

# THAILAND

## INTRODUCTION

by Jira Jintanugool and Philip D. Round

**Area:** 513,517 sq km.

**Population:** 52,728,000 (in 1986).

Thailand extends from 5°45'N to 20°30'N and from 97°30'E to 105°45'E, and is approximately 1,500 km from north to south and 800 km from east to west. It is situated in the Indochinese peninsula of the Indomalayan Faunal Region. The country may be divided into four distinct regions. The northern and western parts of the country are chiefly mountainous, with granitic and metamorphic rocks rising to heights of 1,000-2,000m. Thailand's highest mountain, Doi Inthanon, rises to 2,590m.

These areas, by way of their major rivers (Ping, Wang, Yom and Nan in the north, and the Kwaie River System in the west), form the watershed for the Central Plains, which extend to the coast in the vicinity of Bangkok. These marshy alluvial plains, most of which lie below 50m above sea level are now almost entirely given over to rice cultivation and bear a huge and complex network of man-made waterways, serving for irrigation and flood control. Many of the most extensive and best known wetlands in Thailand lie within this region.

The northeastern part of the country consists of a plateau, the Khorat Plateau, which was raised to its present elevation of 100-200m during a period of uplift in the Tertiary Epoch. The poor soils are derived from marine sands, clays and salt deposits. The entire area drains into the Mekong River, which forms the boundary between Thailand and its neighbours to the east. Areas of alluvial soils and marshy wetlands are mostly concentrated along the two major tributaries of the Mekong, the Mun and the Chi.

The fourth region of the country is the Peninsula, which comprises a southward extension of the western mountain spine. The mountains are very steep, but some important freshwater wetlands lie in the coastal fringes. The coastline is very long and supports many important mangrove and estuarine sites.

Thailand's climate is tropical and monsoonal with a long, hot, dry season. Most parts of the country receive over four-fifths of their annual rainfall during the southwest monsoon, from May to October. Some areas in the peninsula, particularly on the east coast, receive some additional rainfall from the northeast monsoon during November to January. The least seasonal areas are in the southernmost provinces of Pattani, Yala and Narathiwat which, although they receive rain from both monsoons, are actually wettest in November and December. Narathiwat, together with small areas in the southeast of the country and around Ranong on the west coast of the Peninsula, are the wettest areas of the country, receiving over 3,000 mm of precipitation per year. Most of the country receives 1,000-2,000 mm per year.

The average relative humidity is 74.4% (range 66.0-82.8%). The average temperatures are relatively uniform, both spatially and seasonally, and are influenced by the relative proximity to the sea and by the regularity and seasonality of the rainfall. Land-locked provinces have a

greater temperature fluctuation than do coastal ones, and temperatures in April (the hottest month) may rise to over 40°C. The average annual temperature is 27.6°C (range 23.7-32.5).

The country was formerly almost entirely forested, but forest cover had been reduced to 149,053 sq.km by 1985 (Royal Forest Department, 1985). There is great variation in forest types, depending on climate and topography. Dry deciduous formations give way, with increasing rainfall, to semi-evergreen and evergreen types, including tropical rain forest.

Thailand is a zoogeographic crossroads, supporting Indo-Burmese, Indo-Chinese and Sundaic elements in its lowland fauna, together with a Sino-Himalayan montane element. Migratory species from the Palearctic Realm comprise an important proportion of the country's avifauna; many such species are mainly or entirely dependent on wetlands.

### **Summary of Wetland Situation**

Huge areas of Thailand comprise habitat which would formerly have been wetlands; for example the country's Central Plains region. The economy of the people living in many parts of the country must have been intimately involved with wetlands for perhaps as much as 6,500 years, when the beginnings of lowland rice cultivation became evident. Wetlands have been

important not only as a source of water and food (rice, fish, waterfowl), but also for transport and communications. From 1850 onwards, there was a great increase in foreign trade, with rice as the principal export, and a concomitant increase in the building of canals and the drainage of swamps (Owen, 1971). It is probably true to say that most major freshwater wetlands had already been greatly modified by the beginning of the Twentieth Century, and soon afterwards followed the extinction of much wildlife which had been associated with permanently or seasonally inundated plains, such as Javan Rhinoceros, Schomburgk's Deer, Giant This and Sarus Crane (*Rhinoceros sondaicus*, *Cervus schomburgki*, *Pseudibis gigantea* and *Grus antigone*). Most lowland populations of elephants probably also disappeared at this time.

In recent decades, land development has accelerated with the construction of a great many reservoirs for irrigation, flood control and, latterly, hydro-electric development. The great increase in land under cultivation, combined with intensive human use of those small wetlands which remain, has greatly reduced wildlife populations and has led to the extirpation of breeding populations of most large waterfowl. The species which remain are chiefly those which can nest and roost in small woody copses or on water bodies, and flight out to feed in adjacent rice paddies and other temporarily inundated areas.

Mangrove and other coastal ecosystems were much less affected until recently, since they were hitherto only subject to activities such as fishing and a low level of timber exploitation. Klankamsorn *et al.* (1981) listed the area of mangrove in Thailand in 1961 as 3,679 sq.km. By 1979 however, this had been reduced by 22% to 2,873 sq.km as a result of cutting for charcoal and timber and clearance for the establishment of prawn ponds. Clearance for aquaculture during the past decade has been especially rapid; while the results of a major ongoing inventory are not yet available, mangrove areas may be expected to show a further devastating decline. The associated mudflats, which support huge numbers of passage or wintering shorebirds, still remain, although local reclamation for aquaculture and industrial development has taken place.

The economic welfare of Thailand is dependent to a very great extent upon the use and development of wetlands. This has long received official recognition; the Royal Irrigation Department was first established (as the Canal Department) in 1902, and the Committee for Coordination of Investigations of the Lower Mekong Basin was established in 1957 by the governments of the five riparian countries, including Thailand. Yet because wetlands impinge upon so many aspects of the economic sphere, they have been subjected to a great many uncoordinated developments. In some cases, several projects with mutually incompatible goals have been carried out at the same site. Because the small scale utilization of wetlands by the villagers living around their margins is so widespread and the pattern of use so complex and varied, the benefits reaped by local economies have proved difficult to evaluate and have often been neglected when assessing the costs of large scale development schemes. In addition, the assessment of environmental impacts, particularly insofar as wildlife conservation is concerned, have often been omitted. Only in recent years have integrated management plans or development studies been undertaken for specific wetland sites; a recent model is the Songkla Lake Basin Planning Study (Sinclair, 1985).

To summarize, therefore, wetlands in Thailand play an important role in sustaining the living standards of millions of people. Because these areas receive such a high level of use, their wildlife conservation attributes may be less than spectacular. Nevertheless, a great many sites continue to be of international importance, especially as sites for migratory waterfowl.

Thai wetlands may be classified, with particular reference to their importance for waterfowl conservation, as follows:

1. Open seacoasts, sandy beaches and offshore islands

Such sites have only been treated in this inventory where they occur in association with other coastal wetland sites, such as mudflats and mangroves. There are many hundreds of islands and small rocky outcrops off the west coast of the peninsula, most of which have never been surveyed. Offshore islets continue to be of importance as nesting sites for the Pacific Reef Egret *Egretta sacra* and terns such as *Sterna dougalli*, *S. sumatrana*, *S. bergii* and *S. anaethetus*. *Anous stolidus* and *Sula leucogaster* may also both occur but are now very scarce. The Beach Thick-Knee *Esacus magnirostris* is restricted to sandy beaches on offshore islands, while both the Malaysian Plover *Charadrius peronii* and the Little Tern *S. albifrons* breed on sand beaches of mainland and island coasts.

2. Intertidal mudflats and mangroves

Such areas are of great conservation value in Thailand, having enormous importance in sustaining both inshore capture fisheries and aquaculture. The most extensive and species-rich mangrove ecosystems are found along the west coast of the peninsula which supported 63% of the total mangrove area of 2,871 sq.km at the end of 1982. There are also several important mangrove and mudflat sites on the east coast of the peninsula as well as in the inner gulf, although huge areas have been converted to prawn ponds. The status of the mangrove ecosystem in Thailand and its biological and ecological characteristics, exploitation and management have recently been reviewed by Aksornkoae (1987).

Mudflats are of great wildlife conservation importance and support huge numbers of passage and wintering herons and shorebirds. Over 10% of the world population of the Asian Dowitcher *Limnodromus semipalmatus*, for example, is concentrated on 100-200 ha of mudflats southwest

of Bangkok for a crucial period of the spring migration. The mangroves themselves still support nesting colonies of cormorants, herons and a few Lesser Adjutants *Leptoptilos javanicus*, together with considerable numbers of some birds of prey such as Brahminy Kites *Haliastur indus*. Two other species for which Thai mangroves are important are the Brown-winged Kingfisher *Pelargopsis amauroptera* and the Mangrove Pitta *Pitta megarhyncha*, both of which are restricted to the west coast.

### 3. Lower Perennial Rivers

This category is taken also to include associated features such as oxbow lakes and riverine marshes. The lower reaches of most rivers have now been almost entirely deforested, except where narrow fringes of fresh and brackish water swamp woodlands remain along their banks. Because the riverbanks usually support a high human population density, relatively few waterfowl are found. The grounds of temples which abut onto the banks may support breeding colonies or large roosts of herons or storks, together with a few Black Kites *Milvus migrans*. Vertical earth banks support a few nesting Pied Kingfisher *Ceryle rudis*, while mud and sand banks support passage shorebirds as well as the resident River Lapwing *Vanellus duvaucelii*. The Mekong River, in the vicinity of Chiang Saen near the far north of Thailand, probably supports the richest lowland riparian bird fauna. As well as wintering flocks of ducks and shorebirds, the area until recently held such presumed residents as Greater Thick-Knee *Esacus recurvirostris*, Indian River Tern *Sterna aurantia* and Black-bellied Tern *S. acuticauda*. There are also a few colonies of Plain Sand Martins *Riparia paludicola*. The scarce and local Jerdon's Bushchat *Saxicola jerdoni* appears to be associated with stands of the tall grass *Saccharum arundinaceum* in riverine floodplains. The species may have decreased greatly as a result of the burning of such vegetation in order to open up seasonally inundated alluvial soils for dry season cultivation.

The endangered White-eyed River-Martin *Pseudochelidon sirintarae* is presumed, like its African congener, to nest somewhere on riverine sand banks, quite probably in northern Thailand.

Large areas of seasonally inundated land lie along the courses of many rivers in Thailand, particularly along the Mun and Chi in the northeast. Many such areas are utilized for the cultivation of vegetables or rice as the seasonal flooding recedes, yet they may perhaps be of considerable value to waterfowl.

### 4. Upper Perennial Rivers

This habitat comprises larger streams in hilly or plateau country to the foothills and margins of the plains. Because the upper reaches of many rivers are still largely forested, they may continue to support a considerable diversity of wildlife, including a great many non-aquatic species. Some of the more important sites are already enclosed within the boundaries of Yot Dom Wildlife Sanctuary and Phu Jang Na Yoi National Park.

The White-winged Wood-Duck *Cairina scutulata*, having been extirpated from wetlands in the plains, now appears to be restricted to a very small number of sites where sluggish-flowing reaches of upper perennial rivers are found in plateau country. Other species, which are associated with faster-flowing rivers include Lesser Fish-Eagle, Red-headed Vulture, Green Peafowl and Crested Kingfisher (*Ichthyophaga humilis*, *Sarcogyps calms*, *Pavo muticus* and *Megaceryle lugubris*). Many such sites, including many small streams and torrents, may be of

critical conservation importance for various frogs and toads. There has never been any comprehensive assessment of the conservation status of Thai amphibians, however, so that many important sites doubtless remain undocumented.

#### 5. Freshwater lakes, ponds and associated marshes

Most such sites are small (less than 500 ha); they are typically surrounded by large areas of rice paddy or other cultivation, and a great many lie within 1-2 km of major rivers. Almost all receive heavy human use, and both direct disturbance and habitat disturbance greatly limit the utilization of such areas by wildlife. The vegetation is usually restricted to floating or submerged aquatic plants alternating with open water, and supports such breeding waterfowl as Pheasant-tailed Jacana *Hydrophasianus chirurgus*. The highest diversity of breeding and wintering birds is usually found at those sites, which contain extensive areas of emergent vegetation, especially *Phragmites* or *Typha*. Many such sites are of international or national importance for their wintering duck populations.

#### 6. Water storage reservoirs

A few such sites are known to support wintering concentrations of ducks, as well as such breeding species as *Porphyrio porphyrio*, and the comments made under the previous category apply equally to these sites. Most larger reservoirs, constructed for hydro-electric power generation, are situated in steep river valleys, are very deep, and usually support very little wildlife. Many irrigation reservoirs, on the other hand, are situated in the plains, are relatively shallow, and show considerable annual fluctuation in area. Such sites may be of value for wintering and passage wading birds.

#### 7. Rice paddies

Rice paddies constitute an important and very extensive, seasonally inundated habitat for birds. The extent to which these areas can be utilized, however, depends upon the availability of undisturbed roosting and nesting sites, such as clumps of trees and permanent water bodies. Egrets and herons feed to a considerable extent in flooded paddies; cormorants utilize ditches around their margins, and the Asian Open-billed Stork *Anastomus oscitans* feeds both in flooded and dry paddies. Areas of hard, dry paddy stubble in the late dry season are utilized by huge numbers of nesting Oriental Pratincoles *Glareola maldivarum*.

#### 8. Freshwater swamp woodlands

Detailed information on the history of such sites is usually lacking. In most cases, such swamp woodlands may be merely the degraded remnants of primary peat swamp forest formations. The most disturbed sites, particularly those which have been subject to repeated burning, are species-poor and are usually dominated by *Melaleuca leucadendron*. Some *Aistonia spathulata* may occur in the less disturbed sites, as at Thale Noi Non-Hunting Area in Peninsular Thailand. Small areas of other freshwater swamp woodland formations may occur along the banks of larger rivers and other sites which are subject to occasional inundation. Such sites are of considerable importance for nesting and roosting colonies of larger water birds, such as cormorants, herons and storks.

#### 9. Peat swamp forests

These are wetlands dominated by a species-rich forest community growing on waterlogged peat. They are botanically very rich, and may be of great conservation importance for amphibians and for some fish, such as the walking catfish *Prophagorus nieuhoi* and possibly the highly endangered Asian Bonytongue *Scieropages formosus*. In terms of their avifauna, they are important in supporting a great many arboreal members of the lowland forest community, which are scarce, or absent elsewhere due to the almost complete destruction of terrestrial lowland forest. Pa Phru, in Narathiwat Province, is the only example of this habitat remaining in Thailand, although many other areas, now dominated by a species-poor *Melaleuca* woodland, may be degraded remnants of this type.

## **Wetland Research**

### Intertidal sites

The Remote Sensing and Mangroves Project (1984-87) of the National Research Council is using LANDSAT data together with aerial photography in order to assess mangrove resources at eight test sites, each of 10,000 ha less. This work is supported by the International Development Research Centre, and the information gathered will be made available to the National Economic and Social Development Board. The Forest Management Division of the Royal Forest Department is also mapping mangrove resources and refining a system for their classification, using a combination of aerial photography and satellite imagery. The Phuket Marine Biological Center is carrying out research on the mangrove ecosystem of the Phang-nga Bay Area. A joint Interwader and Prince of Songkla University Project is conducting surveys of migratory shorebirds in peninsular Thailand, along with sampling of mudflat meiofauna and an assessment of the impact of shorebird hunting. Shorebirds are also being censused in the inner Gulf of Thailand.

### Freshwater Sites

Research on Thailand's only remaining primary peat swamp forest at Pa Phru (also known as Phru To Daeng) is being carried out under the auspices of the National Environment Board, in order to develop an integrated management plan for the site. The Biology Department of Prince of Songkla University together with the Institute of Southeast Asian Biology, Aberdeen, Scotland, is carrying out a programme of biological research on the aquatic resources of Lake Songkhla. The Regional Remote Sensing Training Center at the Asian Institute of Technology, Bangkok, has mapped the surface waters throughout the Khorat Plateau region of the northeast and the data are available on computer.

## **Wetland Area Legislation and Administration**

The Royal Forest Department was established in 1896 and some laws governing the exploitation of forest resources were enacted. The Forest Act came into being in 1941, and this was superseded by the National Reserved Forest Act in 1964. Because "forest" refers to any land the ownership of which has not been legally entered in accordance with the Land Laws, some wetlands were also covered under these Acts. Large areas of mangrove were declared as National Reserved Forest.

In terms of wildlife conservation, the two key pieces of legislation are the Wild Animals Reservation and Protection Act (1960) and the National Parks Act (1961). The former provided for species protection legislation as well as the establishment of two categories of nature

reserve: Wildlife Sanctuaries, which are fully protected, and Non-Hunting Areas, where human access and use of the site are permitted. National Parks, like Wildlife Sanctuaries, are fully protected.

While a few wetland National Parks have been established, and some important wetlands (such as rivers) are partly enclosed within Wildlife Sanctuaries, the most frequent designation for wetland nature reserves is as Non-Hunting Areas. While this allows for some compromise, promoting wildlife conservation at the same time as recognizing the legitimate needs for human exploitation of wetlands, it has also led to severe problems. The term 'Non-Hunting Area' is itself a misnomer, since its jurisdiction extends only to those animals listed as "non-hunting species" for each specific site. Furthermore, no additional habitat protection measures are enacted: a piece of swamp woodland, for example, can only be protected from felling if it is listed under the National Reserved Forest Act (1964).

The Department of Fisheries has responsibility for aquatic and marine biological resources, but is chiefly concerned with the use of these resources as food. Although conservation projects, such as the captive propagation of the Mekong Giant Catfish *Pangasianodon gigas* have been undertaken, the Department is less concerned with species conservation *per se* than with stocking potentially suitable areas with useful food fish.

The impact of aquaculture projects upon the wetland ecosystems is rarely assessed.

The Fisheries Act (1947) allows for the establishment of Preservation Fisheries. These are areas which lie adjacent to a monastery or place of worship, or in zones of navigation, locks, dams or weirs, and may include any areas specifically designated as being suitable for the conservation of aquatic animals. No fishing or aquaculture activities are allowed in areas so designated without the permission of the Director General of Fisheries. Other regulations govern fishing activities elsewhere; these include restrictions on the types of traps or nets which may be used.

Flood control and irrigation comes under the mandate of the Royal Irrigation Department and is regulated by the People Irrigation Act (1939) and by the State Irrigation Act (1942), amended in 1954. Individuals wishing to carry out irrigation projects are obliged to notify the relevant authority, either the local or provincial authorities or the Ministry of Agriculture, depending upon the size of the area affected. Projects carried out do not require any environmental impact assessment.

Under the Land Consolidation Act (1974), a Central Committee on Land Consolidation has been established within the Ministry of Agriculture. This aims to intensify agriculture on selected areas, principally through the improvement of drainage, construction of roads and the straightening of field boundaries. Since most of the areas involved are rice paddies, this Act also impinges markedly upon wetlands.

Land use and ownership is regulated under The Land Code (1954). Provision is also made for a category of "common land", where private ownership of land is prohibited, but where unrestricted public use is granted. Some wetland sites, ponds and canals, later declared as Non-Hunting Areas, fall into this category.

Because the lowlands in general, and wetlands in particular, are almost without exception regarded as being available for public use, development or settlement, their conservation in Thailand has been seriously compromised.

## Organizations involved with Wetlands

### a) Governmental Organizations

#### 1. Ministry of Agriculture and Cooperatives

##### - Royal Forest Department

Responsible for the protection and management of forests, national parks, wildlife sanctuaries and non-hunting areas; wildlife conservation and research.

##### - Royal Irrigation Department

Responsible for irrigation, drainage, the development of water resources and flood control.

##### - Department of Land Development

Responsible for land-use classification, land policy, land surveys and land development; soil and water conservation.

##### - Department of Fisheries

Responsible for fisheries control, regulation, conservation and development; fish breeding, fish stocking and aquaculture.

#### 2. Ministry of Science, Technology and Energy

##### - Office of the National Environment Board

Acts chiefly in an advisory and information capacity on environmental matters.

##### - National Research Council

Promotion and coordination of research; remote sensing. - National Energy Authority  
Responsible for some small scale hydro-electric dam projects; involved in proposed projects in the Mekong Basin.

- Thailand Institute of Scientific and Technological Research Conducts research under contract to government and international agencies. In recent years, it has carried out biological surveys of some wetland sites and has conducted environmental impact assessments. Maintains the National Reference Collections of biological specimens.

#### 3. Ministry of the Interior

##### - Land Department

Responsible for land registration and ownership.

- Administration Department

Responsible for local and provincial administration in all matters concerned with the land and public welfare through a network of Province Governors and District Chiefs. This impinges greatly upon conservation and land use.

4. Electricity Generating Authority of Thailand A government enterprise which has constructed a number of huge hydro-electric dams.

5. Asian Regional Remote Sensing Training Centre, Asian Institute of Technology The Centre is mapping the surface waters of northeast Thailand for the National Social and Economic Development Board.

6. Mekong Secretariat, United Nations ESCAP The Secretariat has a large amount of remote sensing data and has supported many surveys in the Mekong countries.

b) Non-governmental Organizations

- Wildlife Fund - Thailand
- Project for Ecological Recovery
- Bangkok Bird Club
- ICBP National Section

c) Universities

- Mahidol University (Bangkok) Particularly the Center for Wildlife Research in the Department of Biology.
- Kasetsart University (Bangkok) Particularly the Faculty of Forestry and Department of Conservation.
- Prince of Songkhla University (Pattani) Particularly the Biology Section, Department of Science and Mathematics.

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## WETLANDS

Site descriptions taken from a report prepared for this Directory by Jira Jintanugool of the Wildlife Conservation Division, Royal Forest Department, and Philip D. Round of the Center for Wildlife Research, Mahidol University.

**Wetland name:** Chiang Saen Basin

**Country:** Thailand

**Coordinates:** 20°10'-20°18'N, 99°57'-100°11'E;

**Location:** the basin extends from the Golden Triangle, 10 km north of Chiang Saen, downstream along the Mekong River for 29.5 km to Ban Suan Dok, below the confluence of the Nam Mae Kok. It also extends for about 18 km southwest from Chiang Saen, encompassing Nong Wiang, Chiang Saen and Mae Chan Districts, Chiang Rai Province, and upstream along the Nam Mae Kok for approximately 15 km.

**Area:** 10,000 ha.

**Altitude:** 350-400m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 11, 13, 14, 15, 18 & 19.

**Description of site:** Open, deforested rivers, with sand banks and small islands. The Mekong River at this location is over 0.5 km wide. The banks of the rivers are cultivated right up to the water margins, but patches of dense scrub remain. The area includes the basin of Nong Wiang (4,000 ha), which is largely paddy interspersed with patches of seasonally flooded grassland, grazing marshes and small pools, together with Nong Bong Khai (also known as Chiang Saen lake; approximately 200 ha). Low deforested foothills lie around the margins of the site. These are cultivated in parts. There is a fairly high human population density and many houses are scattered throughout the drier parts of the area. The Laotian shore of the Mekong, though also populated, is still largely wooded. There are great fluctuations in the depth of the Mekong River at Chiang Saen. The river is at its deepest in November to December and reaches its lowest depth in April. There is usually little or no overspill from the banks, and flooded areas inland are confined to the basin of Nong Wiang.

**Climatic conditions:** Tropical monsoonal climate.

**Principal vegetation:** Patches of *Saccharum arundinaceum* along rivers. Many areas along the riverbanks are overgrown with a dense scrub of *Mimosa pudica*. Land Use Classification Division (1977-1979) lists 3,000 ha along the floodplain of the lower Nam Mae Kok as "abandoned land". There is little emergent vegetation in the ponds and lakes other than *Nelumbo nucifera* and small patches of *Cyperus* spp. There are extensive areas of rice paddy and other cultivation in the low-lying areas along rivers. The deforested foothills support patches of bamboo scrub (*Bambusa* sp) among other woody secondary growth. Most such areas are, however, cultivated.

**Land tenure:** The areas of open water are state owned. The Thai-Laotian border runs along the Mekong, close to the Thai shore. The Nam Sop Ruak at the Golden Triangle forms the Thai-Burmese border. Most areas of marshland and riverine floodplain are in private ownership. Surrounding areas are mainly privately owned agricultural land.

**Conservation measures taken:** Nong Bong Khai was declared as a Non-Hunting Area in 1985. The Non-Hunting Area encompasses only open water and no adjacent shoreline other than one small area, which has been set aside for building the reserve headquarters. The Department of Fisheries collaborates with local fishermen in obtaining eggs and sperm from the endangered Mekong Giant Catfish *Pangasianodon gigas* in order to rear fry for release.

**Conservation measures proposed:** The establishment of an additional Non-Hunting Area at Nong Wiang has been proposed. The burning and cutting of waterside vegetation, together with the

hunting of waterfowl, should be suppressed. At Nong Bong Khai and elsewhere, "scrapes" might be made around the lakeshore in order to improve feeding opportunities for shorebirds.

**Land use:** Fishing, using gill nets, throw-nets and electrocution. Fishermen at Nong Bong Khai are able to catch approximately one kilogram of fish per day. In addition, small freshwater shrimps are harvested and are used for making chilli paste. One crop of irrigated or rain-fed rice is grown per year. Many areas of riverine floodplain are used for cultivating maize or green vegetables, and it is not unusual for cultivation to be practised right up to the water's edge. As the water levels drop, from late December onwards, so the cultivation proceeds further into the fertile alluvial soils along the river margin. There are fruit orchards (mainly lychees) and fields of hill rice and maize in surrounding areas.

Possible changes in land use: Increasing tourism is leading to a gradual proliferation of guest bungalows, restaurants and other facilities around the lake shore at Nong Bong Khai and along the Mekong. In the water catchment area, there is likely to be an increase in already deforested land under cultivation due to the adoption of lucrative cash crops such as coffee.

**Disturbances and threats:** Each dry season, there is much burning of scrub, reeds and other riverine vegetation in order to open up areas for cultivation. Such massive habitat disturbance certainly deprives some species, such as *Saxicola jerdoni*, of suitable undisturbed habitat. Fishermen walk or swim out to riverine sand bars in the drier months, causing indirect disturbance to nesting and migrant water birds. In addition, there is a certain amount of direct disturbance, both from shooting and the taking of eggs for food. The area is heavily-fished. Almost the entire width of the Mekong at Chiang Khong, downstream of the present site, is blocked off by nets during the dry season in order to catch the endangered Mekong Giant Catfish *Pangasianodon gigas*. The Department of Fisheries has never attempted to halt this practice.

**Economic and social values:** Many people, both Thai and Laotian, are dependent upon the Mekong fisheries. In addition, tourism is rapidly expanding in the area and generally attracts the younger, lower-budget foreign travelers as well as a great many Thai nationals. Income from this source at present goes directly into the pockets of local people since there are no outside, large-scale tourist developments. Already, such tourists include a small proportion of bird-watchers.

**Fauna:** The Mekong Giant Catfish *Pangasianodon gigas* has been recorded from both the mainstream of the Mekong River and its tributary, the Nam Mae Kok (Rainboth et al., 1976).

The wetland supports a wide range of wintering and possibly some resident bird species, which are scarce, or absent elsewhere in Thailand. The Mekong River may act as a major flyway for waterfowl. In addition to those species which winter regularly, occasional vagrants such as *Anser indicus* (four birds in January 1984) have been recorded. *Ciconia nigra* has been recorded on a number of occasions, the last as recently as December 1983. *Tadorna feruginea* is an occasional visitor, and this may be the only site where *Anas poecilorhyncha* is regular (up to 50 birds have been recorded). Small numbers of other ducks have been found: *Dendrocygna javanica* (up to 200), *Anas acute*, *A. crecca*, *Aythya* spp including *A. haeri*. The riverine sand banks also support a variety of shorebirds, some of which may breed. These include flocks of over 200 *Glareola lactea* and up to eight *Vanellus duvaucelii*, together with occasional *Burhinus oedicephalus*. *Esacus magnirostris*, *Sterna aurantia* and *S. acuticauda* were formerly recorded (Deignan, 1945; King, 1966) and may still be present. Other riparian birds include *Ceryle rudis* and a colony of at least 40 nests of the scarce and local *Riparia paludicola*. Scrub on riverine sand banks supports small wintering flocks of *Emberiza spodocephala*. Freshwater marshes and paddies support wintering flocks of egrets and a few herons (*Ardea cinerea*, *A. purpurea*), the harriers (*Circus (aeruginosus) spilonotus*, *C. melanoleucos*), and *Vanellus cinereus*. A survey of wetland and scrub habitats around Nong Bong Khai in December 1985 produced 69 bird species, with a further seven species being recorded from Nong Wiang (Amget et al. 1985). There is no recent information on breeding birds. *Saxicola jerdoni* was formerly present (King, 1966) and almost certainly still occurs.

**Special floral values:** None known.

**Research and facilities:** Information collected by bird-watchers in 1983-86 is held on file at the Center for Wildlife Research at Mahidol University in Bangkok. A temporary office has been established at the Nong Bong Khai Non-Hunting Area, and the Superintendent, Mr Pramook Onlamai, is collecting some basic information on local human use of the site.

**References:** Amget *et al.* (1985); Deignan (1945); King (1966); Land Use Classification Division (1977-1979); Rainboth *et al.* (1976).

**Criteria for inclusion:** lb, 2b.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Tha Ton Marsh

**Country:** Thailand

**Coordinates:** 20°02'N, 99°24'E;

**Location:** 3 km southeast of the village of Ban Tha Ton, Mae Ai District, Chiang Mai Province.

**Area:** c.6,000 ha.

**Altitude:** c.450m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 11, 13, 15 & 18.

**Description of site:** A marshy basin lying upstream of the confluence of the Nam Mac Kok and Nam Mae Fang rivers. The rivers are broad with sand and shingle banks at their confluence. Upstream, for about 13 km above the confluence, the Nam Mae Fang is deeper and slower-flowing, fringed with reeds and tall grasses. These riverine marshes form a corridor 0.2-2.0 km wide and occupying a total area of 1,350 ha, but are now much fragmented. There are also small areas of fish ponds. The most extensive lowlands, in the northern part of the basin, are occupied by rice paddies (approximately 4,600 ha). To the south, there are low hills with patches of degraded dry dipterocarp woodland and cultivation. The area is at its wettest during the late wet season from October onwards, into the early dry season, when active irrigation of the rice paddies occurs. At this time, the wetland is flooded to a depth of 20-30 cm. It dries out almost completely from February onwards, apart from a small area of irrigated rice paddies. The rivers are permanent, but their water level drops markedly in the late dry season, from March onwards. Small areas of open water remain in the fishponds.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,268 mm (range 500-2,032 mm), 89.1% of which falls during the southwest monsoon in May to October. The mean annual temperature is 25.8°C (range 6.0-41.5°C). (Data from Chiang Mai).

