

SOCIALIST REPUBLIC OF VIETNAM

INTRODUCTION

by Le Dien Duc

Area: 329,566 sq.km.

Population: 59,713,000 (1985).

The Socialist Republic of Vietnam is situated along the southeastern margin of the Indochinese Peninsula. It stretches from latitudes 8°30' to 23°30'N and has a coastline of about 3,200 km on the Gulf of Tonkin and East Sea (South China Sea). Three-quarters of the country is hilly or mountainous, with the highest peaks rising to 3,134m (Fan si Pan) in northwestern Vietnam where they form an extension of the great Himalayan range. The ten million hectares of low-lying potential arable land are mostly situated in the large fertile plains of Nam Bo (6 million ha) and Bac Bo (1.5 million ha), which include the Mekong and Red River deltas respectively (Vu Tu Lap, 1979).

Although almost the whole of the country lies within the tropics, the climate varies from humid tropical conditions in the southern lowlands to temperate conditions in the northern highlands. The mean annual temperature at sea level is about 27°C in the south, falling steadily northwards to about 21°C in the extreme north. Most of the country receives about 2,000 mm of rainfall per year, but the mountains of the narrow central region of the country are considerably more humid, with an annual rainfall of up to 3,000. Three monsoons affect the climate of Vietnam. The winter monsoon, which affects only the northern part of the country, comes from the northeast and is rather cold and dry with occasional light drizzle. South of 16°N, the western trade winds prevail throughout the winter months and create a more humid tropical maritime climate. The south or southeast monsoon and the west monsoon both come off the sea during the summer months, bringing warm, damp, tropical weather to the whole country. During hot weather, typhoons sometimes develop over the East Sea, and sweep up the coastal areas of central and northern Vietnam often causing considerable damage (Vu Tu Lap, 1979). The frequency of such monsoons has increased in recent years, and may be a consequence of local climatic changes relating to deforestation.

The human population of Vietnam constitutes the country's most valuable renewable resource as well as the greatest threat to the environment. The total population was already almost 60 million in 1985, representing a mean density of over 180 people per sq.km. This large population, which continues to grow at 2.3% per annum, is placing an impossible strain on the environmental capacity of the country. In recognition of the over-population problem, the government is pursuing a programme of family planning. This is having good results in urban areas, but the greatest problem is in the mountain and midland areas where the peasants still have very large families and human growth is still possible through shifting agriculture at the expense of the remaining forests.

The original vegetation of Vietnam was almost entirely comprised of tropical forest, two-thirds of which was dry evergreen and semi-evergreen forest. By 1943, forest cover had declined to around 43%, with extensive areas cleared in coastal regions and in the floodplains of the Mekong and Red Rivers. The period from 1945 to 1975 witnessed almost uninterrupted warfare, with severe damage to natural resources. An estimated 22,000 sq.km of forest and farmland were destroyed, mainly in the south of the country, by intensive bombing, tactical spraying of 72 million liters of herbicides (including 44 million liters of Agent Orange), mechanical forest clearance and napalming of flammable *Melaleuca* forests (Agarwal, 1984; Kemf, 1986 & 1988; Vo Quy, 1985).

Forest cover has declined even more rapidly since hostilities ceased, principally due to clearance for agriculture, forest fires, extraction of timber and firewood, and urban expansion (Anon, 1985; Vo Quy, 1985). The forest cover is presently estimated at 19%, with the rate of deforestation estimated at between 100,000 and 200,000 ha per annum (Kempf, 1988). Deforestation is particularly severe in the middle part of the country, where some 130,000 sq.km have been cleared leading to siltation, floods, drought and heavy losses of topsoil (IUCN, in prep).

The forests of Vietnam contain a great wealth of plant species. It is estimated that there are about 12,000 species of plants of which only 7,000 have as yet been described. These include some 2,300 species that are known to be used by man for food, medicines, animal fodder, wood or other purposes. Undoubtedly many more will be found to be beneficial when their properties are fully explored. The flora shows a very high level of endemism, centred in four main refugia: the alpine zone of the Hoang Lien Son Mountains, the Ngoc Linh Mountains, the Lam Vien Highlands and the humid forests of central Vietnam. Many of these species are confined to small geographical ranges and occur at low individual densities, which render them highly vulnerable as the forests are cut into smaller patches and eventually cleared completely.

The fauna of Vietnam is also very diverse. Some 273 species of mammals, 774 species of birds, 180 species of reptiles and 80 species of amphibians are known from the country, in addition to many hundreds of species of fishes and many thousands of species of invertebrates. Like the plants, these groups show a high degree of local distinctiveness, with many endemic species of great conservation interest. Some of the most spectacular species include Asian Elephant, Javan Rhinoceros, Banteng, Kouprey, Tiger, Snub-nosed Monkey, Douc Langur, Black Gibbon, Eastern Sarus Crane, Black-necked Stork (*Elephas maximus*, *Rhinoceros sondaicus*, *Bos sauveli*, *B. javanicus*, *Panthera tigris*, *Pygathrix avunculus*, *P. nemaus*, *Hylobates concolor*, *Grus antigone sharpii*, *Ephippiorhynchus asiaticus*), many other large water birds nesting in huge colonies in the Mekong delta, Green Peafowl *Pavo muticus*, several rare pheasants, crocodiles, pythons and sea turtles.

Properly managed and utilized, the wildlife of Vietnam could be a very valuable renewable resource, but the decline of the country's wildlife is proceeding quickly. Not only is the habitat of many species vanishing as forests are cut and waterways polluted, but also the pressure of uncontrolled hunting has exterminated many local populations and some entire species from the country. Although there are now lists of protected species and many protected areas, there is no control of hunting and almost all of the population has access to firearms.

In recognition of the severe environmental problems facing the country, the Committee for the Rational Utilization of Natural Resources and Environmental Protection was established in 1981 under the auspices of the Ministry of Higher and Vocational Education. This Committee, which is an autonomous body of over 300 scientists from diverse disciplines, subsequently drafted a National Conservation Strategy for Vietnam, in collaboration with IUCN (Anon, 1985). In this document the major environmental threats are identified and it is recommended that priority be given to: (a) reducing the population growth rate to zero; (b) increasing the rate of reforestation to 1,000,000 ha per annum, with a final target of covering 50% of the land mass; and (c) establishing a National Board of Environmental Coordination at ministerial level, with wide cross-sectoral powers to formulate and enforce new environmental legislation and regulations. A National Board for the Conservation of Nature was established in 1986, thus endorsing the strategy at the highest level. In 1986, Vietnam signed international agreements with IUCN and her neighbours Kampuchea and Laos to cooperate in wildlife conservation. As an initial step in such cooperation, two projects were identified: (a) the protection of endangered wetland birds in the Mekong Delta shared between Vietnam and Kampuchea, e.g. Sarus Crane *Grus antigone*, Giant This *Thaumatibis gigantea* and White-shouldered This *Pseudibis davisoni*; and (b) the protection of Kouprey *Bos sauveli* (MacKinnon, 1986).

The legacy of war continues to hamper development and conservation efforts with unexploded munitions and discarded military equipment found throughout the country. Large areas of secondary grass *Imperata cylindrica* have replaced forests, and some 20 to 25 million bomb craters hamper agriculture and irrigation (Anon, 1985). Persistent dioxin impurities in Agent Orange herbicide have contaminated the soil and entered food chains (Agarwal, 1984; Kemf, 1986). Furthermore, this contamination appears to have blunted reforestation efforts with some areas remaining barren. Between 100,000 to 200,000 ha of forest are replanted annually, but due to fires, pests and illegal felling, only about one-third survives (Anon, 1985; Kemf, 1986).

Summary of Wetland Situation

Vietnam possesses a great diversity of wetland habitats including large estuarine and delta systems with extensive mangrove swamps and tidal mudflats, vast areas of seasonally inundated plains with rice paddies and *Melaleuca* forest, numerous small offshore islands, large coastal brackish and saline lagoons, large areas of saltpans and aquaculture ponds, many freshwater lakes and water storage reservoirs, and numerous rivers and streams. Much the largest wetland area is the Mekong Delta in the south, with its elaborate network of river channels and vast areas of rice paddies, mangrove forests, *Melaleuca* forests, tidal mudflats, shrimp ponds and fish ponds. In the middle part of the country, most of the significant wetlands are coastal lagoons and water storage reservoirs, whilst in the north, there are numerous lakes and reservoirs in the basin of the Red River and extensive mudflats and mangrove swamps in its delta.

The wetlands of Vietnam play a very important role in the national economic, and throughout the country the level of exploitation of wetlands is very high. A great proportion of the country's rice, fish, shrimp and other food production is derived from the wetland regions, particularly the Red River Delta in the north and the Mekong Delta in the south. In the early 1950s, the Mekong Delta accounted for 70% of the rice, 70% of the duck meat and eggs, 60% of the chicken meat

and eggs, 50% of the pork and 37% of the fish produced in the south, along with significant proportions of the bananas, pineapples, coconuts, vegetables, jute and sugar cane.

Because of the great demand for food production, large areas of wetland have been drained for agricultural purposes. An estimated 124,000 ha (some 40-50%) of the mangrove forests in the Mekong Delta were destroyed by herbicides during the war, and since then, mangrove and *Melaleuca* forests have been cut down for charcoal, firewood and timber for construction purposes, and cleared to make way for shrimp and fish ponds. Furthermore, the use of Agent Orange during the war has had a lasting effect on the vegetation, limiting the success of the reforestation programmes.

Despite the high human population density and intensive exploitation, the wetlands continue to support a great diversity of wildlife. The coastal wetlands, in particular, are of considerable importance for migratory waterfowl, providing rich staging and wintering areas for about 100 species. Many thousands of ducks and geese continue to winter in the wetlands of the Red River Delta, although numbers are reported to have decreased considerably during the last decade. The delta is also a very important staging and wintering area for herons and egrets, shorebirds, gulls and terns, and is particularly noteworthy for its large wintering populations of the rare Black-faced Spoonbill *Platalea minor* and Saunders' Gull *Larus saundersi*. The mangrove forests and *Melaleuca* forests of the Mekong Delta still support large numbers of herons, egrets, storks and ibises, and seven large breeding colonies have been located in recent years. The eastern race of the Sarus Crane *Grus antigone sharpii*, once thought to be on the verge of extinction, was recently discovered wintering in large numbers at Dong Thap Muoi in the northern delta, while several other rare species, such as Black-necked Stork *Ephippiorhynchus asiaticus*, Lesser Adjutant *Leptoptilos javanicus* and Greater Adjutant *L. dubius* were found to be resident in this area. However, two rare species, which formerly occurred in the delta, namely the White-shouldered This *Pseudibis davisoni* and Giant This *Thaumatibis gigantea*, have not been observed during recent surveys and may now be extinct in Vietnam.

The State Programme on the Rational Utilization of Natural Resources and Environmental Protection (52-02) has played a leading role in wetland conservation nationwide. However, many local governments and individuals have taken a keen interest in wetlands and their wildlife, and have made a significant contribution to wetland conservation.

In April 1987, the Government of Vietnam produced a policy for the rational utilization of wetland areas throughout the country. The first step was the declaration by the Government of eight protected areas in wetland regions. These included Ba Be Lake (450 ha) and Nui Coc Reservoir (2,580 ha) in the north, and six wetlands in the Mekong Delta: the Tram Chim Crane Reserve at Dong Thap Muoi (9,000 ha), the breeding colonies of large water birds at Bac Lieu (40 ha), Cai Nuoc (20 ha) and Dam Doi (119 ha), the Nam Can Mangrove Reserve (7,547 ha) and the Vo Doi *Melaleuca* Protected Forest (3,945 ha).

Management plans for the most important reserves are currently being prepared by several research institutes in the north and south. In October 1987, a short training course on the management of protected areas was held in Cat Ba National Park for the directors of national parks and reserves and other key personnel. In addition, the Working Group on Wetlands and

Water birds within the Natural Resources and Environment Programme has conducted short training programmes at the waterbird colonies in Minh Hai Province and in the Crane Reserve in Dong Thap Province. An education centre will be constructed at the Crane Reserve in 1989.

In September 1987, the Government of Vietnam became a Contracting Party to the Ramsar Convention, and designated a part of the Red River Delta for inclusion in the Ramsar List of Wetlands of International Importance. This action demonstrates the intention of the Vietnamese Government to pursue a sound policy of wetland conservation to ensure that high levels of utilization can be sustained.

Wetland Research

Because of the great agricultural and fisheries potential of wetlands in Vietnam, many domestic and overseas research institutions have conducted scientific research on the wetlands, and have initiated projects for their exploitation and utilization. However, no proper scientific base has ever been established for these activities, owing to the lack of satisfactory basic inventories. Those inventories, which have been carried out, were not sufficiently comprehensive and did not take into account all natural and socio-economic values.

The Mekong Delta has been well-studied through the UN-sponsored water and related resources development programme, the Mekong Project, launched in the late 1950s. A Committee for Coordination of Investigations of the Lower Mekong Basin (Mekong Committee) was established in 1957 by the four governments of the riparian countries, Kampuchea, Laos, Thailand and Vietnam, under the auspices of the Economic and Social Commission for Asia and the Pacific (ESCAP) of the United Nations. The goal of this Committee has been the comprehensive development of the water and related resources of the basin for hydro-electric power, irrigation, fisheries, flood control, drainage, navigation improvement, watershed management and water supply (Mekong Committee, 1970; Pantulu, 1986a). The Committee has sponsored a number of studies in Vietnam, including hydrographic surveys along the lower Mekong and its distributaries, socio-economic investigations, geological and mineral surveys, and studies of agricultural potential (Mekong Committee, 1978). Preliminary surveys of the fisheries were completed in the 1960s (Mekong Committee, 1976). The Committee also conducted a general survey of the wildlife of the Mekong Basin, which included recommendations for the establishment of a network of protected areas (McNeely, 1975).

One of the most useful research programmes in recent years has been a study of agricultural development proposals based on water regulation in the Mekong Delta, carried out by Dutch consultants in 1970-1974 (Mekong Committee, 1977). From 1983 to 1985, State Programmes 02-01 and 60-02 dealt with zoning and planning in the Mekong Delta with a view to the wise exploitation of wetland resources in the delta. These programmes included studies of natural factors such as climate, hydrology and geomorphology, as well as socio-economic surveys. The characteristics of the wetlands, their formation and distribution were also investigated, and many suggestions were made for further research.

Since 1982, the State Programme on Rational Utilization of Natural Resources and Environmental Protection has involved a considerable amount of research on the ecology, flora

and fauna of mangrove and *Melaleuca* forests in the Mekong Delta, and has included surveys of the waterbird colonies in these forests. The Eastern Sarus Crane and several other rare bird species were rediscovered during these surveys. Similar studies are now being carried out in the Red River Estuary, where the fauna and flora have still to be adequately documented.

Wetland Area Legislation

Until very recently, there has been no legislation specific to wetlands or protected areas. Legislation covering forest protection and exploitation, conservation of water resources and hunting has been used on an *ad hoc* basis to establish reserves (IUCN, in prep). However in 1985, after five years of preparation, the Government of Vietnam declared that it would establish a comprehensive system of protected areas throughout the country including five national parks and 82 other reserves. The national parks are Cat Ba Archipelago (26,300 ha), Con Dao Archipelago (6,000 ha), Ba Vi near Hanoi (2,430 ha), Cuc Phuong near Hanoi (25,000 ha) and Bach Ma Hai Van in the centre of Vietnam. The total area of this proposed system is about one million ha or 3% of the total land surface.

Wetland Area Administration

The main administrative body is the Department of Basic Inventory in the State Committee for Science and Technology. This department is responsible for submitting plans for the establishment of protected areas to the Government, requesting the ultimate decisions from the Government, and implementing effective coordination between different research institutes. The Ministry of Forestry is responsible for the development and management of protected areas. The Ministry submits its outline master plans for protected areas both to the Government and to the Department of Basic Inventory for their approval. The Department of Forest Management and Protection in the Ministry of Forestry is responsible for the management of protected forests, while the nature reserves, including the protected waterbird colonies, are managed by forestry officers of the local People's Committees.

The Ministry of Water Resources and Ministry of Agriculture are also involved in the establishment of protected wetland areas. The Division of Agricultural Water Supply in the Ministry of Water Resources plays an important role in the decision making process, while the Ministry of Agriculture resolves any problems arising from a conflict between agricultural development and wetland conservation. The State Programme on Rational Utilization of Natural Resources and Environmental Protection plays an important role in the development and management of the protected area system by carrying out research and acting as a scientific advisory body.

Organizations involved with Wetlands

- a) Governmental Organizations
 - State Committee for Science and Technology
 - Department of Basic Inventory.
 - Ministry of Forestry

Department of Forest Management and Protection.

- Ministry of Water Resources

Division of Agricultural Water Supply.

- Ministry of Agriculture

- Ministry of Fisheries

- Ministry of Higher and Vocational Education

State Programme on Rational Utilization of Natural Resources and Environmental Protection (52-02).

The Programme includes the Wetland and Waterbird Working Group. - National Mekong Committee

b) Universities

- University of Hanoi

The Department of Biology conducts studies on rice paddies and riverine systems.

- University of Science and Letters (Ho Chi Minh City) -University of Arts and Letters (Ho Chi Minh City)

WETLANDS

Site descriptions compiled by Le Dien Duc of the Wetland and Water bird Working Group in the State Programme on Rational Utilization of Natural Resources and Environmental Protection. Information was provided by the Ministry of Fisheries, the Ministry of Agriculture, the Resources and Environmental Centre of the Ministry of Forestry, the Fisheries Department of Bac Thai Province, the Fisheries Department of Thuan Hai Province, Ho Tay Fishery Enterprise, the People's Committee of Hai Phong, the Nha Trang Institute of Ocean Studies, Professor Thai Van Trung, G.E. Morris and Derek A. Scott.

Wetland name: Ba Be Lake

Country: Vietnam

Coordinates: 22°24'N, 105°37'E;

Location: approximately 5 km from Cho Ra District Town, Cho Ra District, Cao Bang Province.

Area: 450 ha.

Altitude: 250-300m.

Biogeographical Province: 4.10.4.

Wetland type: 14.

Description of site: A freshwater lake in a limestone mountain area; the only significant natural mountain lake in Vietnam. The lake is 8 km long and up to 0.8 km wide; the average depth varies from 17m to 23m, and the maximum depth is 29m. The surrounding limestone hills rise to peaks at 570-893m. The lake is connected to the Nang River by a channel; at high water levels during the rainy season, the lake drains into river via this channel, while during the dry season, water flows from the river into the lake. In the hills to the northwest of the lake, there is a famous series of waterfalls, Dau Dang, stretching for about 10 km. There are also many caves and grottos in the area, the most famous being Phuong Grotto.

Climatic conditions: Tropical monsoonal climate.

Principal vegetation: No information is available on the aquatic vegetation. The lake is surrounded by tropical rain forest, some of which remains in good condition.

Land tenure: People's Committee of Cho Ra District.

Conservation measures taken: In 1985, the Government decided to designate the lake and its environs as a National Park. The Ministry of Forestry and the Natural Resources and Environmental Centre are currently working together on a management plan for the park. The hunting of animals and cutting of trees are strictly prohibited.

Conservation measures proposed: Environmental education must be promoted in the region if the level of poaching is to be reduced.

Land use: Aquaculture is permitted on a limited scale at the lake. Tourism will be developed in the area in the near future.

Disturbances and threats: The most serious threat is illegal hunting. Some protective measures have already been taken, but these are not as yet fully effective.

Economic and social values: The lake is of considerable importance for the local communities as it regulates water supply to the entire region. It is set amidst spectacular mountain scenery and thus has considerable potential for both national and international tourism. Plans have already been made to develop the area for tourism, which should enhance the income of the local people.

