# COASTAL SENSITIVITY OVERVIEW

# OF THE

# STRAIT OF MALACCA

Compiled by the World Conservation
Monitoring Centre (WCMC)
Cambridge

for

International Maritime Organisation (IMO)

May 1994

WORLD CONSERVATION
MONITORING CENTRE

The mission of the
World Conservation Monitoring Centre is to provide
information on the status, security and
management of the Earth's biological diversity.

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# BACKGROUND

The World Conservation Monitoring Centre (WCMC) was set up in 1979 as an information centre to provide reliable scientific data on the sate of the world's biodiversity. This work has been greatly facilitated by the WCMC's status as a joint venture between its three partners, the International Union for Conservation of Nature (IUCN), the World Wide Fund for Nature (WWF) and the United Nations Environment Programme (UNEP). In order to monitor the world's biodiversity, large quantities of data have been collected and entered into extensive databases on a wide range of subjects. Each of the units within the WCMC, Habitats, Species and Protected Areas, have specialised in collecting data on a particular aspect of biodiversity. Today, these large data sets (tabular and GIS) contain some of the most accurate and detailed inventories of the world's biodiversity, a summary of which was published in *Global Biodiversity: Status of the Earth's Living Resources* (WCMC, 1992).

The World Conservation Monitoring Centre maintains a large amount of information relating to marine and coastal environments and their conservation, and is involved in a number of proposed and ongoing projects in this field. Increasingly, this information is being managed using GIS. Particular attention has been devoted to mapping sensitive coastal ecosystems and this information is of interest to oil companies for oil spill emergency response and contingency planning, and has been used in several such applications (see Section 7). Data relevant to coastal sensitivity mapping are held within the Centre's Biodiversity Map Library and comprise protected and unprotected important areas for conservation, mangroves, coral reefs, forests, wetlands and species. Additional information is held in the Centre's paper files and library - some of the information provided in this report are examples.

This summary report of the coastal sensitivity of the Strait of Malacca has been compiled as background material for the International Maritime Organisation (IMO).

# CONTENTS

# Section 1. INTRODUCTION

The maps and enclosures show many of the important ecosystems and species found in the Malacca Strait area, but special attention should be drawn to the following:

## Mangroves

Mangroves are an important habitat in the Strait of Malacca, although the distribution is scattered and hence is not clearly shown on the maps. (More detailed information is provided in the wetland site sheets found in Section 3.) Generally, mangroves are located in more sheltered areas and are often closely linked to fisheries, providing shelter and nursery areas for numerous fish species, and hence are often of major economic and ecological importance.

Oil can be extremely damaging to mangrove communities, particularly to saplings - oil can smother the aerial roots and block the lenticels which can lead to restricted growth, defoliation and/or mortality. There is also evidence of the toxic effect of oil, particularly the shorter-chain molecules and aromatic fractions, which can kill trees. Many of the invertebrate species associated with mangroves are also adversely affected. The use of dispersants is controversial. A considerable amount of work has been done in the region (Hoi-Chaw and Meow-Chan, 1984).

## Coral Reefs

Coral reef resources along the north-east coast of Sumatra as a whole are not highly developed. Most of the eastern coastline of Sumatra is dominated by silt-laden waters, with high sedimentation rates. Salinity fluctuates over large areas. Similar conditions apply over much of the west coast of Peninsular Malaysia, although here there are several offshore islands where important coral reef communities have developed.

Reefs are well developed in the nearby Nicobar Islands and also, though more distant, in the Andaman Islands and off the west coasts of Thailand, Peninsular Malaysia and islands in the close vicinity of Singapore (including the Riau and Lingga islands of Indonesia).

There is evidence that petroleum hydrocarbons have numerous detrimental effects on coral reproduction, larval development and settling, growth rate, photosynthesis, cell structure, feeding and behavioural responses. Such effects are probably the result of hydrocarbon fractions being incorporated into the water column, and can be exacerbated by the use of dispersants. A far greater threat comes from the smothering of corals by crude oil during particularly low tides - this is known to cause massive mortality, and toxins can enter the food chain through coral feeding fishes as a result. For coral reefs, as for other pelagic and subtidal benthic communities. It is clear that mechanical recovery of the oil from the surface or adjacent beaches is preferred over the use of emulsifiers of dispersants, which, in themselves, are frequently toxic.