**Principal vegetation:** No detailed surveys of aquatic communities have been made, but the vegetation is believed to be poor in species. The dominant emergent is probably *Saccharum arundinaceum*, with some *Phragmites australis*. Large areas are now dominated by *Mimosa pudica*. Adjacent areas are predominantly agricultural land, with rice paddy in the low-lying areas and sugar cane and maize in the foothills, among patches of dry dipterocarp woodland dominated by species of *Shorea* and *Dipterocarpus*. The watershed of the Nam Mae Kok still supports some sub-montane and montane evergreen forest and secondary growth.

**Land tenure:** The wetland is mainly or entirely in private ownership. Surrounding areas include both privately owned farmland and National Reserve Forest in public ownership.

**Conservation measures taken:** None.

**Conservation measures proposed:** The site might be considered for establishment as a Non-Hunting Area or other reserve.

**Land use:** Rain-fed rice paddy (one crop per year) on 2,300 ha, and irrigated rice paddy (two crops per year) on a further 2,300 ha. Some fields of maize and vegetables are grown among the drier parts of the reed-beds, and there is grazing by domestic buffalo. Maize and sugar cane are grown as "slash-and-burn" crops in the nearby foothills.

**Disturbances and threats:** With greatly improved drainage, the continued annual burning of reed-beds in order to open up new areas for cultivation is a major threat to roosting and nesting sites for birds. Existing estimates of the cover of "natural grassland", which includes reeds, are probably highly inaccurate. The reed-bed is already greatly fragmented and could completely disappear unless it is afforded some protection in the near future. There is also much illegal hunting and netting of birds.

**Economic and social values:** No information.

**Fauna:** One of the most outstanding areas in northern Thailand in terms of the variety of wintering birds which it supports. Small numbers of herons (*Egretta garzetta*, *E. intermedia*, *E. alba*) winter in the area, and *Ardea cinerea* and *Botaurus stellaris* are both annual visitors.

There are occasional records of *Ciconia nigra*, *Tadorna ferruginea* and *Anas poecilorhyncha* (up to five birds). During the ploughing stage of the rice paddies (December-January), the basin attracts many hundreds of shorebirds, particularly *Charadrius dubius*, *Tringa glareola* and *Calidris temminckii*. There are also flocks of up to 20 *Vanellus cinereus*, many wagtails (chiefly *Motacilla flava*, *M. citreola*) and pipits (chiefly *Anthus cervinus*). The Rosy Pipit *Anthus roseatus* was discovered wintering here in 1982; 15-20 birds are usually present (Round, 1983). A few harriers, *Circus (aeruginosus) spilonotus* and *C. melanoleucos*, also winter in the area. The reed-beds provide a roosting site for many hundreds of wagtails and buntings (*Emberiza aureola*, *E. fucata*, *Melophus lathami*). There are recent records of *Charadrius placidus* on sand banks on the Nam Mae Kok at Tha Ton. There are few breeding season records, but sand banks on the rivers are known to support a few breeding pairs of *Charadrius dubius*. The marshes probably support a few pairs of *Ixobrychus sinensis*, *I. cinnamomeus* and *Dendrocygna javanica*. The reed-bed is one of very few sites known to support the scarce and local *Saxicola jerdoni*. At least two territories are known and the species is presumed to breed. The area is a former site for *Grus antigone* which is now extinct in Thailand. In addition, there are old records of both *Esacus magnirostris* and *Sterna aurantia* from sand banks on the Nam Mae Kok at Tha Ton (Deignan, 1945). Both of these species may still occur in Thailand but are thought to be endangered.

**Special floral values:** None known.

**Research and facilities:** Most of what is known about the site has been gleaned from the reports of those visiting bird-watchers who have filed their records at the Center for Wildlife Research.

**References:** Deignan (1945); Land Use Classification Division (1977-1979); Round (1983).

**Criteria for Inclusion:** 2b.

**Source:** Jim Jintanugool and Philip D. Round.

**Wetland name:** Nong Luang

**Country:** Thailand

**Coordinates:** 19°47'-19°52'N, 99°57'E;

**Location:** 17 km southeast of Chiang Rai town, Muang District, Chiang Rai Province; 6 km from Wiang Chai District.

**Area:** 2,000 ha.

**Altitude:** 400m; surrounded by low rolling hills rising to 523m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 11, 13, 15, 18 & 19.

**Description of site:** A complex of small pools, reed-beds, grassland and rice paddies along the Huai Luang and Nam Mae Sakun, tributaries of the Nam Mae Kok. The area lies at the extreme southeast corner of the extensive alluvial basin around Chiang Rai town and is bounded by low hills. The wetland is transected by a road. An embankment along the Huai Rong Boa, another tributary of the Nam Mae Sakun, has probably served to reduce the areas of seasonal inundation. The areas of open water are rather small, ranging in size from 5-50 ha. Paddies occupy

approximately 1,200 ha and marshes 400 ha. There are also seven bamboo-covered islands at the site, of which the largest is approximately 40 ha. The wetland is fed by freshwater run-off from the nearby hills and a major inflow from the Nam Mae Sakun. The outflow is also into the Nam Mae Sakun, which flows into the Kok River. Flooding is most extensive during the late wet season and early part of the dry season. The margins of the area dry out gradually until the beginning of the rains in May.

**Climatic conditions:** Tropical monsoonal climate.

**Principal vegetation:** Extensive beds of *Saccharum arundinaceum*. The floating vegetation includes *Eichhornia crassipes*. Land to the west of the site is mainly under cultivation, but there are still many patches of bamboo and deciduous woodland among the hills to the east.

**Land tenure:** The marshes and open water areas are under public ownership; the paddies are privately owned but are mostly worked by tenant farmers. Surrounding areas are privately owned farmland.

**Conservation measures taken:** None.

**Conservation measures proposed:** It is proposed to establish a Non-Hunting Area, covering an area of 1,470 ha, at Nong Luang.

**Land use:** Fishing, cattle grazing and cultivation of lotus and rice (one crop per year of irrigated or rain-fed rice); cultivation of vegetables and lychee orchards in surrounding areas.

**Disturbances and threats:** The burning and cutting of reeds in order to open up areas for cultivation (lotus in flooded areas and vegetables in the drier situations) is a major threat. Hunting of waterbirds is reported to be heavy.

**Economic and social values:** Nong Luang supports an important small-scale local fishery. In addition, the water body serves as a source of water for irrigating the small rice paddies around its margins.

**Fauna:** Not yet surveyed in detail. The area is known to support a few wintering egrets, together with small numbers of *Dendrocygna javanica*, *Nettapus coromandelianus*, *Gallinula chioropus* and *Porphyrio porphyrio*. The extensive reed-beds can be expected to support wintering *Botaurus stellaris*, *A. purpurea* and reed warblers *Acrocephalus* spp, as well as breeding and wintering *Ixobrychus* spp. The habitat almost certainly supports *Saxicola jerdoni*. At least six different wintering Pied Harriers *Circus melanoleucos* were seen in December 1985.

Otters *Lutra* sp are reported to occur.

**Special floral values:** One of the most extensive remaining reed-beds in northern Thailand; probably a good representative fragment of the kind of habitat which once covered huge areas of the plains around Chiang Rai.

**Research and facilities:** A fisheries station of the Inland Fisheries Division, Department of Fisheries, is situated at Nong Luang.

**References:** Amget et al. (1985); Land Use Classification Division (1977-79).

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

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Nong Hang

**Country:** Thailand

**Coordinates:** 19°30'N, 99°48'E;

**Location:** in Phan District, Chiang Rai Province.

**Area:** 740 ha.

**Altitude:** 400m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 15.

**Description of site:** Not surveyed, but identified as of possible interest from map sheets (Land Use Classification Division 1977-1979). A complex of three small pools on the Nam Mac Hang waterway, which drains into the Nam Mae San. One other pool of six ha, Nong Wiang Hao, is situated three km to the northeast.

**Climatic conditions:** Tropical monsoonal climate.

**Principal vegetation:** Rice paddy. Secondary growth and degraded forest on nearby hills.

**Land tenure:** No information.

**Conservation measures taken:** None.

**Land use:** Rice paddy (one crop of wet season rice per year).

**Disturbances and threats:** No information.

**Economic and social values:** No information.

**Fauna:** No information.

**Special floral values:** No information.

**References:** Land Use Classification Division (1977-1979).

**Criteria for inclusion:** 0.

**Source:** Era Jintanugool and Philip D. Round.

**Wetland name:** Nong Leng Sai

**Country:** Thailand

**Coordinates:** 19°23'N, 99°49'E;

**Location:** about 25 km north of the town of Phayao, Mae Chai District, Phayao Province.

**Area:** 1,050 ha.

**Altitude:** 400m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 15.

**Description of site:** An extensive marsh lying on a tributary of the Nam Mae Ing upstream of Kwan Phayao. The marsh drains out at its southern end. Land Use Classification Division (1977-1979) marks six pools of less than 10 ha in size at the southern end.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,309 mm (range 710-1,997 mm), 87.8% of which falls during the southwest monsoon (May to October). The mean annual temperature is 26.3°C (range 3.9-44.1°C). (Data from Nan Province, to the east).

**Principal vegetation:** No information is available on the aquatic vegetation. Chiefly rice paddy in adjacent areas.

**Land tenure:** The wetland is state owned; public use is permitted. Surrounding areas are mainly privately owned.

**Conservation measures taken:** None.

**Conservation measures proposed:** The site requires a survey in order to determine its status.

**Land use:** No information. Cultivation of rice (one crop of wet-season rice per year) in surrounding areas.

**Disturbances and threats:** No information.

**Economic and social values:** No information.

**Fauna:** No information.

**Special floral values:** No information.

**References:** Land Use Classification Division (1977-1979).

**Criteria for inclusion:** 0.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Kwan Phayao

**Country:** Thailand

**Coordinates:** 19°10'N, 99°52'E;

**Location:** the wetland extends up to four km north and west of the town of Phayao, Phayao Province.

**Area:** 2,300 ha.

**Altitude:** 380m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 14 & 19.

**Description of site:** A large, permanent, freshwater lake (1,980 ha), fringed by approximately 3,000 ha of rice paddy to the south and west and with a marshy area and some old oxbows (c.300 ha) at the northern end where the Nam Mae Ing empties into the lake. There is also some inflow from the Mae Tam which empties into the lake from the south. The eastern shore of the lake is largely built-up, and the town of Phayao lies near the southeast corner. The lake empties to the east, via the Nam Mae Ing, into the Mekong. The water level is controlled by a sluice gate and a spillway; the mean depth is 1.7m, and the pH varies from 6.0-9.1. Kwan Phayao is one of the largest semi-natural wetlands in northern Thailand.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,064 mm. The mean monthly relative humidity ranges from 70 to 80%; the mean monthly temperature, from 19.5 to 27.5°C.

**Principal vegetation:** Thirty-six species of aquatic plants have been recorded. *Najas graminea* and *Ceratophyllum demersum* are the predominant submerged plants. There is also much *Salvinia cucullata*, *Eichhornia crassipes*, *Nelumbo nucifera*, and some *Scirpus grosus*.

Adjacent areas are almost entirely cultivated (mainly rice paddy with some maize, groundnuts and tobacco).

**Land tenure:** The lake is in public ownership, but the adjacent shoreline is mainly privately owned. Surrounding areas are privately owned farmland, much of which is leased to tenant farmers.

**Conservation measures taken:** None.

**Conservation measures proposed:** None

**Land use:** Fishing with the aid of gill-nets, and cultivation of lotus; mainly rice paddy (one crop per year) with some cultivation of green vegetables, tobacco, maize and groundnuts in surrounding areas.

Possible changes in land use: The wetland is one of three sites proposed for the Large-Scale Inland Fisheries Project (L.S.I.F.P.) of the Department of Fisheries. This has recommended increasing fish production by manipulation of water levels, dredging to improve spawning grounds, fish stocking and increased pen culture of fishes. The project also recommends the utilization of aquatic macrophytes for biogas production, animal feed and fish feed.

**Disturbances and threats:** Most emergent lakeshore vegetation has already been destroyed due to lotus cultivation. The use of boats on the lake by fishermen and the widespread hunting of waterfowl around the lake have greatly reduced usage of the area by waterfowl. The implementation of L.S.I.F.P. could have some damaging impact upon the ecosystem since reduced fluctuations in water level would reduce feeding opportunities for wading birds. There could also be changes in the lakeshore vegetational succession. Any additional impact on the diversity of wild fish populations would need to be evaluated. However, there has already been so much human disruption of the lake ecosystem (e.g. through the introduction of *Tilapia nilotica*) that any further impact may be minor. The collection of vegetation for biogas, if restricted to *Eichhornia*, would not be damaging.

**Economic and social values:** The average net income from fishing has been estimated at Bht.7,800 per household per year (approximately US\$312). The lake is important as a source of municipal water supply (7,680 cu.m per day). Approximately 5,000 fishermen operate in the lake, but a total of 500,000 persons are dependent to some extent on the lake's resources (Anon, 1985).

**Fauna:** The standing crop of fish has been estimated at 159 kg/ha. Twenty-two species have been recorded, but just five species make up over 90% of the fish biomass. Chief among these are *Tilapia nilotica* (productivity 21.9 kg/ha/year) and *Anabas testudineus* (2.19 kg/ha/year).

Forty-seven species of resident and migratory birds were recorded during a one day survey in January 1982. The only wildfowl present were a few *Anas acuta* and unidentified *Anas sp.*

Usage of the open water by waterfowl is low, but would probably increase if disturbance by fishermen could be reduced. The surrounding marshes and paddies support *Circus (aeruginosus) spilonotus* and *C. melanoleucos* in winter.

**Special floral values:** None known.

**Research and facilities:** A Government Fisheries Station is sited at the lake, the annual reports of which are available through the library of the National Inland Fisheries Institute at Kasetsart University, Bangkok. Staff and students of the Biology Department, Chiang Mai University, have conducted research on the aquatic fauna and flora.

**References:** Anon (1985a); Land Use Classification Division (1977-1979).

**Criteria for inclusion:** 1 e.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Beung Khong Long Non-Hunting Area

**Country:** Thailand

**Coordinates:** 17°58'-18°03'N, 103°59'-104°02'E;

**Location:** extending up to 10 km north of the village of Ban Pho Mak Khaeng, Seka District, Nong Khai Province.

**Area:** 1,290 ha.

**Altitude:** 160m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 14 & 19.

**Description of site:** A large, permanent lake, approximately 10 km from north to south and 1.5 km from east to west. Two-thirds of the area (910 ha) is open water. There are a few vegetated islands in the lake, some of which support trees, and 380 ha of marshland at the northern end. The outflow is at the south end of the lake; water releases are controlled by a sluice, and under normal circumstances, a high water level is maintained. Most of the lake is 0.5-1.0m deep, although the maximum depth is about 6m. The lake is surrounded by cultivation, with the principal human settlements at the southern tip.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,367 mm (range 929-1,998 mm), 87.5% of which falls during the southwest monsoon from May to October. The mean annual temperature is 26.8°C (maximum 43.9°C, minimum 2.5°C). The climate is characterized by a short cool season and a longer, hotter dry season.

**Principal vegetation:** Extensive beds of *Cyperus spp*, *Eleocharis sp* and *Nelumbo nucifera*, with smaller areas of taller reeds and *Scirpus grossus*. Some *Eucalyptus* trees have been planted along the western shore of the lake. Adjacent areas are chiefly under cultivation, although there are a few small patches of dry evergreen woodland, bamboo and forest fallows. There are also about 100 ha of primary evergreen woodland dominated by *Dipterocarpus alatus* at Don Sawan and a neighbouring area, at the northern end of the lake.

**Land tenure:** The wetland is state owned and open to public use; surrounding areas are mainly private farmland and villages.

**Conservation measures taken:** The site was established as a Non-Hunting Area in 1982.

**Conservation measures proposed:** The site should be surveyed at regular intervals during the winter months to determine whether it supports any appreciable populations of migratory waterfowl, and during the wet season in order to determine the breeding bird community.

**Land use:** Fishing, chiefly using nets and traps; cultivation of rice (one crop of wet-season rice per year) and cassava in surrounding areas.

Possible changes in land use: There is a strong likelihood of increased tourism and recreational use at the site.

**Disturbances and threats:** Fishing is probably a major source of indirect disturbance, limiting the usage of the site by waterfowl. There is also some illegal hunting of waterfowl.

**Economic and social values:** The site could have considerable amenity value. The lake is stocked with common food fish species and the fishery is of local importance.

**Fauna:** Some 200 Mekong Giant Catfish *Pangasianodon gigas* have been released in the lake by the Department of Fisheries.

At least 300 egrets winter at the site, together with large numbers of *Ardeola bacchus*. Duck numbers were estimated at a minimum of 3,000 in January 1986. The principal species were *Dendrocygna javanica*, *Nettapus coromandelianus*, *Anas acuta* and *A. querquedula*. Other species recorded included *Porphrio porphyrio*, *Gallinula chioropus* and *Hydrophasianus chirurgus*. There has been one sighting of a pelican *Pelecanus sp.*

**Special floral values:** Not known, but probably of considerable interest. The site supports one of the last fragments of lowland evergreen forest in the entire northeast region of the country.

**Research and facilities:** A preliminary survey of the site was made prior to its establishment as a Non-Hunting Area. A further visit was made by Jira Jintanugool in January 1987. Some accommodation is available at the headquarters of the Non-Hunting Area.

**References:** Land Use Classification Division (1977-1979).

**Criteria for inclusion:** lb. 2b.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Lower Nam Mong Basin

**Country:** Thailand

**Coordinates:** 17°48'-17°57'N, 102°31'-102°38'E;

**Location:** extending between Si Chiang Mai and Tha Bo Districts of Nong Khai Province, 0-10 km from the Mekong River.

**Area:** c.10,000 ha.

**Altitude:** c.160m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 11, 13, 14, 15 & 19.

**Description of site:** A marshy floodplain, extending for approximately 15 km along the Nom Mong River. The site includes at least seventeen patches of marsh or lakes, ranging in size from 10 to 270 ha. These lie scattered among rice fields together with a few patches of degraded woodland. The site is transected by a number of roads. It has been identified from Land Use Classification Division (1977-1979), and has not been ground-checked in recent years.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,367 mm (range 929-1,998 mm), most of which falls during the southwest monsoon (May to October). The mean annual temperature is 26.8°C (range 2.5-43.9°C). (Data from Udon Thani, to the south).

**Principal vegetation:** No information is available on the aquatic vegetation. Adjacent areas are chiefly under rice cultivation, with a few patches of dry dipterocarp woodland remaining.

**Land tenure:** The site is under both private and state ownership. Surrounding areas are chiefly in private ownership.

**Conservation measures taken:** None.

**Conservation measures proposed:** The site should be surveyed to determine whether or not it is of significant conservation value.

**Land use:** Rice cultivation, with one crop of wet-season rice per year.

**Disturbances and threats:** No information.  
**Economic and social values:** No information.  
**Fauna:** No information.  
**Special floral values:** No information.  
**References:** Land Use Classification Division (1977-1979).  
**Criteria for inclusion:** 0.  
**Source:** Era Jintanugool and Philip D. Round.

**Wetland name:** Nong Hua Khu Non-Hunting Area  
**Country:** Thailand  
**Coordinates:** 17°35'N, 102°37'E;  
**Location:** near Ban Nong Hun Khu village, 20 km from the town of Ban Phu, Ban Phu District, Udon Thani Province.  
**Area:** 11 ha.  
**Altitude:** 185m.  
**Biogeographical Province:** 4.10.4.  
**Wetland type:** 14.  
**Description of site:** A small, permanent, natural pond surrounded by paddyfields. Inflow is from local run-off.  
**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,282 mm (range 860-1,833 mm), 85.4% of which falls during the southwest monsoon (May to October). The mean annual temperature is 27.6°C (range 6.3-42.5°C).  
**Principal vegetation:** The pond is fringed with small areas of *Saccharum arundinaceum*, *Cyperus* spp and *Scirpus mucronatus*. Adjacent areas are chiefly rice paddy with a few patches of dry dipterocarp woodland.  
**Land tenure:** The wetland is state owned and open to public use; surrounding areas are privately owned farmland.  
**Conservation measures taken:** The site was established as a Non-Hunting Area in 1984. The local "kamnan" (Head of the Subdistrict) has safeguarded the waterfowl at the site from disturbance since 1974. By local agreement, fines of Bht.1,000 have been levied for illegal hunting.  
**Conservation measures proposed:** A major waterfowl site, worthy of regular censusing. The boundaries of the Non-Hunting Area should be extended to encompass adjacent woodlands if *Sarkidiornis melanotos* is found to be breeding in the vicinity.  
**Land use:** Some recreational use; the pond is also an important source of water for cattle. Cultivation (chiefly rain-fed, single crop rice paddy) in surrounding areas.  
**Disturbances and threats:** No information.  
**Economic and social values:** An important local amenity.  
**Fauna:** At least 2,500 ducks were present in January 1987. The predominant species were *Dendrocygna javanica*, *Anas querquedula* and *A. acuta*. also present were single *A. clypeata* and *Aythya* sp (probably *A. baeri*). The local kamnan reported the occasional presence of up to 10 *Sarkidiornis melanotos*, which may breed in nearby woodlands.  
**Special floral values:** None known.  
**Criteria for inclusion:** 2b.  
**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Nong Han Kumphawapi  
**Country:** Thailand  
**Coordinates:** 17°10'N, 103°02'E;

**Location:** extending for up to 12.5 km north of the town of Kumphawapi, Udorn Thani Province.

**Area:** 4,100 ha.

**Altitude:** 170m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 14 & 19.

**Description of site:** A freshwater lake of about 1,760 ha, surrounded by approximately 2,360 ha of marshland which fringes the entire shoreline and extends back as far as 1.5 km; one of the largest natural wetlands in the northeast part of the country. The lake extends for seven km from north to south and three km from east to west at its widest point. The main inflow is from the Huai Phai Chan Yai, which flows off the highlands to the east, but there are other smaller streams entering from the north and west. The outflow is at the south end of the lake, into the Lam Pao river system. The lake is shallow (mostly less than one metre deep) and permanent, with considerable seasonal fluctuations in water level. There is a fairly high human population density around the lakeshore, scattered chiefly among seven small villages.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,367 mm (range 929-1,997 mm), 87.5% of which falls during the southwest monsoon (May to October). The mean annual temperature is 26.8°C (range 2.5-43.9°C).

**Principal vegetation:** *Scirpus grossus*, *Eichhornia crassipes*, *Nelumbo nucifera* and many short grasses. Chiefly cultivation in adjacent areas, with some patches of dry dipterocarp woodland remaining, especially on the uplands.

**Land tenure:** The site is state owned and open to public use; surrounding areas are mainly privately owned farmland.

**Conservation measures taken:** None.

**Conservation measures proposed:** The site should be surveyed to determine its present status and conservation importance. It may be suitable for establishment as a Non-Hunting Area.

**Land use:** Fishing and the raising of domestic ducks; cultivation in surrounding areas, mainly cassava and sugar cane, with some areas of single crop rice (one wet-season crop per year).

**Disturbances and threats:** The lake appears to be silting up. The levels of disturbance by fishermen are very high and probably limit the utilization of the site by waterfowl.

**Economic and social values:** The wetland is important as a source of water for local use. Although there is no irrigation project at the site, water is hand-carried by local people for household use.

**Fauna:** No information.

**Special floral values:** No information.

**References:** Land Use Classification Division (1977-1979).

**Criteria for inclusion:** 2b.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Nong Han

**Country:** Thailand

**Coordinates:** 17°06'-17°15'N, 104°07'-104°20'E;

**Location:** extending up to 12 km northeast from the town of Sakhon Nakhon, Sakhon Nakhon Province.

**Area:** 12,520 ha.

**Altitude:** c.150m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 14.

**Description of site:** A large, permanent, freshwater lake situated among low rolling hills, and with a catchment area of 1,653 sq.km; one of the largest natural water bodies in the country. There are small areas of paddy and patches of marshland, these last totaling 750 ha. The western shore of the

lake is somewhat urbanized, and the town of Sakhon Nakhon lies at the southwest corner. The main inflow is from the Nam Pung River, which runs off the Phuphan mountain range to the south. The only significant outflow is the Nam Khan, which drains southeast into the Mekong River. A spillway and two sluice gates have been installed. The average depth of the lake is 1.9m and the maximum depth, 4.3m; the pH ranges from 7.0-8.4. There are considerable fluctuations in water level, with some areas around the margins drying out at the height of the dry season.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,531.7 mm. The mean relative humidity ranges from 62-80%, the mean air temperature from 23-28°C, and the water temperature from 31-34°C.

**Principal vegetation:** *Pistia stratiotes* and *Eichhornia crassipes* predominate among 18 species of aquatic plants which also include *Scirpus grossus*, *Eleocharis plantaginea*, *Nelumbo nucifera* and *Nymphoides indicum*. Adjacent areas are mainly under cultivation, with some patches of scrub woodland.

**Land tenure:** The lake is under public ownership; surrounding areas are mainly in private ownership.

**Conservation measures taken:** None.

**Conservation measures proposed:** The site has been proposed as a Non-Hunting Area.

**Land use:** Fishing with gill nets, hooks and traps; cultivation of rice (one crop of wet-season rice per year) and some cassava, cotton and maize in surrounding areas.

Possible changes in land use: This is one of the sites suggested for implementation of the Large Swamp Inland Fisheries Project, which aims to increase fish yields through stocking, dredging and manipulation of water levels.

**Disturbances and threats:** The great intensity of human use probably restricts utilization of the area by waterfowl. There will almost certainly be direct disturbance of nesting species, e.g. the taking of eggs for food. Pesticide levels have not been assessed, but there may be some input of persistent organochlorines into the lake system from areas of cotton grown in nearby uplands. There may also be reduced inflow to the lake as a result of increased utilization of water upstream for irrigation and water resource projects.

**Economic and social values:** Some 11,700 fishermen live around the lake and the net annual income from fishing has been estimated at Bht.1 1,200 (about US448) per household per year (Anon, 1985). The average daily catch has been estimated at 1,794 kg of which 39% is consumed locally (Jansirisak, 1977). The lake is a source of municipal water supply at the rate of 15,840 cu.m per day, supplying a total of 900,000 persons.

**Fauna:** A total of 44 species of fish has been recorded (National Inland Fisheries Institute, 1980). *Puntius leiacanthus* predominates numerically, accounting for 20% of the total number of fish caught. The standing crop of fish has been estimated at 32 kg/ha (Anon, 1985) and 34-87.5 kg/ha (Jansirisak 1977). No information is available on the other fauna.

**Special floral values:** No information.

**Research and facilities:** The Sakhon Nakhon provincial fisheries station is sited at the lake.

**References:** Anon (1985a); Hiranwat et al. (1977); Jansirisak (1977); National Inland Fisheries Institute (1980).

**Criteria for inclusion:** lb, le, 2b.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Nong Waeng Non-Hunting Area

**Country:** Thailand

**Coordinates:** 15°55'N, 102°16'E;

**Location:** in front of the District Office, Khon Sawan, Chaiyaphum Province.

**Area:** 17.5 ha.

**Altitude:** c.170m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 14.

**Description of site:** A small, permanent, freshwater lake situated on the outskirts of the small town of Khon Sawan. The site is mainly open water with small areas of fringing aquatic vegetation, and is ringed by minor roads and houses. It acts as a daytime refuge for wintering wildfowl which flight out to feed in adjacent areas along the Lam Nam Chi, 5-10 km to the southeast. The maximum depth in the dry season is 1.5m.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,282 mm (range 860-1,633 mm), 85.4% of which falls during the southwest monsoon (May to October). The mean annual temperature is 27.6°C (range 6.3-42.5°C).

**Principal vegetation:** Large areas of *Nelumbo nucifera*, *Eichhornia crassipes* and *Pistia stratiotes* on the surface of the lake, and fringing stands of *Scirpus mucronatus* and *Scieria oryzoides*. Chiefly rice paddy in adjacent areas.

**Land tenure:** The lake is state owned; surrounding areas are mainly private households and small-holdings.

**Conservation measures taken:** The site was declared as a Non-Hunting Area in 1982. Fishing is prohibited.

**Conservation measures proposed:** None

**Land use:** Recreation and water supply for the municipality; cultivation of rice (one crop of wet-season rice per year) in surrounding areas.

**Disturbances and threats:** None known.

**Economic and social values:** The site has great recreational value and is the venue for an annual "duck fair", the impetus for which was provided by the enlightened local District Officer. The annual festivities centre around entertainments and a market. There is no deliberate disturbance of the waterfowl.

**Fauna:** The fish fauna includes a variety of common and widespread species. Up to 8,000 ducks winter in the area, roosting on the lake and flighting out to feed in adjacent rice paddies. The predominant species are *Dendrocygna javanica*, *Anas querquedula* and *A. acuta*, with up to 100 *Nettapus coromandelianus*. Other species known to occur include *Anas clypeata*, *Gallinula chioropus*, *Porphyrio porphyrio*, *Fulica atra* and *Metopidius indicus*. Waterfowl recorded during a census in mid-January 1988 included 5,200 *D. javanica*, 2,565 *A. querquedula* and 30 *A. acuta*.

**Special floral values:** None known.

**Research and facilities:** None

**References:** None

**Criteria for inclusion:** 2b, 3b.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Nong Lahan

**Country:** Thailand

**Coordinates:** 15°35'-15°40'N, 101°50'-101°56'E;

**Location:** about 3 km northeast of Chatturat, Chaiyaphum Province.

**Area:** 2,500 ha.

**Altitude:** 190m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 14 & 19.

**Description of site:** A huge area subject to shallow flooding, between the Mae Nam Chi and the town of Chatturat, near the southwest tip of a basin of several hundred sq.km of rice paddy. The Chi River skirts the wetland at its northern end, passing within less than 500m. Most of the area is

seasonally flooded, but there is at least one permanent lake of 90 ha, Nong Bua Ya, at the southern end. Two other such lakes, Nong Hin Tang, with a total area of 70 ha, are included in the Nong Lahan complex, but these may already have been drained. The main outflow is via the Mae Nam Chi; this is probably also the major source of inflow, through flood spillage in the late wet season (July to November). The maximum depth of water is only 1.0-1.5m, and there are extensive shallows of 15-25 cm, even as early as December. The lake dries up gradually during the dry season, diminishing in surface area by at least 50% during normal years and exposing extensive areas of mud which become covered with short grass. The site is undoubtedly one of the largest and richest remaining wetlands in the entire northeast of Thailand.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,282 mm (range 860-1,633 mm), 85.4% of which falls during the southwest monsoon (May to October). The mean annual temperature is 27.6°C (range 6.3-42.5°C).