Fauna: The fish fauna includes 17 native species, four of which are of economic value. Approximately 100 species of birds and 30 species of mammals have been recorded in the area, including several rare and endemic species. Pheasants of the genus *Lophura*, Green Peafowl *Pavo muticus*, gibbons *Nycticebus* sp and Francois Leaf Monkey *Presbytis francoisi* may still be present.

Special floral values: Ba Be Lake is the only mountain lake in Vietnam, and possesses a flora unique at national level.

Research and facilities: Some preliminary faunal surveys have been carried out in the area.

References: Nguyen Van Hao (1964).

Criteria for inclusion: 1a, 2a, 2b.

Source: Le Dien Duc.

Wetland name: Thac Ba Reservoir

Country: Vietnam

Coordinates: 21°42'-22°05'N, 104°45'-105°03'E;

Location: 10 km from Yen Bai Town and one km from Yen Binh District Town, southeastern Hoang Lien Son Province.

Area: 23,400 ha.

Altitude: 40-60m.

Biogeographical Province: 4.10.4.

Wetland type: 17.

Description of site: A large water storage reservoir created in 1963 by a dam on the Chay River. The difference in elevation between the bed of the river upstream and downstream of the reservoir is 130m. The reservoir has a deeply indented shoreline with many bays, peninsulas and islands. To the north lies the high plateau of Cao Khanh at about 400m elevation.

Climatic conditions: Tropical monsoonal climate with an average annual rainfall of 1,786 mm, a mean annual temperature of 22.9°C and a mean relative humidity of 85%.

Principal vegetation: Some reed-beds, marsh grasses and low shrubs. The region was formerly covered with lowland rain forest, but this soon disappeared with the construction of the reservoir.

Land tenure: Owned by the People's Committee of Hoang Lien Son.

Conservation measures taken: There are restrictions on cultivation on the steep slopes surrounding the reservoir and deforestation in the watershed. Reafforestation is being promoted in the catchment area to reduce soil erosion.

Conservation measures proposed: None

Land use: Fishing, irrigation, hydro-electric power and recreation.

Disturbances and threats: The main threat is siltation, which is seriously reducing the life span of the reservoir. An estimated 5.35 million tonnes of silt enter the reservoir each year. Because of this siltation, it is no longer possible to generate electricity during the dry season.

Economic and social values: In addition to providing water for irrigation and generation of electricity, the reservoir supports a large fishery which constitutes a very important protein source for the local population. Fish production is currently 100-150 metric tonnes per year.

Fauna: The reservoir is an important staging and wintering area for a variety of migratory waterfowl. Prior to the construction of the reservoir, the forests of this region were very rich in wildlife. It is hoped that with reafforestation in the area, wildlife populations will recover.

Special floral values: No information.

Research and facilities: No information

References: No information

Criteria for inclusion: 3b.

Source: Le Dien Duc.

Wetland name: Chu Lake

Country: Vietnam

Coordinates: 21°36'N, 104°54'E;

Location: in ha Hoa District, Vinh Phu Province.

Area: 300 ha.

Altitude: 30m.

Biogeographical Province: 4.10.4.

Wetland type: 14.

Description of site: A small, natural freshwater lake set in a valley in hilly country. The lake is fed by the Van and Thoi streams, and drains into the Red River. The lake is surrounded by low hills with many human settlements and areas of rice paddies.

Climatic conditions: Tropical monsoonal climate.

Principal vegetation: The lake supports a variety of aquatic plants and marsh grasses. Surrounding areas support shrubs and grasses.

Land tenure: Owned by the People's Committee of ha Hoa District.

Conservation measures taken: No information.

Conservation measures proposed: None

Land use: Fishing and water supply for irrigation. Rice is grown on the margins of the lake in the dry season.

Disturbances and threats: No information.

Economic and social values: The lake supports a small fishery, yielding about 10 metric tonnes per year.

Fauna: The lake is thought to be an important staging and wintering area for migratory waterfowl, but no surveys have been made.

Special floral values: No information.

Research and facilities: No information

References: No information

Criteria for inclusion: lb.

Source: Le Dien Duc.

Wetland name: Chinh Cong

Country: Vietnam

Coordinates: 21°31'N, 105°05'E;

Location: 5 km from Vu Yen Town and the Red River, Thanh Hoa District, northwestern Vinh Phu Province.

Area: 400 ha.

Altitude: 10-20m.

Biogeographical Province: 4.10.4.

Wetland type: 14.

Description of site: A small, natural freshwater lake with abundant aquatic vegetation, in the Red River basin. The water level varies considerably between the dry season and the wet season. The lake is fed by two streams, the Ca and Ky, which show pronounced seasonal variations in flow. During the rainy season, the lake also receives silt-laden floodwaters from the Red River through a canal and from bank overflow. The lake is surrounded by rice paddies and low hills. In the past the hills were covered with forest, but this has now been cleared for agricultural land and human settlement.

Climatic conditions: Tropical monsoonal climate.

Principal vegetation: The lake supports a rich growth of aquatic plants including species of *Nymphaea* and *Lotus*.

Land tenure: Owned by the People's Committee of Thanh Hoa District.

Conservation measures taken: None.

Conservation measures proposed: None

Land use: Fishing, fish culture and water supply for irrigation. Rice is grown on the margins of the lake during the dry season.

Disturbances and threats: Parts of the lake and marshes have been drained for agricultural purposes, and the aquatic resources are being over-exploited. The lake formerly supported a very rich fish and bird fauna, but as a result of interference with the water level and other disturbances, fish and bird populations are now much reduced.

Economic and social values: The lake is important for agriculture, irrigation purposes and fish culture. Fish production is currently about 25-30 metric tonnes per year.

Fauna: A very important wintering area for migratory waterfowl, notably cormorants, ducks, geese and shorebirds. A species of pelican *Pelecanus* sp also occurs. Waterfowl populations have, however, declined in recent years as a result of drainage activities and excessive disturbance.

Special floral values: No information.

Research and facilities: No information

References: No information

Criteria for inclusion: 1b, 3b.

Source: Le Dien Duc.

Wetland name: Nul Coc Reservoir

Country: Vietnam

Coordinates: 21°33'-21°37'N, 105°40'-105°44'E;

Location: 15 km from Thai Nguyen Town and 5 km from Dai Tu District Town, southern Bac Thai Province.

Area: 2,580 ha.

Altitude: 60m.

Biogeographical Province: 4.10.4.

Wetland type: 17.

Description of site: A water storage reservoir with a capacity of 175 million cubic metres, constructed in 1977 on the Cong River, a tributary of the Red River. The reservoir is surrounded by hills with shrubby areas and secondary forest.

Climatic conditions: Tropical monsoonal climate with an average annual rainfall of 2,002 mm, a mean annual temperature of 23.2°C and a mean relative humidity of 82%.

Principal vegetation: No information is available on the aquatic vegetation. Two decades ago, the surrounding hills were covered with dense forest, but most of this has disappeared due to uncontrolled exploitation of the forest resources by the local people. The dominant plant species are *Rhodomyrtus tomentosa*, *Melastoma candidum*, *Cratocylon* spp and *Eupatorium odonatum*.

Land tenure: Owned by the People's Committee of Thai Nguyen Town.

Conservation measures taken: In 1985 the Government of Vietnam designated the reservoir and its environs as a protected area, in an effort to prevent further deforestation and thereby reduce the siltation rate. Some reforestation is being carried out on the denuded slopes around the reservoir.

Conservation measures proposed: The protected area should be extended to include the entire water catchment area of the reservoir.

Land use: Fishing, water supply for irrigation, and recreation for the people of Thai Nguyen Town, a centre for the steel industry. The reservoir currently supplies water for 13,000 ha of wet rice cultivation. Several small holiday resorts have been built on the shores of the reservoir.

Disturbances and threats: Forest clearance for fuel wood, construction materials and agricultural land in the catchment area has led to serious erosion and increased siltation in the reservoir. The cultivation of cassava and other crops on the steep slopes around the reservoir has been particularly harmful, while heavy grazing by domestic cattle is preventing natural regeneration of the vegetation.

Economic and social values: The reservoir supports a significant fishery and is an important source of water for irrigation. Fish production is estimated at 120-150 metric tonnes per year. The reservoir is also important for outdoor recreation; it is situated in a region of spectacular landscapes and is a popular resort for people from Thai Nguyen.

Fauna: At least ten native species of fishes occur in the reservoir, several of which are of economic importance. About 40 species of birds and 15 species of mammals have been recorded in the reservoir area. Several species of ducks occur in winter, particularly *Dendrocygna javanica*, *Anas crecca* and *A. acuta*, and a small breeding colony of *Ardeola bacchus* and *Egretta* spp has recently been established on an island in the lake.

Special floral values: No information.

Research and facilities: No information

References: No information

Criteria for inclusion: 3b.

Source: Le Dien Duc and the Fisheries Department of Bac Thai Province.

Wetland name: Vac Swamp

Country: Vietnam

Coordinates: 21°18'N, 105°36'E;

Location: on the southern edge of Vinh Yen Town, Vinh Phu Province.

Area: 250 ha.

Altitude: Below 10m.

Biogeographical Province: 4.10.4.

Wetland type: 15.

Description of site: A freshwater swamp fed by the Ca Lo and Cau Bon Rivers, in the basin of the Red River to the south of Vinh Yen Town. Low hills to the east are covered with shrubs and rice paddies.

Climatic conditions: Tropical monsoonal climate.

Principal vegetation: The swamp supports a rich growth of aquatic plants and marsh grasses, and is surrounded by tall trees. Adjacent areas are under cultivation for rice.

Land tenure: Owned by the People's Committee of Vinh Yen Town.

Conservation measures taken: The authorities of Vinh Yen Town have decided to establish a reserve at the swamp for recreational purposes.

Conservation measures proposed: None

Land use: Fishing, aquaculture and water supply for irrigation. Rice is grown in the margins of the swamp during the dry season.

Disturbances and threats: No information.

Economic and social values: The swamp supports a small fishery, yielding 40-50 metric tonnes per year, and is important for irrigation purposes. It is also a resort area for various national and local organizations.

Fauna: No information.

Special floral values: No information.

Research and facilities: No information

References: No information

Criteria for inclusion: lb.

Source: Le Dien Duc.

Wetland name: Song Da Reservoir

Country: Vietnam

Coordinates: 20°48'N, 105°19'E;

Location: near the town of Hoa Binh, ha Son Binh Province.

Area: 72,800 ha.

Altitude: c.100m.

Biogeographical Province: 4.10.4.

Wetland type: 17.

Description of site: A large water storage reservoir with a capacity of 1.6 billion cubic metres, constructed in 1985 on the Da River for the generation of hydro-electric power, irrigation, aquaculture and water regulation. The reservoir is surrounded by secondary forests, cultivated areas and human settlements.

Climatic conditions: Tropical monsoonal climate.

Principal vegetation: No information is available on the aquatic vegetation. The natural vegetation in surrounding areas includes young secondary forest, bamboo, shrubs and grasses, especially *Imperata cylindrica*, *Melastoma candidum*, *Rhodomyrtus tomentosa* and *Cratocylon* sp.

Land tenure: Owned by the People's Committee of ha Son Binh Province.

Conservation measures taken: The water catchment area of the reservoir is protected. Some reforestation is being undertaken around the reservoir, and agro-forestry schemes are in operation in the area.

Conservation measures proposed: None

Land use: Generation of hydro-electricity, water supply for irrigation, fishing and recreation.

Disturbances and threats: The main threat is cultivation on steep slopes in the catchment area, which leads to serious erosion and consequent siltation problems.

Economic and social values: The reservoir is very important for the local and national economy because of its hydro-electric power (1.92 million kw). It irrigates a huge area in the Da River basin, and should eventually support a major fishery of considerable importance to the local communities. The reservoir has considerable potential for recreation and tourism, which could provide a good income for local people.

Fauna: The reservoir is still very young and is of little value for wildlife. However, as the lake matures and if the adjacent secondary forests are protected, the area could become important for a variety of wildlife species, including waterfowl.

Special floral values: None known.

Research and facilities: No information

References: No information

Criteria for inclusion: le.

Source: Le Dien Duc.

Wetland name: Ho Tay (Tay Lake)

Country: Vietnam

Coordinates: 21°03'N, 105°50'E;

Location: in the northern suburbs of Hanoi, two km from the city centre.

Area: 413 ha.

Altitude: 3.5m.

Biogeographical Province: 4.6.1.

Wetland type: 14.

Description of site: A natural freshwater lake on the south bank of the Red River (Hong Song), formed by a shift in the course of the river in the past. The lake is fed by local rainfall, seepage and wastewater from the city of Hanoi. The lakebed is a compound of sand and clay, with a layer of mud 1-2m deep. The average depth of water is 1.5-2.0m (minimum 1.0m, maximum 3.0m). The lake is surrounded by the suburbs of Hanoi.

Climatic conditions: Tropical monsoonal climate with an average annual rainfall of 1,678 mm, a mean annual temperature of 23.5°C and a mean relative humidity of 84%.

Principal vegetation: The lake supports a rich growth of aquatic plants including *Vallisneria spiralis*, *Myriophyllum spicatum* and *Nymphaea* sp, and there are some small patches of emergent marsh vegetation around the lake margins.

Land tenure: Owned by Hanoi City.

Conservation measures taken: The local People's Committee has decided to restrict the amount of waste water flowing into the lake from the city.

Conservation measures proposed: None

Land use: Fishing, aquaculture and outdoor recreation including water sports. There is a large international tourist hotel on the edge of the lake.

Disturbances and threats: The most serious threat to the lake is the inflow of polluted water from the city. There has been some infilling and reclamation for urban development; during the period 1964-79, the surface area of the lake was reduced by 53 ha. The surrounding area is very densely populated and there is a considerable amount of disturbance to waterfowl.

Economic and social values: The lake supports a significant fishery, yielding 400-600 metric tonnes per year, and is a very popular recreation area for the people of Hanoi.

Fauna: An important staging and wintering area for migratory waterfowl, particularly ducks. The importance of the site has decreased considerably in recent years as a result of increased disturbance, and some species, such as *Fulica atra*, which were once abundant are now scarce. Nevertheless, almost 2,000 waterfowl were present in March 1988 including:

1,800 *Anas crecca*

50 *A. querquedula*

50 *A. clypeata*

45 *Aythya baeri*

Other waterfowl recorded at the lake include *Phalacrocorax niger*, *Nycticorax nycticorax*, *Ardeola bacchus*, *Egretta garzetta*, *Ardea cinerea*, *Amaurornis phoenicurus* and *Larus ridibundus*.

Special floral values: None known.

Research and facilities: No information

References: No information

Criteria for Inclusion: 1b, 3b.

Source: Le Dien Duc and Derek A. Scott.

Wetland name: Cam Son Reservoir

Country: Vietnam

Coordinates: 21°32'N, 106°34'E;

Location: 15 km north of Luc Ngan District Town, in northern ha Bac Province.

Area: 2,620 ha.

Altitude: c.100.

Biogeographical Province: 4.6.1.

Wetland type: 17.

Description of site: A water storage reservoir with a capacity 250 million cubic metres, created in 1960 by a dam on the Hoa River, a tributary of the Thuong River. The reservoir is 25-30 km long and 8-15 km wide. The surrounding hills rise to 300m, and there are limestone hills and cultivated areas to the southeast. A decade ago, the adjacent slopes were densely forested, but most of the forest has now been cleared for timber, firewood and agricultural land.

Climatic conditions: Tropical monsoonal climate with an average annual rainfall of 1,395 mm, a mean annual temperature of 21.4°C and a mean relative humidity of 31%.

Principal vegetation: No information is available on the aquatic vegetation. There are some shrubby areas and patches of secondary forest on the adjacent hillsides.

Land tenure: Owned by the People's Committee of Luc Ngan District.

Conservation measures taken: Some reforestation is being carried out in the water catchment area.

Conservation measures proposed: None

Land use: Generation of hydro-electricity, fishing and water supply for irrigation.

Disturbances and threats: The most serious threat is the use of poisons and explosives to catch fish, resulting in large-scale destruction of aquatic resources.

Economic and social values: The reservoir produces 4,500 kw of hydro-electricity, and supports a significant fishery, with an average production of 70 kg/ha.

Fauna: The reservoir provides a sanctuary for a variety of native stream fishes, and is an important staging and wintering area for migratory waterfowl.

Special floral values: None known.

Research and facilities: Some studies have been carried out on fisheries production.

References: Nguyen Van Hao (1979).

Criteria for inclusion: 2b, 3b.

Source: Le Dien Duc.

Wetland name: Cat Ba Archipelago

Country: Vietnam

Coordinates: 20°42'-20°54'N, 106°52'-107°07'E;

Location: off the northeast coast of Vietnam in Halong Bay, about 30 km east of Hai Phong City and Port.

Area: 34,500 ha.

Altitude: 0-331m.

Biogeographical Province: 4.6.1.

Wetland type: 03, 05, 07, 12, 15 & 21.

Description of site: Cat Ba Archipelago consists of one main island and 366 smaller islands. The archipelago possesses a great variety of landscapes and diversity of ecosystems including offshore coral reefs, sandy beaches (3,580 ha), mangrove forests (2,300 ha), freshwater swamp forests, small freshwater lakes and forested hills. There are many areas of spectacular scenery, especially in the "sugar loaf" limestone karst areas on the main island where there are numerous waterfalls, caves and grottos. The principal streams on the main island are the Thung Luong, Treo Corn, Hoi Trung Trang and Viet Hai. There are several small lakes and ponds in the hills, the largest of which is Ech Lake, a permanent lake with a surface area of 3 ha and a depth of about 50m. Much of the main island is between 50m and 200m above sea level; the highest peaks rise to 331m (Cao Vong) and 302m (Hien Hoa), and only 10% of the island is below 50m in elevation. However, some places in the interior of the main island, such as Ang Tom in Viet Hai Village, are below sea level. The principal beaches are at Cai Vieng, Hong Xoai Lon and Hon Xoai Be.

The tidal range is 3.3-3.9m (exceptionally 4.0m). The salinity of the surrounding waters fluctuates seasonally, ranging from 31.11 p.p.t. in the dry season (December to March) to 9.30 p.p.t. in the wet season (June to September). Most of the streams are seasonal, flowing only after tropical rain storms, but some of the streams in the higher valleys are perennial or almost so. Most of the rain water flows into caves and grottos, and follows underground streams to the sea. There is often, therefore, a severe shortage of fresh water during the dry season.

Climatic conditions: Tropical monsoonal climate with pronounced wet and dry seasons. The average annual rainfall is 1,700-1,800 mm, the mean annual temperature at sea level 25-28°C, and the mean relative humidity 85%. The rainy season lasts from May to September, the heaviest rainfall occurring in July and August. The average temperature at this season is 30°C; the prevailing wind is southeasterly, and typhoons and tropical storms are frequent. The dry or cold season lasts from November to March. The temperature normally varies between 16°C and 19°C, although it occasionally drops to below 10°C. There is often some drizzle in the months of February, March and April.

Principal vegetation: There are three main types of vegetation in the archipelago: tropical evergreen forest on the hills, freshwater swamp forest at the foot of the hills, and coastal mangrove forest. The hill forests include species such as *Spondias lakonensis*, *Milium flipes*,

Indospermum sp, *Pometia pinnata*, *Euphorbia* sp, *Carralli lancaefolia* and *Dimerocarpus brenieri*, with trees up to 20-30m in height. Species of Urticaceae and Orchidaceae are dominant in the lowest stratum of the forest. On the mountain summits, the vegetation is drought resistant and stunted due to the strong winds, the trees not exceeding 5m in height. In some places *Sasa japonica* is dominant.

Common species in the swamp and foothill forests include *Dracontomelum duperreanum*, *Aglaia gigantea*, *Duabanga sonneratioides*, *Lagerstroemia balansea*, *Pterospermum* sp, *Cinnamomum* spp, *Caryodaphnopsis tonkinensis* and *Peltaphorum tonkinensis*. These species, which grow to heights of about 20m, dominate the upper stratum of the forest. A lower stratum with trees up to 12m in height includes *Engelhardtia spicata*, *Gironniera subaequalis* and *Garcinia* sp. while a third stratum with trees up to 8m in height includes *Aiphonsea* spp and *Ardisia tonkinensis*.