**Species**
The Strait of Malacca and the Nicobar Islands are extremely important as both feeding and a breeding area for turtles: four species are known to nest: Green turtle *Chelonia mydas*, hawksbill *Eretmochelys imbricata*, leatherback *Dermochelys coriacea* and olive ridley *Lepidochelys olivacea*.

Whales and dolphins are known to occur in these waters, while dugong *Dugong dugon* (classified as Vulnerable) inhabits some of the coastal waters. Many coastal sites are important for seabird colonies.

**Protected areas**
Some of the important ecosystems and important areas for biodiversity are protected by law. These important areas are listed and mapped in Section 5.

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## Section 2. COASTAL FORESTS

Mangroves of Peninsular Malaysia are found along the sheltered west coast of fronting the Strait of Malacca, where they form an almost continuous belt, about 20 km at its greatest width. The most extensive groups of mangroves occur along the estuaries of the larger rivers, and are managed by the State Forest Departments for timber production on a sustained yield basis.

Mangroves in Peninsular Malaysia occur primarily in the western States of Perak, Selangor and Johor. The most extensive area is the Matang Forest Reserve, in the Perak area, which has been managed since the last century. In recent years there has been severe pressure to use the mangrove lands for agriculture, urbanisation, ponds and fisheries. Forest Department records shown that over a 20-year period from 1965 to 1985, the total area of mangroves declined from 1184 sq. km to 983 sq. km for the whole of Malaysia. In Selangor alone, 86 sq. km were cut down in 1988-9.

Malaysian mangroves support a variety of endangered species of wildlife such as proboscis monkey *Nasalis larvatus*, estuarine crocodile *Cocodylus porosus*, milky stork *Mycteria cinerea* and lesser adjutant stork *Leptoptilos javanicus*, as well as many other highly specialized species whose survival depends on the existence of the mangrove ecosystem. Major threats include reclamation for agricultural purposes, clearance for aquaculture ponds, exploitation for wood-chips and other non-sustainable exploitation for timber.

Peat swamp forests are also significant in southeastern Pahang, Johor, Selangor and Perak and is valuable as a sustainable timber resource, for flood-mitigation and water supply. Peat swamp forests are used by endangered mammals such as the proboscis monkey.