**Principal vegetation:** Extensive areas of tall "reeds", either *Saccharum arundinaceum* or *Scieria poaeformis*, together with some areas of scrubby swamp woodland around the lake margins. Dense mats of *Salvinia cucullata* cover the water surface and there is much submerged weed (possibly *Elodea* sp). There is also some *Nelumbo nucifera*, which is actively encouraged. Adjacent areas are mainly under cultivation for rice, but there are scattered trees and small patches of bamboo *Bambusicola* sp.

**Land tenure:** The wetland is state owned and open to public use; surrounding areas are privately owned farmland.

**Conservation measures taken:** None.

**Conservation measures proposed:** A Fisheries Station is to be established at the wetland. The site should be established as a Non-Hunting Area or other category of reserve.

**Land use:** Fishing, cultivation of lotus, raising of domestic ducks, hunting of wintering waterfowl and occasional netting of roosting flocks of small passerine birds. In addition, there is some cattle grazing and rice cultivation around the lake margins. The predominant land use in surrounding areas is rice cultivation (one crop of wet-season rice per year).

**Disturbances and threats:** The principal threats are the reduction in areas of lakeside vegetation due to the cutting of trees for charcoal and the burning of reeds in order to open up areas for lotus cultivation. The area is also heavily over-fished and hunting pressure is intense. Not only is there widespread shooting of larger birds by local people, but occasional netting forays are made by market trappers who sell small passerines (wagtails, weavers and buntings) for food.

**Economic and social values:** The lake is of tremendous importance as a source of water in an area prone to drought. It provides a source of water for the municipality of Chatturat, and also for local villagers who hand-carry water from the lake for household use. Jute, which is grown in the surrounding areas, is soaked in the lake. The lake is also important for watering livestock and ensuring an adequate supply of animal fodder. The marsh grasses are grazed by domestic livestock and some aquatic plants are harvested as fodder, e.g. for feeding to pigs. Lotus *Nelumbo nucifera* has a variety of uses; the tubers and seeds are eaten, while the leaves are used for wrapping food items. No information is available on the fishery, but this is clearly of great importance.

**Fauna:** The area supports a great concentration of wintering waterfowl, including *Dendrocygna javanica* (over 2,000), *Anas querquedula* (at least 6,500), *Nettapus coromandelianus* (30), and *Fulica atra* (95). In addition, over 30 *Ardea cinerea*, a few *A. purpurea* and 200 *Anastomus oscitans* have been recorded, together with flocks of *Ardeola bacchus* and three species of *Egretta*. The area supports many wintering raptors, including *Milvus migrans* (50-100) and *Circus (aeruginosus) spilonotus* (10-20). There have been occasional records of *Gyps bengalensis*, which is close to extinction in Thailand. Several hundred shorebirds are frequently present: in order of abundance, these are *Tringa glareola*, *Calidris subminuta*, *Gallinago gallinago*, *Pluvialis dominica* and *Calidris temminckii*. Other species have included *Tringa nebularia*, *Calidris alpina* and *Philomachus pugnax*. This is also a regular site for the scarce and

local *Glareola lactea* which may well breed. In addition, there are large roosts of weavers *Ploceus* spp and the bunting *Emberiza aureola*. A total of 76 species of birds was recorded in the area during a two day survey in late December 1984.

The area has never been surveyed during the wet season, but species recorded during the winter months which are thought to breed at the lake include *Tachybaptus ruficollis*, *Dendrocygna javanica*, *Nettapus coromandelianus*, *Porphyrio porphyrio*, *Metopidius indicus* and *Hydrophasianus chirurgus*. Larger waterbirds such as egrets, storks and herons do not breed because of human disturbance.

**Special floral values:** None known.

**Research and facilities:** Many groups of bird-watchers have visited the site and have filed their records at the Association for the Conservation of Wildlife in Bangkok.

**References:** Land Use Classification Division (1977-79).

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

**Source:** Era Jintanugool and Philip D. Round.

**Wetland name:** Mun River

**Country:** Thailand

**Coordinates:** 15°28'N, 103°00'E to 15°08'N, 104°25'E;

**Location:** the course of the River Mun from Phuthaisong District, Maha Sarakham Province, downstream through Buriram and Surin Provinces to Muan District, Sisaket Province.

**Area:** Approximately 200 km of river and 54,000 ha of riverine marshes.

**Altitude:** 130m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 11, 15 & 18.

**Description of site:** An area of marshes flanking the banks of the Mun River and in places extending more than two km back from each bank. The site includes some areas of marsh on the lower reaches of the major tributaries of the Mun, of which the most extensive lie along the Lam Phiappa. There is great seasonal variation in the extent of standing water, flooding usually reaching a peak in October and November. The site has not been ground-checked and no further information is available. Areas of marshland and other habitats were identified from Land Use Classification Division Maps, 1978-79.

**Climatic conditions:** Tropical monsoonal climate.

**Principal vegetation:** No information is available on the aquatic vegetation. Adjacent areas are mainly under cultivation, although a few patches of dry dipterocarp woodland persist.

**Land tenure:** No information.

**Conservation measures taken:** None.

**Conservation measures proposed:** The area should be surveyed in order to determine the extent and value of remaining natural or semi-natural wetland habitats.

**Land use:** Not known, but human use through fishing is expected to be intensive. The principal land use in surrounding areas is rice cultivation (one crop of wet-season rice per year).

**Disturbances and threats:** Probably considerable; in some areas, urban sprawl may be encroaching on marshy habitats, and hunting pressure is probably intense.

**Economic and social values:** No information.

**Fauna:** No information.

**Special floral values:** No information.

**Research and facilities:** None

**References:** Land Use Classification Division (1977-1979).

**Criteria for inclusion:** 0.

**Source:** Era Jintanugool and Philip D. Round.

**Wetland name:** Confluence of the River Mun and River Chi

**Country:** Thailand

**Coordinates:** 15°10'-15°15'N, 104°35'-104°50'E;

**Location:** the Lower Mae Nam Chi in Kanthararom District, Sisaket Province, together with its confluence with the Mae Nam Mun, downstream along the Mae Nam Mun to Muang District, Ubon Ratchathani Province.

**Area:** 9,750 ha.

**Altitude:** c. 120m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 11, 15, 18 & 19.

**Description of site:** An area of riverine marshes flanking both banks of the rivers and in places extending up to three or four km back from the banks. The marshes are probably subject to overspill from the Mun and Chi Rivers during the late wet season, with flooding most marked during October and November. The human population density is fairly high, and the site borders on the provincial town of Ubon at its downstream margin. The site has been identified from Land Use Classification Division Maps, and has not been ground-checked.

**Climatic conditions:** Tropical monsoonal climate.

**Principal vegetation:** No information is available on the aquatic vegetation. Adjacent areas are mainly under cultivation, but a few small patches of dry dipterocarp woodland persist.

**Land tenure:** No information.

**Conservation measures taken:** None.

**Conservation measures proposed:** The area should be surveyed in order to determine its conservation value.

**Land use:** Fishing and rice cultivation; rice cultivation in surrounding areas (one crop of dry-season rice per year).

Possible changes in land use: The westward urban spread of Ubon Ratchathani town is encroaching upon the wetland.

**Disturbances and threats:** Probably hunting and the cutting and burning of tall grass and other riparian vegetation combined with a generally high level of human use of the area.

**Economic and social values:** No information.

**Fauna:** No information.

**Special floral values:** No information.

**Research and facilities:** None

**References:** Land Use Classification Division (1977-1979).

**Criteria for inclusion:** 0.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Lam Plai Mat

**Country:** Thailand

**Coordinates:** 14°47'-14°57'N, 102°52'E;

**Location:** situated on the Lam Nam Mat, a tributary of the Mae Nam Mun. The site extends for 8 to 26 km upstream of the district town of Lam Plai Mat, Buriram Province.

**Area:** 1,900 ha.

**Altitude:** c. 160m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 11, 15, 18 & 19.

**Description of site:** A large area of seasonally flooded marshy land flanking both banks of the Lam Nam Mat, subject to overspill from the river during the wet season. The area is frequently flooded during the wet season, but reverts to a canalized river in the driest months. The site has been identified from Land Use Classification Division Maps, and has not been ground-checked. The area is classified as "waste land", which is land not utilized for cultivation.

**Climatic conditions:** Tropical monsoonal climate subject to a long, hot dry season from November to April. Over 80% of the annual rainfall occurs during the southwest monsoon.

**Principal vegetation:** No information is available on the aquatic vegetation. Adjacent areas are mainly under cultivation.

**Land tenure:** The wetland is state owned and open to public use; surrounding areas are mainly in private ownership.

**Conservation measures taken:** None.

**Conservation measures proposed:** The area requires a survey to determine its status and conservation value.

**Land use:** Water storage; a small dam has been constructed in order to maintain artificially high water levels. Cassava, sugar cane and wet-season rice (one crop per year) are grown in surrounding areas.

**Disturbances and threats:** No information.

**Economic and social values:** No information.

**Fauna:** No information.

**Special floral values:** No information.

**Research and facilities:** None

**References:** Land Use Classification Division (1977-1979).

**Criteria for inclusion:** 0.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Huai Chorakhe Mak and Huai Talat Non-Hunting Areas

**Country:** Thailand

**Coordinates:** 14°53'N, 103°03'E;

**Location:** 11 km southwest of the town of Buriram, Muang District, Buriram Province.

**Area:** Huai Chorakhe Mak 760 ha; Huai Talat 820 ha.

**Altitude:** c. 160m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 17.

**Description of site:** Two reservoirs created in about 1975 by the damming of small streams, and situated approximately one km apart on an extensive floodplain. There is relatively little emergent or aquatic floating vegetation and no permanent marshland. Inflow is via the Huai Chorakhe Mak into the westernmost of the two sites, and from run-off, chiefly from the south and west, via a number of other small streams. The reservoirs drain into the River Mun. The average depth of water is 5-7m. Both wetlands are permanent, with a seasonal fluctuation in water levels of approximately 2m. The area of open water diminishes by approximately 25% during the dry season, when much dense weed and some mud is exposed.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,197 mm, over 80% of which falls during the southwest monsoon (May to October). There is a long, hot, dry season during which the annual temperature may rise to 4.4°C. The mean annual temperature is 27.1°C. (Data from Nakhon Sawan, 110 km to the northeast of the site).

**Principal vegetation:** There is a bed of a few hectares of *Cyperus sp.* and *Lepironia sp.* occurs at the western end of *Huai Chorakhe Mak*. The floating aquatic vegetation includes *Nelumbo nucifera*

and *Nymphaea* sp. There are some patches of dry dipterocarp woodland in surrounding areas, but most of the land is under cultivation, mainly for rice.

**Land tenure:** The water bodies are under public ownership; privately owned small-holdings abut on to the shores. Surrounding areas are privately owned.

**Conservation measures taken:** The water bodies were declared as a Non-Hunting Area in 1980. This only includes those areas up to the shoreline and does not encompass any adjacent lands.

**Conservation measures proposed:** The boundary of Huai Chorakhe Mak Non-Hunting Area should be extended to encompass approximately 100 ha of woodland at the northeast corner of the reservoir. Human use of the sites should be zoned or restricted in order to minimize disturbance of waterfowl.

**Land use:** Fishing, raising of ducks and the collection of aquatic plants for pig food. Some plots of vegetables are grown on areas of shoreline, which are exposed by receding waters in the early dry season. The principal activity in surrounding areas is the cultivation of rice (one crop of wet-season rice per year).

**Disturbances and threats:** The high intensity of human use causes direct disturbance of waterfowl and probably prevents recolonization of the shoreline by emergent aquatic plants.

**Economic and social values:** The reservoirs are important as a source of water for household use in the provincial town of Buriram and also for irrigation.

**Fauna:** Both reservoirs have been stocked with common fish species. The wetlands support a wintering concentration of about 5,000 *Dendrocygna javanica*. Up to 8,000 wintering or passage *Egretta* sp have been recorded roosting in woodland on the north shore of Huai Chorakhe Mak. Other waterfowl include *Tachybaptus ruficollis*, *Porphyrio porphyrio* (about 200 individuals with possibly as many as 40-50 breeding pairs), *Metopidius indicus*, *Gallinix cinerea* and small numbers of passage shorebirds. A few *Ardea cinerea* are usually present in winter.

**Special floral values:** None known.

**Research and facilities:** The headquarters of the Non-Hunting Area are situated at Huai Chorakhe Mak and two officials are stationed there. There is also a Freshwater Fisheries Station at the reservoir.

**References:** Land Use Classification Division (1977-1979).

**Criteria for inclusion:** 2b.

**Source:** Era Jintanugool and Philip D. Round.

**Wetland name:** Sanambin Non-Hunting Area

**Country:** Thailand

**Coordinates:** 14°38'N, 103°05'E;

**Location:** two km north of the town of Prakhon Chai, Prakhon Chai District, Buriram Province, in the floodplain of the River Mun.

**Area:** 570 ha.

**Altitude:** c.160m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 15, 17, 18 & 19.

**Description of site:** A water storage reservoir, created in about 1975 by the damming of a natural marshy area. The area of open water (200 ha) is surrounded by an extensive area of marsh grasses. The site is completely encircled by roads. One small village, Ban Thi Sawon, lies within the boundary of the Non-Hunting Area. The wetland is fed by the many small watercourses, which transect the floodplain. The main outflow is via small canals for the purposes of irrigation and municipal water supply. The depth of water is 2-3m. There is always a minimum of about 200 ha of open water, even at the height of the dry season. In the wet season, flooding of the plains is so extensive that the permanent water body is linked to flooded areas elsewhere.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,197 mm, over 80% of which falls during the southwest monsoon (May to October). There is a long, hot, dry season during which the maximum temperature may rise to 43.4°C. The mean annual temperature is 27.1°C. (Data from Nakhon Ratchasima, 110 km to the northeast of the site).

**Principal vegetation:** *Typha angustifolia*, *Eleocharis* sp and *Cyperus* sp fringe parts of the reservoir, and there is a considerable amount of *Nymphaea* sp on the open water. There is also a small area of swamp woodland on the shore of the lake. Adjacent areas are mainly under cultivation, chiefly for rice paddy, but there are some patches of dry dipterocarp woodland.

**Land tenure:** The wetland is under public ownership. Parts of the site have been encroached upon by villagers, however, for both houses and cultivated plots. Surrounding areas are privately owned farmland.

**Conservation measures taken:** The site was declared as a Non-Hunting Area in 1980.

**Conservation measures proposed:** Human use of the site should be zoned in order to minimize disturbance to waterfowl. Another Non-Hunting Area should be established in Nang Rong District, Buriram Province (c.30 km distant) in order to encompass the wooded nesting areas of the Comb Ducks *Sarkidiornis melanotos* which visit Sanambin.

**Land use:** Fishing, raising of domestic ducks, and rice growing in seasonally flooded marshland; rice cultivation (one crop of wet-season rice per year) in surrounding areas.

Possible changes in land use: The Royal Irrigation Department has proposed to build a higher dam in order to flood the area to a greater depth.

**Disturbances and threats:** Villagers have been known to steal the eggs and young of *Sarkidiornis* from nesting areas outside the Non-Hunting Area. There is a considerable amount of illegal hunting and constant, incidental disturbance of the water birds from fishermen. Parts of the wetland have been encroached upon for cultivation or settlement.

**Economic and social values:** The site is an important source of water for household use in Prakon Chai District.

**Fauna:** The reservoir has been stocked with common species of food fish. It is the only site in Thailand where *Sarkidiornis melanotos* occurs regularly; up to 20 birds have been reported, usually between December and August. The rare White-winged Wood-Duck *Cairina scutulata* has also been reported; 2-4 individuals were present in April 1986. Some 5,000-7,000 *Dendrocygna javanica* occur in the non-breeding season, together with small numbers of *Anas acuta*, up to 200 *A. querquedula* and as many as 2,000 *Nettapus coromandelianus*. A few pairs of *Dendrocygna* nest. *Gallinula chioropus*, *Porphyrio porphyrio* and *Metopidius indicus* also occur, together with *Ixobrychus flavicollis* (a wet-season visitor which probably breeds), *I. sinensis* and *I. cinnamomeus*. *Ardea purpurea* occurs, but may not breed. Occasional concentrations of up to 10,000 *Egretta spp* have been recorded, apparently on passage, with usually 1,000 birds wintering.

**Special floral values:** None known.

**Research and facilities:** A Non-Hunting Area Station with one guard has been established at the site.

**References:** Voravan (1986).

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

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Lam Dom Yai

**Country:** Thailand

**Coordinates:** 14°15'-14°30'N, 105°05'E;

**Location:** in Nam Yun District, Ubon Ratchathani Province.

**Area:** Approximately 30 km of river.

**Altitude:** 140-300m; nearby hills rise to 693m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 12.

**Description of site:** A river rising among the rolling hills of the Phanom Dongrak range at the southern margin of the Khorat Plateau which forms the Thai-Kampuchean border. The upper 20 km of the river are fast-flowing and the banks forested. After a swift descent to the plains, the river becomes slow-flowing and the lower 10 km pass through open, cultivated land. The river is a permanent watercourse with an average depth of about 0.5m and many deeper pools. There are marked seasonal fluctuations in water level, the river frequently being in spate during the late wet season, from July onwards.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,197 mm (range 730-2,415 mm), 81.8% of which falls during the southwest monsoon (May to October). The mean annual temperature is 27.1°C (range 4.9-43.3°C). (Data from Nakhon Ratchasima, to the west).

**Principal vegetation:** No information is available on the aquatic vegetation. The upper reaches of the river flow through evergreen forest (often referred to as dry evergreen forest), with secondary deciduous formations around the northern edge of the forest towards the plains and foothills. The plains are mostly cultivated land with some patches of degraded scrub woodland.

**Land tenure:** The river and the remaining forests and secondary growth are state owned. The plains are mostly privately owned small-holdings.

**Conservation measures taken:** Both banks of the river in its forested upper reaches are fully protected by law. The Yot Dom Wildlife Sanctuary abuts on the west bank, while protection of the areas on the east bank (as the Phu Jang Na Yoi National Park) has been proposed.

**Conservation measures proposed:** Much better protection of areas both inside and outside the Yot Dom Wildlife Sanctuary and proposed Phu Jang Na Yoi National Park is needed.

**Land use:** Protected, forested watershed in the upper reaches; cultivation of rice (one crop of wet-season rice per year) in areas adjacent to the lower reaches.

**Disturbances and threats:** The forested upper reaches of the river and adjacent watershed are a major stronghold of the Khmer Rouge and the area is, at present, unsafe to enter. There is almost certainly much hunting at the site. Thai villagers also hunt waterfowl around the settled northern parts of the site.

**Economic and social values:** The river is extremely important as a source of water for household use and irrigation, supplying many thousands of households in the Nam Yun District.

**Fauna:** One of only three sites in Thailand where the endangered White-winged Wood-Duck *Cairina scutulata* has been reported. A few individuals are believed to flight out of the forests at night to feed in rice paddies on the floodplain, close to the foot of the hills. Thai villagers captured three individuals in the winter of 1984/85 on a pond among rice fields at the northern margin at the site. Local Wildlife Division officials report that as many as 10-20 individuals are still present along the forested upper reaches of the river.

Crocodiles (presumably *Crocodylus siamensis*) are said to occur.

**Special floral values:** The headwaters of the Lam Dom Noi flow through the most extensive remaining forest in the Phanom Dongrak range east of the Khao Yai-Tab Lan block.

**Research and facilities:** Some accommodation is available at the headquarters of the sanctuary.

**References:** None

**Criteria for inclusion:** 2a.

**Source:** Era Jintanugool and Philip D. Round.

**Wetland name:** Yom River Floodplain

**Country:** Thailand

**Coordinates:** 16°40'-17°00'N, 99°50'-100°15'E;

**Location:** the floodplain of the Yom River, from the city of Sukkhothai downstream as far as the city of Phitsanulok. Highway 12 skirts to the north and east of the site, linking the two provincial capitals.

**Area:** c.50,000 ha.

**Altitude:** 38-53m.

**Biogeographical Province:** 4.10.4.

**Wetland type:** 14, 15 & 19.

**Description of site:** An extensive alluvial basin bounded to the south and west by low hills and to the east by the Nan River, downstream of Phitsanulok. The area is intensively cultivated (chiefly paddy); scattered throughout the basin there are many small permanent swamps and areas prone to seasonal inundation. Parts of the area are relatively well-wooded by comparison with areas in the southern Central Plains and there is a wide scattering of trees among the rice paddies. The area encompasses the following marshes or water bodies identified from Land Use Classification Division (1977-1979):

1. Beung Phing: 16°40'N, 99°55'E; 160 ha.
2. Beung Kradao: 16°41'N, 99°57'E; 80 ha.
3. Beung Raman: 16°42'N, 100°07'E; 210 ha.
4. Beung Takhreng: 16°43'N, 100°05'E; 210 ha.
5. Nong Thaling Chan (Beung Chan): 16°47'N, 100°07'E; 140 ha.
6. Nong Thale Kao: 16°50'N, 100°13'E; 130 ha.

One other site, Ban Lung Tua, which is not marked as a marsh on any map, acts as a major waterfowl refuge as a result of enlightened management by its owner. Situated in Bang Rakhom District at approximately 16°46'N, 100°06'E, this site, together with the nearby state owned Nang Nam Kao, has been established as the Nong Nam Kao Non-Hunting Area (57.3 ha).

The wetlands are subject to occasional inundation from the Yom River during the late wet season (July to October), and much of the area is actively irrigated during the late dry season (January onwards). Away from the rivers and canals, the wetlands are very shallow, with usually less than one meter of water in the permanent water bodies. There may be little or no flooding in many years.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,113 mm, 86.4% of which falls during the southwest monsoon (May to October). The mean annual temperature is 28.3°C (range 6.1-43.7°C).

**Principal vegetation:** Principally *Eichhornia crassipes* and *Nelumbo nucifera*, with some areas of *Cyperus* spp and *Typha angustifolia*. Considerable areas are marked as "natural marsh grassland" on the Land Use Classification Map, 1978. In adjacent areas, mainly cultivation with many scattered trees, including much *Butea monosperma*, some scrub and bamboo, and occasional patches of mixed deciduous or dry dipterocarp woodland.

**Land tenure:** The wetland is mainly privately owned farmland; surrounding areas are also mainly privately owned.

**Conservation measures taken:** The Nong Nam Kao Non-Hunting Area (57.3 ha) has been established in Bang Rakhom District, Phitsanuloke. This encompasses Ban Lung Tua, an area of fish ponds and semi-natural swamp habitat on a privately-owned small-holding managed as a waterfowl reserve by an enlightened owner, together with the adjacent, state owned water body of Nong Nam Kao.

**Conservation measures proposed:** The entire Yom River floodplain between Sukkhothai and Phitsanuloke should receive a detailed survey in order to assess its conservation value. Particular attention should be paid to locating areas which serve as wintering or feeding areas for wintering waterfowl as well as those areas which may continue to support breeding colonies of egrets and other large water birds.

**Land use:** The principal activity at the wetland and in surrounding areas is the cultivation of rice, but increasing areas are being turned over to vegetables.

**Disturbances and threats:** There is much illegal hunting of water birds away from the one site where they are actively protected. Continued intensification of agriculture is certain to lead to the removal of many existing clumps of trees and bamboo, and may lead to further drainage or flood control works in some areas. The maintenance of standing water to support wildfowl at Ban Lung Tua is dependent upon releases of water from the Royal Irrigation Department. In drier winters, the Irrigation Department does not always agree to make water available for this purpose.

**Economic and social values:** Ban Lung Tua is a major recreational attraction for the people of Phitsanulok, and serves to attract tourists from further afield. Such wetlands as are retained and managed for fish farming are an important source of income for those farmers for whom rice yields too low an economic return.

**Fauna:** The wetlands have been stocked with common species of food fish.

In recent winters, up to 9,000 *Dendrocygna javanica*, 6,000 *Anas acuta*, 5,000 *A. querquedula*, and 170 *Aythya baeri* have been recorded at Nong Nam Kao-Ban Lung Tua together with smaller numbers of *Anas penelope*, *A. crecca*, *A. clypeata* and other ducks. Over 17,000 ducks were present in mid-January 1988, including:

6,400 *D. javanica*

5,000 *A. acuta*

4,740 *A. querquedula*

170 *A. baeri*

It is possible that the importance of the Nong Nam Kao Non-Hunting Area for wildfowl has increased with greater levels of recreational disturbance on Beung Boraphet. The site also supports many *Hydrophasianus chirurgus* as well as small numbers of *Egretta garzetta*, *E. intermedia*, *E. alba*, *Ardea purpurea*, *A. cinerea* and shorebirds such as *Charadrius dubius*, *Tringa nebularia*, *T. glareola*, *Gallinago gallinago* and *Calidris temminckii*. Harriers *Circus* spp occur in winter, along with the occasional Spotted Eagle *Aquila clanga*.

**Special floral values:** None known.

**Research and facilities:** There is no accommodation or office in the Non-Hunting Area, but the landowner, Lung Tua, makes visitors welcome. An observation platform has been constructed.

**References:** Land Use Classification Division (1977-1979).

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

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Beung Si Fai

**Country:** Thailand

**Coordinates:** 16°25'N, 100°20'E;

**Location:** one km southwest of the town of Phichit, Phichit Province.

**Area:** 810 ha.

**Altitude:** 35m.

**Biogeographical Province:** 4.5.1.

**Wetland type:** 14.

**Description of site:** A permanent, freshwater lake, its associated marshes and adjacent rice paddies, situated approximately two km from the Mae Nam Nan and lying on the outskirts of the town of Phichit. The lake is fringed with emergent vegetation in some parts. It is fed by overspill from the River Nan during the late rainy season, and there is no major outflow. The average depth of water is 1.5m (maximum 3.0m).

**Climatic conditions:** Tropical monsoonal climate with an average rainfall of 1,792 mm. The mean annual temperature at Nakhon Sawan, 60 km to the south, is 28.3°C.

**Principal vegetation:** There are small areas of *Arundo donax* and *Cyperus spp* around the lake margins. The floating vegetation includes *Nelumbo nucifera*, *Lemna minor* and *Eichhornia crassipes*. Surrounding areas are almost entirely under cultivation, mainly for rice.

**Land tenure:** The wetland is in public ownership; surrounding areas are privately owned residential areas, commercial properties and rice paddies.

**Conservation measures taken:** Fishing is forbidden in approximately 24 hectares of the lake. The lake was recently cleared of much vegetation in order to create areas of open water.

**Conservation measures proposed:** The site has been proposed as a Non-Hunting Area.

**Land use:** Fishing and cultivation of lotus. The northern end of the site is a public amenity, with gardens, picnic areas and paved access around it. The wetland is surrounded by rice paddies (one crop of wet-season rice per year), and there is a town market nearby.

Possible changes in land use: None known; the authorities intend to preserve the lake as a major tourist attraction.

**Disturbances and threats:** None known.

**Economic and social values:** Recreation and tourism. The lake is a major social amenity.

**Fauna:** The lake has been stocked with common species of food fish. Usage of the area by wintering wildfowl is increasing markedly with improved protection, and the site now supports some 5,000-10,000 roosting *Dendrocygna javanica* outside the breeding season. *Tachybaptus ruficoilis* breeds, and two or three species of *Egretta* are non-breeding visitors. Other water' owl recorded include *Gallinula chloropus*, *Porphyrio porphyrio* and *Metopidius indicus*.

**Special floral values:** None known.

**Research and facilities:** The provincial fisheries station for Phichit Province is sited at the lake. The site is occasionally visited by Brother David Ogle and colleagues of the Nakhon Sawan Bird Club.

**References:** None

**Criteria for inclusion:** 2b.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Beung Boraphet

**Country:** Thailand

**Coordinates:** 15°40'-15°44'N, 100°10'-100°20'E;

**Location:** 2.5-21.0 km east of the town of Nakhon Sawan, Muang District, Nakhon Sawan Province.

**Area:** 13,000 ha.

**Altitude:** 24m.

**Biogeographical Province:** 4.5.1.

**Wetland type:** 14.

**Description of site:** A large freshwater lake, 18 km by 6 km, situated on the east bank of the Mae Nam Nan, close to its confluence with the Mae Nam Ping. The lake lies close to the western margin of the huge Central Plains area of Thailand and is surrounded by rice paddies. It was formed in 1930 by the damming of a freshwater swamp (which formerly covered an area of 64,000 ha) in order to develop the fishery. Embankments have been constructed in some areas around the north and west margins of the lake, together with spillways and lock gates to regulate water levels. The western shore is fringed by a railway line and lies close to the town of Nakhon Sawan. The lake was drained for one month in 1959 and again in 1972, each time being allowed to refill. There is much floating vegetation over the lake surface and some emergent vegetation around the margins. Tall emergent vegetation is very restricted in extent, occurring mainly as floating islands near the northwest corner of the lake. The lake is fed by many shallow streams, which ramify throughout the basin, as well as overspill from the Mae Nam Nan during the flood season. Outflow is via the Ban Pong canal at the southwest tip, into the Mae Nam Chao Phraya. There is a subsidiary outlet, which

empties into the Mae Nam Nan. According to one source (Anon, 1985a), most of the lake is about 1.6m deep and the maximum depth is 5m; according to Suraswadi (1976), the average depth is 3-4m. The lake reaches its maximum depth in the late wet season (October), and is usually at its shallowest in August. Fluctuations in water level and the amount of flooding around the lake margins are reduced by embankments and by the presence of spillways with water control regulators and flap gates. pH values range from 6.6 to 7.9, and Secchi disk values from 0.60 to 1.80m. The oxygen content of the water is fairly high (3.0-8.0 ppm), due to the frequent mixing of waters in the rainy season.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,250 mm, most of which falls between July and October. The average monthly temperatures vary from 12.0°C in December to 34.0°C in May. Water temperatures are usually in the range 27-31°C, but rise to 33-34°C in April and May.

**Principal vegetation:** Dense mats of floating vegetation, chiefly *Coix aquatica*, *Isachne globosa*, *Leersia hexandra*, *Eichhornia crassipes*, *Salvinia cucullata*, *Nelumbo nucifera* and *Nymphaea lotus*. Submerged aquatics include *Hydrilla verticillata*, *Ceratophyllum demersum* and *Utricularia flexuosa*. There are some floating islands of *Phragmites karka*, *Saccharum* sp and *Cyperus* spp, particularly near the northwest corner of the lake, and fairly extensive beds of low sedges *Cyperus* spp along the southern margin. Adjacent areas are almost entirely rice paddy, although there are scattered *Borassus* palms, particularly to the north and east, and some areas of scrub, particularly at the northwest end close to the town of Nakhon Sawan.