The main island has over 2,300 ha of mangrove forest consisting of *Rhizophora mucronata*, *Bruguiera gymnorhiza*, *Kandelia candel* and *Aegiceras mafus*. The trees are, however, only 2-3m in height because of the cold winters, low concentrations of silt and over-exploitation.

In total, 620 species of plants have been recorded in the archipelago.

Land tenure: Public ownership.

Conservation measures taken: In April 1986, the Government of Vietnam declared a large part of the main island and the adjacent waters as a National Park. The total area of 26,300 ha includes 17,300 ha of the main island and 9,000 ha of the adjacent inshore waters. The objectives of the National Park are: (a) to preserve the natural ecosystems and genetic resources of this tropical island; (b) to preserve the cultural and historical features of the island; (c) to restore the native fauna and flora through replanting, re-introductions and habitat improvement; (d) to promote outdoor recreation and environmental education for the general public in collaboration with the tourist industry; and (e) to promote scientific research relevant to the management of the park.

Conservation measures proposed: None

Land use: The principal activities of the local inhabitants are forest exploitation, agriculture and fishing. In 1983, the population of the main island was 7,751. Many of these immigrated from nearby coastal provinces in recent years and have settled mainly in the south of the island. The principal crops are rice, cassava and fruits.

Disturbances and threats: Shifting agriculture, over-exploitation of the forest resources for firewood and construction materials, and the demand for grazing land for domestic animals have resulted in widespread deforestation and destruction of the natural vegetation. This in turn has had a detrimental effect on fish production and water supply. The park authorities are currently promoting rural planning to solve these problems.

Economic and social values: The forests are vital in maintaining the water regime for the whole area; they contain important genetic resources and supply raw materials to the food chain of aquatic animals (fishes, shrimps, bivalves and arthropods). The forests also provide pit props for mining areas in neighbouring Quang Ninh Province. The fishery is important not only for the local people but also for the population of the adjacent mainland (Hai Phong). About 350 tons of fish were landed in 1983.

To date, 17 sites containing the traces of primitive humane have been located on the main island. Stone tools and bones found at the sites indicate that primitive man was living in the caves and grottos on the island between 6,000 and 7,000 years ago. Cai Beo Cave, about 1.5 km southeast of Cat Ba Town, has been studied most intensively. The cave was first discovered by a French archaeologist in 1938. The National Institute of Archaeology surveyed the cave some years later,

and in 1983 the National Institute of Historical Museums and the Historical Museum of Hai Phong continued the research.

Fauna: The fauna of the archipelago has not as yet been studied in detail. However, preliminary surveys have revealed that the fauna is distinctive, with unique elements adapted to the island conditions. One such endemic form is a subspecies of Francois Leaf Monkey *Presbytis francoisi poliocephalus*. Other mammals known to occur on the island include *Macaca mulatta*, *M. nemestrina*, *M. artoides*, *Capricornis sumatrensis*, *Cervus unicolor*, *Muntiacus muntjak*, *Lutra lutra*, *Panthera pardus*, *Felis bengalensis*, *Viverra zibetha*, *Viverricula malaccensis*, *Ratufa bicolor*, *Callosciurus erythraeus*, *Tamiops swinhoe*, three species of *Rattus*, *Hystrix hodgsoni*, *Atherurus macrourus*, *Rhizomys sumatrensis* and *Hipposideros larvatus* (four subspecies). Seals (Pinnipedia) and dolphins (Delphinidae) occur in the surrounding seas.

The islands lie on a major migration route for many species of waterfowl. The beaches and mangrove forests provide feeding and roosting sites for large numbers of birds during the migration seasons, including several species of ducks and geese and many shorebirds. Resident species and summer visitors include *Tachybaptus ruficollis*, *Phalacrocorax carbo*, *Anas poecilorhyncha*, *Amaurornis phoenicurus*, *Gallicrex cinerea* and *Hydrophasianus chirurgus*. Forest birds include the hornbill *Anthracoceros albirostris*, a very rare species in northern Vietnam.

Reptiles include *Gekko gekko*, *Python* sp, *Embrystoma* sp and the sea turtle *Eretmochelys imbricata*.

Some 200 species of fishes, 500 species of molluscs and 400 species of arthropods have been listed for the islands.

Special floral values: The forests contain many very interesting plant species including a subtropical plant *Podocarpus fleuryi* which occurs in a 570 ha patch of primary forest on the east side of the main island.

Research and facilities: Local scientists have conducted preliminary surveys of the fauna and flora, and a considerable amount of archaeological research has been carried out.

References: IUCN (in prep).

Criteria for inclusion: 1b, 1c, 2b, 2 d.

Source: Le Dien Duc.

Wetland name: Red River Delta

Country: Vietnam

Coordinates: 20°00'-21°10'N, 105°50'-106°50'E;

Location: from the region of Hanoi to the shores of the Gulf of Tonkin, northern Vietnam.

Area: 1,743,200 ha.

Altitude: 0-5m.

Biogeographical Province: 4.5.1./4.6.1.

Wetland type: 02, 05, 06, 07, 08, 10, 11, 13, 19 & 20.

Description of site: The Red River (Song Hong) is the largest river in northern Vietnam. It rises in the mountains of Yunnan Province in the People's Republic of China and has a total catchment area of 139,000 sq.km. The river flows for over 500 km through Vietnamese territory before entering the sea in the Gulf of Tonkin. The triangular delta has its apex in the region of Hanoi, about 120 km from the coast. Here the river divides into its two main distributaries, the southern Song Hong (Red River) and the northern Song Duong.

The mean annual discharge of the Red River at Sontay is 114 cubic kms, equivalent to an average flow of 3,640 cubic metres per second. Some 74.4% of the river discharge occurs during the rainy season, from June to October. At peak flow during the rainy season, the river discharges 30,000 cubic metres per second, as compared with only 430 cubic metres in the dry season. The river carries a very large silt load amounting to 115 million tons per year. The average silt content of the water at Sontay is 990 gm per cubic meter, and the maximum 6,950 gm. The amount of sediments reaching the sea has increased in recent years because of deforestation, intensive cultivation and severe soil erosion in the catchment area. These high concentrations of sediment give the water its red colour.

The maximum tidal range along the coast of the delta is approximately 4m. Salinities increase from about 0.5 p.p.t. in the rivers to 30.0 p.p.t. Offshore, and fluctuate widely depending on the flow in the river and state of the tide. The pH varies from 8.0 to 8.4, reaching its highest levels in November and its lowest levels in May and June. Water temperatures vary both seasonally and with distance from the coast; in summer the surface temperature of the rivers is 27-30°C (somewhat higher than the temperature of the adjacent sea), while in winter the temperature is 24-26°C (somewhat lower than that of the sea).

Almost the entire delta has been reclaimed for agricultural land, aquaculture ponds, forestry and urban development. Some parts of the delta have been drained by cutting off river channels, while others have been protected from flooding by dikes averaging 3-4 metres in height. Some of these dikes date back to the eleventh century. Approximately 47% of the delta (820,800 ha) is agricultural land, and there are only some 47,900 ha (5.7%) of permanent lakes and ponds. Almost the entire outer edge of the delta is protected by a high sea wall, beyond which there is only a narrow zone of intertidal sand or mud flats. However, the rate of accretion at the river mouths is about twice that of erosion, and new mudflats and sandy islands are constantly being formed.

The principal land use throughout the delta is the cultivation of rice. The whole region produces about three million tons of rice per year (an average yield of 2,835 kg/ha in 1985). To facilitate rice production, some 1,080 km of embankments, 34,400 km of canals, 1,310 drains, 217 reservoirs and 1,300 pumping stations have been constructed. However, during periods of heavy rainfall, the existing facilities are only able to drain about 70% of the rice-growing areas. The other 55,000 ha remain flooded and are incapable of producing a rice harvest. It has been suggested that the best solution to this problem would be to retain these low-lying areas as wetlands and manage them for fisheries and other wetland products, rather than attempt to drain them for rice production. An agricultural cooperative in Hai Hung Province has already adopted this approach with good results, and it is likely that other cooperatives will follow their example in the future.

The most important site for nature conservation in the delta is at the mouth of the main branch of the Red River in ha Nam Ninh and Thai Binh Provinces (site 11 a).

Climatic condition: None

Principal vegetation: None

Land tenure: None

Conservation measures taken: None

Conservation measures proposed: None

Land use: None

Disturbances and threats: None

Economic and social values: None

Fauna: None
Special floral values: None
Research and facilities: None
References: None
Criteria for inclusion: None
Source: None

Wetland name: Red River Estuary

Country: Vietnam

Coordinates: 20°10'-20°22'N, 106°20'-106°39'E;

Location: 45 km ESE of Nam Dinh Provincial Town and 110 km southeast of Hanoi, in the provinces of Thai Binh and ha Nam Ninh.

Area: c.15,000 ha.

Altitude: 0-3m.

Biogeographical Province: 4.5.1./4.6.1.

Wetland type: 02, 05, 06, 07, 08, 10, 11 & 19.

Description of site: The outer estuarine system of the main Red River (Song Hong) channel, near the southern end of the Red River Delta. Most of the estuary is confined within a high sea dike. The area can be divided into three major zones: (1) land inside the sea dike; (2) coastal marshes, mudflats and beaches beyond the sea dike; and (3) the islands in the estuary.

1. The area inside the sea dike includes raised land behind the dike, an elaborate network of canals and river channels with fringing marshes, sandy areas with human settlements, and large areas of agricultural land reclaimed by polderization.

2. The coastal zone consists of extensive intertidal mudflats, mangrove swamps, salt marshes and sandy beaches. Large parts of the mudflats and mangroves have recently been impounded for shrimp ponds. Both accretion and erosion are taking place, but accretion is dominant, the rate of accretion being twice that of erosion. In recent years, accretion has resulted in the outward extension of the mudflats by about 500-600m per year, and the level of the land outside the sea wall has risen by almost 10 cm per year. The maximum tidal range is approximately 4m.

3. Several large, low-lying islands have been formed by accretion in the mouth of the river, the main ones being Con Ngan and Con Lu. The fine deposits of silt on the landward, protected side of the islands have been colonized by mangroves, which currently cover some 3,000 ha. The exposed seaward side of the islands consists of sandy beaches.

Climatic condition: Tropical monsoonal climate with a pronounced maritime influence. The average annual rainfall is 1,600-1,800 mm, 85% of which occurs during the rainy season in summer (April to October). The heaviest rainfall occurs in August and September; this combines with high river levels to cause extensive flooding throughout the delta. The winters are cool and dry, with mean monthly temperatures varying from 16.3° to 20.9°C and mean minimum temperatures from 14.4°C to 19.7°C. However, temperatures occasionally fall well below this, and an absolute minimum of -14.4°C has been recorded. Fine drizzle is frequent in early spring,

after which temperatures rise rapidly to a maximum of 40°C in May. The summers are warm and very humid, with average temperatures ranging from 27°C to 29°C, and mean maxima from 31°C to 33°C. The prevailing winds are north and east in winter, and east and southeast in summer. Typhoons and tropical storms are frequent between July and October, and often cause considerable damage. During the period 1911 to 1965, the region withstood 40 typhoons. However, the frequency of storms and typhoons has increased in recent years, and there are now usually two or three storms, typhoons or whirlwinds in the delta region every year.

Principal vegetation: The vegetation in the estuarine marshes includes *Phragmites* sp, *Cyperus* sp and algae such as *Rhizosolenia*, *Chaetomorpha*, *Clenophora*, *Enteromorpha*, *Oedogonium*, *Crispum* and *Gracilaria*. The natural mangrove vegetation of the delta includes a variety of species such as *Sonneratia caeseolaris*, *Kandelia candel*, *Aegiceras corniculatum*, *Avicennia* sp, *Rhizophora stylosa*, *Bruguiera gymnorhiza*, *Acanthus ebracteatus* and *Derris trifoliata*. However, the natural mangrove forests have long been replaced by a much simpler planted community dominated by *S. caeseolaris*, *B. gymnorhiza* and *Aegiceras corniculatum*.

Land tenure: State owned (agricultural cooperatives).

Conservation measures taken: A committee including local administrators, local scientists and scientists from the State Programme on Rational Utilization of Natural Resources and Environmental Protection has been set up to coordinate scientific activities in the region and to make recommendations to the Provincial People's Committees concerning sustainable development of the estuary. Some 12,000 ha of the site were designated as a Wetland of International Importance under the Ramsar Convention in September 1988.

Conservation measures proposed: The local authorities and scientists from the State Programme on Rational Utilization of Natural Resources and Environmental Protection are currently discussing the possibility of setting up a multipurpose reserve in the estuary to protect migratory waterfowl populations and to promote conservation of the aquatic resources for sustainable use. The reserve, with an area of 12,000 ha, would incorporate coastal mudflats and mangroves south of the river mouth and would take in the accreting islands of Con Ngan and Con Lu. A major part of the management would involve replanting large areas with mangroves.

Land use: Fishing (finfish, crabs and molluscs), aquaculture (shrimps) and agriculture (mainly rice); also duck-raising, the harvesting of rushes for weaving (mats, bags and carpets), the collection of honey in the mangrove forest, and the hunting of migratory shorebirds, particularly with nets. There are presently some 300,000 people living in the area, with approximately 78% of the work force engaged in agriculture and 20% in fishing.

Disturbances and threats: The principal threat to the estuarine system is the construction of new dikes and reclamation of mangrove swamps and mudflats for agricultural land and shrimp ponds. Some 2,000 ha of mangrove forest have recently been cleared for shrimp ponds, and mangrove forest has also been cleared for the cultivation of rushes. The demands of the local people on the natural resources of the estuary are constantly increasing, and over-exploitation is already affecting some of the resources. Fish production has decreased as a result of over-exploitation and destruction of the mangrove forests, and waterfowl populations have declined as a result of excessive hunting and other disturbance. In particular, the gathering of bivalves for human consumption causes a considerable amount of disturbance to waterfowl populations. The construction of Da Dam upstream on the Red River is likely to have a serious long-term effect on the estuarine system.

Economic and social values: The region is of considerable importance for its rice and fisheries production. Rice production is estimated at 30,000-40,000 metric tonnes per year, and fish

production at 8,000 to 10,000 tonnes per year. Shrimp production was estimated at 6.8 tonnes in 1983 and 24.5 tonnes in 1984; since then, the production has risen sharply with the development of aquaculture schemes. In Xuan Thuy District alone, about 200 tonnes of shrimps were produced in 1987. In this same district, crabs produce an annual harvest of about 50 tonnes and molluscs a harvest of about 1,200 tonnes (mainly large bivalves). The production of rushes for weaving is also very important in the local economy, with an estimated harvest of 16,000 to 20,000 tonnes per year. The production of honey has, however, fallen from around 50 tonnes per year to only 10 tonnes, as the area of mangrove forest has been reduced. About one million domestic ducks are reared each year in Xuan Thuy District.

Fauna: The Red River estuary is the most important staging and wintering area for migratory waterfowl such as ducks, geese and shorebirds in northern Vietnam. Huge concentrations of birds occurred in the past, but numbers have declined sharply during the last decade due to excessive shooting, netting and trapping, the cutting of mangrove forests and generally high levels of human disturbance. Nevertheless, the estuary continues to be of great importance, and may still hold more than 100,000 birds between October and March or April. Over 21,000 waterfowl were recorded by Le Dien Duc and D.A. Scott during a brief survey of part of the area in March 1988. These included:

300 *Ardeola bacchus*
95 *Bubulcus ibis*
850 *Egretta garzetta*
150 *E. alba*
500 *Ardea cinerea*
32 *Platalea minor*
500 *Anas penelope*
2,500 *A. crecca*
100 *A. querquedula*
400 *A. clypeata*
1,000 *Limosa limosa*
30 *L. lapponica*
300 *Numenius arquata*
1,500 *Tringa erythropus*
110 *T. totanus*
300 *T. stagnatilis*
250 *T. nebularia*
130 *Gallinago gallinago*
70 *Calidris tenuirostris*
230 *Limicola falcinellus*
750 *Larus ridibundus*
200 *L. saundersi*
600 *Chlidonias hybrida*

and at least 10,000 unidentified small shorebirds (*Charadrius* and *Calidris*). The large numbers of Saunders' Gull *L. saundersi* were of particular interest and represent the largest wintering concentration of this rare species hitherto discovered. Other rare species present in March 1988 included Swinhoe's Egret *Egretta eulophotes* (one) and Asian Dowitcher *Limnodromus semipalmatus* (three). As many as 62 Black-faced Spoonbills *P. minor* had been present earlier in the year, along with 200 *Anser anser*. The local people report that a species of pelican,

presumably *Pelecanus crispus*, is a regular visitor in November and December. Fischer (1983) recorded 38 species of shorebirds in the Red River Delta. The most abundant migrants and winter visitors were *Charadrius dubius*, *C. leschenaultii*, *Tringa glareola*, *Xenus cinereus*, *Actitis hypoleucos*, *Gallinago stenura*, *G. gallinago*, *Calidris ruficollis* and *C. subminuta*. Other regular migrants included *Pluvialis dominica*, *P. squatarola*, *Charadrius placidus*, *C. alexandrinus*, *C. mongolus*, *Numenius phaeopus*, *N. arquata*, *Tringa totanus*, *T. nebularia*, *T. ochropus*, *Heteroscelus brevipes* and *Calidris temminckii*. One hundred and fifty-six species of fishes are known to occur in the estuary. Ten species make up the bulk of the commercial catches, although about 40 species are of some economic value. The benthic fauna includes at least 12 genera of Bivalva and two genera of Gastropoda. The most abundant shrimps are *Penaeus orientalis*, *P. merguensis*, *P. japonicus* and *Metapenaeus sp.* *Brachyura* include *Scylla serrata* and species of *Eriochier*, *Neptunus*, *Mecerothainus*, *Uca* and *Hemigrapheus*. The estuarine system supports a rich and diverse zooplankton. A total of 185 species has been recorded, including 107 Copepoda, 14 Cladocera, eight Siphonophora, eight Chaetognatha, six Amphipoda, six Tunicata, five Protozoa, four Ostracoda, three Pteropoda-Heteropoda, two Rotatoria, two Cumacea, one Sergestinae, one Euphausidae and 18 Nauplius. All are euryhaline and eurythermic species, which have originated from tropical seas and have become adapted to the high fluctuations in salinity occurring in the estuary. During spring and early summer, the density of planktonic organisms varies over a wide range from 1,600 to 267,450 individuals per cubic meter (mean 15,470). The density decreases rapidly during the rainy season to a mean density of 6,170 individuals per cubic meter by the end of summer.

Special floral values: No information.

Research and facilities: Scientists from the State Programme on Rational Utilization of Natural Resources and Environmental Protection have been conducting studies on the natural resources of the Red River Estuary since 1982.

References: Fischer (1983); Karpowicz (1985); Stoutjesdijk (1982).

Criteria for inclusion: 123.

Source: Le Dien Duc and Derek A. Scott.

Wetland name: Xe Go Reservoir

Country: Vietnam

Coordinates: 18°13'N, 105°55'E;

Location: 10 km south of ha Tinh Town, Cam Xuyen District, Nghe Tinh Province.

Area: 2,500 ha.

Altitude: 60-80m.

Biogeographical Province: 4.5.1.

Wetland type: 17.

Description of site: A water storage reservoir with a capacity of 345 million cubic metres, on the Ba Mo River. The reservoir is about 50 km in length but only 1.5 km wide at its widest, and is surrounded by bare hills with limestone outcrops. The depth varies from 6-27m.

Climatic conditions: Tropical monsoonal climate.

Principal vegetation: No information.

Land tenure: Owned by Nghe Tinh Province.

