mangroves in the case of the Deep Bay mudflats, to slowly extend out over the mudflats as it silts up. However, ^{210}Pb analysis of sediment cores from Inner Deep Bay has shown that the rate of sedimentation may have doubled since the mid-1980s (Peking University, 1995), probably due to a combination of an increase in the sediment load in the water and reduction in water flow through the Bay. The current sedimentation rate is estimated to be some 1.3–2.8 cm per year (Ove Arup, 2002).

The short term effect of the increase in sedimentation, is that mangrove seedlings (mainly *Kandelia candel*) which colonise the mudflat in front of the floating hides on the edge of the Mai Po mangroves, have to be removed on an annual basis. This is so as to maintain an area of mudflat for feeding waterbirds, also so that the mangrove trees do not obstruct the view from the hides as they grow.

In view of the fact that the mudflats do not appear to be expanding out into Deep Bay (Fung pers. comm.; Chinese University of Hong Kong), colonisation of the mudflat by mangroves over the long-term will lead to the loss of the mudflat feeding habitat for waterbirds. This problem still has to be addressed by the Hong Kong SAR Government, and a management strategy developed for managing the Deep Bay mangrove.

10.3.5. Visitor Management

In order to ensure the long-term protection of wetland reserves such as Mai Po, there is a need to promote public awareness of the importance of the site, such as through guided visits. However, there is a need at the same time, to minimise the disturbance caused through large numbers of such visits. As a result, visitor access into any protected area has to be controlled. Whilst access to some parts of

the reserve may be unrestricted, access to other parts may have to be restricted, depending on the importance of these areas for wildlife and their sensitivity to human disturbance.

In 1976, it was decided that with the increasing urbanisation of the area around Mai Po, access to the site would have to be restricted to those people holding Mai Po Entry Permits issued by the Agriculture, Fisheries and Conservation Department (AFCD). These permits are issued to members of the Hong Kong Birdwatching Society, students or researchers, or volunteers working at Mai Po.

The restricted access status of the MPNR is enforced by AFCD, who have a Nature Wardens office by the main entrance into MPNR. All visitors to the reserve must first show the Nature Wardens their valid Mai Po Entry Permit before being allowed in. Anyone who enters the reserve without such a permit may be liable to a fine.

Groups of visitors to Mai Po are mainly guided along the eastern, landward portion of the reserve from the car park to the Wildlife Education Centre and a Nature Trail. Certain groups of secondary school students will have the additional opportunity of visiting the Floating Boardwalk and Hides. Generally, groups of general visitors and students are not taken to the southern *gei wai* (*gei wai* #20–24), which is managed as a relatively undisturbed part of the reserve.

Some 40,000 people visit Mai Po each year, with about one quarter being school students on one of the 400 special visits organised for primary and secondary students. The Education Department funds the school visits and outside charities sponsor visits by the disabled. However, visitors on the public visits have to make a minimal donation to WWF Hong Kong.

10.4. Summary

From the early 1990s, there has been an increase in public awareness of the importance of environmental conservation which has led to increased numbers of people visiting the MPNR. Apart from learning about the ecological and cultural importance of the Reserve, many visitors, especially birdwatchers, have also taken an interest in the management of the Reserve itself. Whilst such interest is to be promoted, there is also a need for the Reserve to provide a better explanation of how the site is managed so that apparent conflicts can be avoided, such as why:

- access to the Reserve has to be restricted;
- management tools such as herbicides and fire have to be used;
- trees have to be felled from within a nature reserve; and
- mangrove trees have to be removed from the mudflat.

Through greater public awareness of the work of the reserve, it is hoped that there can be greater support for the reserve's work.

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