**Land tenure:** The lake is state owned, although there are now many illegally established households around the shoreline. Surrounding areas are mainly in private ownership.

**Conservation measures taken:** An area of 45,000 ha, covering the lake and surrounding areas of paddy, was declared as a Non-Hunting Area in 1975. Fishing is forbidden in certain parts of the lake.

**Conservation measures proposed:** The Fisheries Department is proposing to take further measures to rationalize human use of the lake, and to relocate those households, which have been illegally established around the lakeshore. The remaining areas of reeds and waterside scrub should be protected more effectively from cutting and burning. The illegal trapping and shooting of birds in areas surrounding the lake should be suppressed, and the disturbance to roosting and nesting birds caused by tourists in boats should be carefully regulated. Some areas of the lakeshore around the Non-Hunting Area headquarters could be managed to attract shorebirds. At the present time, foraging opportunities for these species are very restricted because of the absence of muddy shallows. Searches for the endemic and endangered White-eyed River-Martin *Pseudochelidon sirintarae* should be mounted.

**Land use:** Fishing, using illegal methods such as gill nets which are set from small motor boats, throw nets and electrification, as well as by legitimate means such as hook and line and traps; also illegal propagation of lotus. Approximately 30,000 people live around the margins of the lake. The principal activities in surrounding areas are rice cultivation (one crop of wet-season rice per year), cattle grazing and pig farming. Small areas of corn, mung beans, cotton and groundnuts are grown in the upland areas around the basin.

Possible changes in land use: The lake is one of three sites chosen for the implementation of the Large Swamp Inland Fisheries Project (LSIFP) which seeks to increase fish yields through manipulation of water levels, dredging to improve spawning grounds and fish stocking. In addition, pen culture of fishes is recommended together with the utilization of aquatic macrophytes for biogas production.

**Disturbances and threats:** Local people continue to burn and cut *Phragmites* and other emergent vegetation in order to increase the areas under lotus cultivation. They also cut waterside scrub and trees for charcoal production. There is still much illegal hunting of waterfowl at the lake, and roosting flocks of small birds are netted for food. One of the principal trapping methods is to set a

monofilament fishing line with hooks placed at 10-20 cm intervals across the flight lines of the birds. Baited hooks and lines are also used. Farmers occasionally put out large quantities of grain baited with acutely toxic chemicals in order to kill waterfowl, which they claim are grazing on their rice paddies. The lake is littered with remnants of plastic fishing nets, which may cause the deaths of many birds. There is some evidence to suggest that, in spite of stocking, present fish yields may be lower than in the past because of many successive years of over-exploitation.

There have been no checks to determine the levels of pesticide contamination in the lake basin. While persistent pesticides are little used in rice-growing areas, there is the possibility of contamination from persistent organochlorines used extensively on cotton crops in the nearby uplands. This may have contributed to the disappearance of larger predatory birds. There may now be reduced inflow of water into the lake due to increased diversion of streams for cultivation in the catchment area.

**Economic and social values:** Some 5,100 fishermen live around the lake, and as many as 1,000,000 persons may be dependent upon the resources of the swamp basin. The average net income per household from fishing is Bht.11,400 (about US\$456) per year (Anon, 1985). Fish yields have ranged from 422,305 kg/year to 1,081,665 kg/year, the higher figure coinciding with the drainage of the lake, prior to refilling, in 1972. According to officials at the Fisheries Station, the "officially recognized" yield of fish per year is about 250 metric tonnes; in reality, the yield may be as high as 400-500 tonnes if fish from all areas in and around the lake are taken into consideration. The lake is important as a source of water for irrigating rice and other crops and in ensuring fresh fodder for cattle. In addition, many people utilize the vegetation. The leaves of *Nelumbo nucifera* are utilized for wrapping material, and the seeds of *Nelumbo* and stems of *Nymphaea lotus* are utilized for food. Water Hyacinth (*Eichhornia crassipes*) and some other aquatic plants are fed to pigs. The lake is an important tourist attraction and many people visit it, either to stay at the Non-Hunting Area headquarters or to take boat rides on the lake. A proportion of these visitors hire local boatmen.

**Fauna:** The standing crop of fish has been estimated at 84 kg/ha (Anon, 1985) and at 79.4 kg/ha to 102.4 kg/ha (National Inland Fisheries Institute, 1980). A total of 148 species of fish has been recorded, chiefly of the families Notopteridae, Cyprinidae, Siluridae, Schilbeidae, Ophiocephalidae and Eleotridae. The predominant species in the catches are:

*Osteochilus hasselti* (16.2%)

*Ophicephalus striatus* (10.6%)

*Clupeioides hypsalosoma* (7.05%)

*Labiobarbus liniatus* (7.05%)

*Pristolepis fasciatus* (6.3%)

Other edible fishes known from the lake include *Pangasius fowleri*, *P. larnandii*, *Ophicephalus micropeltes*, *Tachysurus argyropleurum*, *Wallago sp.*, *Albulichthys albuloides*, *Lutjanus annualris*, *Puntius sp.*, *Notopterus notopterus*, *N. chitala*, *Monopterus albus*, *Macrones numerus*, *Callichrous bimaculatus*, *Probarbus jullieni*, *Labio dyochoilus*, *Kyphosus waigiensis*, *Clarias batrachus*, *Oxyeleostris marmorata*, *Mastacembelus armatus* and *Trichopodus trichopodus* (Pramoj Waithayakul and David Ogle, pers. comm.).

*Beung Boraphet* is the most important known site for wintering ducks in Thailand, with yearly maxima of at least 16,000 *Dendrocygna javanica* and 30,000 *Anas querquedula*, smaller numbers of *Anas acuta* (2,500) and *Aythya baeri* (maximum 426), and a few *Anas penelope*, *A. falcata*, *A. crecca*, *A. clypeata*, *Aythya nyroca* and *A. fuligula*. One or two *Sarkidiornis melanotos* may occur from time to time. *Nettapus coromandelianus* is present throughout the year (100-1,000 birds), and up to 430 *Fulica atra* have been recorded in winter. Other wintering species include *Ardeola bacchus*, *Bubulcus ibis*, *Egretta garzetta*, *E. intermedia*, *E. alba*, *Ardea cinerea*, *A. purpurea*, *Anastomus oscitans* (400 in January 1988), *Circus (aeruginosus) spilonotus*, *C. melanoleucos* and, occasionally, *Aquila clanga*. There is one record of *Haliaeetus albicilla* in trade, said to have been

taken from the vicinity of Nakhon Sawan. There are also large roosts of wagtails (*Motacilla* spp) and weavers (*Ploceus* spp) together with Yellow-breasted Buntings *Emberiza aureola* and Barn Swallows *Hirundo rustica*. The White-eyed River-Martin *Pseudochelidon sirintarae* is known only from this site; nine specimens were netted amongst *H. rustica* in January-February 1968, and there have been two subsequent sight records (King & Kanwanich, 1978; D. Ogle pers. comm.).

In the breeding season, both *Ixobrychus sinensis* and *I. cinnamomeus* are plentiful, and a few pairs of *Ardea purpurea* are said to breed near the east end of the lake. Otherwise, large Ciconiiform birds are absent, perhaps because of the lack of suitably extensive and undisturbed areas of swamp woodland or reed-beds. Other species, which do breed, include *Dendrocygna javanica* (10-100 pairs at the lake and undoubtedly many more nest scattered at low density throughout the surrounding paddy basin) and *Tachybaptus ruficollis* (over 100 pairs), *Nettapus coromandelianus* (10-100 pairs), *Porzana cinerea* (50-100 pairs), *Porphyrio porphyrio* (100-1,000 pairs), and *Hydrophasianus chirurgus* (100-1,000 pairs). This is almost certainly the most important breeding station for the latter species in the country. *Pelecanus philippensis* and *Leptoptilos dubius* have occasionally been reported on passage.

A scrub-covered outcrop at the eastern end of the lake still supports a population of *Macaca fascicularis*. A few *Crocodylus siamensis* are reported to occur in the lake, but some, if not all, of these may be individuals, which have escaped from captivity.

Invertebrates include high densities of *Planorbidae* and *Ampullaridae* (Mollusca). The most abundant insect orders are *Ephemeroptera*, *Trichoptera*, *Coleoptera*, *Diptera* and *Hemiptera*. Crustaceans of the families *Potamidae* and *Paleopteridae* are widespread and abundant; these include the economically important giant freshwater prawns *Macrobrachium rosenbergii* and *M. sintangense*.

**Special floral values:** None known.

**Research and facilities:** The most detailed recent studies of the aquatic ecosystem are found in Suraswadi (1976) and Anon (1985a). The most accurate and detailed information on the bird species diversity and numbers are found in the reports of those bird-watchers who have filed their records at the Association for the Conservation of Wildlife in Bangkok. Thongaree (1982) completed a study of the breeding biology of *Hydrophasianus chirurgus* at the lake. Brother David Ogle of La Salle Chotiravi School, Nakhon Sawan, together with Pramroj Waithayakul and colleagues from the Nakhon Sawan Bird Club, make regular visits to the lake and carry out small-scale banding of passerine birds in lakeshore vegetation. Sophasan and Dobias (1984) gave an account of the bird-trapping methods formerly used by villagers at the lake and made recommendations for habitat surveys and the conservation of *Pseudochelidon sirintarae*. Annual reports of fish landing statistics are compiled by the Department of Inland Fisheries Station. The headquarters of the Non-Hunting Area is situated on the southern shore of the lake, while the Department of Inland Fisheries Station is located near the northwest corner.

**References:** Anon (1973 & 1985a); Association for the Conservation of Wildlife (1981); King & Kanwanich (1978); National Inland Fisheries Institute (1980); Ogle (1986); Sophasan & Dobias (1984); Suraswadi (1976); Thongaree (1982); Thonglongya (1968).

**Criteria for inclusion:** 123.

**Source:** Era Jintanugool and Philip D. Round.

**Wetland name:** Khwae Yai River System

**Country:** Thailand

**Coordinates:** 14°40'-16°04'N, 98°37'-99°10'E;

**Location:** in the Dawna Hills region of western Thailand, shared between the Provinces of Tak, Uthai Thani and Kanchanaburi.

**Area:** Length of river approximately 280 km along the main Khwae Yai (also known as the Mae Klong) and Nam Mae Chan, and approximately 123 km along its major tributary, the Huai Kha Khaeng; also a great many smaller tributaries. The system drains a watershed of approximately 15,000 sq.km.

**Altitude:** 150-650m.

**Biogeographical Province:** 4.5.1.

**Wetland type:** 12.

**Description of site:** Fast-flowing rivers running through hilly, wooded country, ranging from less than 150m above sea level up to 650m in the upper reaches. Parts of the riverbeds are rocky; other parts are shallow with sand bars and gravel banks. Still backwaters and oxbow lakes occur, particularly along the upper part of the Huai Kha Khaeng. The lower reaches of the Khwae Yai flow through a gorge upstream of Ban Nam Choan. Below this, the area has been inundated by the Srinakarin Reservoir which was completed in 1980. The rivers are permanent but subject to wide seasonal fluctuations in level. Water levels begin to rise rapidly in July, and the flow reaches its maximum shortly after the cessation of the southwest monsoon in November. Depths range from no more than a few cm in places to several metres in parts of the Khwae Yai. The pH is 7.0, dissolved oxygen 8.4 mg/l, alkalinity 48 mg/l and Secchi Disk transparency 55 cm. (Measurements made at Nam Choan on the Khwae Yai; Chantsavang et al., 1986).

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 984 mm, 80% of which falls during the southwest monsoon (May to October). The mean annual temperature is 27.8°C (range 5.5-43.5°C). (Data from Kanclianaburi, to the south of the site).

**Principal vegetation:** No information is available on the aquatic vegetation. Adjacent areas support a mosaic of different forest types, ranging from dry dipterocarp forest savannas and mixed deciduous forest to dry evergreen forest (Neal, 1967). The area has been subject to a low level of human disturbance for many centuries and there is a local preponderance of large-cuim bamboos *Bambusa* spp. An evergreen gallery type formation occurs patchily along the banks of the rivers. Nearby mountains support a hill evergreen formation above 1,000m elevation.

**Land tenure:** The rivers and surrounding areas are state owned. There are, however, several Karen villages along the River Khwae.

**Conservation measures taken:** The entire lengths of the rivers under consideration are enclosed within the boundaries of the contiguous Thung Yai and Huai Kha Khaeng Wildlife Sanctuaries and are therefore totally protected in law.

**Conservation measures proposed:** The site has been proposed as a World Heritage Site. A proposal has been made for the establishment of a research and training centre for forestry staff and students in the Huai Kha Khaeng Sanctuary, and there is also a proposal to produce a management plan for the site. The site should receive a comprehensive biological survey, in order to determine the populations of key riverine species, to map the crossing routes of large mammals and to locate mineral licks etc. There should be more frequent patrolling of remote riverine areas in both sanctuaries. This might be combined with an organized, recreational trekking programme.

**Land use:** Wildlife conservation and recreational trekking. Inhabitants of the Karen villages along the Khwae Yai engage in subsistence hunting, rice cultivation and fishing. There is a considerable amount of illegal hunting and collection of forest products throughout the area.

**Possible changes in land use:** The upper Khwae Yai has been proposed as the site of a major hydro-electric dam project, the Nam Choan Dam. This project was shelved, for the second time in six years, in April 1988. Hmong hilitribes, currently practising shifting cultivation on the hill range dividing the upper Khwae Yai from the Huai Kha Khaeng, are to be resettled elsewhere.

**Disturbances and threats:** The Nam Choan Dam, if constructed, would have flooded all of the lowland riverine habitat remaining along the Khwae Yai (c.13,700 ha). This would have divided an existing contiguous protected area of approximately 500,000 ha into three smaller sub-units and would have effectively prevented gene flow between the populations of large mammals within them.

Key habitats for such lowland bird species as *Cairina scutulata*, *Ichthyophaga humilis*, *Torgos calvus*, *Pavo muticus* and *Heliopais personata*, as well as for many large mammals, would have been submerged. The recent proposal to revive the Nam Choan Dam project provoked heavy protest not only from conservation bodies, but also from local villagers and townspeople in Kanchanaburi Province, who opposed the project principally on the grounds that it would damage watersheds and because the dam would have been sited on a seismically active fault. Following a prolonged debate, the proposal was shelved by Thailand's Council of Economic Ministers in early April 1988. The project's suspension was due in large part to the substantial campaign of opposition mounted by a well-informed committee appointed to study the dam's impact. The considerable concern shown by international conservation bodies around the world may also have contributed. Although the Nam Choan Dam project has not been cancelled outright, it seems highly unlikely that it could be disinterred, given the present socio-economic climate in Thailand.

The area is subject to a high level of disturbance by poachers. These include recreational hunters from Bangkok and other major centers of population. There are a number of mining operations around the western margins of Thung Yai and these undoubtedly cause some disturbance, the more so because access roads cross Thung Yai Wildlife Sanctuary. There are several Karen villages along the course of the Khwae Yai in Thung Yai Wildlife Sanctuary, while the uplands support a population of about 5,000 Hmong tribesmen. Both these ethnic groups practise subsistence hunting and shifting cultivation. Semi-evergreen forest habitats along the rivers and elsewhere are annually damaged by fires, deliberately set by rural people and other trespassers. This seems certain to affect the ecology of the forests and perhaps lead to a reduction in species diversity of plants and animals.

**Economic and social values:** The area is of international conservation value and has been recognized as a site of World Heritage Quality (Commission on National Parks and Protected Areas, 1982). It is the only relatively little-disturbed riverine ecosystem remaining in the entire country. Together with its associated watershed, it is undoubtedly the single most important area for wildlife conservation in Thailand. It is a major water source for millions of people living downstream, in the major agricultural areas extending from the town of Kanchanaburi to the Gulf of Thailand at Samut Songkhram. The output of freshwater at the mouth of the Mae Kiong is probably essential in maintaining the important coastal fishery and aquaculture industry. The impoundment of freshwater during the construction of the Srinakarin Dam on the lower River Khwae resulted in widespread encroachment of saline water into formerly rich agricultural areas in the Mae Kiong delta, and many coconut plantations and fruit orchards died. The impact of such impoundment upon the fishery and upon agriculture has never been assessed. The area has considerable recreational and amenity potential. Huai Kha Khaeng receives several hundred visitors per year, most of whom are Thai nationals.

**Fauna:** The Khwae River system is an important fishery. At Ban Nam Choan, the standing crop was estimated at 123.75 kg/ha. A total of 33 species of freshwater fish was recorded by Chantsavang *et al.* (1986). Phumpakapun *et al.* (1986) list 52 species of freshwater fish for Huai Kha Khaeng.

The area supports the following aquatic or predominantly riverine species of birds, which are scarce or endangered in Thailand: *Anhinga nielanogaster*, *Cairina scutulata*, *Ichthyophaga humilis*, *Torgos calvus*, *Pavo muticus*, *Heliopais personata*, *Megaceryle lugubris* and *Rhyticeros subruficollis*. It may be the only area, which is large enough to support viable populations of these species. The continued presence of the endangered White-winged Wood-Duck *C. scutulata* was confirmed as recently as early 1988, when a pair and single bird were observed in the area (B. Stewart Cox, pers. comm.).

The area is very rich in large mammals. These include five species of macaque monkeys *Macaca* spp (more than any other site in Asia), two or three species of leaf monkeys *Presbytis* spp, otters, probably both *Lutra perspicillata* and *Aonyx cinerea*, Asian Wild Dog, Asiatic Black Bear, Hog Badger, Leopard, Tiger, Asian Elephant, Tapir, Sambar, Banteng and Gaur (*Cuon alpinus*, *Selenarctos thibetanus*, *Arctonyx collaris*, *Panthera pardus*, *P. tigris*, *Elephas maximus*, *Tapirus*

*indicus*, *Cervus unicolor*, *Bos javanicus* and *Bos gaurus*). A herd of about 50 Gaur sighted in Thung Yai Wildlife Sanctuary in March 1985 is the largest such ever seen in Thailand. The lower Huai Kha Khaeng also supports a small population of the Water Buffalo *Bubalus bubalis*, said to be wild, although their origins may be slightly suspect owing to the former presence of domestic stock at the site. Both the Sumatran Rhinoceros *Dicerorhinus sumatrensis* and the Brow-antlered Deer *Cervus eldi* are said to be present.

Chunarch and Nabhitabhata (1986) list 61 species of reptiles for Huai Kha Khaeng Wildlife Sanctuary, and Phumpakapun *et al.* (1986) list 17 species of amphibians.

**Special floral values:** The site comprises the only intact lowland riverine system within any park or sanctuary in Thailand.

**Research and facilities:** Accommodation is available at the headquarters of both the Huai Kha Khaeng and the Thung Yai Wildlife Sanctuaries. Research facilities are available at the Wildlife Research Station at Khao Nang Rum in Huai Kha Khaeng, and a number of research projects, principally concerning terrestrial vertebrates, are in progress. A road suitable for access by four-wheel drive vehicles extends to the Huai Kha Khaeng in the vicinity of its confluence with the Huai Mae Dee, near the southern limit of the site. Dirt roads, used for access by mining trucks, cross Thung Yai Sanctuary in various places.

**References:** Chantsavang *et al.* (1986); Chunarch & Nabhitabhata (1986); Commission on National Parks and Protected Areas (1982); Phumpakapun & Kutintara (1983); Phumpakapun *et al.* (1986); Round (1983).

**Criteria for inclusion:** lb. 2a, 2b, 2c.

**Source:** Era Jintanugool and Philip D. Round.

**Wetland name:** Southern Central Plains of Thailand

**Country:** Thailand

**Coordinates:** 13°30'-15°00'N, 99°40'-101°15'E;

**Location:** extending from the gulf coast of Thailand, in the vicinity of Bangkok, upstream along the Chao Phraya River to the town of Chainat; delimited to the east and west by uplands. The site encompasses the whole or parts of the provinces of Bangkok, Thonburi, Nonthaburi, Samut Songkhram, Samut Sakhon, Samut Prakan, Nakhon

4. Beung Chawak, Suphanburi Province: 320 ha; a lake and adjacent marsh, important for wintering wildfowl.

A great many other areas receive de facto protection because they exist in the grounds of Buddhist temples (wats) or because private farmers choose to offer sanctuary for water birds nesting on their land. The better known sites include:

1. Ban Lung Jorm, Ban Thasadet, Suphanburi Province: a roosting and nesting site for herons and cormorants on privately owned farmland.
2. Wat Jantharam, Bang Ban District, Ayutthaya Province: a breeding site for five or six pairs of *Milvus migrans*.
3. Wat Kanom Tai, Bang Pa-In District, Ayutthaya Province: the site of a colony of *Pteropus lylei* and nesting colony of *Phalacrocorax niger*.
4. Ban Lung Tuam, Nong Khae District, Saraburi Province: a roosting and nesting site for herons and cormorants on privately owned farmland.
5. Wat Ko Loi, Nong Khae District, Saraburi Province: the site of a colony of *Pteropus lylei*.
6. Wat Tha Sung, Pathum Thani Province: the site of a colony of *Pteropus lylei*.
7. Wat Samo Son, Bang Len District, Nonthaburi Province: a nesting and roosting site for herons and cormorants, and the site of a colony of *Pteropus lylei*.

8. Wat Pho, Bang Khla District, Chachoengsao Province: the site of a colony of *Pteropus lylei*.
9. Khlong Lat Krabang, Lat Krabang District, Bangkok: an area with several nesting and roosting sites for egrets and pond herons.
10. Dee Som Choke Housing estate, Lard Prao Road, Bangkok: an area of small ponds and marshes in the suburbs of Bangkok, ringed by middle-class housing and protected and publicized by a sympathetic landowner; an important wintering area for wildfowl.
11. Suan Somdet, Muang District, Ayutthaya Province: a small pond supporting a concentration of wintering waterfowl, chiefly *Dendrocygna javanica*.
12. Wat Lam Mahamek, Lard Lumkaeo District, Pathumthani Province: a nesting and roosting site for cormorants, egrets and herons.

**Conservation measures proposed:** Formal protection should be extended to the above sites, where practicable. In addition, the following sites should receive legal protection:

1. Khan Haam, Uthai District, Ayutthaya Province: a newly established nesting colony of *Anastomus oscitans*.
2. Nong Samur, Visetchaichan District, Ang Thong Province: a colony of a few hundred *Anastomus oscitans* nesting in clumps of trees among farmland. Local people at present take eggs for food.
3. Wat Samrae, Pathumthani Province: a roosting site for over 800 wintering *Milvus migrans*, which congregate in tall *Borassus* palms. Although the site is known by the name of a nearby temple, the roosting area is outside its boundaries and is therefore unprotected.
4. Rangsit marshes, Rangsit District, Pathumthani Province: the largest freshwater swamp remaining anywhere on the outskirts of Bangkok and possibly the largest such anywhere in the southern Central Plains, covering an area of 200-300 ha. The site possesses a large *Typha* bed and supports a great variety of wintering and nesting water birds.

One of the chief constraints upon the utilization of the area by the more sensitive, larger water birds appears to be the lack of undisturbed, wooded nesting areas close to suitable swampy feeding areas. Efforts should be made to try and establish such a site in a wetland nature reserve. Many other species of animals would also undoubtedly benefit. More attention should be given to publicizing water bird sites. If observation facilities and interpretive centers were established, they could have considerable value in promoting conservation awareness. The Wildlife Conservation Division should make more effort to publicize knowledge of existing legislation, with a view to appraising villagers, police and government official to the fact that most bird species are already protected in law. Many birds are still shot or trapped and their eggs or young stolen from the nest, either for food or for sale.

A detailed inventory of all known water bird nesting or roosting sites should be carried out.

**Land use:** Chiefly rice cultivation. Most of the area produces one crop of rice per year, during the wet season. However, because of the widespread availability of irrigation, two rice crops are produced in many areas. Rice cultivation is becoming increasingly mechanized, as buffaloes and hand rotovators used in ploughing give way to tractors and other heavy machinery. In addition, increasing areas are now being given over to alternative crops. These include a variety of vegetables and fruits such as oranges, bananas and grapes, frequently grown on bunds raised above the level of the former paddy. There are increasing areas of *Casuarina* plantations. In some areas, there is still a high density of the palm, *Borassus flahellifer*, which is a source of sugar used in local confections. The fruits are also harvested and eaten fresh. In the wetter, more marginal areas lotus *Nelumbo nucifera* and *Ipomoea* are cultivated as table vegetables. Fishing with a variety of traps and nets is almost universally practiced. There is now a much increased emphasis on aquaculture, both for fish and for the giant freshwater prawn *Macrobrachium rosenbergii*. *Macrobrachium* is also caught from the wild along the main waterways, by using hand lines.

Increasing areas around the edges of Bangkok and other major towns are being given over to housing and industry. Many areas support orchards of mangoes, durians and other fruits. Riverine

sand and gravel deposits, and sometimes clay and topsoil, are extracted for construction purposes. There is also much small-scale brick making using clay deposits.

Possible changes in land use: Increasing industrialization and the intensification and mechanization of agriculture seem likely to cause a further reduction in wildlife habitat.

**Disturbances and threats:** The increasing mechanization of agriculture seems certain to lead to an overall increase in the size of rice paddies and the consequent loss of many marginal areas and clumps of trees which are of value for wildlife. Some key areas around Bangkok, such as Rangsit marshes, are in danger of being filled in and built upon. Firearms are widely possessed and a great many larger birds are shot illegally. So far as is known, pesticides should not present a threat to wildlife since the compounds used in rice paddies are non-persistent. Analysis of the eggs of *Anastomus oscitans* in 1985 did not show deleterious levels of organochlorine contamination (A. Spaans, pers. comm.).

**Economic and social values:** The area is of immense national economic importance. Thailand is the world's largest exporter of rice, most of which is grown in its Central Plains. The fishery is difficult to evaluate, since fishing is such a universally practised activity throughout the entire Central Plains region and makes a direct or indirect contribution to the economy of virtually every household. However, aquaculture for *Macrobrachium* prawns and for food fishes is of immense importance to the economy of small-holders as it becomes less profitable to grow rice. There are more than 1,500 commercial prawn breeders operating in the Central Plains and it is estimated that the net profit per hectare from prawn "grow-out" ponds is Bht.36,000 (US dollar1,380) per year (Johnson, 1986). The waterways of the region have long provided a means of communication and transport.

**Fauna:** The intensively cultivated nature of the area belies its very great conservation importance. Although most water birds occur at a relatively low density, the total number dependent upon the resources of the southern Central Plains is enormous. The Thai breeding populations of *Phalacrocorax fuscicollis*, *Ardeola speciosa*, *Bubulcus ibis*, *Egretta garzetta*, *E. intermedia*, *E. alba* and *Anastomus oscitans* are believed to be entirely restricted to the southern Central Plains. While other sites such as Beung Boraphet may show more spectacular concentrations of wintering ducks, very few Ardeidae breed there. Some of the most important breeding colonies and roosting sites for herons, egrets and/or cormorants in the Central Plains are at Ban Lung Jorm (Suphanburi Province), Wat Tarn En and Wat Kanom Tai (Ayutthaya Province), Wat Ratsattha Krayaram (Samut Sakhon Province), Ban Lung Tuam (Saraburi Province), Wat Samo Son (Nonthaburi Province), Khlong Lat Krabang (Bangkok) and Wat Lam Mahamek (Pathumthani Province). The colony of *Anastomus oscitans* at Wat Phai Lom Non-Hunting Area is believed to support 16,000-20,000 individuals during the nesting season (December to April), and may be the largest single concentration of the species in Asia. There are other large breeding colonies of this species at Nong Samur in Ang Thong Province (several hundred pairs) and at Khan Haam in Ayutthaya Province.

The Oriental Darter *Anhinga melanogaster* is still present in the area, but is now believed to be threatened or endangered. One or two birds are still seen in most years at Wat Tarn En, but the species no longer breeds. Other nationally rare or endangered waterfowl which still occur annually in small numbers, but which may no longer breed, include *Pelecanus philippensis*, *Mycteria leucocephala*, *Leptoptilos dubius* and *Threskiornis melanocephalus*. A few *P. philippensis* are occasionally attracted by the concentration of kites at Wat Samrae in Pathumthani Province, and *M. leucocephala* occurs regularly on passage at Ban Lung Jorm in Suphanburi Province. Up to 90 *T. melanocephalus* have been recorded roosting at the Wat Tarn En Non-Hunting Area, and up to 70 have been recorded on passage at Ban Lung Jorm. Concentrations of wintering Anatidae occur at several localities, notably the Dee Som Choke Housing Estate area in Bangkok (up to 20,000 ducks, chiefly *Dendrocygna javanica* and *Anas querquedula*, with occasionally one or two *Sarkidiornis melanotos*), Beung Chawak in Suphanburi Province (up to 1,000 *D. javanica* and 1,000 *A. querquedula*) and Suan Somdet in Ayutthaya Province (chiefly *D. javanica*). The total number of

*D. javanica* wintering in the Central Plains is probably between 50,000 and 100,000 birds. This species and *Nettapus coromandelianus* are also widespread breeding birds in small numbers. Other species of water birds which breed or probably breed in the area include *Tachybaptus ruficollis*, *Phalacrocorax niger*, *Nycticorax nycticorax*, *Ixobrychus sinensis*, *I. cinnamomeus*, *I. flavicollis*, *Rallus striatus*, *Porzana fusca*, *P. cinerea*, *Amaurornis phoenicurus*, *Gallicrex cinerea*, *Porphyrio porphyrio*, *Metopidius indicus*, *Rostratula benghalensis* and *Vanellus indicus*. From February onwards into the first half of the wet season, the area is particularly important for breeding *Glareola maldivarum*. A great many other species of shorebirds occur in winter or on passage.

The area supports large numbers of wintering *Milvus migrans*, and at a few sites, there are major roosts of several hundred birds in *Borassus* palms (e.g. 800 at Wat Samrae in Pathumthani Province). A few pairs of both this species and *Haliastur indus* nest, while *Elanus caeruleus* is very common. *Aquila clanga* is an annual winter visitor and passage migrant in small numbers, and *A. heliaca* has been recorded. *Circus (aeruginosus) spilonotus* is abundant and *C. melanoleucos* also occurs.

Earth banks along the course of the Chao Phraya river and in a few old oxbows support nesting *Ceryle rudis*. The better wooded parts are important for the rather local *Pelargopsis capensis*. Clumps of woodland support *Tyto alba* and a great variety of small insectivorous birds, including *Pericrocotus cinnamomeus*. There are large colonies of the flying fox *Pteropus lylei* at Wat Tarn En, Wat Kanom Tai, Wat Ko Loi, Wat Tha Sung, Wat Samo Son and Wat Pho.