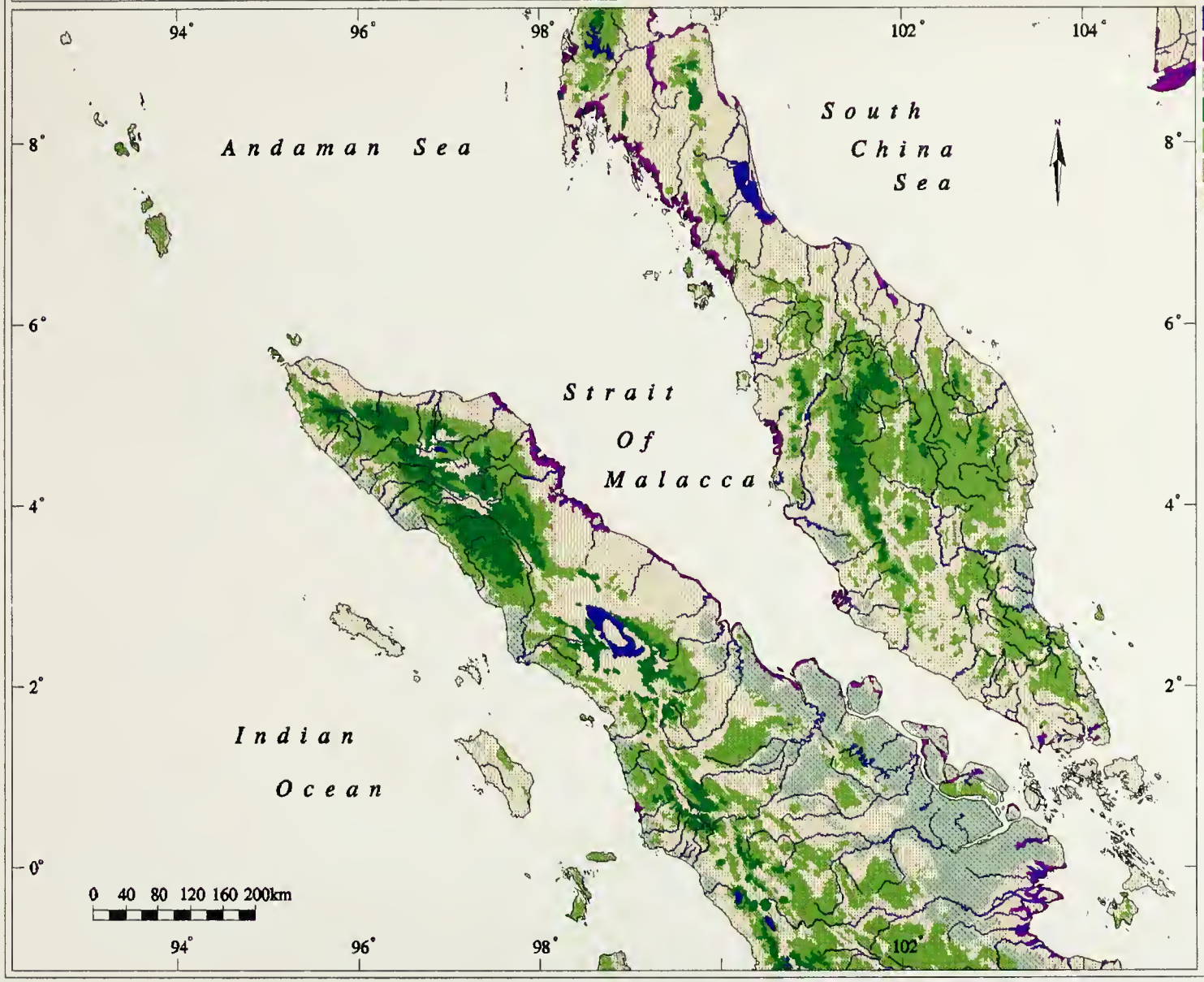
Large tracts of mangrove are found throughout the Indonesian archipelago but areas such as the Banyuasin Musi River Delta on the east coast of Sumatra, comprises some of the most extensive mangrove forests in Sumatra and are important breeding and nursery grounds for many species of marine fish, prawns and shrimps. Peat swamp forest and mangroves are particularly extensive along the eastern coast of Sumatra. Indonesian mangroves have been little affected by large-scale forest exploitation until 1975 but they are probably now the most threatened forests in the archipelago. This is particularly worrying from an economic point of view, as well as an ecological one, as the export value of Indonesian fisheries was at least US$194 million in 1978, with a recorded harvest of mangrove-linked fisheries of 550,000 tonnes. Some destruction of mangroves has occurred as a result of over-exploitation by traditional users, but most destruction results from conversion of land for agriculture, brackish water fishponds, salt ponds, and human settlement. Fishponds are particularly extensive in Sumatra.

Peat swamps are highly significant in eastern Sumatra and form important watershed areas, absorbing and storing excess water which reduces flooding in adjacent areas. They are also important for sustainable forestry with many commercially valuable timber species such as ramin *Gonystylus bancanus, Shorea spp., Cratoxylum spp.* and important for products such as rattans, resins, fruits etc. Relatively large areas of the shallower peat swamp forests along the Malacca Strait are being drained to provide farmland for new transmigrants.

Mangroves occur on both coasts of Thailand but 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. The Centre for Conservation Biology at Mahidol University estimates that only 6 % of mangroves are in protected areas, and that many of these are degraded scrub. Few areas of tall species-rich mangrove forests are protected; the best examples are found in Tarutao National Park in northern Strait of Malacca.

See Map for major mangrove and peat swamp formations.

# Strait of Malacca - Forests




KEY

- Water bodies
- Mangrove
- Inland swamp
- Montane rain forest
- Lowland rain forest
- Lowland monsoon forest
- Non tropical moist forest

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## Section 3. IMPORTANT COASTAL WETLANDS

The following list and descriptions of important wetland sites have been derived from *A Directory of Asian Wetlands* (1989), a regional inventory of important wetland areas compiled by Derek Scott of the International Waterfowl and Wetlands Research Bureau.

Coastal wetlands, such as intertidal mudflats and mangroves (mentioned above) are of enormous conservation and economic value. Intertidal mudflats in Thailand are of great wildlife conservation importance and support huge numbers of passage and wintering herons and shorebirds. There are also extremely important wetland habitats in Malaysia where mudflats that are associated with mangrove forests support the richest benthic fauna e.g. Matang in Perak and the Kelang Islands in Selangor - these areas therefore represent the richest feeding grounds for migratory shorebirds and resident waterbirds such as herons, egrets and storks. These areas are also of major importance to marine fisheries.