Conservation measures taken: The local authorities have placed restrictions on cultivation on the adjacent slopes, and have carried out some reforestation.

Conservation measures proposed: None

Land use: Irrigation, generation of hydro-electricity and aquaculture. The reservoir irrigates 18,000 ha of wet rice cultivation in Nghe Tinh Province.

Disturbances and threats: Cultivation of cassava and other crops on the steep slopes around the reservoir has resulted in a serious siltation problem in the reservoir.

Economic and social values: Very important for irrigation, fishing and hydro-power for the local communities.

Fauna: The reservoir is reported to be an important staging and wintering area for migratory waterfowl, but no details are available.

Special floral values: No information.

Research and facilities: None

References: Tran Dinh Phuc (1981).

Criteria for Inclusion: 0.

Source: Le Dien Duc.

Wetland name: Bau Xen Lake

Country: Vietnam

Coordinates: 17°11'N, 106°55'E;

Location: near Sen Thuy Village, Le Ninh District, Binh Thien Province.

Area: 200 ha.

Altitude: 8m.

Biogeographical Province: 4.5.1.

Wetland type: 14.

Description of site: A small freshwater lake in the coastal lowlands of central Vietnam, four km from the sea. The lake is surrounded by rice paddies, human settlements and shrubbery, and there is a high ridge of sand dunes to the east.

Climatic conditions: Tropical monsoonal climate.

Principal vegetation: No information.

Land tenure: Owned by the People's Committee of Le Ninh District.

Conservation measures taken: None.

Conservation measures proposed: None

Land use: Irrigation, fishing, water supply for domestic consumption, and outdoor recreation. The lake is used to irrigate 700 ha of rice paddies.

Disturbances and threats: None known.

Economic and social values: The lake is of considerable importance to the local communities for irrigation, fisheries production, water supply and recreation.

Fauna: The lake is thought to be an important staging and wintering area for migratory waterfowl, but no details are available.

Special floral values: No information.

Research and facilities: None

References: None

Criteria for inclusion: 1b.

Source: Le Dien Due.

Wetland name: Tam Giang Lagoon

Country: Vietnam

Coordinates: 16°32'-16°39'N, 107°26'-107°37'E;

Location: 10 km north of Hue, southeastern Binh Thuan Province.

Area: 7,800 ha.

Altitude: 0-2m.

Biogeographical Province: 4.5.1.

Wetland type: 08.

Description of site: A large, brackish, coastal lagoon, about 20 km long and up to three km wide. The lagoon extends in a northwest-southeast direction parallel to the coast, and is separated from the sea by a sandy ridge formed by coastal deposition. The northern end of the lagoon is the mouth of O Loan River; both the river and the lagoon open into the sea at the Thuan An and Tu Hien channels. Six other rivers also flow into the lagoon: the Bo, Huong, Truoi, Dap Dinh, Thien Hoa and Cong Quan. The mean depth of the lagoon is 0.8m; the water is brackish, with a salinity of 16.6-21.8 p.p.t.

Climatic conditions: Tropical monsoonal climate with a rainy season from August to December; the heaviest rainfall occurs in October and November. The mean January temperature is 20.1°C, and the mean June temperature 29.2°C.

Principal vegetation: Nine species of vascular plants have been recorded in the lagoon, five of which belong to the Hydrocharitaceae. The dominant species is *Najas indica*, with a biomass of 2,500 gm per square meter. *Hydrilla verticillata* is dominant in the O Loan River, with a biomass of 200-250 gm per square meter. Eighty-six species of algae have recently been listed. The species composition varies widely according to season; during the rainy season, freshwater algae predominate, while during the dry season, marine algae predominate.

Land tenure: State owned (Province and District).

Conservation measures taken: The provincial authorities have developed a policy for the rational utilization of the lagoon.

Conservation measures proposed: None

Land use: Fishing (finfish, shrimps, crabs and bivalves) and recreation; agriculture in adjacent areas.

Possible changes in land use: Priority is being given to the development of aquaculture (fish, shrimp and *Gracilaria verrucosa*) in the lagoon.

Disturbances and threats: The salinity of the lagoon has decreased as the Tu Hien channel has become blocked by continuing coastal deposition. This has had an adverse effect on many aquatic species. Over-exploitation of the fishery resources is also a problem.

Economic and social values: The lagoon supports a major fishery which is important not only as a protein source for the local communities, but also for export. The annual production of finfish alone is estimated at 3,600 metric tonnes. The lagoon also has considerable potential for outdoor recreation and tourism.

Fauna: A very important area for wildlife. The lagoon supports a rich fish and invertebrate fauna, and is a major staging and wintering area for migratory waterfowl, particularly ducks and shorebirds.

Special floral values: No information.

Research and facilities: None

References: Karpowicz (1985); Vu Trung Tang & Dang Thi Sy (1982).

Criteria for inclusion: lb, le, 3b.

Source: Le Dien Due.

Wetland name: Bien Ho Lake

Country: Vietnam

Coordinates: 14°03'N, 108°00'E;

Location: 8 km north of Plei Ku Town, Plei Ku District, Gia Lai-Kontum Province.

Area: 600 ha.

Altitude: 800m.

Biogeographical Province: 4.5.1.

Wetland type: 14.

Description of site: A natural freshwater lake on a high plateau formed by three or four extinct volcanic craters. The lake is surrounded by bare hillside and rocky mountains.

Climatic conditions: Tropical monsoonal climate.

Principal vegetation: One hundred and twenty-two species of phytoplankton and two species of phytobenthos have been recorded in the lake.

Land tenure: Owned by the People's Committee of Plei Ku Town.

Conservation measures taken: Some measures have been taken to maintain water quality. Bare hillsides around the lake have been replanted to reduce soil erosion and siltation.

Conservation measures proposed: None

Land use: Fishing and water supply for irrigation and domestic use.

Disturbances and threats: Siltation is a problem, and there is some oil pollution from motorboats.

Economic and social values: The lake supports a small fishery yielding 3-5 metric tonnes of fish per year; it provides drinking water for local communities and irrigation water for 600 ha of rice and 250 ha of tea plantations at the Bien Ho State Farm.

Fauna: The lake is known to support a rich fish fauna and a variety of waterfowl, but no details are available. Fifty-four species have been recorded in the zooplankton.

Special floral values: No information.

Research and facilities: None

References: None

Criteria for inclusion: lb.

Source: Le Dien Due.

Wetland name: Quy Nhon Swamp

Country: Vietnam

Coordinates: 13°50'-13°55'N, 109°13'-109°18'E;

Location: on the coast north of Quy Nhon Town, Nghia Binh Province.

Area: 5,000 ha at high tide; 3,200 ha at low tide.

Altitude: Sea level.

Biogeographical Province: 4.5.1.

Wetland type: 07 & 08.

Description of site: A natural saline swamp opening to the sea through a channel 700m wide. Several rivers including the ha Thanh, Am Phu and Dai An flow into the swamp. The average

depth is 1-2m and the maximum 7-10m. There are several small islands with mangrove forest in the northern part of the swamp.

Climatic conditions: Tropical monsoonal climate with an average annual rainfall of 1,690 mm, a mean annual temperature of 26.6°C and a mean relative humidity of 80%.

Principal vegetation: The islands support mangrove forest with *Sonneratia alba* and several other species. One hundred and thirty-six species of flowering plants and algae have been recorded at the swamp, along with numerous species of phytoplankton including 50 species of Rhodophyta. *Gracilaria verrucosa* is particularly abundant, with a production of 362 gm per square meter in April and 140 gm per square meter in August.

Land tenure: Owned by the People's Committee of Nghia Binh Province.

Conservation measures taken: None.

Conservation measures proposed: None

Land use: Aquaculture (*Gracilaria verrucosa* and shrimps).

Disturbances and threats: None known.

Economic and social values: Aquaculture of *Gracilaria verrucosa* and shrimps for export.

Fauna: No information.

Special floral values: No information.

Research and facilities: None

References: None

Criteria for inclusion: lb.

Source: Le Dien Due.

Wetland name: Cu Mong Lake

Country: Vietnam

Coordinates: 13°30'-13°38'N, 109°12'-109°18'E;

Location: 30 km south of Qui Nhon, northeastern Phu Khanh Province.

Area: 3,000 ha.

Altitude: Sea level.

Biogeographical Province: 4.5.1.

Wetland type: 08.

Description of site: A saline coastal lagoon, separated from the sea by a long sandy peninsula and opening to the sea at its southern end through a channel 400m wide. The bed of the lagoon consists of sand and mud. There are human settlements around the lagoon, and forested hills to the north and south.

Climatic conditions: Tropical monsoonal climate. Principal vegetation: A variety of algae.

Land tenure: Owned by the People's Committee of Phu Khanh Province.

Conservation measures taken: Plans have been made for the rational utilization of the fishery and other aquatic resources of the lagoon.

Conservation measures proposed: None

Land use: Fishing (finfish and shrimps) and harvesting of seaweed.

Disturbances and threats: The principal threat is the over-exploitation of the aquatic resources.

Economic and social values: The fishery and seaweed resources are of considerable importance to the local communities.

Fauna: The lagoon is thought to be an important staging and wintering area for migratory waterfowl, but no details are available.

Special floral values: No information.

Research and facilities: None

References: None

Criteria for inclusion: lb.

Source: Le Dien Duc.

Wetland name: O Loan Lake

Country: Vietnam

Coordinates: 13°17'N, 109°17'E;

Location: 0.5 km west of Tuy An District Town and 30 km north of Tuy Hoa Town, northeastern Phu Khanh Province.

Area: 150 ha.

Altitude: Sea level.

Biogeographical Province: 4.5.1.

Wetland type: 08.

Description of site: A saline coastal lagoon formed by coastal deposition; the lagoon is separated from the sea to the east by a sandy peninsula, and opens into the sea through a small channel. The southern shore comprises submerged sand dunes. The lagoon is surrounded by low hills and rice paddies.

Climatic conditions: Tropical monsoonal climate.

Principal vegetation: Aquatic grasses such as *Thalassia* sp, *Myriophyllum spicatum* and algae.

Land tenure: Owned by the People's Committee of Tuy Hoa District.

Conservation measures taken: None.

Conservation measures proposed: None

Land use: Fishing, harvesting of crabs and molluscs, and aquaculture (shrimps and *Gracilaria verrucosa*).

Disturbances and threats: The principal threat is over-exploitation of the aquatic resources.

Economic and social values: The fishery resources are of considerable importance to the local communities.

Fauna: Thought to be an important staging and wintering area for migratory waterfowl, but no details are available.

Special floral values: No information.

Research and facilities: None

References: None

Criteria for inclusion: lb.

Source: Le Dien Duc.

Wetland name: Bau Sau (Le-Hiam)

Country: Vietnam

Coordinates: 13°05'N, 108°49'E;

Location: 2.5 km from Bung and Bai villages, near Kronpa and Suoi Trai villages, Tay Son District, Phu Khanh Province.

Area: 80 ha in the rainy season; 30 ha in the dry season.

Altitude: c.90m.

Biogeographical Province: 4.5.1.

Wetland type: 15.

Description of site: A permanent freshwater swamp in Kron Trai Wildlife Sanctuary, on the border between Phu Khanh Province and the high plateau (Tay Nguyen) provinces of Gia Lai-Kontum and Dak Lak. The water supply appears to come from the nearby Ba River.

Climatic conditions: Tropical monsoonal climate with an average annual rainfall of 1,300-1,400 mm, a mean annual temperature of 26.4°C and a mean relative humidity of 83%.

Principal vegetation: The swamp supports an abundant growth of reeds and other aquatic plants. Some rice is grown in adjacent areas. The surrounding forests of the wildlife sanctuary are dominated by species of *Lagerstroemia* and *Dipterocarpus* and associated species such as *Cratocylon* sp and *Acanthus* sp.

Land tenure: Owned by Tay Son District.

Conservation measures taken: The swamp is protected within the Kron Trai Wildlife Sanctuary (20,000 ha). The local people, especially the inhabitants of Bung and Bai villages, have been exposed to environmental education and are conscious of the need to conserve their natural resources. As a consequence, there is now little illegal hunting in the area.

Conservation measures proposed: None

Land use: The entire swamp is used for the natural production of crocodiles for meat and hides. The swamp also provides water for irrigating adjacent rice paddies.

Disturbances and threats: Crocodile hunting causes considerable disturbance to wildlife, and there is a possibility that the crocodiles are being over-exploited. The principal threat elsewhere in the wildlife sanctuary is shifting agriculture.

Economic and social values: The swamp provides water for irrigation during the dry season, and supports a small crocodile industry.

Fauna: Bau Sau (which translates as "Crocodile Swamp") supports a population of about 200 Siamese Crocodiles *Crocodylus siamensis*, a species listed as endangered in the IUCN Red Data Book and now extinct in the wild throughout most of its former range. Other reptiles include *Gekko gekko* and many species of snake.

The swamp is very important for water birds, particularly during the dry season when all other swamps in the region have dried out. Waterfowl recorded in recent years include *Phalacrocorax carbo*, *Ixobrychus cinnamomeus*, *Egretta alba*, *Ardea cinerea*, *Dendrocygna javanica*, *Anas querquedula*, *Amaurornis phoenicurus*, *Gallinula chloropus*, *Vanellus duvaucelii* and *Gallinago gallinago*. The surrounding forests are rich in bird life and support a variety of larger mammals including *Nycticebus coucang*, *Selenarctos thibetanus*, *Felis temmincki*, *Panthera tigris*, *P. pardus*, *Cervus unicolor*, *Bos gaurus*, *Capricornis sumatraensis* and *Manis pentadactyla*.

Special floral values: No information.

Research and facilities: None

References: Pham Mong Giao (1981).

Criteria for inclusion: 1b, 2a, 3 b.

Source: Le Dien Duc.

Wetland name: Lak Lake

Country: Vietnam

Coordinates: 12°25'N, 108°11'E;

Location: 32 km southeast of Buon Ma Thuot Provincial Town, Lak District, Dak Lak Province, Tay Nguyen (High Plateau).

Area: 500 ha.

Altitude: c.440m.

Biogeographical Province: 4.5.1.

Wetland type: 14.

Description of site: A natural freshwater lake in the swamp region of the Dak Lak High Plateau. The lake is fed by several small streams rising in the forested hills to the north, east and south; it drains west into a large area of swamps along the Krong-Ana River. The flat bed of the lake consists of a layer of detritus 40-60m deep.

Climatic conditions: Tropical monsoonal climate.

Principal vegetation: The lake supports an abundant growth of aquatic plants and is surrounded by reed-beds and swamp vegetation. Concentrations of 3-4 million phytoplankton cells per litre of water have been reported.

Land tenure: Owned by the Fishery Department of Dak Lak Province.

Conservation measures taken: None.

Conservation measures proposed: None

Land use: Fishing, aquaculture and water supply for irrigation. Rice, coffee and other crops are grown in the surrounding area.

Disturbances and threats: Cultivation of the steep slopes around the lake has resulted in severe soil erosion and siltation in the lake.

Economic and social values: The lake supports a small fishery, yielding 40-50 metric tonnes per year, and is an important source of water for irrigation.

Fauna: The lake and adjacent swamps are known to be important for waterfowl, but no details are available. The Siamese Crocodile *Crocodylus siamensis* formerly occurred in the area, but has not been recorded in recent years.

Special floral values: No information.

Research and facilities: None

References: None

Criteria for inclusion: lb.

Source: Le Dien Duc.

Wetland name: Nai Swamp

Country: Vietnam

Coordinates: 11 °37'N, 109°02'E;

Location: 7 km northeast of Phan Rang Town, Ninh Hai District, eastern Phu Khanh Province.

Area: 1,000 ha.

Altitude: Sea level.

Biogeographical Province: 4.5.1.

Wetland type: 07, 08, 09 & 10.

Description of site: A brackish coastal lagoon with an average depth of 6-7m, surrounded by brackish marshes, mangrove swamps, salt pans and shrimp ponds. The lagoon is connected to the sea by a canal some two km long and 500-800m wide. Fresh water enters the system via two canals at the north end of the lagoon. The wetland formerly included 130 ha of mangrove swamp, but most of this has now been cleared for salt pans and shrimp ponds.

Climatic conditions: Tropical monsoonal climate with an average annual rainfall of 1,374 mm, a mean annual temperature of 26.4°C and a mean relative humidity of 81%.

Principal vegetation: The mangrove forest is dominated by species of *Aegiceras* and *Bruguiera*. *Gracilaria verrucosa* is very common in shallow parts of the lagoon.

Land tenure: Owned by the People's Committee of Phu Khanh Province.

Conservation measures taken: None.

Conservation measures proposed: None

Land use: Fishing, aquaculture (fishes, shrimps and *Gracilaria verrucosa*) and salt production.

Disturbances and threats: None known.

Economic and social values: The lagoon and associated aquaculture ponds support a significant fishery, yielding about 46 metric tonnes of fish per year as well as large quantities of shrimps. Salt production is also very high, but production figures are not available. *Gracilaria verrucosa* is cultured for export.

Fauna: The area is known to be important for both resident and migratory water birds, but no details are available.

Special floral values: No information.

Research and facilities: None

References: None

Criteria for inclusion: lb.

Source: Le Dien Duc.

Wetland name: Nam Cat Tien

Country: Vietnam

Coordinates: 11°32'N, 107°23'E;

Location: 110 km northwest of Ho Chi Minh City and 120 km southeast of Da Lat, Tan Phu District, Dong Nai Province.

Area: 2,500 ha.

Altitude: 120m.

Biogeographical Province: 4.5.1.

Wetland type: 14, 15 & 21.

Description of site: A small, permanent, freshwater lake and a large area of seasonal lakes and marshes surrounded by seasonally flooded swamp forest, in Nam Cat Tien Forest Reserve. The southern part of the reserve (15,000 ha) consists of the riparian lowlands of the Dong Nai River. Some 2,500 ha of these lowlands are flooded during the rainy season, creating three small lakes: Fish, Bird and Crocodile. Only Crocodile Lake (30-50 ha) retains water throughout the dry season.

A hydro-electric dam has recently been constructed at Tn An on the Dong Nai River downstream of the reserve. The dam will flood large areas of forest south of the reserve, and the shallow end of the reservoir will extend to within a few km of the reserve boundary.

Climatic conditions: Tropical monsoonal climate with a pronounced dry season from November to April and a rainy season from May to October. The average annual rainfall is 2,435 mm, the mean annual temperature 25.5°C, and the mean relative humidity 80%.

Principal vegetation: No information is available on the aquatic vegetation. The seasonally flooded grassland is dominated by *Saccharum spontaneum* and *Negrada neyraudiana*, and the swamp forest by *Hydrocarpus anthelmintica* mixed with *Ficus benjamina*. The wetland is

bounded to the east, south and west by dense humid evergreen forest with dipterocarps, such as *Dipterocarpus alatus*, *D. dyeri*, *Anisoptera costata*, and species of *Shorea* and *Hopea*. Land to the north is under cultivation, mainly for rice. The nearby hills support semi-evergreen and deciduous forest with *Lagerstroemia calyculata* and Leguminosae such as *Azofelia xylocarpa*, *Dalbergia bariensis*, *D. cochinchinensis* and *Pterocarpus pedatus*. A high diversity of orchids (Orchidaceae) has been recorded, particularly in the wetland areas; 62 species of 28 genera have been listed, the dominant genera being:

Dendrobium (17 species)

Sarcanthus (6)

Eria (4)

Bulbophyllum (4)

Land tenure: State owned.

Conservation measures taken: The wetland and surrounding forests are protected in the Nam Cat Tien Forest Reserve (36,500 ha), established in 1978 by decision No. 360/TTg 7/7/1978 of the Council of Ministers and entrusted to the Dong Nai Provincial Forestry Department for protection. The forestry protection staffs are mainly concerned with preventing fires and illegal cutting of trees, and there is no management at the wetland. Some of the farmers living in the southeast of the reserve were relocated across the reserve boundary in 1986. In December 1987, the Dong Nai Forestry Department agreed to set aside a proportion (perhaps as much as 10%) of its profits from forest exploitation in the Province for investment at Nam Cat Tien.