The Water Monitor *Varanus salvator* and Reticulated Python *Python reticulatus* both still occur in the area.

**Special floral values:** None known.

**Research and facilities:** The Bangkok Bird Club has conducted partial censuses of the *Anastomus oscitans* colony at Wat Phai Lom and a number of members maintain some record of important waterbird roosting or nesting sites. Other research on *A. oscitans* has been carried out by Buphar Amget of the Royal Forest Department, by Inkapatanakul (1986) and by Lauhachinda (1969). Many sites within the southern Central Plains are visited by bird-watchers whose records are on file at the Center for Wildlife Research, Mahidol University, Bangkok.

**References:** Inkapatanakul (1986); Johnson (1986); Kerdtham & Pumsaka (1983); Lauhachinda (1969); Lekagul *et al.* (1985).

**Criteria for inclusion:** 123.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Gulf of Thailand

**Country:** Thailand

**Coordinates:** 13°10'-13°33'N, 99°57'-101°02'E;

**Location:** the inner Gulf of Thailand in the vicinity of Bangkok. The site extends from Ban Pak Thale, Phetchaburi Province, in the west, north and east past the mouths of the Mae Kiong, Tachin, Chao Phraya and Bang Pakong Rivers, to the town of Chonburi, Chonburi Province, in the southeast.

**Area:** Length of coastline approximately 150 km; in some areas, the mudflats exposed at low tide extend up to two km from the shore.

**Altitude:** Sea level.

**Biogeographical Province:** 4.5.1.

**Wetland type:** 01, 02, 06, 07, 09 & 10.

**Description of site:** A large area of intertidal mudflats around the shores of a huge, shallow sea bay forming the estuary of four major rivers, the Mae Klong, Tachin, Chao Phraya and Bang Pakong. The area formerly supported extensive mangroves. While the largest areas have now been cleared for aquaculture and salt pans, much secondary mangrove still remains and is usually found as a narrow (10-100m) fringe along the seaward margins. Extensive areas of low scrub are found in the

brackish marshes along the landward edge. In places, the open shrimp ponds and saltpans extend two to three km inland and, together with the offshore mudflats, provide an important feeding and roosting area for many thousands of shorebirds. The human population density is extremely high, and there is an increasing amount of heavy industry, especially extending eastwards from Bangkok along the lower reaches of the Chao Phraya River. The water regime is extremely complex, with great variations in turbidity and salinity influenced by seasonal variation in the amount of freshwater entering via the rivers and by direct run-off from the land. The bay is very shallow, the sea-bed sloping gently to a depth of six metres 10-20 km offshore. The tidal amplitude varies from 1.4m at neap tides to 3.8m at spring tides. There are usually two high tides and two low tides per day, but these are often asymmetrical. Throughout the months December-January, the mudflats are covered throughout the daylight hours.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,418 mm, 85.8% of which falls during the southwest monsoon (May to October). The mean annual temperature is 28.1°C (range 9.9-39.9°C).

**Principal vegetation:** Mangroves in which species of *Rhizophora* are usually dominant. *Nypa fruticans* is frequent in the understorey. Extensive degraded areas are dominated by the fern *Acrostichum aureum*. Large areas of "back mangrove" are dominated by scrub formations grading into *Typha* marsh in freshwater areas. Other areas inland are mainly cultivated (orange groves, coconut groves and rice paddies) or urbanized.

**Land tenure:** The wetlands are mainly state owned. Areas of shrimp ponds and saltpans are occupied both legally and illegally by the operators. Some areas are owned by the Military. Surrounding areas are privately owned farmland and households.

**Conservation measures taken:** No protected areas have been established. The Association for the Conservation of Wildlife formerly maintained a few bird observation hides at Bang Pu, four km east of the Chao Phraya river mouth, but these have fallen into disrepair. Some small patches of mangrove derive a measure of protection from the proximity of Buddhist temples, and some reseeded of mangrove has been undertaken.

**Conservation measures proposed:** Parts of the area, including selected mangrove, shrimp pond and intertidal habitats, should be set aside as Non-Hunting Areas. The most suitable areas, both in terms of their mangrove resources and in terms of the numbers of roosting and feeding shorebirds which they support, lie between the mouths of the Tachin and Mae Klong rivers and in the major mangrove inlet which lies between the towns of Phetchaburi and Samut Songkhram. Existing legislation should be enforced in order to prevent further encroachment into mangroves and also to protect shorebirds against hunting. Educational and recreational facilities, such as bird observation hides, a nature centre and wooden walkway nature trails through the mangrove, should be established.

**Land use:** Fishing from boats, with trawl nets and gill nets; aquaculture for penaeid prawns; salt production. The area is also a rich source of crabs and shellfish. There is an important fishery of the Green Mussel *Perna viridis* at the mouth of the Bang Pakong River, while cockle culture is practised in Phetburi Province, at the western extremity of the site. Some cockles are also harvested when young and then shipped to southern Thailand for rearing in shellfish beds at Bandon Bay and other localities. Fruits of the *Nypa* palm are harvested for food. Mangroves are cut for pulpwood (used in construction and fencing) and for charcoal production. Land use in adjacent areas includes cultivation (wet-season rice, with small areas of second crop rice, coconuts, orange groves and vegetables), housing and industry.

Prawn farming is at present undergoing a transition. The old-style, shallow, naturally-seeded ponds are being replaced by deep, intensively managed ponds which are seeded with purchased larvae. Land prices are escalating rapidly.

Possible changes in land use: There is an increasing amount of industrialization and urban development throughout the area. There has been a recent proposal for a project to establish an

"integrated fishing and industrial community" in the Tachin River estuary. Some 2,400 ha on both banks of the estuary would be affected by reclamation and dredging for the development of a huge marine port and industrial estate with support industries (e.g. fish processing and canning plants). The proposal was made by the Department of Fisheries and has been approved by a joint public/private coordinating sub-committee, which is to forward it to the Policy and Planning Committee in the Ministry of Agriculture.

There is increased industrialization and urban development in the water catchment area. The construction of two large hydro-electric dams on the Khwae River system is believed to have resulted in reduced freshwater inflow from the Mae Kiong River. A third such dam has been proposed (the Nam Choan Dam), but this project has recently been shelved.

**Disturbances and threats:** If the project to establish a fishing and industrial community in the Tachin River estuary is carried out, it will almost certainly have a major destructive impact upon the most important areas for migrant and wintering shorebirds. An important staging area for *Limnodromus semipalmatus* appears to lie in the heart of the area proposed for reclamation. The project would also damage the local aquaculture and fishery interests. The site is under great human pressure through continued cutting of mangroves and the reclamation of marshy areas for building land. Feeding and roosting areas for shorebirds are being lost as shallow prawn ponds are replaced by deeper, steep-sided and intensively managed ponds. There is a considerable amount of pollution from both industrial waste and raw sewage, and this may be linked to the occasional occurrence of "red tides", caused by sudden blooms of dinoflagellates. In addition, there is widespread hunting of shorebirds and herons for food; birds are both shot and netted. Cultivated areas are suffering as a result of the encroachment of salt water which may be a direct result of the major hydro-electric schemes in the water catchment area.

**Economic and social values:** The site makes an immense contribution to the living standards of the local inhabitants and people of Bangkok, as a source of seafood and raw materials. The towns of Samut Sakhon and Samut Songkhram are important fishing ports at the mouths of the Tachin and Mae Klong Rivers respectively. The main rivers and interconnecting canals which ramify through the area are important for communications. The site also has immense potential for both research and recreation, due to its proximity to Bangkok.

**Fauna:** The area is of international importance as a staging and wintering area for shorebirds. There have been no complete counts at times of peak passage, but there is good reason to believe that the site regularly supports concentrations of 10,000-20,000 shorebirds of up to 36 species. An aerial survey in October 1984 revealed 11,310 shorebirds (Parish & Wells 1985). The numbers of birds present in winter may be smaller; the predominant species at this time are *Pluvialis dominica*, *Charadrius alexandrinus*, *C. mongolus*, *Tringa totanus*, *T. stagnatilis*, *T. glareola* and *Calidris ferruginea*. Concentrations of over 2,000 of each of these species are regular. The site annually supports more than 300 *Tringa erythropus* from December to March. Concentrations of up to 130 *Ardea cinerea* and 36 *Mycteria leucocephala* have been recorded, together with the occasional *Pelecanus philippensis*. A spectacular concentration of Asian Dowitchers *Limnodromus semipalmatus* occurs each spring, when over 500 birds have been recorded on mudflats to the west of the Tachin River during the first week of April. Passage is spread from about mid-March until early May, and so the total number of birds using the site is probably much higher. Several hundred *Limosa limosa* and *L. lapponica* are also present at the same time. Some 5,000-10,000 gulls and terns (chiefly *Larus brunnicephalus* and *Chlidonias hybrida*) are present in late autumn and winter. The site is also important for breeding birds. There are several colonies of *Egretta garzetta* and *E. alba* in the mangroves, and *Butorides striatus* and *Haliastur indus* are common and widespread. Both *Hirnantopus himantopus* and *Sterna albifrons* breed in shrimp pond habitats. The mangroves are also important for a number of small land-birds, such as *Treron vernans* and *Pachycephala cinerea*, and a great variety of warblers and flycatchers occur on passage or in winter. The site is a

regular wintering area for small numbers of birds of prey such as *Pandion haliaetus* and *Falco peregrinus*.

**Special floral values:** None known.

**Research and facilities:** Bird count data for the site are held on file at the Centre for Wildlife Research, Mahidol University, in Bangkok and at the Asian Wetland Bureau in Kuala Lumpur. The site continues to be visited regularly by bird-watchers.

**References:** Lekagul *et al.* (1985); Parish & Wells (1985).

**Criteria for inclusion:** 123.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Khlung

**Country:** Thailand

**Coordinates:** 12°16'-12°27'N, 102°08'-102°22'E;

**Location:** at the mouth of the Mae Nam Wale on the coast of southeast Thailand, extending 20-40 km southeast of the town of Chanthaburi, Chanthaburi and Trat Provinces.

**Area:** Approximately 25,000 ha.

**Altitude:** Sea level.

**Biogeographical Province:** 4.5.1.

**Wetland type:** 02, 06, 07, 08 & 10.

**Description of site:** An area of mangroves, mudflats and shrimp ponds, situated at the junction of the Mae Nam Wale and Khlung Wale. The site is enclosed by a long coastal spit which runs southeast from the mouth of the Mae Nam Chanthaburi to the mouth of the Mae Nam Wale. A rocky hill, Khao Ang Krapong, lies on the east side of the river mouth. The coastal spit and much of the hinterland is heavily populated and is now dominated by shrimp ponds. There is a great, though seasonally variable, input of freshwater through the rivers. The greatest freshwater run-off occurs from July through to November. The salinity is 20.96-22.04 pp.t. in the Class I Mangrove zone of tallest trees towards the seaward edge, and 18.62-20.67 in the landward Class II and III zones. The pH is 6.7-7.0 at the seaward edge and 6.1-6.6 towards the landward edge. The highest spring tides are 2.0-2.4m (exceptionally 2.6m) above the lowest low water, and the neap tides occasionally as low as 0.7-0.8m.

Anon (1985b) gives land use figures for a 9,000 ha Test Site of the National Remote Sensing and Mangroves Project as follows: total area of mangroves 3,879 ha (Class I Mangrove 1,125 ha, Class II Mangrove 1,164 ha, Class III Mangrove 1,590 ha); shrimp farms 359 ha; paddy fields 1,105 ha; standing trees (presumably non-mangrove species) 359 ha; clearings 972 ha; open water 2,485 ha. Kiankamsorn *et al.* (1981) listed the total area of mangroves in 1979 as 17,008 ha and of mudflats as 5,232 ha.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 3,164 mm, 88.5% of which falls during the southwest monsoon, from May to October. The mean annual temperature is 27.2°C (range 8.9-40.8°C).

**Principal vegetation:** Mangroves; Class I mangrove is dominated by species of *Rhizophora*, *Avicennia*, *Bruguiera* and *Xylocarpus* and *Nypa fruticans*, with a narrow fringe of *Sonneratia sp* along the seaward margin. Class II mangrove is dominated by *Ceriops sp*. The most detailed information is given in Aksornkoae (1976). Adjacent areas are almost entirely cultivated, with coconut palms, fruit orchards and, further inland, rubber plantations. Upland outcrops such as the mountains of Khao Sabap and Khao Soi Dao, well inland, are still forested.

**Land tenure:** The wetland is state owned. Surrounding areas are mainly privately owned.

**Conservation measures taken:** Most of the mangrove area has been declared as National Reserve Forest and may be cut under concession, on a rotational basis. Small areas have been reseeded with mangrove species.

**Conservation measures proposed:** Mangrove land-use zoning has been proposed. The area requires a detailed survey to determine its current conservation value, particularly as regards the mangrove community and as a likely feeding area for wintering or passage shorebirds.

**Land use:** Fishing, aquaculture and both legal and illegal wood-cutting. Some areas adjacent to the landward edge are given over to rice cultivation and coconut plantations.

**Disturbances and threats:** The continued cutting of mangroves, both legally and illegally, and the conversion of formerly wooded areas to shrimp ponds are the major threats to the site. Anon (1985b) reported a 50% decline in the area occupied by tall, Class I mangrove in the years 1975-1985, and since then, there has been further massive illegal clearance of mangroves for aquaculture.

**Economic and social values:** The mangrove resource is of great local and regional importance for its fishery and as a source of timber and other products such as fruit and thatch from *Nypa* palms.

**Fauna:** There have been no detailed surveys of the area. Balanca *et al.* (1986) found only small numbers of migrant shorebirds (40 individuals of 10 species) in February 1986. However, this survey may not be representative since the tides were high throughout the daylight hours at the time of the survey and, in addition, the most extensive areas of fish ponds (which might be expected to support roosting and/or feeding shorebirds) were not visited. Usage of the area is expected to be much higher. King (1966) collected three specimens of *Heliopais personata* at Ban Saentung, Trat, at the northeast boundary of the site in April 1966.

**Special floral values:** The area supports the largest and most diverse mangrove area in the inner Gulf of Thailand.

**Research and facilities:** The area is a test site of the National Research Council of Thailand's National Remote Sensing and Mangroves Project, 1985-1987. Aksornkoae (1976 & 1981) has carried out extensive research on the structure, composition, phenology and regeneration of the mangroves at this site.

**References:** Aksornkoae (1976 & 1981); Anon (1985b); Balanca *et al.*(1986); Klankamsorn *et al.* (1981).

**Criteria for inclusion:** lb. 2b.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Khao Sam Roi Yot National Park

**Country:** Thailand

**Coordinates:** 12°07'-12°16'N, 99°52'-100°01'E;

**Location:** 20 km south of the town of Pranburi, in Kui Bun District, Prachuap Khiri Khan Province.

**Area:** Total area 13,000 ha of which approximately half is wetland habitat.

**Altitude:** Sea level.

**Biogeographical Province:** 4.5.1.

**Wetland type:** 03, 04, 05, 06, 07, 08, 10, 11, 15 & 19.

**Description of site:** An area of coastal marshes, paddies and patches of degraded mangrove situated at the foot of an outcrop of limestone mountains which rise to 605m. The site encompasses what appears to be the largest freshwater marsh in Thailand, totaling almost 6,000 ha, together with 640 ha of open coastal flats and 950 ha of paddies. Between the mouths of the Khlong Khao Daeng and the Khlong Bang Pu, sandy beaches alternate with small areas of mudflats, shrimp ponds and rocky cliffs. There are five offshore islets along this stretch. Apart from a few hectares north of the mouth of the Khlong Khao Daeng, most of the mangrove occurs in narrow fringes along the riverine margins. There is a high human population density in the area and the site has been greatly modified by man, with drainage ditches and embankments being constructed in order to control water levels around the margins of the marsh. The freshwater marsh is about 1-2m deep, and is fed by springs, as well as by two rivers. There is considerable seasonal variation in the extent of

flooding, but the marsh has never dried out. Parts of the area are tidal. The tidal amplitude at Hua Hin, some 40 km to the north, varies from 0.9m at neap tides to 2.7m at spring tides.

**Climatic conditions:** Tropical monsoonal climate with an average rainfall of 1,036 mm, 71.3% of which falls during the southwest monsoon, from May to October. The mean annual temperature is 27.4°C (range 13.9-38.6°C).

**Principal vegetation:** The main freshwater marsh is dominated by *Phragmites australis*, which covers an area probably in excess of 3,000 ha. Around the margins are small areas of *Typha angustifolia*, low *Scirpus*, probably *S. articulatus*, *Eleocharis spp*, *Cyperus spp*, *Arundo donax* and *Themeda arundinacea*. The drier margins of the site support clumps of *Bambusa sp*. *Rhizophora* is dominant in the mangrove stands along the tidal reaches of the rivers. *Casuarina equisetifolia* is found along sandy coastal beaches and sand spits. Mixed deciduous woodland and bamboo cover the dry, rocky mountains adjacent to the site. Rice is grown in wetter areas, with some dry land crops scattered among clumps of bamboo on dry sandy soils.

**Land tenure:** The wetland is state owned and open to public. Illegal encroachment has occurred in many parts of the marsh. The nearby rocky mountains are state owned, with adjacent lowlands being farmed as private small-holdings.

**Conservation measures taken:** Most of the area is protected as a National Park. Some planting of *Rhizophora* mangroves has been undertaken, and a preliminary management plan for the site has been prepared (Pirawat, 1986).

**Conservation measures proposed:** It is proposed that human use of the area be zoned (Pirawat, 1986). The boundaries of the park should be properly surveyed and extended to include the entire freshwater marsh area as well as at least some of the areas which are under aquaculture. Better protection of both freshwater and coastal habitats is needed. Efforts to suppress illegal hunting of wildlife should be increased. It may be desirable to limit access by tourists to sandy beaches at certain times of the year in order to avoid disturbance of nesting *Charadrius peronii*.

**Land use:** Fishing, chiefly with the aid traps; also aquaculture in brackish areas, rice cultivation and cattle grazing. Rice cultivation (one crop of wet-season rice per year), cultivation of pineapples, vegetables and sugar cane, and cattle grazing in adjacent areas.

Possible changes in land use: Intensification of aquaculture in brackish water areas and a slow increase in tourism.

**Disturbances and threats:** The principal threats stem from intensified use by local people of habitats within, or immediately adjacent to, the park, a problem which is exacerbated by the fact that the park's boundary has not yet been formalized. Many people have land rights within the park, and in recent years, many areas have been greatly modified by aquaculture. There is a danger that such activities, through modifying the tidal flow patterns, could change the present beach topography. There is small-scale agricultural encroachment into the drier margins of the freshwater marsh. Local people hunt wildlife illegally both in the marshy areas and in the adjacent forested mountains within the park. Increased human use of sandy beaches, especially through tourism, could disturb sensitive nesting species such as *Charadrius peronii* and *Sterna albifrons*. The use of snares to catch water birds, particularly rails and crakes, for human consumption appears to be increasing.

**Economic and social values:** The area is clearly of great local economic importance for both its freshwater and brackish water fisheries, while the village of Ban Khao Daeng is also a small marine fishery port. Tourism is of growing importance; visitors to the National Park often purchase provisions locally, and boatmen are often hired to take visitors out to accommodation on remote headlands, inaccessible by land. The site has great recreational value because it offers the visitor a very wide variety of natural attractions (sandy beaches, clear waters offshore, islands, caves, mountains, woodlands and wetlands) within a relatively small area.

**Fauna:** A total of 237 species of birds (both land birds and water birds) has so far been recorded at the park. The park is of importance for many larger water birds; it is one of very few sites in

Thailand where *Ardea purpurea* breeds, and there is a small egret colony. *Dendrocygna javanica* is present all year round as are *Rallus striatus*, *Porzana cinerea* and *Porphyrio porphyrio*. Other breeding species of conservation importance include *Haliaeetus leucogaster* (one or two pairs), probably *Falco peregrinus*, *Sterna albifrons*, *Charadrius peronii* (about five pairs), and, on offshore islets, *S. sumatrana* and probably *S. bergii*.

Annual wintering or non-breeding visitors include *Ardea cinerea* (over 60 birds), *Mycteria leucocephala* (1-5 birds), *Leptoptilos dubius* (usually one individual) and *Threskiornis melanocephalus*. A few thousand *Dendrocygna javanica* are found in winter. Other duck species recorded in small numbers include *Anas acuta*, *A. crecca*, *A. querquedula*, *A. clypeata* and *Aythya nyroca*. The site is important for wintering raptors. In addition to many *Circus (aeruginosus) spilonotus* and *C. melanoleucos*, two *Aquila clanga* and one *A. heliaca* are recorded annually over the freshwater marshes.

More than 3,000 wintering shorebirds of up to 42 species may, at times, be present on the foreshore and in adjacent paddies. There are usually several hundred *Charadrius dubius*, *C. mongolus*, *Tringa stagnatilis* and *T. glareola*, and 100-200 *Calidris ruficollis* and *C. subminuta*. Some 20-30 *Xenus cinereus* and *Calidris alba* are regularly present on the open sandy shore. *Calidris tenuirostris* is annual on passage in small numbers. Other water birds include wintering concentrations of at least 10 *Hydroprogne caspia* and 45 *Sterna bergii*. The endangered Nordmann's Greenshank *Tringa guttifer* has been recorded, and may be a regular winter visitor to the area in very small numbers. Other scarcer visitors have included occasional *Numenius madagascariensis*, *Limnodromus semipalmatus* and *Eurynorhynchus pygmaeus*.

The freshwater marsh supports a great variety of wintering migrant passerines and is probably of conservation importance as a site for *Acrocephalus* spp and other warblers. It is the only known wintering site for the little-known *Acrocephalus (agricola) tangorum* and is the southernmost wintering area for *Erithacus svecicus* (and possibly many other species) in continental Southeast Asia.

The forested crags within the park support Serow *Capricornis sumatraensis*, an endangered species in Thailand.

**Special floral values:** The site presents an unparalleled variety of habitats situated in close proximity to one another.

**Research and facilities:** Most available information on the site has been compiled from the reports of visiting bird-watchers and from data collected by Interwader. This information is held on file at the Centre for Wildlife Research, Mahidol University, Bangkok. The National Parks Division staff at the site have themselves compiled a bird list. Accommodation is available at the National Park headquarters.

**References:** Bijlsma & de Roder (1985); Lekagul *et al.* (1985); Parish & Wells (1985); Pirawat (1986).

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

**Source:** Era Jintanugool and Philip D. Round.

**Wetland name:** Thung Kha

**Country:** Thailand

**Coordinates:** 10°19'N, 99°10'E;

**Location:** on the east coast of the peninsula, extending up to 20 km north of the town of Sawi, Chumphon Province. The northern shore of the bay is about 15 km south of the town of Chumphon.

**Area:** c.5,000 ha.

**Altitude:** Sea level.

**Biogeographical Province:** 4.5.1.

**Wetland type:** 03, 04, 05, 06 & 07.

**Description of site:** A large sea bay with approximately 22 km of shoreline, enclosing an extensive area of mudflats and fringed with mangroves. Klankamsorn *et al.* (1981) have estimated the area of mudflats in Sawa District as 1,728 ha and that of mangroves as 2,384 ha. The site is accreting gradually to the eastwards. Two major rivers, the Khlong Sawi and the Khlong Sawi Thao, enter the bay and provide a seasonally variable freshwater inflow. The bay is very shallow, with an extensive area offshore only 1-3m deep at mean low water. The tidal range at Ko Mattaphon varies from 0.7m at neap tides to 1.5m at spring tides.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 2,070 mm falling during both monsoons. The wettest month is November (average rainfall 360.6 mm) and the driest March (64.9 mm). The relative humidity varies from 78% in March and April to 86% in October. The average daily temperature varies from 25.1°C in December to 28.6°C in April.

**Principal vegetation:** Mangroves, most of which have been logged at some time in the past. *Rhizophora* dominates along the seaward edge and along the main waterways. There is little or no *Sonneratia*; this species may have been lost due to logging. *Avicennia* occurs as a pioneer species where sediments are accreting along the seaward edge. *Ceriops* and (probably) *Xylocarpus* dominate on the higher ground, towards the landward edge. Adjacent areas inland are chiefly under cultivation.

**Land tenure:** The wetland is state owned; surrounding areas are mainly privately owned or occupied.

**Conservation measures taken:** The mangrove area is listed as National Reserve Forest. Some planting of *Rhizophora* mangroves has been undertaken by the Royal Forest Department.

**Conservation measures proposed:** A management plan for the site is under preparation as part of a development project funded by the Asian Development Bank.

**Land use:** Fishing and harvesting of crabs. The wetland also supports an important fishery, for the mussel *Perna viridis*. Local people plant the mangrove *Ceriops* which is harvested on rotation for fuel wood and charcoal. Adjacent areas are used for the cultivation of rice and, to a lesser extent, coconuts.

Possible changes in land use: There is the likelihood that a project to establish mangrove plantations will be developed with funding from the Asian Development Bank. Up to the present time, there has been very little clearance of mangroves for aquaculture.

**Disturbances and threats:** The most potentially damaging threat would be the conversion of the mangrove areas to shrimp ponds. However, local people at the site have shown no inclination to clear the mangroves outright as they realize considerable income from mangrove timber. Further intensification of cutting for increased charcoal production could damage the integrity of the site. Similarly, the conversion of large areas to even-aged stands of intensively managed plantations (under the proposed Asian Development Bank project) would reduce the value of the site for wildlife.

**Economic and social values:** Both the harvesting of mangrove and the mussel fishery are of great local economic importance.

**Fauna:** The waterfowl have not been surveyed, but the area is likely to be of considerable importance for a variety of passage or wintering shorebirds.

*Macaca fascicularis* and *Crocodylus porosus* are said to occur.

**Special floral values:** Possibly one of the least disturbed areas of mangrove on the gulf coast of Thailand.

**Research and facilities:** P. Namlabudha of the Remote Sensing Subdivision of the Royal Forest Department is conducting detailed mapping of the mangrove resources, using a combination of aerial photographs and satellite imagery.

**References:** Klankamsorn *et al.* (1981); Ngampongsai & Nabhitabhata (1987).

**Criteria for inclusion:** lb.

**Source:** Jim Jintanugool and Philip D. Round.

**Wetland name:** Ao Bandon (Bandon Bay)

**Country:** Thailand

**Coordinates:** 9°11'-9°24'N, 99°13'-99°41'E;

**Location:** extending between Chaiya and Don Sak Districts of Surat Thani Province, on the east coast of peninsular Thailand. The site covers all the coast in the immediate vicinity of the provincial capital, Surat Thani.

**Area:** Approximately 102 km of shoreline.

**Altitude:** Sea level.

**Biogeographical Province:** 4.5.1.14.7.1.

**Wetland type:** 02, 06, 07 & 10.

**Description of site:** The largest estuarine and mangrove inlet on the east coast of the Malay Peninsula. A huge area of intertidal mudflats, extending 1-2 km offshore, encompasses the delta of the Tapi River and at least nine other smaller rivers. The area is backed up inland to a distance of two km by shrimp ponds and degraded mangrove, including large areas of dead and dying trees. Most of the mangrove has been cleared leaving a narrow fringe of tallish trees (10-15m high) along the seaward edge. The bay is very shallow with extensive areas less than one meter deep at mean low water. In areas of shrimp ponds, the salinity ranges from 1.5 p.p.t. in the rainy season to 33 p.p.t. in the dry season. The mean tidal range is 1.10m; the amplitude at spring tides is 1.90m (occasionally as much as 2.2m), and that at neap tides, 0.7m. Tidal influences are modified by freshwater run-off from the Tapi River catchment.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,755.3 mm, the heaviest rain usually falling in November (346.2 mm). February is the driest months, receiving an average of 13.2 mm. Most rain falls during the southwest monsoon (May to October), but the season is extended into December by the onset of the northeast monsoon. The prevailing winds are northeast from November to April and southwest from May to October. The mean annual temperature is 26.3°C (range 22.2-32.1°C). The relative humidity varies from 76% in March to 88% in November.

**Principal vegetation:** *Sonneratia* is dominant in the mangrove on the seaward edge, and is fringed behind with *Rhizophora*. In only a few areas is this belt of mangroves more than 100m wide, and along much of the coastline it is much less. There are extensive areas of dead mangrove among the shrimp ponds. Adjacent land is mainly under cultivation with rubber plantations, rice paddies and field crops. There is some secondary evergreen forest on the nearby hills.

**Land tenure:** The wetland is state owned, though many areas have been settled illegally; surrounding areas are mainly in private ownership.

**Conservation measures taken:** Some small-scale replanting of mangrove has been undertaken. Bandon Bay is a designated site under the ASEAN/USAID Coastal Resources Management Project (CRMP), which aims to develop site-specific coastal resource management plans.

**Conservation measures proposed:** The following recommendations have been made by Swennen *et al.* (1986):

1. that surveys be made of roosting sites and possible breeding sites of *Egretta* spp in relict stands of mangrove;
2. that such roosting and breeding sites be protected from human disturbance;
3. that more detailed studies be made of the feeding habits of shorebirds using the area;
4. that the level of research at the Surat Thani Fisheries Station be increased, especially as concerns the relationship between aquaculture and the amount and type of mangrove vegetation.

It is also recommended that better protection be given to the remaining patches of mangrove, and that this be combined with increased replanting. The area might be considered for possible establishment as a Non-Hunting Area.

**Land use:** Fishing, and aquaculture for penaeid shrimps including the Jumbo Tiger Prawn *Penaeus monodon*. The offshore mudflats are used for the culture of oysters *Crassostrea* spp and Green Mussel *Perna viridis*. Cockles *Anadara granosa* are seeded. There are some small areas of saltpans. Most of the adjacent land is used for the cultivation of rice (one crop of wet-season rice per year), but there are also some orange and coconut orchards and small areas of rubber plantation.

Possible changes in land use: Increasing areas are being given over to human habitation, and there is further clearance of mangroves for aquaculture. There is also the likelihood of further industrialization of the areas immediately adjacent to the town of Surat Thani. Increased destruction of the forests of the uplands in the water catchment area may lead to increased amounts of silt entering the estuarine ecosystem.

**Disturbances and threats:** Continued clearance of mangroves for aquaculture may eventually threaten the site with irreparable damage due to erosion of the seaward bunds. Most clearance has taken place in the past five years as a result in part to an influx of settlers from elsewhere.

Industrial effluents and the release of deoxygenated water from the Chiew Nam hydroelectric dam (situated upstream on a major tributary of the Tapi River) are already causing severe pollution.

**Economic and social values:** The fishery is of immense importance and the remaining mangroves are probably essential in maintaining its productivity.

**Fauna:** Information on fish species at the site may be obtained from the Director of the Surat Thani Brackish Water Fisheries Station at Ban Changoe.

The site is believed to be a major wintering and/or staging area for migratory shorebirds. At least 2,840 shorebirds of 22 species were recorded along 17 km of shoreline during a five day survey in late October 1986. These included:

1,290 *Charadrius mongolus*

380 *Pluvialis dominica*

310 *Calidris ferruginea*

200 *Tringa stagnatilis*

140 *Calidris subminuta*

125 *C. ruficollis*

About 500 herons of seven species were also counted, of which over 80% appeared to be *Egretta garzetta*. There were also small numbers of *Ardea cinerea* and *A. purpurea* (Swennen *et al.*, 1986). The area was found to support an extremely high density of wintering *Halcyon pileata*, and the scarce Copper-throated Sunbird *Nectarinia calcostetha*, a species restricted to mangrove habitats in Thailand, was also recorded.

Small numbers of the Estuarine Crocodile *Crocodylus porosus* may still be present (Ngampongsai & Nabhitabhata, 1987).

Some collection of mudflat benthos has been undertaken by Interwader. Although the full results are not yet available, initial examination showed the biomass of invertebrates to be relatively high, with polychaetes, especially nereids, dominating numerically.

**Special floral values:** The remaining mangrove areas are of considerable regional importance.

**Research and facilities:** The Surat Thani Brackish Water Fisheries Station is situated at Ban Changoe on the shores of the bay. This provides a convenient base for shorebird research. Interwader carried out an aerial survey in autumn 1984 and a partial ground-based survey in autumn 1985. Dr Anant Saraya, Chief of the Coastal Investigation Unit in the Brackish Water Fisheries Division of the Department of Fisheries, has detailed information concerning the development of aquaculture at the site.

**References:** Ngampongsai & Nabhitabhata (1987); Swennen *et al.* (1986).

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

**Source:** Jira Jintanugool, Philip D. Round and Interwader.

**Wetland name:** Tapi River and Nong Tung Tong Non-Hunting Area

**Country:** Thailand

**Coordinates:** 8°44'-8°54'N, 99°12'-99°16'E;

**Location:** 35 km SSW of Surat Thani, Khian Sa District, Surat Thani Province.

**Area:** 6,450 ha.

**Altitude:** 20-30m.

**Biogeographical Province:** 4.5.1/4.7.1.

**Wetland type:** 11, 13, 18 & 19.

**Description of site:** A complex of swamps and grasslands along the Tapi River. The main swamp, Nong Tung Tong, lies on the east bank while another, Nong Tung Ka, lies on the west bank. The principal inflow is from the catchment of the Tapi River. The swamps are almost entirely flooded during the late southwest monsoon and during the northeast monsoon (October to December); by the end of the dry season, the swampy areas are very much restricted. The depth of water is usually 1-4m, with a maximum of 6-7m in the Tapi River; the swamp may be reduced to 25 cm in depth by March. The pH is 5.5-6.5.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,755.3 mm. The monthly rainfall reaches a peak in November (average 346 mm), and the driest months are February (13.2 mm) and March (21.9 mm). The relative humidity varies from 76.0% in March to 88.0% in November. The mean annual temperature is 26.3°C (range 22.2-32.1°C).

**Principal vegetation:** Emergent aquatic plants include *Phragmites communis*, *Arundo donax*, *Eleocharis dulcis* and *Oryza latifolia*. The banks of the river are wooded and include such species as *Lagersiroemia speciosa*. Plant communities in adjacent areas are categorized as lowland evergreen scrub forest by Storer (1978). Tree species include *Shorea roxburghi*, *Cyrtococcum patens*, *Parameria laevigata*, *Hydrocarpus anthelmintica*, *Hymenocardia punctata* and *Xanllwphyllum Inceatum*. Other habitats include rice fields, "lallang" meadows, wet meadows and rubber plantations.

**Land tenure:** The wetland is state owned and open to public use; surrounding areas are mainly in private ownership. Some areas are, however, occupied illegally and are still nominally state owned.

**Conservation measures taken:** An area of 2,960 ha was declared as the Nong Tung Tong Non-Hunting Area in 1975.

**Conservation measures proposed:** It is proposed to enlarge the existing Non-Hunting Area to approximately 6,450 ha, in order to encompass other nearby swampy areas.

**Land use:** Fishing and cattle grazing; rice farming and rubber plantations in surrounding areas. Possible changes in land use: There is a prospect of an increased level of tourism at the site.

**Disturbances and threats:** There is a gradual intensification of agriculture along the Tapi River, which is reducing the value of these areas for wildlife. Fire is used routinely by villagers and has severely damaged grasslands at the site. Illegal hunting of birds poses a less serious threat.

**Economic and social values:** The fishery and opportunities for grazing cattle make a contribution to the local economy. The water bodies serve as a source of fresh water for irrigation of rice fields in the dry months of January, February and March.

**Fauna:** At least 13 species of fish are known from the site: *Anabas testudineus*, *Fluta alba*, *Ophiocephalus striatus*, *O. gachua*, *Trichogaster trichopterus*, *T. pectoralis*, *Claris batrachus*, *Trichopsis vittatus*, *Heteropneustes fossilis*, *Rasbora argyrotaenia*, *Mystus nemurus*, *Notopterus notopterus* and *Ompok bimaculatus*.

Both *Dendrocygna javanica* and *Nettapus coromandelianus* breed. Most other waterfowl (eg. *Ardea purpurea*, *A. cinerea*, *Egretta* spp and *Gallicrex cinerea*) occur as winter visitors. *Leptoptilos javanicus* is an occasional visitor. Storer (1978) lists 105 species of birds, including such woodland

species as White-bellied Woodpecker *Dryocopus javensis*, a bird of lowland forest now endangered in Peninsular Thailand, and the scarce and local *Pycnonotus zeylanicus*.

Storer (1978) also lists 20 species of mammals, 11 species of reptiles and eight species of amphibians. The mammals include *Macaca fascicularis*, *Aonyx cinerea*, *Viverra megaspila*, *Felis temminckii* and *Sus scrofa*. The reptiles are *Python bimaculatus*, *Natrix piscator*, *Chrysopelea ornata*, *Naja naja*, *Trimeresurus albolabrus*, *Bungarus fasciatus*, *Platyurus platyurus*, *Gecko gecko*, *Calotes versicolor*, *Varanus sp* and *Malaymys subtrijuga*; the amphibians are *Bufo melanostictus*, *Ooedozygna lima*, *Rana cancrivora*, *R. limnocharis*, *R. hascheana*, *R. macrodactyla*, *Kaloula pulchra* and *Microhyla heymonsi*.

**Special floral values:** None known.

**Research and facilities:** Accommodation is available in the Non-Hunting Area.

**References:** Storer (1978).

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

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Pak Phanang Estuary

**Country:** Thailand

**Coordinates:** 8°21'-8°34'N, 99°58'-100°15'E;

**Location:** the mouth of the Pak Phanang River, Nakhon Si Thammarat Province, on the east coast of Peninsular Thailand.

**Area:** Approximately 15,000 ha.

**Altitude:** Sea level.

**Biogeographical Province:** 47.1.

**Wetland type:** 02, 05, 06, 07 & 09.

**Description of site:** Extensive mudflats (3,910 ha) bordered on the seaward (eastern side) to the south of the Pak Phanang River mouth by a 15 km long sand spit. This spit still encloses an area of mangrove, estimated by Klankamsorn *et al.* (1981) at 7,420 ha. The spit is accreting rapidly, so that mangroves are gradually spreading westwards into the estuary. Much of the area is of low stature fringing mangrove or has been cut over, and only a few hundred hectares of tall, primary mangrove were detected during an aerial survey in October 1984 (Parish & Wells, 1985). To the north of the river mouth, the mangrove area, listed at 4,718 ha in Kiankamsorn *et al.* (1981), has been almost entirely cleared and replaced with shrimp ponds. The associated area of mudflats is estimated at 2,016 ha. A near-continuous line of human settlements extends along the seaward edge of the sand spit, scattered among coconut groves and *Casuarina* trees. There are also some areas of shrimp ponds. At the tip of the spit is an open sandy area, approximately 500m long at high tide, which may be an important roosting site for shorebirds. The entire area was inundated during a typhoon in 1962, when existing villages were destroyed with great loss of life and property. Since that time, the area has been repopulated.

A large and seasonally variable amount of fresh water enters the system from the Phak Phanang River. Water depths range from 0.4-1.7m inshore to 2-6m in the outer bay. The tidal amplitude varies from 0.5m at neaps tides to 1.3m at spring tides.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 2,500.9 mm; the wettest month is November (579.9 mm) and the driest, March (48.4 mm). The influence of the northeast monsoon is strong, and 43.5% of the annual rainfall usually takes place in November. The average annual temperature is 27.6°C (range 22.7-31.9°C). The relative humidity varies from only 73.0% in July to 85.0% in December.

**Principal vegetation:** Mangroves, said to be species-rich, alternating with semi-natural wet grasslands. Coconut groves and *Casuarina* trees occur along the seaward edge of the spit; the *Casuarina* is regenerating naturally. On the western side of the river mouth, there are extensive areas of rice paddy.

**Land tenure:** All intertidal areas and most or all of the areas of shrimp ponds and cleared mangrove are state owned. Human use of the site is, however, permitted and there has been much illegal occupation. Surrounding areas are mainly state owned, but similarly subject to much illegal occupation.

**Conservation measures taken:** An area of 5,680 ha on the eastern side of the river mouth has been established as the Laem Thalemphuk Non-Hunting Area. This includes considerable areas of mangroves and mudflats as well as beach habitat along the sand spit. The mangrove area is classified as National Reserve Forest. Some artificial reefs and islands have been constructed offshore in order to enhance the fishery.

**Conservation measures proposed:** Better protection of remaining mangrove habitat both inside and outside the Non-Hunting Area is needed. In addition, hunting should be strictly controlled; many migrant birds are hunted and netted illegally even within the Non-Hunting Area. The boundary of the Non-Hunting Area should be extended to encompass additional areas of mudflats, mangroves and fish-ponds.

**Land use:** Fishing and aquaculture; agriculture in surrounding areas. Coconut plantations have been established along the sand spit; further inland, wet-season rice is planted. The nests of the Edible-nest Swiftlet *Aerodramus fuciphagus* are harvested from nearby buildings.

Possible changes in land use: Increased clearance of mangroves for aquaculture. There is a proposal to build a harbour at the site in order to promote the development of a marine port. Continuing clearance of forest in the uplands in the water catchment area, remote from the site, may lead to further siltation.

**Disturbances and threats:** Continued clearance of mangrove for the establishment of shrimp ponds and for charcoal production is a major threat to the site. Further clearance of mangroves for industrial development would be a threat if the harbor construction is permitted. The large-scale hunting and netting of birds is probably very damaging to their populations.

**Economic and social values:** Considerable economic benefit is derived from the local fishing and aquaculture industries (penaeid shrimps and harvesting of the bloody cockle *Anadara granosa*). The harvesting of birds' nests is also very lucrative. Tourism is, however, as yet relatively undeveloped. The human population at the site depends for its very existence upon the maintenance of mangroves, which protect this vulnerable area from storm damage or potentially catastrophic inundation.

**Fauna:** Information on the fishes is available from the National Institute of Coastal Aquaculture in Songkhla. Approximately 1,000 shorebirds were recorded during a partial aerial survey in October 1984, while 500 shorebirds of 13 species (including 106 *Tringa totanus* and 158 *T. stagnatilis*) were seen during a ground survey in December 1984 (Parish & Wells, 1985). Most of the area has never been effectively surveyed due to difficulties of access, and it is likely that much higher numbers actually occur. In particular, the site is known to have supported *Limnodromus semipalmalus*. Approximately 50 specimens were collected here between 1910 and 1926 (Robinson & Chasen, 1936), probably consisting mainly of birds taken on southward passage, and there is every reason to expect that the species still occurs. Several *Leptoptilos javanicus* are reportedly present; it is not known whether the species still nests.

The sand beach on the eastern (seaward) edge of the spit can be expected to support nesting *Charadrius peronii* and possibly also *Sterna albifrons*. Coastal vegetation along the sand spit is known to provide important shelter for many other birds during their southward migration, including *Rallina fasciata*, *Pitta moluccensis* and *P. sordida*. The site is a major feeding area for tens of thousands of Edible-nest Swiftlets *Aerodramus fuciphagus*, which nest in buildings nearby. The site is also the northernmost locality on the east coast for the Pied Triller *Lalage nigra*, which inhabits beach scrub and *Casuarina* trees. The mangroves are remarkable in that they support an isolated population of the Sambar Deer *Cervus unicolor*, a species usually associated with terrestrial habitats.

The Long-tailed Macaque *Macaca fascicularis* and Fishing Cat *Felis viverrina* also occur in the area.

**Special floral values:** The site probably supports the richest remaining mangrove flora of any east coast site.

**Research and facilities:** A detailed survey of the marine and littoral environment has been carried out by the National Institute of Coastal Aquaculture, Songkhla. The temporary office of the Non-Hunting Area is located at Ban Kong Khong, some 15 km from the end of the sand spit. The area is a test site of the National Research Council's Remote Sensing and Mangroves Project, 1984-87.

**References:** Jorgensen (1949); Klankamsorn *et al.* (1981); Parish & Wells (1985); Robinson & Chasen (1936).

**Criteria for inclusion:** 1b, 1e, 2a, 2b, 2c.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Thale Noi Non-Hunting Area

**Country:** Thailand

**Coordinates:** 7°43'-8°00'N, 100°05'-100°15'E;

**Location:** at the extreme northern end of Lake Songkhla, where the boundaries of the Provinces of Phatthalung, Songkhla and Nakhon Si Thammarat meet.

**Area:** 45,000 ha.

**Altitude:** 1-2m.

**Biogeographical Province:** 4.7.1.

**Wetland type:** 14, 18, 19 & 21.

**Description of site:** A roughly circular lake, 5 km by 6 km, situated roughly one km to the north of the main part of Lake Songkhla. It is surrounded on three sides by areas of open swamp vegetation, sedge beds and rice paddies. An extensive area of *Melaleuca* swamp forest (4,220 ha) extends to the north. The village of Ban Thale Noi is situated on the western shore. The area of open water occupies 2,800 ha, roughly 60% of which is covered with floating or shallow-rooted aquatic vegetation. Grasslands and sedge beds cover 10,870 ha, and paddies 6,640 ha (Anon, 1981). The principal inflow to the lake is run-off from the steep slopes of the forested Banthad mountain range to the west. Outflow is via the Khlong Nong Riam and Khlong Yuan into Thale Luang, Lake Songkhla. While the lake is permanent, there may be fluctuations of up to 1.0m in depth, water levels usually reaching their minimum in August. The average depth during most of the year is 1.2m; this declines to less than 1.0m during the driest months. The lake is normally fresh to slightly saline (1.48 p.p.t.). At times of low water level during the driest months, some saline water enters the lake from Lake Songkhla, and the salinity may rise to a maximum of 3.5 p.p.t. The pH varies spatially and seasonally from 1.2-8.1 (average 4.4). The northern end, which lies in proximity to the *Melaleuca* swamp forest, is more acid than the south. The acidity increases during the rainy season as organic matter from acid humus leaches into the lake.

Detailed information on the water regime of the entire basin may be found in Sinclair *et al.* (1985).

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 2,162 mm, most of which falls during the northeast monsoon, from October to December. The average relative humidity is 79%. The mean annual temperature is 27.4°C; the maximum mean monthly temperature is 28.5°C in March, and the minimum, 26.5°C in November.

**Principal vegetation:** The principal species of floating and emergent plants are *Eleocharis*, *Hanguana*, *Nymphoides*, *Nymphaea* and *Nelumbo*, together with much *Salvinia* and *Azolla*.

There are some beds of *Phragmites* sp along the northern shore. Adjacent marshy flats support extensive beds of *Phragmites*, *Scirpus mucronatus*, *Cyperus grossus*, together with patches of *Eleocharis* and *Melaleuca*. The *Melaleuca* woodland is a secondary formation which has

presumably replaced a more diverse swamp forest in which *Aistonia spathulata* was co-dominant; a few *Aistonia* trees are still present. There are rice paddies and rubber plantations in the adjacent lowlands, and small areas of degraded evergreen forest on limestone or other outcrops.

**Land tenure:** The wetland is state owned and open to public use; surrounding areas are mainly private small-holdings.

**Conservation measures taken:** The entire area is incorporated within the Thale Noi Non-Hunting Area. The *Melaleuca* forest has the status of National Reserve Forest, so that cutting is forbidden in law.

**Conservation measures proposed:** The preparation of a management plan for Thale Noi has been proposed with a view to the possible upgrading of the whole or parts of the area to Wildlife Sanctuary or National Parks status (Sinclair *et al.*, 1985). Protection of wildlife and habitats should be improved. There should be better monitoring of rare breeding species such as *Mycteria leucocephala*. Artificial nest platforms for this species should be considered, since the small colony is said to be prevented from increasing because of a shortage of suitable large *Aistonia* nesting trees. Muddy scrapes might be constructed in areas surrounding the lake in order to increase their attractiveness to migrant shorebirds.

**Land use:** Fishing with gill nets, traps and electrocution methods. Aquatic vegetation is harvested for cattle fodder, and *Scirpus mucronatus* is planted and harvested for weaving as matting etc. The principal activities in surrounding areas are cultivation of rice (one crop of wet-season rice per year), cattle grazing and charcoal production.

Possible changes in land use: The proposed salinity barrier on adjacent Lake Songkhla may raise the water levels throughout Thale Noi. There has also been a proposal to construct a major new highway across the site, from Hua Sai to Thale Noi, although this has, for the moment, been shelved, partly because of the opposition of the government's Wildlife Conservation Division. It is possible that parts of the area will be developed for agriculture under the Phru Khuan Khreng Swamp Development Project.

**Disturbances and threats:** Threats are posed by current development proposals (see above), by continued clearance of *Melaleuca* for charcoal production, and by the burning or removal of swamp vegetation. There is still some illegal hunting of wildlife, and the eggs and young of *Mycteria* and other larger water birds are frequently taken for food. Fishermen kill otters *Lutra* sp. A large volume of untreated solid and liquid waste enters the lake from villages on the lake shore. Pesticide levels in the lake are reportedly high although the reliability of the data is questionable (Sinclair *et al.*, 1985). No data are available on the possible threat to waterfowl posed by the massive amount of discarded nylon fishing net in the lake.

**Economic and social values:** Villagers derive considerable income from the fishery, from utilizing aquatic plants and from the capture and sale of snakes. There were twelve snake dealers in Ban Thala Noi in 1982 (J. Nabhitabhata, pers. comm.). The lake has great potential for tourism, and although it already receives approximately 100,000 visitors per year, its amenity value could be greatly increased with better management and information services.

**Fauna:** The lake supports the endangered catfish *Prophagorus nieuhofi*.

One hundred and eighty-six species of birds are listed for Thale Noi (Anon, 1981). The lake and its marshes are the most important area within the entire Lake Songkhla basin for waterfowl. They support the only remaining breeding colony of *Mycteria leucocephala* in Thailand. Up to 17 individuals were reported in 1978-79, of which no more than about four or five pairs bred (R. Dobias pers. comm.). Although the species is still present, there appears to be no recent information on numbers. *Leptoptilos javanicus* is an occasional visitor and flocks of up to 20 *Threskiornis melanocephalus* have been recorded. The lake is also one of very few breeding sites in Thailand for *Ardea purpurea*; the number of breeding pairs is not known, but concentrations of up to 1,000 birds have been claimed (Anon, 1981). Up to one thousand *Egretta* spp occur in winter, but it is not known whether any breed. Both *Dendrocygna javanica* and *Nettapus coromandelianus* breed in the

area, and concentrations of up to 10,000 and 20,000 respectively have been reported (Anon, 1981). Several species occur which are primarily associated with wooded habitats and which are of particular conservation significance; these include *Ichthyophaga ichthyaetus*, *Treron fulvicollis*, *Rhyticeros undulatus* and *Ketupa ketupu*. Otters *Lutra sp* are said to be present, and the River Terrapin *Batagur baska* may still occur. This latter species, the eggs and meat of which were formerly harvested for food, is considered close to extinction in Thailand (Bain & Humphrey, 192).

**Special floral values:** The site may contain the largest patch of *Melaleuca* woodland in Thailand.

**Research and facilities:** Accommodation and boat transportation are available at the headquarters of the Thale Noi Non-Hunting Area. The site has been visited by large numbers of bird-watchers, some of whom have filed their records at the Association for the Conservation of Wildlife in Bangkok.

**References:** Anon (1981); Bain & Humphrey (1982); Sinclair *et al.* (1985); Storer (1977).

**Criteria for inclusion:** lb. 1e, 2a, 2b, 3a.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Lake Songkhla

**Country:** Thailand

**Coordinates:** 7°10'-7°50'N, 100°05'-100°40'E;

**Location:** on the east coast of Peninsular Thailand, extending 0-90 km north of the town of Songkhla, Songkhla and Phatthalung Provinces.

**Area:** 104,000 ha.

**Altitude:** Sea level.

**Biogeographical Province:** 4.7.1.

**Wetland type:** 01, 07, 08, 14, 18, 19 & 21.

**Description of site:** A huge, shallow, coastal lagoon of fresh to brackish water, which opens to the sea by way of a short, narrow channel at the town of Songkhla on the southern shore. The lake is fed by about 100 streams and drains a total basin area of about 8,000 sq.km. The lake system is thought to be no more than 2,000 years old, having become isolated from the sea by the development of beach ridges. A great many small villages containing approximately 80,000 persons are scattered around the lake shore, most of these on the eastern side. The lake is usually divided into four distinct regions: from south to north, these are Thale Sap Songkhla, Thale Sap, Thale Luang and Thale Noi. Thale Noi lies to the north of the main lake and while it is best regarded as merely one part of the entire Songkhla Lake system, it has a number of special features which merit treatment as a separate site (site 37). Songkhla Lake is influenced by run-off from the steep, mainly forested mountains to the west and by the introgression of salt water from the sea. Water quality varies greatly throughout the different parts of the lake; there is much seasonal and spatial variation in salinity and turbidity. In Thale Sap, the salinity declines from a maximum of 5.3 p.p.t. in November to only 0.7 p.p.t. in January, following input of heavy rainfall. The turbidity is highest near the shoreline and increases to a maximum of 95-100 FTU in January. During the drier months, March to August, it is around 30-50 FTU. The average depth of the lake is about 1.0-1.5m over most areas, and the maximum depth, 2.5m. There are, however, considerable fluctuations in water level. At the Thale Sap Non-Hunting Area, the average depth in December, at the height of the monsoon, is 1.46m. This declines to about 0.5m by August. The average tidal range at the mouth of the overflow channel is approximately 0.5m, the maximum, 1.3m.

Detailed information on the water regime of the entire lake basin is available in Sinclair *et al.* (1985).

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 2,094 mm. There is, however, is a great deal of variation in the annual rainfall; in 1983, only 983 mm were recorded. Some 60% of the rain falls during the northeast monsoon, from October to December. The wettest month is usually December, while the driest months are from January to April. The mean

relative humidity is 79%, with a minimum of 76% in March and a maximum of 84% in November. The mean daily temperature is 27.6°C (maximum 28.7°C in April, minimum 26.6°C in December). Prevailing winds are easterly during November to April and southwesterly during June to October.

**Principal vegetation:** A total of 19 species of aquatic plants has been collected from the Kukut area of Thale Sap. The chief emergents and lake shore plants include *Scirpus litoralis*, *Paspalum vaginatum*, *Eleocharis dulcis*, *Fimbristylis ferruginea*, *Cyperus distans* and *C. stoloniferus*. In addition, there are small areas which are dominated by a mangrove-type community, the component species being *Sonneratia caeseolaris*, *Rhizophora apiculata*, *Nypa fruticans* and *Acanthus ebracteatus*. At Songkhla, this community occupies waters with a much lower salinity than is typical. Some other lake shore plants, such as *Melaleuca leucadendra*, *Hibiscus tiliatus* and *Olax scandens*, are more typical of sandy, coastal conditions. The chief submerged and floating aquatic species are *Chara sp.*, *Ceratophyllum demersum*, *Hydrilla verticillata*, *Lemna purpusilla*, *Najas spp.*, *Pistia stratiotes* and *Potamogeton malayanus*. The principal vegetation in surrounding areas is rice paddy and *Borassus* palms with some areas of *Melaleuca* scrub.

**Land tenure:** The lake is in public ownership; surrounding areas are privately owned small-holdings.

**Conservation measures taken:** Thale Sap Non-Hunting Area covers 31,500 ha, 48% of which is terrestrial. Thale Noi Non-Hunting Area (45,000 ha), at the north end of the lake, is described separately as site 37. The endangered River Terrapin *Batagur baska* is bred at the Coastal Aquaculture Institute in the town of Songkhla. The shrimp *Macrobrachium rosenbergii* is also bred in captivity and released into the lake.

**Conservation measures proposed:** The proposed establishment of an information centre, together with the imposition of visitors' entrance fees and various improvements in infrastructure, are all aimed at directing benefits to local people who live in and around the sanctuary (Marshall, 1984). If the area were better protected, the reintroduction of *Batagur baska* might be considered.

**Land use:** Chiefly fishing for molluscs, crustaceans and fish, together with some aquaculture. A variety of traps and nets are used. Aquaculture is beginning to be developed, with small areas of ponds for the culture of *Macrobrachium rosenbergii* and for sea-bass. (Anon, 1984). There is some cattle grazing around the lake. Local people utilize various aquatic plants such as *Eichhornia* and *Ceratophyllum* for animal fodder and others such as *Eleocharis* and *Scirpus* for weaving mats etc. Surrounding areas are extensively farmed. Over most of the lake basin (1,648 sq.km) there is one crop of rainfed, wet-season rice per year. Field preparation takes place from August, with most planting in October and the crop being harvested in March. Some 808 sq.km are given over to irrigated rice cultivation. The palm *Borassus flabellifer* is cultivated as a source of sugar and for its fruits. Some caves in limestone islands and other outcrops are important as sources of birds' nests and bat guano. These are leased from the government by a private company and therefore do not directly benefit the local people. There is also a small amount of tin mining in the basin.

**Possible changes in land use:** There is a proposal to construct a salinity barrier in the northern part of the lake, dividing Thale Luang from Thale Sap. This would enable fresh water to be stored in Thale Luang during the wet season in order to extend irrigation schemes, thereby enabling farmers to grow a second crop of rice. (Sinclair *et al.*, 1985). The consequences of such a scheme are potentially very serious. The lower part of the lake, Thale Sap, would change from being brackish to being permanently saline and this would greatly change the species composition and abundance of aquatic plants and animals. The water level in Thale Luang would be raised for long periods and this would increase flooding of areas around the lake. The movements of economically important species such as *Macrobrachium rosenbergii*, which spawns in brackish water and grows to maturity in fresh water, together with clupeid and other fishes, would be disrupted.

The industrialization and development of the basin will certainly lead to a rapid increase in the demands for water. In the water catchment area, Sinclair *et al.* (1985) list seventeen discrete ongoing or committed development projects in the fields of agriculture, aquaculture and construction, which will have direct impact upon the lake basin. Deep water access to the town of

Songkhla is to be improved in order to facilitate its development as a port. A new bridge has recently been constructed across the mouth of Lake Songkhla and a new highway is to be constructed across the basin.

**Disturbances and threats:** Apart from the above, the level of human use is such that larger wildlife has been hunted out, while many smaller species are subject to continual disturbance. The eggs of some water birds, together with many frogs, some reptiles and perhaps small mammals, are taken for food. Over-harvesting of the eggs of the River Terrapin *Batagur baska*, combined with the slaughter of great numbers of adults, has already destroyed a natural resource of great economic value. Repeated burning or cutting of emergent lakeshore vegetation may be the reason for the scarcity of *Phragmites* and other suitable nesting habitat for large water-birds. Fish yields are said to be lower per unit effort than formerly, although no data have been collected to test this. The decline in fish yields may be due either to over-fishing or to deleterious environmental change. A pumping station at Ranot, near the northern end of the lake, was constructed in order to draw off fresh water for irrigation projects. This led to increased salt-water introgression and the practice has since been discontinued.

**Economic and social values:** The resources of the lake basin have tremendous impact upon the economy of the region. Approximately 80,000 people (5% of the population of the entire basin) live around the shores of the lake and directly exploit its resources, while as many as 500,000 people benefit in some way from these resources. The annual yield of fish, obtained from both aquaculture and wild capture, is estimated as 7,000 tonnes per year (Sinclair *et al.*, 1985). Net annual income per person is estimated at Bht.7,000 (US dollar 270) per year, an equivalent amount being earned from rice cultivation. The annual yield of rice from the lake basin is 518,000 tonnes (Sinclair *et al.*, 1985).

There are approximately 40 edible species of fish in the lake. In addition, many molluscs, crustaceans, insects, amphibians, reptiles, birds and mammals are either eaten by man or used for feeding to domestic stock. The aquatic vegetation is an important source of food for cattle. A total of 29 aquatic plant species and 48 plant species which grow wild in surrounding areas are utilized in some way by villagers.

Because of its proximity to Hat Yai, the largest city in southern Thailand, the lake has important recreational and educational values. It also has important research potential and is already receiving study under a project administered jointly by the Prince of Songkla University in Hat Yai and the Institute of South-East Asian Biology, University of Aberdeen.

**Fauna:** There are thought to be several hundred species of fish in the lake, of which 100 species are abundant. Of 66 species collected in the vicinity of the Thale Sap Non-Hunting Area, 26 were freshwater species, 28 brackish to brackish/marine and 12 fresh/brackish or fresh/brackish/marine (Marshall, 1984).

Approximately 140 species of birds have been recorded from the Thale Sap Non-Hunting Area. Most larger species, such as egrets, are present only as winter visitors. The most abundant breeding or apparently resident species are *Tachybaptus ruficollis*, *Ixobrychus sinensis*, *I. cinnamomeus*, *Dendrocygna javanica*, *Nettapus coromandelianus*, *Gallinula chioropus* and *Porphyrio porphyrio*. The lake is important as the only known breeding site for *Himantopus himantopus* in the Malay Peninsula. Wintering concentrations of over 2,000 each of *Dendrocygna javanica* and *Nettapus coromandelianus* have been recorded, together with a few hundred *Anas querquedula*.

At least 19 species of Odonata have been recorded among seven aquatic insect orders in total. The macrobenthic fauna is dominated by Nereidae, Gammaridae and Chironomidae. The overall species diversity of Crustacea is very high.