Conservation measures proposed: The Ministry of Forestry has made plans for the establishment of a National Park during the 1986-1990 five-year plan. In December 1987, a National Workshop supported by UNESCO's Man and the Biosphere Programme was held at Bien Hoa in Dong Nai Province to discuss the problems involved in establishing a National Park, and to finalize the proposal for the designation of Nam Cat Tien as the first Biosphere Reserve in Vietnam. Thai Van Trung has recommended that: (a) all economic activities within the reserve be terminated; (b) the reserve staff be increased and more control posts established; and (c) the reserve be extended to the north to include the forest of Bac Cat Tien, which also has wetland areas.

Land use: Fishing and hunting; hunting, shifting agriculture and forestry in surrounding areas. A small number of Muong tribesmen live in the central valley of the reserve, but plans have been made to resettle these people outside the reserve.

Disturbances and threats: Excessive hunting and fires due to honey collection during the dry season are the only threats at the wetland. The principal threat in the reserve is human population growth and consequent increased exploitation of the forest and its wildlife for timber, food and profit. Most of the area was sprayed with chemical defoliants during the war, and since then much of the forest has been heavily exploited for timber and cleared for agricultural land. Wardening is reported to be inefficient.

Economic and social values: The reserve has considerable potential for scientific research, conservation education and tourism.

Fauna: The wetland supports a wide variety of resident and migratory waterfowl. Groups of 10-20 Lesser Adjutant Storks *Leptoptilos javanicus* have been observed, and the species is said to breed in the centre of the marsh along with various herons and egrets. *Ciconia episcopus* has also been reported in recent years. Other water birds known to occur include *Phalacrocorax niger*, *Anhinga melanogaster*, *Ixobrychus flavicollis*, *Nycticorax nycticorax*, *Ardeola bacchus* (abundant), *Butorides striatus*, *Egretta garzetta*, *E. intermedia*, *Ardea purpurea*, *Amaurornis*

phoenicurus, *Metopidius indicus* (up to 35), *Himantopus himantopus*, *Glareola maldivarum*, *Charadrius dubius*, *Tringa erythropus*, *T. nebularia*, *T. ochropus*, *T. glareola*, *Actitis hypoleucos* and *Gallinago* sp. Some migratory ducks occur during the winter months. The reserve is rich in birds of prey including several species associated with the wetlands, such as *Pandion haliaetus*, *Milvus migrans*, *Haliastur indus*, *Ichthyophaga ichthyaetus*, *Spilornis cheela* and *Microhierax caerulescens*.

The reserve is the only place in Indochina where the Southern Douc Langur *Pygathrix nemaeus nigripes* is still recorded. Other mammals known to occur in the reserve include Black Gibbon, Asian Elephant, Tiger, Leopard, Clouded Leopard, Gaur, Banteng, Indian Muntjac, Sambar and Wild Boar (*Hylobates concolor*, *Elephas maximus*, *Panthera tigris*, *P. pardus*, *Neofelis nebulosa*, *Bos gaurus*, *B. javanicus*, *Muntiacus muntjak*, *Cervus unicolor* and *Sus scrofa*). The Javan Rhinoceros *Rhinoceros sondaicus* was once seen regularly in the marshes, but has now become very rare; about five individuals were believed to be present in the reserve area in 1983, but the population was no longer thought to be viable. Reports of the presence of Kouprey *Bos sauveli* are disputed.

Crocodile Lake was formerly a breeding area for large numbers of the endangered Siamese Crocodile *Crocodylus siamensis* (thousands according to some reports), but numbers have decreased rapidly in recent years and the species is now uncommon in the reserve. Other reptiles include monitor lizards *Varanus* sp.

Special floral values: The forests within the reserve are representative of the tropical lowland mixed Dipterocarp forest ecosystem largely destroyed by chemical warfare elsewhere in southern Vietnam.

Research and facilities: Several faunal and floral surveys have been carried out. In particular, the Forest Ecology Group of the Botanical Museum in Ho Chi Minh City has carried out many investigations in the reserve since 1982. An observation platform was constructed at the marsh in 1987, and there are plans to build a museum and research station capable of accommodating twenty people.

References: IUCN (in prep); Morris (1986, 1987 & 1988a); Thai Van Trung (1985, 1986 & 1988); Truong Quang Tam (1988).

Criteria for inclusion: lb. 2a, 2b, 3b.

Source: Thai Van Trung and G.E. Morris.

Wetland name: Bien Lac

Country: Vietnam

Coordinates: 11°07'N, 107°37'E;

Location: 3 km south of Gia An Town, Tanh Linh District, western Thuan Hai Province.

Area: 2,000 ha in the wet season; 280-340 ha in the dry season.

Altitude: Between 100 and 150m.

Biogeographical Province: 4.5.1.

Wetland type: 14, 15 & 18.

Description of site: A group of several natural freshwater lakes and associated marshes surrounded by seasonally inundated grassland and forest, in the foothills of the southern highlands. The maximum depth of water varies from 0.4-0.8m in the dry season to 5.0-6.0m in the rainy season. The lakes are fed by the Lang Quan, Cau Me and Ke rivers. Large areas of grassland around the lakes are flooded during the rainy season, and are then used for fish culture.

Climatic conditions: Tropical monsoonal climate.

Principal vegetation: No information.

Land tenure: Owned by the People's Committee of Tanh Linh District.

Conservation measures taken: On 25 November 1986, the People's Committee of Thuan Hai Province decided to establish a protected area of 10,025 ha to protect Bien Lac and the surrounding forests. The Forestry Department of Thuan Hai Province is responsible for the management of the area.

Conservation measures proposed: None

Land use: Aquaculture, especially fish culture.

Disturbances and threats: Over-exploitation of fish populations and other aquatic animals could be a problem.

Economic and social values: The fisheries production is important to the local communities.

Fauna: Thirty-eight species of fishes have been found in the lake. No other information is available on the fauna.

Special floral values: No information.

Research and facilities: None

References: None

Criteria for Inclusion: lb.

Source: Le Dien Duc.

Wetland name: Mekong Delta

Country: Vietnam

Coordinates: 8°33'-10°55'N, 104°30'-106°50'E;

Location: the delta region of the Mekong River from the border with Kampuchea to the sea, including the provinces of Long An, Tien Giang, Dong Thap, Ben Tre, Cuu Long, Hau Giang, An Giang, Kien Giang, Minh Hai and Tay Ninh, Ho Chi Minh City and the southern parts of Song Be and Dong Nai provinces.

Area: Approximately 3,900,000 ha in Vietnamese territory.

Altitude: Sea level to 5m.

Biogeographical Province: 4.5.1.

Wetland type: 02, 05, 06, 07, 08, 09, 10, 11, 13, 14, 15, 18, 19 & 21.

Description of site: The Mekong River is one of the great rivers of Asia, ranking twelfth in the list of longest rivers of the world, and sixth in terms of mean annual discharge. It rises at about 5,000m in the Tanghla Shan Mountains, on the northeast rim of the great Tibetan Plateau, and flows for 4,160 km through or along the borders of six countries: China, Burma, Laos, Thailand, Kampuchea and Vietnam. The lower Mekong exhibits pronounced seasonal variations in flow, reflecting rainfall patterns. The river starts to rise shortly after the onset of the monsoon rains in late May, and attains its maximum level in September or October. It then falls rapidly until December and slowly thereafter to reach its lowest level in April and early May.

The Mekong Delta is generally regarded as beginning at Phnom Penh in Kampuchea, where the river divides into its two main distributaries, the Mekong (Tien) and the Bassac (Song Hau Giang). The Mekong (Tien) subsequently divides into six main channels and the Bassac into three to form the nine "dragons" of the outer delta in Vietnam. The delta comprises a vast triangular plain of approximately 5.5 million ha, almost entirely below 5m above sea level. It extends for about 270 km from its apex at Phnom Penh to the the coast, and has a coastline of

about 600 km. Approximately 1,600,000 ha of the inner delta lie within Kampuchea; the remaining 3,900,000 ha constitute the southern tip of Vietnam. The delta is the result of sedimentation and erosion, the sediments varying in depth from at least 500m near the river mouths to only 30m at some places in the inner delta. At the nine mouths of the Bassac and Tien branches, the combined action of river deposition and the sea has produced a coastal belt of slightly higher elevation. Deposition in the delta continues to extend the Ca Mau Peninsula south and west at a rate of 1.50m per year in some places.

A diurnal tide is dominant in the Gulf of Thailand, whilst a semi-diurnal tide is dominant in the East Sea. Generally there are two high waters and two low waters per day, but the two low waters are sometimes very different in level. The average daily tidal range varies between 3.5m and 4.5m in the East Sea and between 0.5m and 0.8m in the Gulf of Thailand. The tidal effects extend throughout the delta area in Vietnam, and about 500,000 ha of land are affected by sea water intrusion during the dry season. Salinity penetration lengths into various branches of the Mekong vary from 20 to 65 km. Because of the large inflow of fresh water from the Mekong, salinities along the eastern coast of the delta are very low, particularly during the flood season. The maximum salinity of 4.0 p.p.t. occurs at the end of the dry season, in April. Towards the end of the rainy season in September and October, the combination of floodwaters from the rivers, local rainfall and tidal inundation can result in the flooding of 3,400,000 ha in the Vietnamese portion of the delta.

The principal soil types in the Vietnamese portion of the delta are as follows:

1. Alluvium soils: these soils are found along the Tien and Hau rivers; they cover an area of 1,110,000 ha (28% of the Vietnamese portion of the delta). The alluvium soils are only slightly acidic (*pH* values of 4.5-6.5), and are suitable for the cultivation of rice.

2. Sulphate soils: these cover an area of 1,590,000 ha, mainly in the Dong Thap Muoi and Long Xuyen quadrangle (Long An). This soil type can be subdivided as follows:

- Salty sulphate: found in Ca Mau and along the shores of the Gulf of Thailand. This subtype covers an area of 1,080,236 ha (28% of the delta).
- Sulphate: found in the Dong Thap Muoi and Long Xuyen quadrangle, in low-lying areas along the Hau River and in parts of the lowlands between the Tien and Hau rivers. This covers an area of 510,027 ha (13% of the delta). These soils have very high concentrations of sulphates and low *pH* values ranging from 2.26 to 3.54.

3. Salty soils: these are found along the coast from Ganh Hao (Minh Hai Province) to Go Cong (Tien Giang Province), Can Duoc and Can Giuoc (Long An Province). They cover an area of 808,749 ha (21% of the delta).

The Vietnamese portion of the Mekong Delta can be subdivided into five main regions: (a) the floodplains of the Tien and Hau rivers; (b) the Thap Muoi closed floodplain system; (c) the Hau Tien open floodplain system; (d) the U Minh *Melaleuca* forests; and (e) the tidal floodplain.

- a) The floodplains along the banks of the Tien and Hau rivers cover an area of 1,201,861 ha (31% of the delta). The region consists of recent alluvial soils, and is the most suitable area for agriculture.

b) The Thap Muoi closed floodplain system covers an area of 414,398 ha (10.6% of the delta). Agricultural potential is very low, the limiting factors being the high concentrations of sulphates, deep and prolonged inundation during the rainy season, and insufficient fresh water during the dry season. In the higher parts of this region, one or two rice harvests can be produced each year, but this entails a considerable amount of drainage and irrigation. The most appropriate forms of land use would be retaining the wetlands in their natural state for nature conservation, management of the *Melaleuca* forests for timber production, and management for fisheries production.

c) The ha Tien open floodplain system covers an area of 217,508 ha (5.6% of the delta). The area is relatively well drained, but is not very suitable for agriculture because of the shortage of fresh water during the dry season and presence of salt and sulphates in the soil. This region should also be maintained in its natural state.

d) The U Minh *Melaleuca* forests cover an area of 189,358 ha (4.9% of the delta). The main soil types are peat and sulphate, and agricultural potential is low. Large tracts of the forest were destroyed by toxic chemicals and napalming during the war, and forest fires continue to destroy large areas; fires during the dry season in 1982-83 and in 1987 were particularly damaging. Reafforestation with *Melaleuca* should be undertaken to restore the forests and maintain fisheries production.

e) The tidal floodplain covers an area of 215,974 ha (5.5% of the delta). Large areas of land subject to tidal inundation occur along the coasts of Long An, Ben Tre, Cuu Long, Hau Giang and Minh Hai provinces. Most of intertidal zone was formerly covered in mangrove forest, but large parts of this were destroyed by toxic chemicals during the war. Almost all of the mangroves in the Dong Nai river system in the northeast were destroyed during the period 1965-1970, along with about 40% of the mangrove forests in the south of the delta. Land use should now be directed towards reafforestation with mangrove species, management of the forest resources and development of fish and shrimp culture.

Seven of the most important wetland areas for nature conservation are described in detail as sites 24a-24g. These are Dong Thap Muoi (24a), Tien River estuary (24b), Minh Hai *Melaleuca* forest (24c), Bac Lieu coastal marshes and bird colony (24d), Dam Doi bird colony (24e), Cai Nuoc bird colony (24f) and Nam Can mangrove forest (24g).

Climatic conditions: Tropical monsoonal climate with a pronounced dry season from December to March or April and a pronounced rainy season during the southwest monsoon from May to October or November. The average annual rainfall ranges from less than 1,500 mm in the central region and northwest to over 2,350 mm in the south, with some 70-80% of the precipitation concentrated into four months at the height of the rainy season. The mean annual temperature is about 26°C throughout the delta, the difference between the mean monthly minima and maxima being only about 5°C. The relative humidity remains high throughout the year.

Principal vegetation: The delta contains about 280,000 ha of mangrove and *Melaleuca* forest. The mangrove forest consists of 46 plant species, 38 of which are of some economic importance. In sequence from the sea, the forest is dominated by *Avicennia*, *Bruguiera*, *Rhizophora* and *Nypa*. The *Melaleuca* forest consists of 77 plant species, with *M. leucodendron* predominating

throughout. By 1980, 2,474,000 ha of the delta were under cultivation, mainly for rice. Some 40 plant species have been identified in the rice paddies.

Land tenure: State owned.

Conservation measures taken: At least six reserves have been established to conserve the wetland ecosystems and their wildlife. These are: the Tram Chim Sarus Crane Reserve in Dong Thap Province (9,000 ha); the Vo Doi Protected Forest in the U Minh *Melaleuca* forests in Minh Hai Province (3,945 ha); the Nam Can Mangrove Reserve in Minh Hai Province (7,547 ha); and three small reserves to protect large breeding colonies of water birds at Bac lieu (40 ha), Cai Nuoc (20 ha) and Dam Doi (119 ha) in Minh Hai Province. A considerable amount of reforestation work has been carried out in the delta; between 1975 and 1985, some 29,188 ha of mangrove forest and 20,734 ha of *Melaleuca* forest were replanted. In many areas, policies have been developed for the conservation and management of wetland resources, and considerable effort has been made in some areas to restore wetlands to their natural condition. In 1983, the Mekong Committee and UNEF sent a joint mission to the delta to formulate and initiate a programme of research and pilot development projects with a view to ensuring environmentally compatible development of water and land resources in the region. In an international agreement on cooperation in wildlife conservation signed by Vietnam and Kampuchea in January 1986, special emphasis was given to the conservation of endangered waterfowl species in the Mekong Delta.

Conservation measures proposed: As a result of three State Programmes concerning development in the Mekong Delta, numerous recommendations have been made for the rational utilization of wetlands in the delta. The Ministry of Forestry aims to enlarge the forested areas in the delta from the present level of about 290,000 ha to between 343,000 and 400,000 ha by reforestation of uncultivated lands. This would include the establishment of an almost continuous forested strip along the seacoast. McNeely (1975) proposed that a delta mangrove reserve be established to take in all coastal mangroves from the town of Bac Lieu southwest to the Nam Can mangroves around Cua Song Bay. He suggested that the seaward edge of the reserve should be inviolable, but certain parts of the reserve might be harvestable on a rotational basis, under strict control. Luthin (1987a & 1987b) has made a variety of recommendations for protection, research, management and public education at the breeding colonies of large water birds in Minh Hai Province.

Land use: Agriculture, fishing and forestry. The human population of the delta has increased rapidly during the past century, from an estimated 1.7 million in 1880 to 4.5 million in 1930 and 13.5 million in 1980. Similarly the area under cultivation has increased dramatically, although this increase has not kept pace with the increase in population. In 1867, an estimated 215,000 ha were under cultivation; this figure had increased to 522,000 ha by 1880 and 2,234,000 ha by 1930. However, between 1930 and 1980 the area of agricultural land increased by only 240,000 ha whilst the population increased by nine million.

Possible changes in land use: The Mekong Committee has considered some 230 possible development projects on the lower Mekong River and its tributaries. One of the primary objectives of this programme is to eliminate seasonal flooding in the delta areas of Kampuchea and Vietnam. Eliminating seasonal flooding would require the upstream storage of floodwaters, primarily in the proposed Pa Mong reservoir in Laos and in the proposed Stung Treng reservoir in Kampuchea, and the diking of riverbanks throughout the delta region. Full implementation of these projects would result in the loss of a large proportion of the seasonally inundated wetlands, with a profound effect on wildlife and fisheries (Mekong Committee, 1976).

Stoutjesdijk (1982) has listed seven major existing reclamation schemes in the delta involving over 920,000 ha of floodplains and tidally inundated lands. These are the Cai San Project (60,000 ha), Quan Lo-Phung Hiep Project (600,000 ha) and Tiep Nhut Project (34,000 ha) on the south bank of the Bassac, the Ba Dong Project (110,000 ha) between the Bassac and the Tien, and the South Kien-Hoa Project (30,000 ha), Ba Tn Project (37,000 ha) and Go Cong Project (50,000 ha) in the Tien estuary. Further extension of the area of agricultural land in the Vietnamese portion of the delta will prove difficult because a large proportion of the land suitable for agriculture has already been developed. The best way to increase production will be to use more intensive farming methods on existing agricultural land. Despite high investment, attempts to drain marginal land in the Dong Thap Muoi area have proved uneconomic, and some of this land has since been restored to its natural state.

Disturbances and threats: Rapid growth in the human population and intensive development of the delta lands for agricultural purposes pose a major threat to the natural wetland ecosystems and their wildlife. Various proposed developments on the lower Mekong River are likely to conflict with wildlife and fisheries interests in the delta. These include large irrigation projects, hydro-electric power projects, other industrial development and flood control projects. Dam construction upstream on the Mekong in Laos and Kampuchea will change the hydrology of the delta, reducing seasonal flow peaks and the extent of flooding. This is likely to have a disastrous effect not only on waterfowl populations but also on those fish species, which utilize the floodplain wetlands for spawning. Changes in water quality and the timing of peak flows are likely to have adverse effects on fish migrations and spawning, and dams will create obvious problems for long distance longitudinal migrants. The dams will reduce sediment flow, particularly in the main channels, and thereby affect the nutrient regime in the delta (Pantulu, 1986b).

The water quality in the lower Mekong has been affected by domestic wastes and agricultural runoff carrying pesticides and fertilizers. Though localized at present, such problems are expected to increase. Industrial activities, such as pulp and paper mills, textile mills and chemical factories, are increasing within the basin, and these, together with increased waste from shipping, are likely to create a serious pollution problem in the future (Pantulu, 1986a).

Economic and social values: The Mekong Delta includes some of the most productive agricultural land in Southeast Asia. In the 1950s, the delta produced 70% of the rice grown in southern Vietnam, along with 70% of the green peas, bananas, pineapples, vegetables, duck meat and duck eggs, 60% of the chicken and hens eggs, 50% of the pork, 37% of the fish, and significant proportions of the jute, coconut, sugar cane and fruit. The annual yield of rice in the delta as a whole currently amounts to about 6.5 million tonnes, with the average yield in the Vietnamese part of the delta at about 2.3 tonnes per hectare.