A few River Terrapins *Batagur baska* may still be present. The species formerly nested in large numbers at Khao Chaison, on the western shore of Thale Sap.

Otters, probably *Lutra perspicillata*, are reportedly present on the lake.

**Special floral values:** None known.

**Research and facilities:** Accommodation is available at the headquarters of the Thale Sap Non-Hunting Area at Kukut, and boats can be rented. A project on the biological resource potential of the Kukut area is being conducted jointly by the Botany Department, Prince of Songkla University, and the Institute of Southeast Asian Biology, University of Aberdeen, U.K.

**References:** Anon (1981); Marshall (1984); Sinclair *et al.* (1985).

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

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Ao Pattani (Pattani Bay)

**Country:** Thailand

**Coordinates:** 6°55'N, 101°18'E;

**Location:** the bay area north of the town of Pattani, shared between Muang and Yaring Districts, Pattani Province.

**Area:** c.5,000 ha; length of coastline approximately 30 km.

**Altitude:** Sea level.

**Biogeographical Province:** 4.7.1.

**Wetland type:** 01, 02, 05, 06, 07, 08, 09 & 10.

**Description of site:** An estuarine bay protected on the northeast side by a 12 km long sand spit. Two major rivers, the Khlong Pattani and Khlong Yam Sai, drain into the bay. Areas of mangrove, both natural and managed (estimated at 836 ha in 1979), are found in the east of the area, and there are areas of degraded saltmarsh along the southern shore. These are interspersed with shrimp ponds and saltpans. The area of mudflat was estimated at 1,968 ha in 1979 (Klankamsorn *et al.*, 1981). The water regime is complex, with tidal influences from the Gulf of Thailand, run-off from the landward side and water draining from the two major rivers. The water depth is highly variable both spatially and temporally. The maximum depth is 3m, although the channel from the port to the open sea is dredged to a depth of 15m. The minimum depth at low tide varies from about 0-4m. The salinity fluctuates widely depending on the stage of the tidal cycle and the season; salinities are low during the rainy season and high during the dry season. In November 1985, they ranged from 3.20-24.67 p.p.t. The turbidity is usually high, especially in the rainy season. The amount of exposed mudflat varies greatly with wind strength and direction, and with tide. A small area of mudflat and saltmarsh is always available for birds even at the highest tides. The tidal amplitude varies from 90 cm at spring tides to 40 cm at neap tides.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 1,645 mm, 63.2% of which falls during the months of October, November and December. The surface water temperature was 27.9-29.2°C in November 1985, and temperatures as high as 31 or even 33°C have been reported at other times.

**Principal vegetation:** Mangrove, dominated by *Rhizophora mucronata* and *R. apiculata*, with *Sonneratia alba*, *Avicennia alba*, *A. officinalis*, *Bruguiera gymnorhiza*, *B. cylindrica*, *B. parviflora*, *Xylocarpus moluccensis*, *Acanthus ilicifolius*, *Excoecaria agallocha* and *Nypa fruticans*. Natural beach vegetation along the sand spit is dominated by *Casuarina equisetifolia*. The dominant plant in the *saltmarsh* is *Sesuvium portulacastrum*. Predominantly agricultural land in adjacent areas; mostly rice cultivation, coconut palm and cashew nut plantations.

**Land tenure:** Areas below the low tide mark are state owned; parts of the shoreline are state owned and parts are privately owned. From the eastern side of the Pattani river mouth to Ban Bang Ta Wa, areas of intertidal mudflat, saltmarsh and shrimp ponds are part of the Prince of Songkhla University campus. Surrounding areas are mainly private small-holdings.

**Conservation measures taken:** None.

**Conservation measures proposed:** Swennen *et al.* (1986) proposed the following measures:

1. Protecting mudflat and saltmarsh areas from reclamation as a University Conservation Area; acting to minimize or prevent direct disturbance, including bird catching; promoting the site as a centre for education and research.
2. Moving the seaward bund of existing prawn pond developments inland, to at least 100m back from the high tide line.
3. Assessing the likely impact of the proposed developments of Pattani port with respect to the site. Possible pollution problems and the likely impact upon the physical and social environment of the bay should be considered.
4. Increased research by scientists from Prince of Songkla University on ecology and the impact of present human activities.

The Pattani Bay Conference, 24-26 March 1986, recommended the establishment of a database at the P.S.U. Campus to cover all aspects of the bay (i.e. industry, fisheries, aquaculture, agriculture, ecology and culture).

Parts of the site might be considered for inclusion in a Non-Hunting Area or other category of nature reserve.

**Land use:** Inshore fisheries and aquaculture (penaeid shrimps, green mussels and oysters). Mangroves are cut on a rotational basis for pole wood and charcoal production. The marine alga *Gracilaria* is harvested for the extraction of agar. Surrounding areas are mostly agricultural land, with coconut palm and cashew nut orchards on poor, sandy soils. A developing industrial zone exists to the east of mouth of the Pattani River.

Possible changes in land use: In the Proceedings of the Pattani Bay Conference, 24-26 March 1986, a great increase in the development of the area was proposed, including the following:

1. The establishment of prawn culture ponds within the present mangrove and mudflat zones.
2. The development of a major industrial zone at the river mouth, in close conjunction with 3 and 4 below.
3. Increased port developments for use by the expanding fishing fleet, and by larger commercial shipping.
4. The development of the port of Pattani as the major distribution centre for the extreme south of Thailand.
5. An increase in heavy industry and a gradual shift away from economic dependence upon fisheries.
6. An increase in coastal recreation and tourism.

The headwaters of the Pattani River in the Budo mountain range are likely to suffer from continued deforestation due to shifting cultivation.

**Disturbances and threats:** The major threats stem chiefly from the developments outlined above and include increased industrial pollution and dredging within the bay, and continued destruction of the remaining saltmarsh, mudflats and mangroves for the construction of shrimp ponds. The latter will not only reduce wildlife habitat, but will also reduce the yield of the inshore fishery.

Large numbers of migratory shorebirds and land birds are captured for food or as cage birds. Fourteen villages engage in bird-catching activity and during October 1985 to September 1986,

3,784 shorebirds were caught by 146 villagers from nine villages. The chief species trapped were *Tringa totanus* (1,859 birds, 49% of the total catch); *Calidris ferruginea* (368 birds) and *Charadrius mongolus* (298 birds). It was estimated that as many as 71,550-97,000 snare loops may be set in the birds' roosting and foraging areas, and that over 10,000 shorebirds may be caught per year (Ruttanadakul & Ardseungnern, 1986). Boats from outside the area frequently enter the bay in order to fish with push-nets. This is very destructive of the sea-bed and the practice is opposed by local villagers. Part of the area is to be developed as a "beach recreation area". This may entail replacement of some areas of mudflats and salt marsh by sand.

**Economic and social values:** Pattani is a major port for the offshore fishery in the Gulf of Thailand, one of the most economically important fishery zones in the entire Asian-Pacific Region. The continued high productivity of the bay is essential for the inshore fishery, which is of major local importance. The area is unique with respect to its formation and hydrology, and is of great ecological interest. Because of its proximity to the Prince of Songkla University campus, it offers unparalleled opportunities for ecological research into the mangrove and marine ecosystems. A joint project between Interwader and P.S.U. (1984-86) has created a promising foundation for future study.

**Fauna:** Studies indicate that more than 10,000 shorebirds of up to 32 species utilize the bay at times of peak passage. The highest individual count during the period February to September 1986 was 2,753 birds, but evidence is given to suggest that the total numbers using the bay are much higher and that turnover is very rapid (Ruttanadakul & Ardseungnern, 1986). In 1987, the monthly maxima were 4,165 in February and 4,555 in September. The site receives higher usage in autumn than in spring. The predominant species are *Charadrius mongolus*, *Tringa stagnatilis*, *Calidris ruficollis*, *C. subminuta* and *Limicola falcinellus*. The Asian Dowitcher *Limnodromus semipalmatus* is a regular autumn passage migrant in significant numbers; at least 30 birds occur each year, and 104 were recorded in August 1987. There is one record of *Eurynorhynchus pygmeus* (13 birds in October 1984), and *Calidris acuminata* has also been recorded; these are only the second records of these species for Thailand.

Ten species of Ardeidae have been recorded. *Butorides striatus* breeds, and 1. *flavicollis*, *Egretta garzetta*, *E. interinedia*, *E. alba* and *Ardea cinerea* occur in winter. The sand spit to the east of the river mouth may be an important landfall for migrants including *Rallina fasciata*, *R. eurizonoides*, *Pitta moluccensis* and *P. sordida*.

The Malayan Box Tortoise and the otter *Lutra perspicillata* occur in the area.

The intertidal mudflats are extremely rich and have been found to support a higher ash-free dry weight of zoo-benthic biomass than any other site in Thailand. In 1984, the five main groups of prey species for shorebirds accounted for 29.6 g.AFDW/sq.m, with other groups which are important for the ecosystem totaling 12.5 g.AFDW/sq.m (Parish & Wells, 1985). The area was particularly rich in polychaete worms.

**Special floral values:** The bay supports a relatively high diversity of mangrove species, together with an extensive area of an uncommon salt marsh community dominated by *Sesuvium portulacastrum*.

**Research and facilities:** Nukul Ruttanadakul and Surapol Ardseungnern of the Biology Department, Prince of Songkla University, are conducting research at the site. Studies include monthly counts of shorebirds, monitoring the trapping of birds by villagers, and determination of the seasonal variation in the biomass of benthic invertebrates throughout a yearly cycle (a joint programme undertaken with NIOZ, Texel, The Netherlands).

Future research and conservation activities include:

1. Collection of additional hunting data.
2. Regular monitoring of shorebird movements throughout the bay.
3. A campaign to reduce hunting pressure through promoting educational awareness.
4. Collaboration with hunters to initiate a large-scale bird-ringing scheme.

5. The increased involvement of students from Prince of Songkla University in the shorebird studies. The local office of the Department of Fisheries in Songkhla is carrying out some ecological studies of the area with particular regard to the coastal fishery. Mr Sin Trokvinas of the National Institute of Coastal Aquaculture, Songkhla, has important baseline information on the site.

**References:** Klankamsorn *et al.* (1981); Ruttanadakul & Ardseungnern (1986); Swennen *et al.* (1986).

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

**Source:** Jira Jintanugool, Philip D. Round and Interwader.

**Wetland name:** Pa Phru

**Country:** Thailand

**Coordinates:** 6°03'-6°21'N, 101°50'-102°03'E;

**Location:** in the Sungei Golok basin, between Tak Bai, Sungai Golok and Sungai Padi Districts, Narathiwat Province, within a few km of the Malaysian border. **Area:** 34,636 ha.

**Altitude:** Near sea level.

**Biogeographical Province:** 4.7.1.

**Wetland type:** 21 & 22.

**Description of site:** A large depression, approximately 28 km by 8 km and within seven km of the coast, supporting 9,684 ha of primary peat swamp forest in proximity to 14,600 ha of *Melaleuca* woodland and scrub, and 9,800 ha of degraded grasslands. The site is separated from the sea by a belt of low-lying country to the east. To the west, the site is bounded by further lowland cultivation and a mountainous ridge which rises to 1,182m. The human population density is high and the higher ground around the margins of the site bears a network of roads. A smaller area of degraded peat swamp, from which all the primary forest has been removed, lies to the north, on the opposite bank of the Bang Nara River. The northern part of the site drains into the Bang Nara River while the southern parts empty into the Sungei Golok River system. The site is a permanent swamp with an average water depth of 1.0-1.5m (maximum 2.0m), although there may be fluctuations in water level of up to one metre. The water overlies 5-8m of peat. Extensive flooding may occur in surrounding areas during the northeast monsoon season. The pH is approximately 7.0 in the primary peat swamp forest and as low as 4.0-5.0 in the degraded areas. The Bang Nara River is tidal.

**Climatic conditions:** Humid tropical climate. This is one of the least seasonal regions of the country, with an average annual rainfall of 2,643.4 mm falling throughout the entire year. The wettest months are October to December, during the northeast monsoon, when the monthly precipitation is usually 300 to over 500 mm. During the driest months, February to April, the average monthly rainfall is 60-80 mm. The relative humidity is always high, ranging from 77.0% to 85.0%. The average daily temperature is rather constant at 26.2-28.6°C.

**Principal vegetation:** In the open water swamp, floating aquatic plants include *Eichhornia crassipes*, *Spirodela polyrhiza* and *Jussiaea repens*. Submerged aquatics include *Blyxa japonica*, *B. echinosperma*, *Najas graminea* and *Hydrilla verticillata*. Emergents include *Eleocharis dulcis*, *Fimbristylis miliacea*, *F. acuminata*, *Monochoria vaginalis*, *Nymphaea nouchali* and *Lindernia crustacea*. The dominant plants in marginal areas of the swamp include *Ceratopteris thalictroides*, *Leersia hexandra*, *Jussiaea linifolia*, *Blechnum orientale*, *Lygodium microphyllum*, *Stenochiana palustris* and *Acrostichum aureum*.

A species-rich primary peat swamp forest is found in the least disturbed areas. The upper storey includes *Neesia altissima*, *Dacryodes incurvata*, *Podocarpus wallichianus*, *Elaeocarpus grandiflorus*, *Stemonurus malaccensis*, *Cratoxylum arborescens*, *Xylopia fusca*, *X. maingayi*, *Palaquium obovatum* and a great variety of other species. The middle storey includes *Myristica elliptica*, *Goniothalamus giganteus*, *Polyalthia curtisii*, *Crudia caudata*, *Baccaurea bracteata*, *Blumeodendron kurzii* and *Cinnamomum* sp among other species. The lower storey includes

*Eleiodoxa conferta*, *Calamus caesius*, *Pandanus* spp and *Mapania* sp. *Koompassia malaccensis* occurs around the margins of the site. In those parts of the area which have been cut, the succession is initiated by such species as *Macaranga prunosa*, *Alstonia spathulata*, *A. pneumatophora* and *Archidendron clypearia*. As a result of repeated disturbance, especially through the agency of fire, large areas have come to be dominated by *Melaleuca cajeputi* from which any succession back to peat swamp forest is impossible (Santisuk & Niyomdham, 1985). Surrounding areas are mainly cultivation and degraded scrubland.

**Land tenure:** The wetland is state owned; surrounding areas are privately owned small-holdings.

**Conservation measures taken:** Part of the site (16,000 ha) was declared as a Non-Hunting Area in 1985. Most remaining forest, almost all of which lies within the boundaries of the Non-Hunting Area, is classified as National Reserve Forest. A management strategy for the entire area is to be developed by the Pikultong Development Research Center during 1987-89. The terms of reference of the project are as follows:

1. to evaluate the existing conditions of the resources at Phru To Daeng (also known as Pa Phru);
2. to minimize or mitigate the environmental impacts from development plans which have already been implemented;
3. to establish guidelines for the sustainable development and conservation of the peat swamp;
4. to integrate the policy and coordinate the work of the various government agencies involved in the development of wetlands;
5. to compile a development strategy which will take account of environmental and natural resources aspects as well as socio-economic aspects.

The site has already been zoned for land use according to the following categories (Anon, 1985c):

- I. A reserve zone, encompassing all the primary peat swamp forest (9,180 ha).
2. A conservation zone, for rehabilitation of disturbed forest (17,589 ha).
3. A development zone in areas where the forest has been totally destroyed. This will be available for appropriate agricultural development, irrigation, road construction etc. (15,127 ha).

**Conservation measures proposed:** The Wildlife Conservation Division is attempting to establish the major part of the site as a Wildlife Sanctuary, which would enable it to receive full habitat protection in law. The site has also been proposed as a Biosphere Reserve. The use of fires should be strictly controlled. There should be a moratorium on all further development at the site until the likely impact of any further changes in land use have been evaluated under the above studies.

**Land use:** Fishing and the collection of forest products such as the fruits of *Eleiodoxa conferta*, an understory palm; cultivation of rubber, rice and vegetables and production of charcoal in surrounding areas.

**Possible changes in land use:** The Irrigation Department has already initiated some drainage operations in order to minimize flooding around the site. A canal, draining into the Bang Nara River, has been dug into parts of the area although its continuation into the remaining swamp forest has so far been prevented. Some 4,200 ha of the degraded area have been gazetted for settlement under the Cooperative Promotion Department of the Ministry of Agriculture, in order to establish villages where the main activities would centre around rice and rubber cultivation.

**Disturbances and threats:** As above; developments undertaken since 1981 by the Royal Irrigation Department and the Cooperatives Promotion Department have severely damaged the integrity of the site, reducing the area of primary peat swamp forest by two-thirds. However, the widespread realization that these developments have damaged the scientific and conservation value of the site and actually reduced, rather than increased, the benefits reaped by local people has led to their cessation. The areas of acidic, peaty soils exposed by cutting and through the use of fire can only sustain rice cultivation for one or two years before they lose their fertility and are colonized by *Melaleuca* scrub. As the total area of the site is reduced through drainage, so the possibility of accidental fire damage to remaining primary forest is increased. Large areas were damaged by a major peat fire in the dry season of 1983.

**Economic and social values:** The local people derive considerable benefits from the forest products which they harvest from the site. These include forest fruits, rattans and hardwoods as well as fish and frogs. The raw fruits of the palm *Eleiodoxa conferta* could be sold for Bht.80 (about US dollar3.00) per 20 liters in 1983. The leaves of the palm *Metroxylon sagus* are used for making thatch while the stems are utilized as fodder for pigs and chickens, as a table vegetable, and for extracting starch used in making flour. The fruits are eaten by children.

The site is unique in Thailand and has very great research and educational potential. The local inhabitants belong to an ethnic minority with Malaysian affinities. Their lifestyle differs greatly from that of the Central Thais and is in danger of being disrupted through the introduction of inappropriate or unsustainable agricultural techniques.

**Fauna:** The area supports the walking catfish *Prophagorus nieuhoi* which, according to Bain and Humphrey (1982), is threatened in Thailand. Other species of fish known to occur include *Notopterus notopterus*, *Cyclocheilichthys repasson*, *C. apogon*, *Hampala macro/epidota*, *Puntius fasciatus*, *P. leicanthus*, *Clarias macrocephalus*, *Anabas testudineus*, *Trichogaster pectoralis*, *T. trichopterus*, *Channa lucius*, *C. micropeltes*, *C. striatus* and *Mastacembelus armatus*. The site may conceivably still support *Scieropages formosus*, which is endangered throughout its Southeast Asian range.

As regards its avifauna, the site is chiefly of note for the variety of terrestrial lowland forest birds which it supports. Most such species are endangered in Thailand as a result of the almost complete destruction of the lowland rainforest biome. They include *Treron capellei*, *T. fulvicollis*, *Otus rufescens*, *Harpactes kasumba*, *Anthracoceros malayanus*, *Megalaima rafflesii*, *Malacopteron affine*, *Macronous ptilosus* and *Stachyris nigricollis*. This is also the only known site in Thailand for *Copsychus pyrropygus*. *Prionochilus thoracicus* is present and *Rhyticeros corrugatus* could occur. The Grey-headed Fish-Eagle *Ichthyophaga ichthyaetus*, an endangered species in Thailand and Malaysia, is still present. Three Lesser Adjutant Storks *Leptoptilos javanicus* were seen in the area in late September 1987.

Mammals include the Banded Leaf Monkey, Long-tailed Macaque, Flat-headed Cat, Tiger and Lesser Mouse Deer (*Presbytis melalophos*, *Macaca fascicularis*, *Felis planiceps*, *Panthera tigris* and *Tragulus javanicus*). The Agile Gibbon *Hylobates agilis* was formerly present but has now been extirpated. Important and endangered reptiles known from the area include the False Gharial *Tomistoma schlegelii* and the Bornean Painted Callagur *Callagur borneoensis*. Among economically important invertebrates, both *Macrobrachium lanchesteri* and *M. rosenbergii* are present.

**Special floral values:** The site is unique; over fifty species of plants new to Thailand have been discovered here. In addition, there are no fewer than 66 tree species in 29 families which are judged to be of economic importance (Dr Chawalit Niyomdham, pers. comm). This is the only site in Thailand for the palm *Cyrtostachys laka*.

**Research and facilities:** Detailed research on the botany of the site is being carried out at the request of the government by Dr Thawatchai Santisuk and Dr Chawalit Niyomdham of the Silviculture Division in the Royal Forest Department. A detailed inventory of the vertebrate fauna

has been made by the Technical Section of the Wildlife Conservation Division, Royal Forest Department. A management plan (Anon, 1985c) has already been produced and further evaluation of the site will be carried out during 1987-89 by the Pikulthong Development Research Center. Accommodation is available at the headquarters of the Non-Hunting Area.

**References:** Anon (1985c); Bain & Humphrey (1982); Chookajorn et al. (1985); Naksiri (1985); Round (1988); Santisuk & Niyomdham (1985).

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

**Source:** Era Jintanugool and Philip D. Round.

**Wetland name:** Tarutao Island

**Country:** Thailand

**Coordinates:** 6°30'-644'N, 99°36'-99°42'E;

**Location:** approximately 22 km off the coast of Satun, western Peninsular Thailand.

**Area:** The total land area of Tarutao Island is 15,100 ha of which no more than 2,000 ha are wetland habitat.

**Altitude:** All wetlands are at or near sea level. The island rises to 708m.

**Biogeographical Province:** 4.7.1.

**Wetland type:** 05, 06 & 07.

**Description of site:** A steeply mountainous, mainly forested island with six distinct areas of mangroves and associated intertidal mudflats around its coast. The island formerly supported a human population which has since been evacuated. Approximately 10% of the area has been logged, cultivated or otherwise disturbed. The island is now included in the Tarutao National Park which encompasses 149,000 ha of open sea and islets together with the principal islands of Tarutao, Rawi and Adang.

The following areas were measured from the 1:50,000 Topographic Map:

1. Khlong Phante Malakaa: 195 ha; an open water inlet with well developed mangrove, parts of which have been disturbed, and a narrow fringe of mudflats. Parts of the mangrove occur in association with limestone sink-holes.

2. Ao Tab Lingai: 128 ha; an area of relatively undisturbed mangrove (78 ha) with a narrow fringe of mudflats and a grassy sand spit (50 ha).

3. Ao Tab Wao: 198 ha; an area of mangroves (72 ha) and mudflats (126 ha).

4. Ao Tab Dabu: 97 ha; an area of mangroves (38 ha) and mudflats (59 ha).

5. Ao Tab Dang: c.810 ha; an area of well developed mangroves (57 ha), less disturbed than at Khlong Phante Malakaa and with many huge *Sonneratia* trees, adjacent grassy flats (55 ha), and very extensive mudflats (c.700 ha) around the southern shore of island.

6. An unnamed area on the northeast coast, south of Laem To Sen: 13 ha; mangroves.

The water regime is principally tidal with some freshwater run-off. The tidal amplitude at Ko Koi Noi ranges from 0.5m at neap tides to 3.0m at spring tides.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 2,614 mm, most of which falls during the months of May to November. The average temperature is 27.5°C.

**Principal vegetation:** Chiefly mangroves; there are some pockets of undisturbed vegetation with trees 20m tall, but most of the area was cut-over 10-20 years ago. *Rhizophora apiculata* and *R. mucronata* usually dominate, with *Sonneratia* spp in the least disturbed sites and some *Nypa*

*fruticans*. Small areas of freshwater swamp forest with much *Salacca conferta* occur around Ao Tab Dang (Congdon, 1982). Some 60% of the island is covered with semi-evergreen rain forest. There are good examples of various coastal plant communities including a herbaceous strand flora, a *Barringtonia* formation, and patches of a coastal heath forest dominated by *Melaleuca cajuputi* and *Eugenia spicata*. Another distinct forest type occurring on limestone outcrops is also recognized (Congdon, 1982).

**Land tenure:** The island and its wetlands are state owned; the surrounding seas are Thai territorial waters.

**Conservation measures taken:** The entire area lies within Tarutao National Park. A preliminary management plan has been prepared.

**Conservation measures proposed:** A comprehensive management plan is currently being prepared for Tarutao National Park, and will contain proposals for improved conservation measures. Tarutao has been proposed as a World Heritage Site. Use of sandy beaches by tourists should be restricted, preferably by zoning. This would protect vulnerable nesting shorebirds such as *Charadrius peronii* and possibly *Esacus magnirostris* from undue disturbance.

**Land use:** Mainly recreational, although transient fishermen continue to make occasional visits. There is a considerable amount of fishing with trawl nets and lights in the surrounding waters, and also some illegal dynamite fishing, especially over coral reefs.

Possible changes in land use: It is proposed to build an all-weather concrete landing quay, which would improve access to the site. At the present time, the park is closed to tourists throughout the monsoon season. There may also be pressure to build additional park accommodation.

**Disturbances and threats:** Such threats as have been documented affect mainly the offshore marine resources within the park. (Coral reefs are being destroyed by dynamite fishing; sea turtles are being caught by trawlers).

**Economic and social values:** The park has great appeal for tourism and recreation, and is one of only two sites in Thailand to be listed as an ASEAN Heritage Park.

**Fauna:** The wetlands support the scarce *Ardea sumatrana*, which is believed to nest here. *Heliopais personata* is found regularly on the Khlong Phante Malakaa (three birds were seen in April 1986) and has also been recorded from Ao Tab Dang. It is still not known whether the species is resident or a winter visitor. Rocky or sandy beaches may be expected to support *Esacus magnirostris*. There is one record of *Pseudibis gigantea*, collected in 1904 (Riley, 1938), and unconfirmed reports suggesting the occasional (post 1980) presence of *Ephippiorhynchus asiaticus* have been received. *Pelargopsis amauroptera* and *Pitta megarhyncha* are both mangrove specialists with limited world ranges occurring on Tarutao.

The park is important as one of the last sites in Thailand for nesting marine turtles. A few individuals of three species, *Lepidochelys olivacea*, *Eretmochelys imbricata* and *Chelonia mydas*, still come ashore to lay their eggs on the beaches of the Adang island group, to the west of Tarutao Island.

**Special floral values:** The island supports extremely good examples of beach and coastal, terrestrial floristic formations. Such vegetation has usually been destroyed from similar situations on the mainland. The park supports a number of plant species which are either very rare or absent elsewhere in Thailand: among these is *Aegialites rotundifolia* (Plumbaginaceae) which is restricted to mangroves. Congdon (1982) lists no fewer than 56 species of mangrove and brackish water plants from Tarutao.

**Research and facilities:** Botanical survey work on Tarutao has been carried out since the turn of the century, and culminated in the intensive study of Congdon (1982). Research on coral reefs is also being carried out by Dr Allan Geater and associates from the Prince of Songkhla University in Hat Yai. A preliminary inventory of the birds was produced by Congdon and Sayer (unpublished) and is held on file at the Centre for Wildlife Research at Mahidol University in Bangkok.

**References:** Congdon (1981 & 1982); Mahidol University (1977); Riley (1938).

**Criteria for inclusion:** Ib, 2a, 2b.

**Source:** Era Jintanugool and Philip D. Round.

**Wetland name:** Palian-Langu

**Country:** Thailand

**Coordinates:** 6°50'-7°15'N, 99°35'-99°45'E;

**Location:** on the west coast of Peninsular Thailand; shared between Palian District, Trang Province and Langu District, Satun Province.

**Area:** 31,200 ha of mangrove (in 1979); approximately 75 km of coastline.

**Altitude:** Sea level.

**Biogeographical Province:** 4.7.1.

**Wetland type:** 02, 06 & 07.

**Description of site:** Extensive areas of secondary mangrove and logged primary mangrove with a narrow fringe of tidal mudflats around the mouths of six rivers. The coastline is highly convoluted, with many large inlets and some sandy beaches. The tallest remaining mangrove lies on the seaward edge. At the time of the survey (October 1984), the mangroves were showing good regeneration and there were still few shrimp ponds in the area. There is great seasonal variation in the amount of freshwater run-off; the turbidity increases and salinity decreases during the latter part of the southwest monsoon, from July to November. There are extensive shallows offshore, less than one meter deep at mean low water. The tidal amplitude ranges from 0.5m at neap tides to 3.0m at spring tides.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 2,379.9 mm, most of which falls during the southwest monsoon and the early part of the northeast monsoon, from May to November. The mean annual temperature is 27.4°C (range 22.7-32.3°C); the mean relative humidity, 80%. (Data from Trang, about 50 km to the north).

**Principal vegetation:** Mangrove swamps. Chiefly cultivation in adjacent areas, with forest and secondary growth on steep mountains and headlands.

**Land tenure:** The wetland is state owned; surrounding areas are partly private small-holdings and partly state owned.

**Conservation measures taken:** The mangroves are administered as concession areas and in theory are therefore subject to control. Some replanting of mangroves is undertaken.

**Conservation measures proposed:** Some areas of mangroves should be scheduled either as National Parks or Non-Hunting Areas.

**Land use:** Fishing for fin-fish and crabs, and cutting of mangroves for charcoal and fence posts. There is some aquaculture, chiefly using cages for fin-fish such as sea-bass *Lates calcarifer* and grouper *Epinephelus tauvina*. This has been promoted under the FAO Bay of Bengal Programme; up to the end of 1985, there were 391 fish cages in Palian District alone, scattered among 123 owners (Drewes, 1986). Rubber plantations and coconut groves in surrounding areas.

Possible changes in land use: There may be a trend towards increased aquaculture at the site.

**Disturbances and threats:** The principal threat is the continued intensive cutting and removal of mangroves. Larger birds are frequently shot.

**Economic and social values:** The mangroves will continue to provide a source of timber if exploited on a sustainable yield basis. In addition, they probably contribute to maintaining the yield of the offshore fishery. Fin-fish cage culture is very rewarding and can yield an estimated profit of Bht.1,444 per cage per year (Drewes, 1986). The beaches may have considerable recreational value.

**Fauna:** An important staging and wintering area for migratory shorebirds; 2,450 shorebirds were recorded along eight km of shoreline between Laem Mangang (17°04'N) and Khlong Wang Won (17°01'N) in October 1984 (Parish & Wells, 1985). The area may also be important for passage and wintering *Egretta* spp, breeding Reef Egret *Egretta sacra* and possibly *Ardea sumatrana*. There was

a sighting of *Leptoptilos javanicus* at the site in February 1986. The area supports a high density of *Haliastur indus* and a few *Haliaeetus leucogaster*.

**Special floral values:** None known.

**Research and facilities:** The area is a test site of the Remote Sensing and Mangroves Project, 1984-87, of the National Research Council. Interwader carried out an aerial survey in October 1984.