The lower Mekong River and its delta support one of the largest inland fisheries in the world. During the past decade, the Vietnamese portion of the delta has yielded an annual harvest of about 400,000 metric tonnes of fish. Approximately 156,000 tonnes of this are derived from the brackish water and estuarine zone. However, fish production has been declining in recent years as a result of over-exploitation, forest destruction, and drainage of wetlands for agriculture and the affects of toxic chemicals such as Agent Orange.

The mangrove and *Melaleuca* forests constitute an important forestry resource, potentially capable of meeting the local demand for construction materials, firewood, fodder for domestic animals and other forest products. In addition, the *Melaleuca* forests provide a valuable harvest of honey from wild bees' nests, amounting to five or six liters of honey per hectare per year.

The mangrove forests also play a very important role in coastal protection and land reclamation. Mangrove species not only retard erosion due to tidal action (of vital significance in a region prone to typhoons), but also tend to accumulate soil around their root systems, thereby accelerating accretion of new land.

Fauna: The fauna of the delta includes 23 species of mammals, 386 species and subspecies of birds, 35 species of reptiles, six species of amphibians and 260 species of fishes. Five species of dolphins have been recorded. Two of these, *Stenella malayana* and *Tursiops aduncus*, are confined to the estuarine zone, but the other three, the Irrawaddy Dolphin *Orcaella brevirostris*, Chinese White Dolphin *Sotalia chinensis* and Black Finless Porpoise *Neophocaena phocaenoides*, occur upstream into Kampuchea. Other wetland mammals known to occur include the Crab-eating Macaque *Macaca fascicularis*, Smooth-coated Otter *Lutra perspicillata* and Fishing Cat *Felis viverrina*. The Clawless Otter *Aonyx cinerea* may also occur.

The avifauna includes about 92 species of waterfowl and a variety of other species associated with wetlands, such as the raptors *Pandion haliaetus*, *Haliastur indus*, *Haliaeetus leucogaster*, *Ichthyophaga ichthyaetus* and *Circus (aeruginosus) spilonotus*, and about eight species of kingfishers (Alcedinidae). The delta is particularly important for its large populations of cormorants, herons, egrets, storks and ibises, which nest in huge colonies in the mangrove and *Melaleuca* forests. Vo Quy (1984) estimated that between 200,000 and 250,000 birds were nesting at the main colonies in the southern part of the delta in 1982. Seven large colonies are presently known, the largest being at Bac Lieu (Vinh Thanh), Dam Doi (Ngoc Hien) and Cai Nuoc (Tan Hung). A very large colony in the Minh Hai *Melaleuca* forests disappeared in the early 1980s, but two or three new colonies have recently become established in the Nam Can mangrove forests. The breeding species include three species of cormorants *Phalacrocorax* spp, *Anhinga melanogaster*, a wide variety of herons and egrets (notably *Ardea sumatrana*), seven species of storks and the ibises *Threskiornis melanocephalus* and *Plegadis falcinellus*. All seven species of storks have, however, decreased markedly in recent years. *Mycteria cinerea* and *Leptoptilos dubius* are now very rare, and no breeding sites are known. *Mycteria leucocephala* and *Anastomus oscitans* still breed in small numbers at four and three colonies, respectively, while *Ciconia episcopus*, *Ephippiorhynchus asiaticus* and *Leptoptilos javanicus* occur in ones and twos at several sites. The pelicans *Pelecanus onocrotalus* and *P. philippensis* were reported to be common in the 1960s (Wildash, 1968), but *P. onocrotalus* seems to have disappeared completely, and *P. philippensis* is now rare.

The Dong Thap Muoi wetlands are very important for the endangered eastern race of the Sarus Crane *Grus antigone sharpii*. This crane, which formerly nested in the area, disappeared during the war years but has returned in recent years as a non-breeding visitor; over 1,000 individuals were present in spring 1988. Three other endangered species of waterfowl, the White-shouldered This *Pseudibis davisoni*, Giant This *Thaumatibis gigantea* and White-winged Wood-Duck *Cairina scutulata*, still occurred in the delta in reasonable numbers in the 1960s (Wildash, 1968). However, none of the three has been reported since about 1980, although it is believed that the two ibises may still survive in very small numbers in the wetlands along the Kampuchean border. In addition to the colonial nesting water birds, there are many other resident waterfowl which remain fairly common, such as *Tachybaptus ruficollis*, *Dendrocygna javanica*, *Nettapus coromandelianus*, *Anas poecilorhyncha*, *Rallus striatus*, *Gallicrex cinerea*, *Porphyrio porphyrio*, the two jacanas (Jacanidae), and several shorebirds (e.g. *Rostratula benghalensis*, *Esacus magnirostris*, *Glareola maldivarum* and *G. lactea*). The Masked Finfoot *Heliopais personata* and Indian Skimmer *Rhynchops albicollis* are also known to occur. Common passage migrants and

winter visitors include four species of ducks (notably *Anas querquedula*), a large number of migratory shorebirds, and several species of terns. Fischer (1983) gives some information on the migratory shorebirds. He observed large numbers of shorebirds of over 20 species in the eastern part of the delta in autumn 1980. The most abundant species were *Himantopus himantopus*, *Charadrius dubius*, *C. leschenaultii*, *Tringa nebularia*, *T. ochropus*, *T. glareola*, *Actitis hypoleucos*, *Xenus cinereus*, *Gallinago stenura*, *G. gallinago*, *Calidris ruficollis*, *C. subminuta* and *C. teminckii*. A flock of 22 Asian Dowitchers *Limnodromus semipalmatus* in Minh Hai Province was particularly noteworthy.

Reptiles include the monitor lizard *Varanus salvator*, the python *Python reticulatus*, four species of water snake *Enhydryis* spp, the endangered River Terrapin *Batagur baska* and the Estuarine Crocodile *Crocodylus porosus*.

In the brackish water and coastal zone, the fish fauna is dominated by Clupeidae, Scombridae, Sciaenidae, Tachysauridae, Polynemidae, Tachysuridae and Cynoglossidae. Most of the species are diadromous and some, particularly species of Polynemidae and Tachysuridae, seasonally ascend the rivers to spawn in the gradient or freshwater zone of the estuaries. In the freshwater zone, the fishes are dominated by species of Cyprinidae, Siluridae, Clariidae, Schilbeidae, Bagridae, Sisoridae, Akysidae, Chanidae and Ophicephalidae. Over 200 species of fishes contribute to the commercial fishery, along with many shellfish, mussels and clams (Mollusca), and prawns and shrimps, notably *Macrobrachium rosenbergii* and *Penaeus monodon* (Pantulu, 1986b).

Special floral values: The delta still contains some tracts of mangrove and *Melaleuca* forest in relatively good condition.

Research and facilities: Many Vietnamese and overseas research institutions have conducted and are conducting scientific research in the Mekong Delta, and a considerable amount of information is now available, particularly on the mangrove forests, fishery resources and agricultural potential. The Committee for Coordination of Investigations of the Lower Mekong Basin (the Mekong Committee) has undertaken many studies during the past twenty years aimed at full development of the Mekong Delta. One of the major studies, concerning the development of marshes and tidal lands, was carried out by the Netherlands Delta Team between 1970 and 1974 (Mekong Committee, 1977). Other studies sponsored by the Mekong Committee have concerned the fisheries (Mekong Committee, 1976). During the period 1983-85, State Programmes 02-11 and 60-02 considered zoning and planning issues in the delta with a view to sustainable exploitation of the natural resources. These programmes incorporated studies of natural factors such as climate, hydrology and geomorphology as well as socio-economic surveys. During the period 1982-85, State Programme 52-02 supported a considerable amount of research on the mangrove and *Melaleuca* forests, including research on the breeding colonies of water birds.

References: Fischer (1983); Hoang Thi San & Phan Nguyen Hong (1984); Karpowicz (1985); Le Dien Duc (1984, 1987a & 1987b); Le Dien Duc & Le Dinh Thuy (1987); Le Dien Duc *et al.* (1986); Luthin (1987a, 1987b & 1988), Ly Tho (1985); McNeely (1975); Mekong Committee (1970, 1976, 1977, 1978, 1981, 1982 & 1985); Morris (1986 & 1988b); Nguyen Hoang Tn (1984a & 1984b); Pantulu (1986a & 1986b); Phan Nguyen Hong (1984a, 1984b, 1984c & 1984d); Phung Trung Ngan (1987); Stoutjesdijk (1982); Vo An ha & Nguyen Dinh Dien (1985); Vo Quy (1984); Vo Quy & Le Dien Duc (1984); Vo Quy & Phan Nguyen Hong (1984); Vo Quy *et al.* (1984); Vu Trung Tang *et al.* (1981); Wildash (1968).

Criteria for inclusion: 123.

Source: Le Dien Duc and references.

Wetland name: Dong Thap Muoi

Country: Vietnam

Coordinates: 10°35'-11°00'N, 105°20'-106°00'E;

Location: between Cao Lanh Provincial Town and the Kampuchean border, in Tam Nong, Thanh Binh and Hong Ngu Districts, Dong Thap and Long An Provinces.

Area: 300,000 ha.

Altitude: 0.5-1.5m.

Biogeographical Province: 4.5.1.

Wetland type: 15, 18, 19 & 21.

Description of site: A large area of seasonally flooded alluvial plains on the north bank of the Mekong (Tien) River near the Kampuchean border, with patches of *Melaleuca* forest, some permanent ponds and marshes, and areas of rice paddy. Most of the wetland is flooded only during the rainy season and dries out completely during the dry season. The floodwaters are fresh but sometimes become affected by sulphates from the soil, especially in April, May and June. Flooding commences at the beginning of July; from then until the end of January, large areas are flooded to a depth of 2m. Peak flooding occurs between late September and the end of October, when some areas are flooded to a depth of 3.38m.

A major effort was made to drain the wetland during the war. Drainage ditches were dug through the marsh and the *Melaleuca* forests were destroyed with toxic chemicals and napalm. Drainage activities continued after the war in an attempt to reclaim the land for agricultural purposes. A complicated system of canals has now been constructed, and some areas have been converted into rice paddies and other agricultural land. However, despite the high investment of manpower and financial resources, rice production has been low because of the problem of sulphate soils. As drainage has proceeded, acid sulphates in the soil have risen to the surface, and pH levels have fallen to as low as 2.8 in some places. Attempts to reclaim those parts of the marsh with high sulphate content have now been abandoned, and some previously drained areas have been restored to their natural condition.

Climatic conditions: Tropical monsoonal climate, with a rainy season from the end of April to November and a dry season from December to early April. The annual rainfall varies from 1,200 mm to 2,400 mm, about 90% of the precipitation occurring during the rainy season. The mean monthly temperature varies from 25°C to 28°C. Evaporation is 1,500-2,000 mm per year.

Principal vegetation: The swamp and grassland vegetation is dominated by species such as *Leptochloa chinensis*, *Echinochloa crusgalli*, *Marsilea minuta*, *Cyperus elatus*, *C. polystachys*, *Eriochloa procera*, *Eleocharis dulcis*, *Sacciolepis myuros*, *Nelumbium nelumbo* and *Nymphaea* sp. Most of the original *Melaleuca* forests were destroyed during the war or subsequently cleared for timber and agricultural land. In recent years, however, large areas with sulphate soils unsuitable for agriculture have been replanted with *Melaleuca*. Wild rice *Oryza sativa* grows naturally in the marsh, and provided an important source of food for the local people during the war. The principal tree species on the dikes are *Lagerstroemia speciosa*, *Ficus microcarpa*, *Eleocharis* sp and *Morinda persicacfolia*. Small patches of natural forest on higher ground are dominated by species of Dipterocarpaceae.

Land tenure: Under provincial ownership.

Conservation measures taken: A scientific committee has recently been set up to help the local authorities develop policies for the sustainable exploitation of the natural wetland resources. In many parts of Dong Thap Muoi, drainage plans have been abandoned in favour of restoration of the wetland ecosystem and rational utilization of the natural resources. Dikes have been constructed to maintain water levels and increase pH levels, and some 30,000 ha have been replanted with *Melaleuca*. Several wetland reserves have been established, notably the Tram Chim Sarus Crane Reserve in Tam Nong District. This reserve was established by Dong Thap Province in 1986; its initial area of 5,000 ha was increased to 9,000 ha in 1987. Construction works have been carried out at the reserve with the objectives of restoring the ecosystem to attract various bird species, promoting scientific research, and encouraging tourists to visit the area.

Conservation measures proposed: Further work proposed at the Tram Chim Reserve includes strengthening the dikes surrounding the reserve, installing water control structures, establishing a visitor centre and guest house, and improving conservation awareness amongst the local people.

Land use: Large areas are used for the cultivation of a floating strain of rice which can be grown even during the rainy season. Areas with a high sulphate content in the soil are used for forestry (*Melaleuca*), fishing and duck rearing. Reclaimed land is used for the cultivation of rice, sugar cane, jute, fruits, groundnuts and vegetables.

Disturbances and threats: The main threats to the region are encroachment by local people for settlement and agriculture, and over-exploitation of the wildlife resources such as fish, shrimp, small mammals, birds, snakes and turtles. Hunters use poisoned bait to catch herons and egrets for food, and other large water birds such as *Leptotilos javanicus*, *Mycteria leucocephala* and *Grus antigone* are occasionally killed. Wintering ducks are caught in nets and sold in the local markets.

Economic and social values: Dong Thap Muoi contains the largest area of floating rice in the Mekong Delta. The wetland supports a major fishery, and is capable of providing a valuable forestry resource. The wetland serves as an important natural flood basin, storing water during the rainy season and reducing flooding in the more densely populated areas of the lower delta. Because of its impressive wildlife including several rare species, the area has considerable potential for scientific research, environmental education and nature-oriented tourism.

Fauna: Dong Thap Muoi is one of the most important areas in the Mekong Delta for both resident and migratory waterfowl, and is much the most important area for the endangered eastern race of the Sarus Crane *Grus antigone sharpii* hitherto known. The crane was a common breeding bird in the area some 30-40 years ago, but disappeared completely during the war years and has only recently returned as a non-breeding visitor during the dry season. Groups of 10-20 birds were observed by Vietnamese biologists in early 1985. Since then, the population has increased rapidly and each year the birds have stayed longer in the area. An estimated 400-500 cranes were present in January 1988, and over 1,000 were recorded in April 1988. Some cranes are now present all year except in September and October, when the land is deeply flooded.

The largest concentrations of waterfowl occur during the winter months, as water levels are falling. A concentration of 20,000-30,000 ducks, mainly *Anas querquedula* with some *A. acuta* and *A. penelope*, was observed in December 1987. Other common species include *Phalacrocorax niger*, *Ardeola bacchus*, several species of *Egretta*, *Ardea purpurea*, *A. cinerea*, *Anas poecilorhyncha*, *Metopidius indicus*, *Himantopus himantopus*, *Glareola maldivarum*, *Pluvialis dominica*, *Numenius arquata*, *Tringa totanus*, *T. nebularia*, *T. stagnatilis* and *T. glareola*. The storks *Mycteria leucocephala*, *Ephippiorhynchus asiaticus* and *Leptotilos*

javanicus and the ibis *Threskiornis melanocephalus* are regular visitors in small numbers. It is possible that the endangered White-shouldered This *Pseudibis davisoni* and Giant This *Thaumatibis gigantea* still exist in the area, although none has been seen in recent years. The harriers *Circus (aeruginosus) spilonotus* and *C. melanoleucos* are common winter visitors.

Mammals include an otter *Lutra* sp. The rich reptilian fauna includes a wide variety of snakes and turtles. The dominant fishes are species of *Ophiocephalus*, *Clarias* and *Anabas*.

Special floral values: One of the common marsh plants, *Eleocharis dulcis*, is the principal food of the Sarus Cranes.

Research and facilities: Preliminary faunal and floral surveys have been carried out, and a detailed study of the Sarus Crane population was initiated in 1988.

References: Karpowicz (1985); Le Dien Duc (1984, 1987a & 1987b); Morris (1988b); Vo Quy (1984); Vo Quy & Le Dien Duc (1984).

Criteria for inclusion: 123.

Source: Le Dien Duc and Derek A. Scott.

Wetland name: Tien River Estuary

Country: Vietnam

Coordinates: 9°45'-10°20'N, 106°02'-106°48'E;

Location: 50-120 km south of Ho Chi Minh City, Ben Tre Province.

Area: c.25,000 ha.

Altitude: 0-1.5m.

Biogeographical Province: 4.5.1.

Wetland type: 02, 06, 07, 10, 11 & 19.

Description of site: The estuarine system of the Tien River, the northernmost of the two main distributaries of the Mekong River. The Tien River has six distributaries, which enter the sea along the coast of Ben Tre Province, in the northeastern part of the delta. There are extensive intertidal mudflats and some 16,500 ha of mangrove forest at the river mouths, and cultivated plains with a complicated system of canals inland. In recent years, large areas of mangrove forest have been cleared for shrimp and fish ponds. Salinities range from 0.5-30.0 p.p.t.; the tidal amplitude varies from 1.5m at neap tides to 4.0m at spring tides.

Climatic conditions: Tropical monsoonal climate with a pronounced dry season from December to April and a rainy season during the southwest monsoon from May to November. The average annual rainfall is 1,495 mm (maximum 2,285 mm, minimum 955 mm), 85% of the precipitation occurring between May and November. The mean annual temperature is 26.0-27.9°C (mean maximum 32.7°C, mean minimum 23.1°C); the highest temperatures occur in April (34.7°C), and the lowest in January (20.8°C). The mean annual relative humidity is 79.4% (maximum 82.5% in August, minimum 74.1% in April); the mean annual evaporation is 1,159 mm.

Principal vegetation: Mangrove forest dominated by species of *Avicennia*, *Phoenix*, *Acanthus*, *Nypa fruticans* and *Hibiscus* sp. The mangrove forests are now much degraded as a result of over-exploitation for firewood and clearance for aquaculture. The phytoplankton includes 278 species of Bacillariophyta, Pyrrophyta and Cyanophyta. The dominant genera are:

Melosira (9 species)

Thalassiosira (5)

Cyclotella (6)

Coscinodiscus (20)

Rhizosolenia (20)
Bacteriastrum (8)
Chaetoceros (38)
Bidduiphia (14)
Thalassionema (4)
Achnanthes (4)
Navicula (13)
Pleurosigma (4)
Nitzschia (18)
Peridinium (23)
Ceratium (28)

Densities of 114,000 to 3,100,000 individuals per cubic meter have been recorded.

Land tenure: Under cooperative ownership.

Conservation measures taken: None.

Conservation measures proposed: None

Land use: Fishing, aquaculture and outdoor recreation. Aquaculture is very intensive; in 1980 there were 1,800 ha of shrimp and fishponds, and this area had been increased to 3,550 ha by the following year. The adjacent plains are under cultivation for rice, sugar cane and coconuts.

Disturbances and threats: The major threat is the clearance of mangrove forest for aquaculture ponds. The loss of mangrove forest is having an adverse effect not only on waterfowl populations but also on the natural estuarine and inshore fisheries.

Economic and social values: The mangrove forests provide breeding and nursery grounds for many commercially important species of fishes and crustaceans. The estuary supports a major fishery, yielding about 5,500 metric tonnes of fishes and 1,300 metric tonnes of shrimps per year. The region is also a popular recreation area for the people of Ben Tre Province.

Fauna: Thirty-six species have been recorded in the zooplankton, including Rotatoria (1), Cladocera (2), Copepoda (26), Chaetognatha (2), Tunicata (2), Pteropoda (1), Decapoda larvae (1) and Stomapoda larvae (1). The zoobenthos includes 13 families of arthropods and eight families of molluscs. Many species of brackish water shrimp, such as *Penaeus indicus*, *P. monodon*, *P. merguensis*, *Metapenaeopsis barbata* and *Metapenaeus monoceros*, occur along with several species of crabs of the genus *Scylla*. The fish fauna includes Lamniformes (1), Rujiiiformes (3), Torpediniformes (1), Clupeiformes (15), Scopheliformes (2), Anguilliformes (4), Cypriniformes (2), Betoniformes (1), Gadiformes (1), Syngnathiformes (1), Mugilliformes (3), Polynemiformes (3), Pereiformes (54), Pleuronectiformes (7) and Tetrodontiformes (4). Most of the fishes are marine and brackish water species; freshwater species which sometimes occur include *Protus anguileuctatus*, *Leioeassis siamensis*, *Siluriliethys phaiosoma*, *Kryptopterus kryptopterus*, *Clarias macrocephalus*, *C. batrachus* and *Trichogaster trichopterus*. The intertidal mudflats and mangrove swamps are known to be very important for a wide variety of waterfowl, particularly migratory shorebirds, but no details are available.

Special floral values: No information.

Research and facilities: Some research has been carried out on the planktonic fauna and flora and the fishery resources.

References: Vu Trung Tang *et al.* (1981).

Criteria for inclusion: 1b, 1e, 2c, 3b.

Source: Le Dien Duc.

Wetland name: Minh Hal *Melaleuca* Forest

Country: Vietnam

Coordinates: 9°08'-9°30'N, 104°51'-105°18'E;

Location: north and west of Ca Mau Provincial Town, Minh Hai Province.

Area: 163,000 ha.

Altitude: 0.4-1.0m.

Biogeographical Province: 4.5.1.

Wetland type: 15, 19 & 21.

Description of site: A large area of seasonally flooded *Melaleuca* swamp forest in western Minh Hai Province near the shores of the Gulf of Thailand. There are some open swampy areas on the fringes of the forest, e.g. at Ngoc Hoang, and some areas of rice paddies. The forest floods during the rainy season and dries out in the dry season; the maximum depth of water varies from 0.5 to 1.0m. The water is fresh with a pH of 4.5-5.0. Most of the area is covered in a layer of peat 2-3m deep, and the soils have a high acid sulphate content; in the Vo Doi Protected Forest (3,945 ha), there are 3,370 ha of peat soils (83.9%) and 572 ha of clay soils (14%).

In the past, this region was famous for its dense *Melaleuca* forests. However, during the war years the region suffered serious damage from bombing and the extensive use of napalm and toxic chemicals, and since then, large areas have been cleared for timber and agricultural land or destroyed by forest fires. Only some 63,000 ha of forest remain, and much of this, such as the U Minh Thuong forest, is in very poor condition. The U Minh ha forest, which includes the Vo Doi Protected Forest, is in better condition, with trees approximately 4-5m tall and 0.2-0.25m in diameter. Some reforestation has taken place in recent years.

Climatic conditions: Tropical monsoonal climate with a pronounced dry season from November to April and a rainy season during the southwest monsoon from May to October. The average annual rainfall is 2,350 mm (minimum 1,940 mm, maximum 2,810 mm), and the mean annual temperature 26.5°C (mean monthly minimum 24.0°C). The mean relative humidity is 85.6%, and the mean annual evaporation 1,005 mm.

Principal vegetation: *Melaleuca leucodendron* is the dominant tree species throughout the area; the creeper *Stenochlaena palustris* is abundant in the understorey. In the slightly higher areas, *Aistonia spatulata* is the most common species. Swampy areas support dense growths of aquatic grasses, reeds and *Nymphaea* sp. About 40 species of aquatic plants including seven species of *Cyperus* have been recorded in the Vo Doi Protected Forest.

Land tenure: State owned (Minh Hai Province). The Vo Doi Protected Forest is owned by the People's Committee of Minh Hai Province.

Conservation measures taken: In 1975, the provincial authorities initiated a programme to restore the *Melaleuca* forests to their natural condition. Some 5,000 ha of the forest have already been replanted by the Song Trem Forest Station, although this has been complicated by the persistent toxic effects of defoliant herbicides used during the war. A complicated system of canals and dikes has been constructed within the forest to facilitate the manipulation of water levels and to prevent forest fires during the dry season. Observation towers ten metres in height have been constructed to provide an early warning system against fires. In 1985, the National Government established a protected area of 3,945 ha in the U Minh ha forest. This reserve, the Vo Doi Protected Forest, is situated in Tran Van Thoi District, 30 km west of Ca Mau and 12 km from the Gulf of Thailand (9°08'-9°22'N, 104°51'-105°00'E). A management committee has been

set up, and 20 foresters have been employed to protect the reserve. Former rice-growing areas within the protected area have been replanted with *Melaleuca*.

Conservation measures proposed: A management plan for the rational utilization of the forest resources is being developed by the local authorities. There are plans to build a Centre for *Melaleuca* Forest Studies in the Vo Doi Protected Forest.

Land use: Fishing and harvesting of forest products such as timber, firewood and honey. The leaves of *Melaleuca* are processed to produce essential oils for export, and the creeper *Stenochlaena palustris* is used as string. The *Melaleuca* forests grow on sulphate soils generally unsuitable for agriculture, and only a small part of the area is under permanent cultivation. Approximately 1,380 people were living in and around the Vo Doi Protected Forest in 1985. Most of these were dependent on agriculture, mainly the cultivation of rice and bananas.

Possible changes in land use: It has recently been suggested that the peat resources (estimated at about 60 million tonnes) should be exploited on a commercial basis. This suggestion has already met with considerable opposition because of the profound effects that large-scale exploitation of the peat would have on the water regime and the forestry, wildlife and fishery resources of the region.

Disturbances and threats: The most serious threat to the *Melaleuca* forest is fire. This can be particularly damaging when the underlying peat begins to burn. The frequency of forest fires has increased considerably in recent years, and in some cases, hundreds of hectares of forest have been lost. In most cases, the fires are caused by human activities such as rat-catching and honey-gathering. The other main threats to the forest are over-exploitation of the timber resources, forest clearance for human settlement and agriculture (particularly bananas), and peat extraction.

Economic and social values: The *Melaleuca* forest is very important for the local communities; it provides a valuable source of fuel wood and timber as well as a variety of other forest products. The forest produces a large amount of leaf litter which constitutes the first link in the food chain of many aquatic animals and supports a significant fishery. Fish production in the canal system of U Minh Thuong is estimated at about 50 metric tonnes per year. The forest yields a rich harvest of wild honey; as many as 260 people in four small villages in U Minh Thuong earn their living from honey. The peat is a valuable source of fuel and fertilizer. The forests create an attractive landscape and have some potential for nature-oriented tourism.

Fauna: The *Melaleuca* forests of the Mekong Delta were formerly very rich in wildlife, supporting a great diversity of mammals, birds, reptiles and amphibians, and providing nesting sites for huge numbers of large water birds. The wildlife was drastically depleted during the war and as a result of subsequent forest clearance and forest fires. Increased protection and restoration measures in recent years have, however, led to a partial recovery in some species, particularly water birds. A recent survey of the Vo Doi Protected Forest recorded 23 species of mammals, 91 species of birds, 36 species of reptiles and 11 species of amphibians.

The mammalian fauna formerly included Tiger *Panthera tigris*, but this is now extinct in the area. Mammals still present include *Cervus unicolor*, *Muntiacus muntjak*, *Sus scrofa*, *Felis chaus*, *F. temminckii*, *F. viverrina*, *Viverra zibetha*, *Lutra perspicillata*, *Macaca mulatta*, *Tupaia glis*, *Manis javanica* and *Caluosciurus pygerythrus*. However, the populations are small because of frequent forest fires and poaching. Clumps of *Aistonia spatulata* on high ground provide roosting sites for thousands of fruit bats *Cynopterus brachyotis* and *Megaerops ecaudatus*.

The bird fauna includes many wetland birds such as herons, egrets, storks, ibises, ducks, rails and shorebirds, along with a wide variety of typical lowland forest birds. In the past, the forests

supported the largest breeding colonies of water birds in the delta; in 1978, the main colony at Khanh Lam (U Minh Forest) contained *Phalacrocorax niger*, *Anhinga melanogaster*, *Egretta garzetta*, *E. alba*, *Ardea purpurea*, *Mycteria leucocephala*, *Ciconia episcopus*, *Ephippiorhynchus asiaticus*, *Leptoptilos javanicus*, *L. dubius*, *Threskiornis melanocephalus* and *Plegadis falcinellus*. The region also supported populations of the endangered Milky Stork *Mycteria cinerea*, White-shouldered This *Pseudibis davisoni* and Giant This *Thaumatibis gigantea*. However, several large forest fires and the recent expansion of agricultural areas have destroyed much of the nesting habitat and the large colonies of water birds have disappeared. Some herons, egrets and storks still nest in the area, but *L. dubius*, *P. davisoni* and *T. gigantea* may now be extinct in the southern delta, and *M. cinerea* has become very rare. Waterfowl recorded during recent surveys include *Phalacrocorax carbo*, *P. fuscicollis*, *P. niger*, *Anhinga melanogaster*, *Ixobrychus sinensis*, *I. cinnamomeus*, *I. flavicollis*, *Nycticorax nycticorax*, *Ardeola bacchus*, *A. speciosa*, *Egretta garzetta*, *E. intermedia*, *E. alba*, *Ardea purpurea*, *A. cinerea*, *A. sumatrana*, *Mycteria leucocephala*, *Anastomus oscitans*, *Ciconia episcopus*, *Ephippiorhynchus asiaticus*, *Leptoptilos javanicus*, *Threskiornis melanocephalus*, *Dendrocygna javanica*, *Nettapus coromandelianus*, *Rallus striatus*, *Rallina fasciata*, *Gallinago cinerea*, *Porphyrio porphyrio*, *Rostratula benghalensis* and *Glareola maldivarum*. Wintering ducks and shorebirds include *Anas crecca*, *Himantopus himantopus*, *Tringa glareola*, *Actitis hypoleucos* and *Gallinago gallinago*. The area remains rich in birds of prey such as *Elanus caeruleus*, *Milvus migrans*, *Haliastur indus*, *Circus (aeruginosus) spilonotus* and *C. melanoleucos*, and supports five species of kingfishers, *Ceryle rudis*, *Alcedo atthis*, *Pelargopsis capensis*, *Halcyon pileata* and *H. chioris*. Reptiles include *Python molurus*, *Oligodon cychirus*, *Oryzophis prasinus*, *Ptyas korros*, *P. mucosus*, *Trimeresurus allolabris*, *Bulgarus fasciatus*, *Naja naja*, *Calotes versicolor*, *Gekko gekko*, *Mabouya multifasciata* and *Varanus salvator*. Amphibians include *Ichthyophis glutinosus*, *Kaloula pulchra*, *Bufo melanostictus*, *Oedozya limma*, *Rana limnocharis*, *R. macrodactyla* and *R. rugulosa*.

The most abundant fishes are *Ophiocephalus striatus*, *Anabas testudineus*, *Fluta alba* and *Clarias macrocephalus*. The freshwater shrimp *Macrobrachium rosenbergii* also occurs in the area.

Special floral values: The region supports the most extensive stands of *Melaleuca* forest remaining in Vietnam.

Research and facilities: Preliminary faunal and floral surveys have been carried out in the area.

References: Karpowicz (1985); Le Dien Due (1984); Ly Tho (1985); Phung Trung Ngan (1987); Vo Quy (1984); Vo Quy & Le Dien Due (1984).

Criteria for inclusion: 123.

Source: Le Dien Due and Derek A. Scott.

Wetland name: Bac Lieu Coastal Marshes and Bird Colony

Country: Vietnam

Coordinates: 9°00'N, 105°25'E to 9°19'N, 106°01'E;

Location: along 75 km of coast east and west of Bac Lieu, Minh Hai Province. The bird colony (9°15'N, 105°43'E) is 8 km south of Bac Lieu Town and 3 km from the coast.

Area: Coastal marshes c.22,500 ha; bird colony 40 ha.

Altitude: 0-2m.

Biogeographical Province: 4.5.1.

Wetland type: 06, 07, 08, 09, 10 & 19.

Description of site: A 75 km stretch of coastal mudflats with a narrow fringe of *Rhizophora* mangroves backed by a broad belt of saltpans and aquaculture ponds, along the southeast coast of the Mekong Delta; also a small patch of mangrove forest with a large breeding colony of water birds near Bac Lieu Town. In the region of Bac Lieu, the coastal wetlands consist of a zone of mudflats up to 2 km wide at low tide, a fringe of mangroves 100-200m wide, and a large expanse of saltpans two km wide and 1.5 km in length. Many of the saltpans have been abandoned and are now overgrown with salt marsh vegetation. The small patch of mangrove forest at Vinh Thanh near Bac Lieu Town is a remnant of a once extensive forest formed about 40 to 50 years ago, but severely damaged by toxic chemicals during the war and subsequently cleared for agricultural land and aquaculture ponds. The remaining stand of 18 ha has been protected and managed by the local people since 1960. The forest floods to a maximum depth of one metre during the rainy season and dries out completely during the dry season. The soil has a high sulphate content and is therefore unsuitable for agriculture.

Climatic conditions: Tropical monsoonal climate with a pronounced dry season from December to April and a rainy season during the southwest monsoon from May to November. The average annual rainfall is 2,360 mm (minimum 1,940 mm, maximum 2,818 mm), the mean annual temperature is 25.5°C (minimum 15.3°C, maximum 30.3°C), and the mean relative humidity is 85.6%.

Principal vegetation: The coastal mangrove fringe is dominated by species of *Rhizophora*. The dominant tree species at the bird colony are *Lumnitzera racemosa*, *Hibiscus tiliaceus*, *Phoenix paludosa* and *Excoecaria agallocha*; other species include *Thespesia populnea* and *Avicennia alba*. The undergrowth is sparse and characterized by small shrubs of *Lantana camara*, *Ardisia* spp, *Capsicum* spp and *Acrostichum aureum*. Some replanting has taken place, particularly with *P. paludosa*, a thorny species much favoured by the birds for nesting sites. The surrounding grassland is dominated by *Eleocharis spiralis*, *Paspalum vaginatum*, *Fimbristylis littoralis*, *Hygrophila erecta* and *Pluchea indica*. Adjacent areas are under cultivation, especially for rice and coconuts.

Land tenure: State owned; the bird colony is owned by the People's Committee of Bac Lieu Town and Dong Hai State Farm.

Conservation measures taken: The local authorities are carrying out a programme of reforestation with mangrove species along the coastal fringe. The bird colony has been protected unofficially since about 1975. A National Sanctuary of 19 ha was established in 1985, and this has since been increased in size to 40 ha. Some management has been carried out, including replanting with mangrove species, the digging of a moat around the site to prevent poaching, and the construction of a small visitor centre.

Conservation measures proposed: Proposals for the future management and development of the reserve include excavating permanent ponds and creating other marshy habitats to increase species diversity, planting more trees suitable for nesting birds, building observation towers, producing posters of the colony and its birds for educational purposes, training wardens, undertaking research on the ecology of the breeding birds, and developing tourism in the area. The Brehm Fund in the Federal Republic of Germany is assisting in this programme.

Land use: Fishing, aquaculture and production of salt in the coastal marshes; cultivation of rice, coconuts and other crops in surrounding areas. The bird colony is managed exclusively for nature conservation.

Disturbances and threats: The principal threat at the bird colony is poaching. Wardening of the reserve is not very effective, and some eggs and young birds are taken illegally for food and for sale in local markets. Insecticides are widely used on the adjacent rice fields where many of the birds feed. The major threat in the coastal marshes is the continuing destruction of mangrove forest for saltpans and aquaculture ponds.

Economic and social values: The bird colony is of great educational and recreational value because of its proximity to the large town of Bac Lieu.

Fauna: The Bac Lieu mangrove forest is a very important breeding and roosting site for a wide variety of large water birds. In 1979, the total breeding population was estimated at 70,000 birds. The population declined somewhat in the early 1980s, but seems to be recovering again under improved protection. The main breeding season is in the rainy season, from June to August, and most birds move out of the area during the dry season. The breeding species are *Phalacrocorax carbo*, *P. fuscicollis*, *P. niger*, *Anhinga melanogaster*, *Ixobrychus cinnamomeus*, *I. flavicollis*, *Nycticorax nycticorax*, *Ardeola speciosa*, *Bubulcus ibis*, *Butorides striatus*, *Egretta garzetta*, *E. intermedia*, *E. alba*, *Ardea purpurea*, *A. cinerea*, *A. sumatrana*, *Mycteria leucocephala*, *Threskiornis melanocephalus* and *Plegadis falcinellus*. The most abundant species are *P. niger*, *N. nycticorax*, *E. garzetta*, *E. alba*, *T. melanocephalus* (800-1,000 individuals) and *P. falcinellus* (1,200-1,500 individuals). A few Milky Storks *Mycteria cinerea* occasionally visit the colony but no longer breed there. At the height of the dry season in March 1988, about 5,000 birds of nine species were using the colony as a roosting site; these were mostly:

P. niger (1,000)

N. nycticorax (100)

A. speciosa (300)

E. garzetta (3,000)

E. alba (300)

The coastal mudflats and saltpans are of considerable importance not only as feeding areas for herons and egrets from the bird colony, but also as staging and wintering areas for migratory shorebirds and terns. Migratory waterfowl observed in the saltpans near Bac Lieu in mid-March 1988 included several hundred shorebirds of 12 species, 200 *Chlidonias hybrida*, 30 *Gelochelidon nilotica* and 12 *Hydroprogne caspia*.

Special floral values: No information.

Research and facilities: Some preliminary surveys and censuses have been carried out at the bird colony.

References: Le Dien Duc (1984); Le Dien Duc & Le Dinh Thuy (1987); Phung Trung Ngan (1987); Vo An ha & Nguyen Dinh Dien (1985); Vo Quy (1984); Vo Quy & Le Dien Duc (1984).

Criteria for inclusion: 1b, 2c, 3a.

Source: Le Dien Duc and Derek A. Scott.

Wetland name: Dam Doi (Ngoc Hien) Bird Colony

Country: Vietnam

Coordinates: 8°56'N, 105°13'E;

Location: near the southern tip of the Mekong Delta, 5 km SSE of Dam Doi District Town and 70 km southwest of Bac Lieu, Dam Doi District, Minh Hai Province.

Area: 119 ha.

Altitude: 0.5m.

Biogeographical Province: 4.5.1.

Wetland type: 07.

Description of site: A small patch of mangrove forest with trees at least three metres in height, bounded to the northwest by the Dam Doi River and some 17 km from the coast of the East Sea. The Bay Hap canal and many small streams flow through the area. The forest is subject to tidal inundation, with flooding to a depth of one meter. The salinity is 20 p.p.t. The mangrove forest was formed in 1960; although it was sprayed with toxic chemicals during the war, the damage was not very serious and the forest remains in good condition. The site was colonized by nesting water birds in 1964, and now holds the largest breeding colony of water birds in southern Vietnam.

Climatic conditions: Tropical monsoonal climate with a pronounced dry season from December to April and a rainy season during the southwest monsoon from May to November. The average annual rainfall is 2,360 mm (minimum 1,940 mm, maximum 2,818 mm), the mean annual temperature is 25.5°C (minimum 15.3 °C, maximum 30.3°C), and the mean relative humidity is 85.6%.

Principal vegetation: Mangrove forest dominated by species of *Avicennia* (50%), *Bruguiera* (33%) and *Rhizophora* (7%). The forest presents a three-storeyed appearance with a well-developed upper stratum at 15-20m dominated by *Avicennia alba* and *A. officinalis*. Other species include *Rhizophora apiculata* and *Bruguiera parviflora*. The middle stratum with trees 8-10m in height consists of *Excoecaria agallocha*, *Ceriops tagal*, *Phoenix paludosa* and *Nypa fruticans*. The ground flora includes *Acrostichum aureum* with *Acanthus ebracteatus*. Lianas are abundant in exposed sites and include *Derris trifoliata* and *Flagellaria indica*.