**References:** Drewes (1986); Kiankamsorn *et al.* (1981); Parish & Wells (1985).

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

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Ko Libong Non-Hunting Area and Hat Chao Mai National Park

**Country:** Thailand

**Coordinates:** 7°12'-7°22'N, 99°20'-99°29'E;

**Location:** the mainland coast and a large island (Ko Libong) 3.5 km offshore, Trang Province, Peninsular Thailand.

**Area:** Ko Libong is approximately 3,400 ha; Hat Chao Mai National Park is 23,100 ha, but most of this area is open sea.

**Altitude:** Sea level. Forested hills on Ko Libong and Hat Chao Mai rise to 311m and 432m respectively.

**Biogeographical Province:** 4.7.1.

**Wetland type:** 01, 03, 04, 05, 06 & 07.

**Description of site:** The site lies to the west of the mouth of the Mae Nam Trang. The eastern two-thirds of Ko Libong are mainly low-lying mangroves fringed by mudflats to the south and sand flats to the north. The western end is steeply mountainous and still supports some terrestrial forest. The intertidal zone is narrow and rocky; a long sand beach extends along the western shore and there are some offshore coral reefs. A small island (Ko Hard Toop), a ridge of sand and mud with small areas of mangrove, lies 500m off the southeast tip of Ko Libong and is an important roosting site for shorebirds. The boundary of the Non-Hunting Area encompasses the whole of Ko Libong together with some areas of mainland coast including considerable areas of mangrove. There are three main villages on the island. Hat Chao Mai National Park encompasses a stretch of the mainland coast together with two offshore islets. It is best treated together with Ko Libong as the two are adjacent and can be regarded as a single wetland site. The park comprises sand beaches backing onto dry coastal scrub, plantations and steep, forested crags. The most extensive areas of mangrove, however, lie outside the boundaries of the park. The system receives fresh water from the Mae Nam Trang, to the east of the site, and as run-off from the nearby forested crags through numerous small creeks in the mangroves. There are extensive shallows of 1-3m in depth to the southeast of Ko Libong. The strait separating the island from the mainland is 5-7m deep. The salinity is high, approaching fully marine conditions. At low tide, approximately 1,000 ha of sand flats and mudflats are exposed around the island, and approximately 700 ha are exposed along the mainland coast. Except for one sand bar, to the east of the mouth of Khlong Chao Mai off Hat Chao Mai, the mainland mudflats are covered by normal high tides. This is an important alternative roosting area for shorebirds when Ko Hard Toop is covered, as during high spring tides. The tidal amplitude is approximately two metres.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 2,379.9 mm; the region receives rain from both monsoons, the southwest from May to October and the northeast into December. The relative humidity ranges from 70% in February to 86% in October. The average daily temperature ranges from 26.4°C in November to 29.0°C in April. The prevailing winds are west from May to October, and northeast or east in other months. (Data taken at Trang; Sarigabutr *et al.*, 1982).

**Principal vegetation:** Mangrove forest dominated in most areas by young *Avicennia alba*; mature *A. alba* occurs along the seaward fringe, and mature *Sonneratia alba* and *Rhizophora mucronata*

occur within the influence of the channels. The inner mangrove zone is co-dominated by *R. mucronata* and *R. apiculata*. The mangrove is accreting in only a few places along the mainland coast and southern shore of Ko Libong. Much of the area has been logged over, though some large trees remain, particularly around the Non-Hunting Area headquarters. Some dry grassy clearings occur on patches of sandy soils within the mangrove. Four species of sea-grasses have been collected from the mudflats, but these have not as yet been identified. The vegetation in adjacent areas includes beach scrub dominated by *Casuarina equisetifolia*, rubber plantations, some of which contain much secondary growth, and other cultivation, especially coconut palms and bananas, around villages on the mainland.

**Land tenure:** Areas of mangrove are state owned and leased out to concessionaires.

**Conservation measures taken:** The entire island of Ko Libong and part of the mainland coast are incorporated within the Ko Libong Non-Hunting Area. The mainland coast to the west of the Khlong Chao Mai is incorporated within the Hat Chao Mai National Park. Areas of mangrove are, however, excluded from the park.

**Conservation measures proposed:** Swennen *et al.* (1986) suggest that human use of the mudflat areas around the small island of Ko Hard Toop should be reviewed and, if necessary, reduced, since disturbance levels are very high. Better enforcement of existing wildlife protection legislation is needed. The boundaries of Hat Chao Mai National Park should be extended to encompass some areas of mangrove. The status of *Ephippiorhynchus asiaticus* should be determined and any nesting and roosting areas protected.

**Land use:** Inshore fishing, using hand nets and trawl-nets, and harvesting of mudflat invertebrates for food. The latter include bivalve molluscs, sea cucumbers, anemones, priapulids and crabs. There is a small charcoal-producing industry on the northeast shore of Ko Libong, where *Rhizophora* spp are harvested on rotation. Hunting of birds and the few larger mammals occasionally takes place. Cultivation of rubber, bananas, coconut palms and rice in surrounding areas.

Possible changes in land use: There may be an increase in logging of remaining mangrove in the future. The use of the area for tourism is certain to increase.

**Disturbances and threats:** Shorebirds are hunted and netted on a small scale within Ko Libong Non-Hunting Area, and there is a considerable amount of indirect disturbance to roosting and feeding birds. In addition, monitor lizards *Varanus* sp are caught in noose traps and eaten by villagers. Possible future damage to or removal of larger mangrove trees may pose a threat. Over-exploitation of benthic invertebrates may threaten natural stocks. Slash-and-burn agriculture continues to denude hills both in the immediate vicinity of the site and in the headwaters of the Trang river. This could lead to increased siltation at the site.

**Economic and social values:** Both the inshore and offshore fisheries are important on a local scale. The site already has some importance for small-scale tourism; boats are sometimes rented from villagers by bird-watchers or general tourists. The site has considerable importance as a possible future research or bird migration monitoring station, and is one of the most frequently visited shorebird sites in the Peninsula.

**Fauna:** Ko Libong is one of the most important staging and wintering areas for shorebirds in the country; it is used by more than 10,000 shorebirds of up to 33 species each season. Peak counts for the commoner species include over 2,000 sandpipers *Charadrius mongolus* and *C. leschenaultii* and:

600 *Numenius phaeopus*

200 *N. arquata*

1,180 *Limosa lapponica*

410 *Tringa tolanus*

300 *Xenus cinereus*

350 *Calidris tenuirostris*

The concentration of *L. lapponica* is the largest such recorded in Thailand and the Malay Peninsula combined. Scarcer species include *Limnodromus semipalmatus* (75 in October 1984), *Tringa guttifer* (groups of up to 11 birds recorded every winter since 1982), and *Dromas ardeola* (3-12 birds recorded each winter). This is one of the few known wintering sites for *T. guttifer* in the world, and the only regular wintering area for *D. ardeola* in Southeast Asia.

Other waterfowl of note include *Egretta sacra* (maximum 50 birds), *Charadrius peronii* (breeds at Hat Chao Mai), *Sterna bergii* (maximum 100 birds, presumed to breed locally), *Sterna bengalensis* (non-breeding visitor, maximum 60 birds), and *Heliopais personata* (one recorded in March 1986). A few pairs of *Sterna anaethetus*, *S. dougalli* and *S. sumatrana* breed in the area. There is one unconfirmed but probably reliable sighting of the endangered *Sterna bernsteini*; 10 were reported in July 1980 (P. Poonswad, pers. comm). Unconfirmed reports of *Egretta eulophotes* have also been received. Hat Chao Mai is the only known nesting site in the Malay Peninsula for *Ephippiorhynchus asiaticus* (Robinson & Chasen, 1936), and the species is believed still to occur (B. Amget, pers. comm.). The scarce and local *Pelargopsis amauroptera* and *Pitta megarhyncha* both occur in the mangroves on Ko Libong. In all, at least 126 species of birds have been recorded in the area. Monitor lizards *Varanus* sp are present on the island, and dolphins have been seen offshore.

**Special floral values:** The site contains well developed stands of mature mangrove forest which are amongst the best and least disturbed examples of this habitat type on the entire west coast of Thailand.

**Research and facilities:** Count data on shorebirds are available from the Interwader Project at the Asian Wetland Bureau in Kuala Lumpur and from the Center for Wildlife Research at Mahidol University in Bangkok. The Interwader Project has conducted some sampling of benthic invertebrates, but the results are not yet published. Accommodation is available at the headquarters of Ko Libong Non-Hunting Area, at the extreme eastern tip of the island, and at Hat Chao Mai National Park.

**References:** Bijisma & de Roder (1985); Eve & Guigue (1982); Parish & Wells (1985); Robinson & Chasen (1936); Sarigabutr *et al.* (1982); Swennen *et al.* (1986).

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

**Source:** Jira Jintanugool, Philip D. Round and Interwader.

**Wetland name:** Krabi Bay

**Country:** Thailand

**Coordinates:** 7°59'-8°03'N, 98°51'-99°00'E;

**Location:** extending up to 5 km west and 10 km south of the town of Krabi, Krabi Province, on the west coast of Peninsular Thailand, between Khao Laem Nang and Ban Laem Hin.

**Area:** c. 11,400 ha; 26 km of coastline.

**Altitude:** Sea level.

**Biogeographical Province:** 4.5.1.

**Wetland type:** 02, 06 & 07.

**Description of site:** An area of mangroves and mudflats extending from the rocky headland of Khao Laem Nang, east past the complex of rivers which open to the sea at Pak Nam Krabi, to the Khlong Yuan and Khlong Taling Chan, and south to Ban Laem Hin. The site encompasses some areas of steep wooded cliffs. The intertidal mudflats extend up to two km offshore at low tide. Klankamsorn *et al.* (1981) list the area of mangrove and mudflat as 10,212 ha and 1,200 ha respectively. A substantial amount of fresh water enters the system as run-off via the major rivers, especially during the wet season. The sea-bed shelves fairly steeply to two metres immediately offshore, and to 6-10m in the mouths of the major rivers. The tidal amplitude at Ao Nang varies from 1.0m at neap tides to 3.0m at the highest spring tides.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 2,379.3 mm, most of which falls during the southwest monsoon, from May to October. The wettest month is usually September or October (361.0 and 348.6 mm of rainfall respectively) and the driest February (24.9 mm). The relative humidity ranges from 68% in February to 81% in October. The average annual daily temperature is 28.1°C (range 24.0-31.3°C). (Data from Phuket, 60 km to the west).

**Principal vegetation:** Mangroves with a high preponderance of *Rhizophora* spp. The area has been logged, but some tall trees remain. Terrestrial habitats are mostly rubber plantations, coconut groves and jack fruit orchards with a few patches of secondary growth.

**Land tenure:** The wetland is mainly state owned; surrounding areas are privately owned.

**Conservation measures taken:** The sand beaches, rocky wooded hills, mangroves and *Melaleuca* woodland which line the shores of the bay of Ao Nang, to the west of the site east as far as Pak Nam Krabi, are included in the Hat Nopparat Thara-Mu Ko Phi Phi National Park. Areas of mangrove at the site are categorized as National Reserve Forest and can only be cut under legitimate concessions.

**Conservation measures proposed:** The boundaries of Hat Nopparat Thara National Park could be extended along the coast to the east in order to encompass the important areas of mudflats and mangroves.

**Land use:** Fishing and harvesting of crabs. Fruits of the *Nypa* palms are harvested for food, while the fronds are used for thatching. Mangroves are cut on a rotational basis and are used both for charcoal and as a source of pole wood. There has been some development of aquaculture at the site, under the FAO Bay of Bengal Programme. A total of 210 fish cages divided amongst 45 owners had been established up to the end of 1985 (Drewes, 1986). The town of Krabi serves as a major fishing port and is also important as a point from which tourists are ferried to the islands of Ko Phi Phi and Ko Lanta. Adjacent areas are largely devoted to rubber and oil palm plantations. Tourism is expanding very rapidly; the Krabi Bay Resort, a complex of bungalows and a restaurant, has been established at Ao Nang.

Possible changes in land use: None known at present, although there may be pressure to develop the site should the port of Krabi expand. Krabi has also been proposed as one of the possible sites for the development of a plant for the extraction of tantalum from tin slag. The water catchment area has been largely deforested within the past 10-20 years, and the last five years have seen a massive increase in the areas planted with oil palm.

**Disturbances and threats:** Remaining mangroves at the site are under pressure from illegal encroachment, while industrialization and increased aquaculture may also pose threats in the future. There is probably some hunting of larger water birds.

**Economic and social values:** The area has much recreational potential owing to its proximity to the town of Krabi. It is perhaps the most easily accessible area of species-rich mangrove for bird-watchers and naturalists in Thailand, and some boatmen already supplement their income through ferrying parties of bird-watchers.

**Fauna:** The site is one of only four along the west coast of Thailand, identified during an aerial survey in October 1984, which supported a concentration of over 2,000 shorebirds. A roost of 2,200 shorebirds, including about 200 large shorebirds (either *Limosa* spp or *Numenius* spp), was located on a sand bank off the mouth of the Khlong Yuan-Khlong Taling Chan confluence during the survey (Parish & Wells, 1985). In subsequent visits, *Pluvialis squatarola* and *Numenius phaeopus*, together with over 100 *Sterna albifrons* and *S. hirundo*, were recorded on mudflats and sand banks. The mangroves support a relatively high density of *Haliastur indus*. *Haliaeetus leucogaster*, *Heliopais personata*, *Pelargopsis amauroptera*, *Halcyon coromanda*, *Pitta megarhyncha* and *Trichastoma rostratum* also occur. This is the only known site in Thailand for *Cyornis rufigastra*. *Falco peregrinus* (a bird showing the characteristics of an apparently resident form of the species) has been seen at Hat Nopparat Thara. The site should be checked for the presence of *Ardea sumatrana* and *Leptoptilos javanicus*.

**Special floral values:** The site contains good, species-rich mangrove with many tall trees, and is one of the best areas of mangrove remaining on the entire west coast.

**Research and facilities:** Accommodation is available at the headquarters of the Hat Nopparat Thara National Park or in Krabi Town.

**References:** Drewes (1986); Klankamsorn *et al.* (1981); Parish & Wells (1985); Sarigabutr *et al.* (1982).

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

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Ao Phang-Nga (Phang-nga Bay)

**Country:** Thailand

**Coordinates:** 8°08'-8°26'N, 98°27'-98°45'E;

**Location:** in the Province of Phang-nga, on the west coast of Peninsular Thailand; enclosed to the west by the island of Phuket.

**Area:** c.65,000 ha.

**Altitude:** Sea level; hills around the margins of the site rise to 439m.

**Biogeographical Province:** 4.5.1.

**Wetland type:** 01, 02, 03, 04, 05, 06 & 07.

**Description of site:** A huge shallow bay fringed with extensive mangrove swamps, extending north from Phuket Island eastwards along the mainland coast past the mouths of six river systems to the mouth of the Mae Nam Marui. The easternmost boundary of the site is delimited by the large promontory of Khao Ao Muang, which separates the site from another major mangrove inlet, Ao Luk (Krabi Province). A great many limestone pillars and islands rise sheer from the coastal flats, and there are extensive shallows offshore, only 1-4m deep at mean low water. The site encompasses the two offshore islands of Ko Yao Yai and Ko Yao Noi together with a great many smaller islets. Kiankamsorn *et al.* (1981) give the area of mangrove as 21,181 ha and that of intertidal mudflats as 4,048 ha (in 1979). There is massive freshwater run-off from forested hills around the bay during the southwest monsoon. Salinities of 31.5 p.p.t. (April) and 33.0 p.p.t. (August and January) have been recorded. The tidal amplitude at Ao Nng, Krabi, varies from 1.0m at neap tides to 3.0m at spring tides. The tidal regime is complex; the usual pattern is two high tides per day, but there are many irregularities.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 2,379.3 mm, most of which falls during the southwest monsoon, from May to October. The relative humidity varies from 68% in February to 81% in October. The average daily temperature is 28.1°C (range 24.0-31.3°C). (Data from Phuket; Sarigabutr *et al.*, 1982).

**Principal vegetation:** Extensive mangrove forest. Most of the area has been logged and is dominated by large stands of *Rhizophora* and other species in relatively uniform age classes. There are very few areas which still support larger mangrove trees. The structure and composition of the mangrove forest has been studied by Aksornkoae and Kongsangchai (1980). The principal vegetation in adjacent areas is semi-evergreen rain forest, with drier sub-types on exposed limestone outcrops. Rubber plantations dominate in lowland areas outside the National Park.

**Land tenure:** The wetland is state owned and open to public use in many areas; surrounding areas are both privately owned and state owned.

**Conservation measures taken:** The Ao Phang-nga National Park, established in 1981, covers an area of 40,000 ha. Most of the park consists of open water, rocky headlands and forested mountains, and only a relatively small proportion of the total mangrove area is included within the park boundaries. Most of the remaining mangroves have been designated as National Reserve Forest, parts of which are logged under concession.

**Conservation measures proposed:** Phang-nga Bay is a designated site of the ASEAN/USAID Coastal Resources Management Project (CRMP). Environmental consultants attached to this project may be expected to produce recommendations for its conservation and integrated development. Increased areas of mangrove should be incorporated within the Ao Phang-nga National Park. Walkways should be constructed in order to introduce visitors to the mangrove ecosystem. A comprehensive survey of the wildlife resources of Phang-nga Bay is required, as the area has never been adequately studied. Better protection of both marine and coastal resources is needed as most of the area is subject to the depredations of boatmen and fishermen who continue, for example, to collect the eggs of nesting terns and other birds for food.

**Land use:** Fishing, the cutting of mangroves for timber, and harvesting the fronds of *Nypa* palm for the production of thatch. The area is a major tourist attraction and a great many boatmen realize income from parties of sightseers. Caves support populations of Edible-nest Swiftlets *Aerodramus fuciphagus*, the nests of which are harvested and sold as a luxury foodstuff. Phang-nga Bay is one of the principal sites considered for aquaculture development under the FAO Bay of Bengal Programme. The development of fin-fish cage culture, cockle culture and mussel/oyster culture has been promoted. Up to the end of 1985, there were 880 fish cages divided amongst 262 owners in ten villages in Phang-nga Province (Drewes, 1986). In some parts of the area, tin is extracted from sediments obtained by dredging. Rubber is widely cultivated in surrounding areas.

Possible changes in land use: The volume of tourism seems destined to increase greatly. Land use and development of the area is being examined under the ASEAN/USAID Coastal Resources Management Project (CRMP), and various recommendations for the zoning of land use are likely to be made. The Small Scale Fisheries Development Project of the Department of Fisheries may promote aquaculture in some parts of the site. Artificial reefs have been constructed in some areas.

**Disturbances and threats:** The continued cutting of mangroves, both legally and illegally, threatens the integrity of the site, and conversion for aquaculture puts further pressure on the mangroves in the more sheltered areas. Tin dredging may threaten both the mangrove ecosystem and marine ecosystem by siltation. Many areas of corals have already been damaged. Fishermen continue to take the eggs and young of sea-birds such as terns for food. In addition, marine animals such as dugongs and sea-turtles are occasionally caught in trawl nets.

**Economic and social values:** The area has immense value as a source of mangrove products and for its fishery. Cage culture for fin-fish, developed under the FAO Bay of Bengal Programme, has proved to be very lucrative, yielding an estimated profit of Bht.1,444 per cage per year. Cockle culture is much less successful, attracting only businessmen and large entrepreneurs, since it depends for its success upon the illegal import of "seed" from elsewhere; small-scale fisherfolk benefit only as labourers (Drewes, 1986).

Phang-nga Bay is of great importance for research, and is being studied by biologists from the Phuket Marine Biological Center. In addition, the site is a valuable national and international recreational heritage on account of its outstanding beauty.

**Fauna:** The area has never received a complete survey. However, it almost certainly continues to support the scarce and possibly threatened *Ardea sumatrana*, and may also support *Heliopais personata*. *Egretta sacra* and *Butorides striatus* are very common, and *Pelargopsis amauroptera* and *Pitta megarhyncha* probably occur. The islets support breeding colonies of the terns *Sterna dougallii*, *S. sumatrana*, *S. bergii* and probably *S. anaethetus*; the sand beaches provide nesting sites for *Charadrius peronii* and *Sterna albifrons*. *S. bengalensis* has been recorded from the island of Ko Yao Yai, but its status is unknown (Nadee, 1982). There is a relatively high density of both *Haliastur indus* and *Haliaeetus leucogaster* in the area. Wreathed Hornbills *Rhyticeros undulatus* are still fairly common. *Macaca fascicularis* occurs in the area, and the bay may still support a few Dugongs *Dugong dugong* (Dobias, 1982).

**Special floral values:** The area supports one of the most extensive areas of mangrove remaining in Thailand.

**Research and facilities:** Accommodation is available at the headquarters of Ao Phang-nga National Park, at Ban Chap Phrae. Aksornkoae and Kongsangchai (1980) have studied the structure and floristic composition of the mangroves; Papavasith and Setti (1982) have carried out a study of mangrove benthos, and an ongoing programme of research, funded by the Department of Fisheries, is being undertaken from Phuket Marine Biological Center. A management plan for the site is being developed under the ASEAN/USAID Coastal Resources Management Project.

**References:** Aksornkoae & Kongsangchai (1980); Dobias (1982); Drewes (1986); Klankamsorn *et al.* (1981); Nadee (1982); Papavasith & Setti (1982); Parish & Wells (1985); Sarigabutr *et al.* (1982); Whitmore (1975).

**Criteria for inclusion:** lb, le, 2b.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** East Coast of Phuket Island

**Country:** Thailand

**Coordinates:** 7°50'-7°59'N, 98°25'E;

**Location:** extending north and south from the town of Phuket, between Ban Ao Makham in the south and Laem Yabu (Laem Yamu) in the north.

**Area:** 2,100 ha.

**Altitude:** Sea level.

**Biogeographical Province:** 4.5.1.

**Wetland type:** 03, 06 & 07.

**Description of site:** Two bays fringed with secondary mangrove at either side of a rocky headland with sand beaches, at the base of which lies the town of Phuket. The site encompasses four small offshore islands of which the largest is Ko Maphrao. The northern bay is the more extensive, with at least 350 ha of mudflats; the southern bay includes about 300 ha of mudflats. There is relatively little freshwater run-off into the bays. The salinity varies from 30.0 p.p.t. at the landward edge of the mangroves to 31.0 p.p.t. at the seaward edge and 32.0 p.p.t. on the open mudflats. It varies somewhat with the seasons, being least saline at the end of the rainy season in October or November. The tidal range is 2.9m.

**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 2,379.3 mm. The wettest month is usually September (average 361.0 mm) and the driest, February (24.9 mm). The relative humidity varies from 81% in October to 68% in February. The prevailing winds are west from May to October and northeast to east from November to April. The average annual temperature is 28.1°C (maximum 33.0°C in April; minimum 23.3°C in January).

**Principal vegetation:** Extensive young, regenerating *Rhizophora* mangroves. Mainly cultivation in adjacent areas, although there are still 2,200 ha of rain forest on the mountain of Khao Phra Thaew (450m) at the northern margin of the site.

**Land tenure:** The wetland is state owned; surrounding areas are mainly in private ownership.

**Conservation measures taken:** None.

**Conservation measures proposed:** Remaining mudflats and mangroves should be protected from reclamation or other developments. Some reseedling of mangroves should be carried out. Recreational facilities, such as observation hides for observing shorebirds and wooden walkway "nature trails" through the mangrove, might be constructed.

**Land use:** Fishing and harvesting of crabs. Many boats are beached or moored at the site. Coconut plantations, rubber plantations and housing in surrounding areas.

**Disturbances and threats:** Reclamation of mangrove or mudflat areas for housing or tourist developments may be under consideration. A major deep-sea port is to be constructed in the vicinity of the site. There is increased urbanization in the water catchment area due to the rapid expansion of Phuket township.

**Economic and social values:** The site has considerable scientific value, and has been intensively studied by scientists from the Phuket Marine Biological Center. It also has considerable potential for recreation and tourism owing to its proximity to the town of Phuket.

**Fauna:** In October 1984, the northern bay supported 670 shorebirds and the southern bay at least 200, the majority of which were *Tringa totanus* (Parish & Wells, 1985). These numbers are probably an underestimate. Small numbers of herons and egrets are usually present.

The mangrove macrofauna includes Polychaetes (25 species, 0.14 grams dry weight/sq.m); gastropod molluscs (27 species, 1.6 grams dry weight/sq.m); pelecypod molluscs (16 species, of which only *Musculista senhousia* is common, 5.6 grams dry weight/sq.m); and Crustacea (58 species, 3.8 grams dry weight/sq.m). The total primary production of the mangrove is estimated at 2,700 grams dry weight/sq.m/year. The annual production of the mudflats is estimated at 83.2 kcal/sq.m.

**Special floral values:** None known.

**Research and facilities:** The area is a study site of the Phuket Marine Biological Center. It was surveyed briefly by Interwader in October 1984.

**References:** Parish & Wells (1985); Tantichuduk (1982).

**Criteria for inclusion:** lb, 2b, 2c.

**Source:** Jira Jintanugool and Philip D. Round.

**Wetland name:** Bangben

**Country:** Thailand

**Coordinates:** 9°34'-9°45'N, 98°27'-98°34'E;

**Location:** in Kapoe District, Ranong Province, western Peninsular Thailand. The site extends north from the Khlong Kapoe to Ko Klang.

**Area:** c.8,000 ha; the site includes c.30 km of coastline.

**Altitude:** Sea level; rocky outcrops along the coast rise to 264m.

**Biogeographical Province:** 4.5.1.

**Wetland type:** 03, 04, 05, 06 & 07.

**Description of site:** The estuaries of a major river, the Khlong Kapoe, and several smaller rivers to the north, with extensive mangrove swamps and intertidal mudflats. Steep, forested hills slope down to a belt of mangrove scrub, sand and mudflats up to 5 or 6 km wide, with several rocky, forest-covered outcrops at its seaward edge. The main west coast highway passes to the east of the site. There is massive freshwater run-off from the forested mountains to the east during the southwest monsoon season, especially from June to October. The sea-bed shelves fairly steeply, although there are considerable areas of shallows, 1-3m deep at mean low water. The salinity ranges from 26-35 p.p.t. (average 30.18); the average suspended sediment is 6.7-34.9 mg/l, peaking in February. There are two tides per day; the tidal amplitude at Pak Nam Ranong varies from 1.6m at neap tides to 3.3m at spring tides.

**Climatic conditions:** Very wet tropical monsoonal climate with an average annual rainfall of 4,320 mm, 89.6% of which falls during the southwest monsoon from May to October. The average relative humidity ranges from 88% in July, August and September to 72% in March. The mean annual temperature is 26.5°C (mean maximum 38.0°C, mean minimum 13.7°C).

**Principal vegetation:** Mangrove forest and scrub, rather homogeneous in age classes and dominated by *Rhizophora apiculata*, *Sonneratia* spp, *Avicennia* spp, with *Bruguiera*, *Ceriops* and *Xylocarpus* communities along the landward edge. Aksornkoae (1982) recorded a total of 33 tree species. The forests have been logged and are now regenerating. There is a rich bloom of phytoplankton during December; phytoplankton samples show an average of 91,090 cells per liter. Inland, the hills are covered in semi-evergreen rain forest. This is being replaced on the lower slopes by slash-and-burn

cultivation, such as tapioca and hill rice. The lowlands are almost entirely cultivated, supporting rubber plantations.

**Land tenure:** The wetland is state owned; surrounding areas are partly private and partly state owned. Many of the state owned areas are occupied illegally.

**Conservation measures taken:** Rocky wooded areas and sand beaches along the seaward edge of the site, including the hills of Khao Ao Ang and Khao Bang Ben, are included in the Laem Son National Park. Most areas of mangrove and mudflat are, however, excluded. All areas of mangrove are classified as National Reserve Forest and can legally be cut only by concessionaires.

**Conservation measures proposed:** The area has been proposed as a Biosphere Reserve by the National Research Council of Thailand. The boundaries of Laem Son National Park could be extended to include additional areas of mangrove and mudflat. The area requires detailed and regular ground surveys to determine the numbers and species composition of shorebirds using the site.

**Land use:** Fishing, using gill nets, long lines and scoop nets. Mangroves are cut on a rotational basis for charcoal and for timber used in construction. The area is also a major site for recreational marine angling. Cultivation, chiefly coconut palms and rubber, in surrounding areas.

Possible changes in land use: There is likely to be an increase in tourism at the site. Bangben is also one of the sites to be considered for the development of small-scale fisheries under the FAO Bay of Bengal Programme. This seems likely to lead to a great increase in aquaculture. There is a strong likelihood of increased deforestation of hill slopes in the water catchment area.

**Disturbances and threats:** Some silt enters the area from tin mining operations to the north. There is a possibility that tin mining activities will commence at the site, and there could be further clearance of mangroves for aquaculture. The mangrove community is gradually becoming impoverished as a result of repeated cutting and replacement by monocultures of *Rhizophora* and other species for harvest.

**Economic and social values:** The mangrove resource is of major economic importance.

**Fauna:** Some 45 species of fish have been found at Khlong Kapoe (Bhovichitra *et al.*, 1982).

The area is one of only four sites on the west coast of Thailand, identified during an aerial survey in October 1984, which support a concentration of over 2,000 shorebirds. A roost of 4,000 shorebirds was discovered at Khao Ao Ang (9°40'N) during the survey, with a further 290 birds at Khlong Khong (Parish & Wells, 1985). Logged mangrove in the area supports *Phaenicophaeus sumatranus*, *Pelargopsis amauroptera*, *Halcyon coromanda*, *Mulleripicus pulverulentus* and *Pitta megarhyncha*. Local observers have reported the occasional presence of a large, dark stork (either *Ephippiorhynchus asiaticus* or *Leptoptilos javanicus*). Bhovichitra *et al.* (1982) list 29 species of birds including *Charadrius peronhi*, an uncommon resident which nests on sandy beaches. At least 11 species of mammals are known from the site, including the Slow Loris *Nycticebus coucang* (J. Nabhitabhata, pers. comm.).

The mudflats support a high biomass of polychaetes.

**Special floral values:** The area includes one of the richest and most diverse mangrove forests in Thailand.

**Research and facilities:** Accommodation is available at the headquarters of Laem Son National Park. Part of the area is a test site for the Remote Sensing and Mangroves Project (1984-87) of the National Research Council. The effects of tin mining on the mangrove ecosystem in Ranong Province have been studied by Aksornkoae and Saraya (1987).

**References:** Aksornkoae (1982); Aksornkoae & Saraya (1987); Bhovichitra *et al.* (1982); Klankamsorn *et al.* (1981); Parish & Wells (1985); Whitmore (1975).

**Criteria for Inclusion:** 1b, 2b, 3b.

**Source:** Jira Jintanugool and Philip D. Round.

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