Land tenure: The site is owned by the Forest Department of Dam Doi District; surrounding areas are owned by the District Department of Agriculture and agricultural cooperatives.

Conservation measures taken: The site was declared a protected area by the National Government in 1985. Seven guards have been appointed to protect the bird colony, but the level of protection is poor.

Conservation measures proposed: Protection measures should be enforced and some management carried out to improve the site for breeding water birds. The canals leading into the bird colony should be fenced off to prevent access by poachers, and guard posts should be built at critical points around the perimeter of the colony. A programme of environmental education for the general public should be initiated to improve local attitudes to the nesting birds. The Working Group on Wetlands and Water birds plans to organize a short training course on water birds and wetland management for the reserve staff.

Land use: Nature conservation.

Disturbances and threats: There is a considerable amount of illegal harvesting of eggs and young birds for food and for sale in local markets. This heavy exploitation is thought to have been responsible for the recent decline in numbers of birds.

Economic and social values: The large bird colony is thought to be beneficial to agriculture in surrounding areas, because many of the birds feed on insects and other pests in rice fields. The birds' excrement supports the production of algae and zooplankton, which provide a food source for shrimps and fishes in the wetlands around the colony. The spectacular concentrations of birds attract many visitors and could be promoted as a major tourist attraction.

Fauna: The Dam Doi sanctuary holds the largest breeding colony of water birds in southern Vietnam. An estimated 100,000 individuals were present at the height of the breeding season in June, July and August in the late 1970s, but numbers have declined markedly in recent years,

apparently because of illegal exploitation of eggs and young birds for food. The main breeding species are *Phalacrocorax carbo*, *P. niger*, *P. fuscicollis*, *Anhinga melanogaster* (6-10 individuals), *Ixobrychus sinensis*, *I. cinnamomeus*, *I. flavicollis*, *Nycticorax nycticorax*, *Ardeola speciosa*, *Bubulcus ibis*, *Egretta garzetta*, *E. intermedia*, *E. alba*, *Ardea purpurea*, *A. cinerea*, *A. sumatrana*, *Mycteria leucocephala*, *Anastomus oscitans* (8-10 individuals), *Threskiornis nelanocephalus* (1,500-2,000 individuals) and *Plegadis falcinellus* (1,500-2,000 individuals). Other water birds occurring in the sanctuary include *Tachybaptus ruficollis*, *Amaurornis phoenicurus*, *Gallinula chloropus*. The Milky Stork *Mycteria cinerea* is an occasional visitor to the colony but no longer breeds in the area.

Other fauna includes the otter *Lutra perspicillata*, various fruit bats, the python *Python molurus*, monitor lizards *Varanus* sp and frogs of the genus *Rana*.

Special floral values: None known.

Research and facilities: Some preliminary surveys and censuses have been carried out at the colony, but no detailed studies have been made.

References: Le Dien Duc (1984); Le Dien Duc & Le Dinh Thuy (1987); Phung Trung Ngan (1987); Vo An ha & Nguyen Dinh Dien (1985); Vo Quy (1984); Vo Quy & Le Dien Duc (1984).

Criteria for inclusion: 2c, 3a.

Source: Le Dien Duc.

Wetland name: Cal Nuoc (Tan Hung) Bird Colony

Country: Vietnam

Coordinates: 8°58'N, 105°06'E;

Location: near the southern tip of the Mekong Delta, 25 km SSW of Ca Mau, Cai Nuoc District, Minh Hai Province.

Area: Bird colony 13 ha; reserve 20 ha.

Altitude: 0.5m.

Biogeographical Province: 4.5.1.

Wetland type: 07.

Description of site: A small patch of mangrove forest in the southern part of the Mekong Delta, surrounded by agricultural land with many canals and human settlements. The forest holds one of the largest breeding colonies of water birds in the Mekong Delta.

Climatic conditions: Tropical monsoonal climate with a pronounced dry season from December to April and a rainy season from May to November. The average annual rainfall is 2,360 mm, the mean annual temperature 25.5°C, and the mean relative humidity 85.6%.

Principal vegetation: Mangrove forest dominated by *Phoenix paludosa*, with scattered *Nypa fruticans*, *Bruguiera parviflora*, *Excoecaria agallocha* and, on the ground, *Acrostichum aureum*. Lianas such as *Flagellaria indica* and *Sarcolobus globosus* are present. Surrounding areas are under cultivation, mainly for rice.

Land tenure: State owned.

Conservation measures taken: The mangrove forest and environs (20 ha) were declared a protected area by the National Government in 1985. A resident guard is stationed at the bird colony, but the degree of protection is reported to be poor.

Conservation measures proposed: Protection measures should be improved and all access to the bird colony should be strictly controlled.

Land use: Nature conservation.

Disturbances and threats: There is a considerable amount of human disturbance at the colony and illegal harvesting of eggs and young birds for human consumption.

Economic and social values: No information.

Fauna: The Cai Nuoc bird colony is one of the three largest breeding colonies of water birds in the Mekong Delta. Thirty species of water birds are known to breed, the most abundant being cormorants (*Phalacrocorax* spp) and herons and egrets (Ardeidae). The colony is particularly noteworthy for its breeding *Anhinga melanogaster* (15-20 individuals), *Anastomus oscitans* (over 100), *Threskiornis melanocephalus* (500-600) and *Plegadis falcinellus* (1,000-1,300).

Special floral values: None known.

Research and facilities: Some preliminary surveys and censuses have been carried out at the colony, but no detailed studies have been made.

References: Le Dien Duc (1984); Le Dien Duc & Le Dinh Thuy (1987); Luthin (1987b); Phung Trung Ngan (1987); Vo An ha & Nguyen Dinh Dien (1985); Vo Quy (1984); Vo Quy & Le Dien Duc (1984).

Criteria for inclusion: 2c, 3a.

Source: Le Dien Duc.

Wetland name: Nam Can Mangrove Forest

Country: Vietnam

Coordinates: 8°33'-8°50'N, 104°43'-105°10'E;

Location: at the southern tip of the Mekong Delta, south and west of Nam Can District Town, Nam Can, Ngoc Hien and Cai Nuoc Districts, Minh Hai Province.

Area: 76,308 ha.

Altitude: Sea level.

Biogeographical Province: 4.5.1.

Wetland type: 06, 07 & 10.

Description of site: A large area of mangrove forest and associated intertidal mudflats around Cua Song Bay at the extreme southern tip of the Mekong Delta, bounded to the west by the Gulf of Thailand and to the southeast by the East Sea. The entire area is subject to tidal inundation twice daily, the tidal amplitude varying between 0.53m at neap tides and 1.09m at spring tides. The water in the channels is either brackish or saline, and there is no fresh water in the area. The average salinity at Ca Mau Cape is 24.5-26.0 p.p.t., decreasing to 18.0-20.0 p.p.t. after heavy rainfall. Accretion is occurring at a rapid rate, the mudflats extending westwards at about 60m per year.

About 45,000 ha (40%) of the mangrove forest in Minh Hai Province were destroyed by toxic chemicals during the period 1968-1970, and since then many thousands of hectares have been cut down for timber and fuel wood or cleared for the construction of shrimp and fish ponds.

Climatic conditions: Tropical monsoonal climate with a dry season from November to March and a rainy season during the southwest monsoon from April to October. The average annual rainfall is 2,250 mm (range 1,940 to 2,950 mm), the heaviest rainfall occurring in August and September. Mean monthly temperatures range from a minimum of 25.0°C in January to a maximum of 27.8°C in February; mean relative humidities range from 79% to 88%. Storms are frequent in April and May, with wind speeds sometimes exceeding 100 km/hr.

Principal vegetation: Extensive mangrove forests dominated by species of *Avicennia* and *Rhizophora*. The following species have been recorded in the forests: *Avicennia lanata*, *A.*

officinalis, *A. alba*, *Rhizophora apiculata*, *R. mucronata*, *R. orientala*, *R. stylosa*, *Bruguiera parviflora*, *B. gymnorhiza*, *B. sexangula*, *Lumnitzera racemosa*, *Ceriops tagal*, *C. decandra*, *Xylocarpus granatum*, *Sonneratia ovata*, *Excoecaria agallocha*, *Phoenix paludosa*, *Nypa fruticans*, *Kandelia candel*, *Aegiceras corniculatum*, *Acanthus ilicifolius*, *A. ebracteatus*, *Pluchea pteropoda*, *Paspalum vaginatum*, *Acrostichum aureum*, *Derris trifolia* and *Sarcolobus globosus*. The three main groups of algae are *Baccilariophyta*, *Cyanophyta* and *Chlorophyta*. Forty-four genera have been recorded, the commonest being *Rhizozlenia* and *Cyclotella*.

Land tenure: Under provincial ownership.

Conservation measures taken: A protected area of 7,547 ha was established by the National Government in 1985. Reafforestation activities are being promoted by the Forestry Department and by the local people themselves.

Conservation measures proposed: None

Land use: Forest exploitation for timber, fuel wood and charcoal, and fishing for finfish and shellfish. Aquaculture is becoming important, and there are now 7,158 ha of shrimp ponds. Shifting agriculture occurs in areas where the sulphate content of the soil is low.

Possible changes in land use: There are plans to construct additional fish and shrimp ponds in the area.

Disturbances and threats: The main threat is clearance of mangrove forest to make room for fish and shrimp ponds. Thousands of hectares have already been cleared, and this destruction continues. The uncontrolled cutting of mangroves for construction materials, firewood and charcoal is also a major problem. It is widely assumed that water birds, especially the large colonial species, are harmful to aquaculture, and as a result these birds are persecuted in some areas.

Economic and social values: Approximately 70,000 people are dependent to some extent on the Nam Can mangrove forests for their food, fodder, medicines, housing materials and other construction materials. Of a total work force of 27,000, 18,500 are employed in agriculture, almost 4,200 in fishing and 320 in forestry. The local fishery yields an annual harvest of about 10,000 metric tonnes, and thereby constitutes a very important source of protein for the local people. The forest is also a recreation area for local people and other visitors.

Fauna: The mangrove forests are very important for wildlife especially birds. At least two or three new breeding colonies of large water birds have been established in recent years. Resident waterfowl include *Pelecanus philippensis*, *Phalacrocorax carbo*, *Anhinga melanogaster*, *Ixobrychus sinensis*, *I. cinnamomeus*, *I. flavicollis*, *Nycticorax nycticorax*, *Ardeola bacchus*, *A. speciosa*, *Bubulcus ibis*, *Butorides striatus*, *Egretta sacra*, *E. garzetta*, *E. intermedia*, *Ardea purpurea*, *A. cinerea*, *A. sumatrana*, *Anastomus oscitans*, *Ciconia episcopus*, *Threskiornis melanocephalus*, *Plegadis falcinellus*, *Dendrocygna javanica*, *Rallus striatus*, *Amaurornis phoenicurus*, *Gallinula chloropus*. The extensive intertidal mudflats are an important staging and wintering area for large numbers of migratory shorebirds such as *Himantopus himantopus*, *Recurvirostra avosetta*, *Pluvialis dominica*, *P. squatarola*, *Charadrius dubius*, *C. mongolus*, *C. leschenaultii*, *Limosa limosa*, *Numenius phaeopus*, *N. arquata*, *Tringa erythropus*, *T. totanus*, *Xenus cinereus*, *Actitis hypoleucos*, *Gallinago stenura* and *G. gallinago*. Mammals include *Macaca mulatta*, *Lutra perspicillata*, *Viverra zibetha*, *Felis chaus*, *F. viverrina*, *Neofelis nebulosa*, *Sus scrofa* and *Cervus unicolor*. Reptiles and amphibians include *Python reticulatus*, *P. molurus*, *Enhydryis spp*, *Varanus sp*, *Mabouya multifasciata*, *Bufo melanostictus* and four species of *Rana*.

Fifty-three species of fishes have been recorded, representing 13 orders and 29 families. Perciformes comprise 47% of the total (25 species).

Special floral values: The site contains the largest stands of mangrove forest remaining in Vietnam.

Research and facilities: A considerable amount of research has been carried out in the Nam Can mangrove forests by Vietnamese scientists. A scientific workshop on the mangrove ecosystems of Vietnam, held in Hanoi in 1984, reviewed much of this work.

References: Hoang Thi San & Phan Nguyen Hong (1984); Karpowicz (1985); Le Dien Duc (1984); Nguyen Hoang Tn (1984a & 1984b); Phan Nguyen Hong (1984a, 1984b, 1984c & 1984d); Vo Quy (1984); Vo Quy & Le Dien Duc (1984); Vo Quy & Phan Nguyen Hong (1984).

Criteria for inclusion: 123.

Source: Le Dien Duc.

Wetland name: Con Dao Archipelago

Country: Vietnam

Coordinates: 8°37'-8°46'N, 106°32'-106°45'E;

Location: 85 km off the coast of the Mekong Delta, 179 km SSW of Vung Tau and 220 km south of Ho Chi Minh City.

Area: 7,200 ha.

Altitude: 0-577m.

Biogeographical Province: 4.5.1.

Wetland type: 03, 04, 05, 07, 14 & 21.

Description of site: Con Dao Archipelago consists of one large island (Con Dao) and fifteen small islands and islets, 85 km off the mainland coast of southern Vietnam. The islands are rugged and mountainous; much of the main island is over 200m above sea level and two peaks exceed 500m (Tranh Cia Mountain 577m; Chua Mountain 515m). Gradients are generally steep, and the small coastal plains are very narrow. Numerous caves and grottos are found on the higher slopes. There are no permanent rivers or streams on the islands; the only water courses are short streams such as the Bung Beo, Co Ong, Ot, Dong Phuong and Chua Mien, which dry up in the dry season. However, during periods of heavy rainfall in the wet season, flooding can occur in the valleys. There is only one permanent freshwater lake on the islands, Quang Trung Lake. This small lake of 20 ha in extent has a mean depth of 1.22m (maximum 1.5m) and a capacity of about 200,000 cubic metres. However, the lake is gradually becoming overgrown with aquatic vegetation. Underground water is concentrated in the Con Son Valley, where the water table is about one metre above sea level. This source of water has been estimated at 18.4 million cubic metres.

Climatic conditions: Tropical monsoonal climate with a pronounced maritime influence. The average annual rainfall is 2,200 mm (range 1,340-2,730 mm). Over 87% of the precipitation occurs during the rainy season from May to November, the rainfall reaching its peak in October. The dry season lasts from December to April. The mean annual temperature is 26°C; May has the maximum mean monthly temperature (28.3°C) and January the minimum (25.3°C). The absolute maximum and minimum temperatures recorded are 36.0°C and 18.4°C, respectively. The average humidity is 80%; the humidity remains high throughout the year, the minimum mean monthly humidity being 78% in January. The prevailing winds are westerly during the

rainy season and easterly or east-northeasterly during the dry season. Strong winds are frequent in January and February. The mean annual evaporation is 1,033 mm.

Principal vegetation: Some 361 species of plants have been recorded in the archipelago. The vegetation of the islands is similar in composition to that of comparable areas on the mainland. However, because of the great diversity in topography and micro-climate, the islands possess a wide range of forest types in a very small area. These include mangrove forest with species of *Avicennia* and *Rhizophora* on the coast, *Melaleuca* forest on sulphate soils in sand dune areas behind the mangrove forest, lowland moist tropical forest with species of *Dipterocarpus* and many other plant species typical of south and central Vietnam, and a forest type dominated by *Chukrasia tabularis*, which otherwise occurs only in the north-central and northern parts of the country. On sheltered slopes with a deep layer of humus, the forest grows to a considerable height and often contains two or three strata, whereas on exposed slopes, the trees are stunted and the canopy is very dense and even. As a result of 100 years of exploitation, the forests are now much degraded. Recent figures give the total area of forest as 6,324 ha, representing 87.8% of the whole area of the archipelago. This includes 2,096 ha of poor forest, 916 ha of secondary forest, 675 ha of montane forest, 2,331 ha of shrubs and young trees, 161 ha of forestry plantations and 17 ha of mangrove and *Melaleuca* forest.

Land tenure: Public land.

Conservation measures taken: On the recommendation of the Ministry of Forestry and Committee for Rational Utilization of Natural Resources and Environmental Protection, the Government has given protected status to the forests on the main island.

Conservation measures proposed: A proposal that the entire archipelago be designated as a National Park has recently been approved by the Government. A management plan for the National Park is currently being prepared for submission to the Government.

Land use: Fishing and tourism; also some subsistence agriculture, collection of firewood and hunting. The only people resident on the islands are government employees working in administration, forestry, fisheries, tourism and transportation.

Disturbances and threats: Because of difficulties in supplying the islands from the mainland, the government employees resident on the islands have cleared forest to grow their own crops. They also exploit the forest for construction materials and firewood, and hunt the wildlife for food. Over the years, this exploitation has resulted in the degradation of the forests, their wildlife and the marine fauna. Populations of the macaque *Macaca mulatta* and Edible-nest Swiftlet *Collocalia fuciphaga* have declined rapidly in recent years as a result of this exploitation.

Economic and social values: The waters around the islands support an important fishery, producing finfish, shrimps and molluscs not only for local people but also for the markets in Vung Tai and Ho Chi Minh City. With their spectacular scenery and diverse fauna and flora, the islands have considerable potential for both domestic and international tourism. The development of tourism should be given high priority, since it would generate income to improve the standard of living of the government employees on the islands and thereby reduce the need for exploitation of the islands' limited natural resources.

Fauna: In general, the fauna of the Con Dao Archipelago is rather poor in species. A recent list of the species known to occur includes 18 mammals, 62 birds, 19 reptiles, six amphibians, 150 bivalves (27 of which are of economic importance), 34 snails, five crabs, one shrimp, two limuloids, two scorpions, four spiders, two Acarina, four Polypoda, 28 insects and eight corals. Noteworthy mammals include an endemic species of squirrel and an endemic form of the Great Black Squirrel *Ratufa bicolor*. Dolphins *Delphinus sp* and Finless Porpoise *Neophocaena*

phocaenoides regularly occur close inshore around the main island. The macaque *Macaca mulatta* was common on the main island as recently as the late 1970s, but has decreased rapidly in numbers since then due to excessive hunting and human disturbance.

Some of the islands, notably Hon Trung Islet, support large breeding colonies of sea-birds including *Phaethon aethereus*, *Sula dactylatra*, *Sterna dougallii*, *S. sumatrana* and *S. anaethetus*. The archipelago lies on a major bird migration route and provides resting and feeding areas for large numbers of birds during the migration seasons. Water birds known to occur on the islands include *Ixobrychus flavicollis*, *Ardeola speciosa*, *Egretta sacra*, *E. garzetta*, *Dendrocygna javanica*, *Pandion haliaetus*, *Haliastur indus*, *Haliaeetus leucogaster* and a variety of shorebirds. Resident land birds include the Pied Imperial Pigeon *Ducula bicolor*, a species which is scarce throughout much of its range but still rather common on Con Dao. The Edible-nest Swiflet *Collocalia fuciphaga (francica)* nests in caves on some of the islands, along with two other species of swifts, *Apus affinis* and *A. pacificus*. The numbers of swifts are, however, decreasing rapidly due to the collecting of their nests for export.

Reptiles include the sea turtles *Eretmochelys imbricata* and *Chelonia mydas*, two species of monitor lizard *Varanus spp* and two species of pythons *Python spp*.

Special floral values: The vegetation includes many plants of medicinal value, such as *Oroxylon indicum*, and ornamental species sold throughout southern Vietnam and abroad. The wild grape thrives on the islands, the vines producing bunches of grapes weighing more than two kilograms. A distinctive grape has been produced by crossing domestic stock with wild grapes on Con Dao.

Research and facilities: Several faunal and floral surveys have been carried out on the islands.

References: Vo An ha *et al.* (1983 & 1987).

Criteria for inclusion: lb, 2a, 2c, 2d.

Source: Le Dien Duc.

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