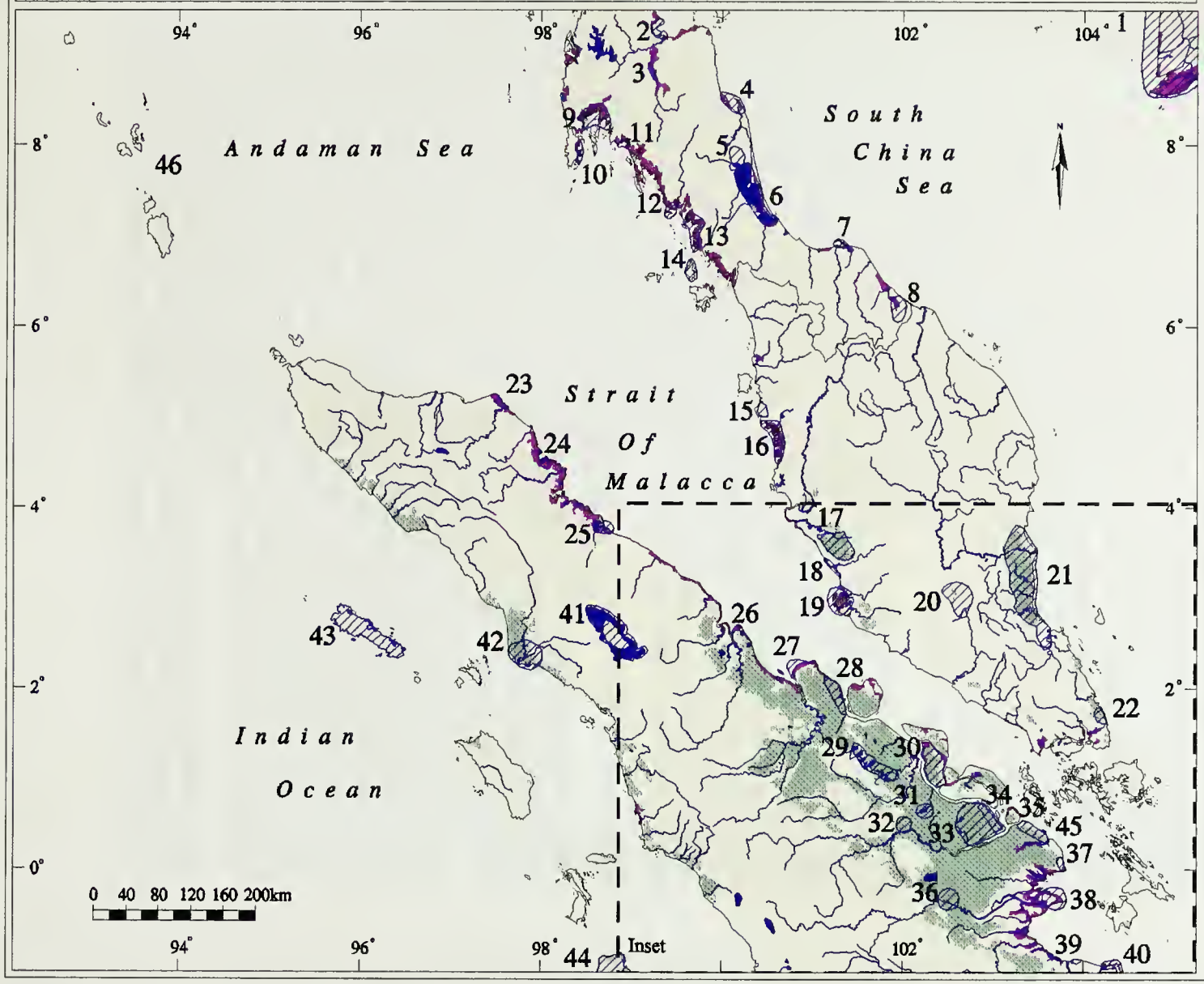
The following sites are illustrated on the accompanying map and include mangrove formations as well as other important coastal wetlands.

**List of Wetland Sites (see Map)**

| MAP NUMBER | NAME OF WETLAND SITE |
|---|---|
| 1 | Khlung |
| 2 | Ao Bandon (Bandon Bay) |
| 3 | Tapi River and Nong Tung Non-hunting Area |
| 4 | Pak Phanang Estuary |
| 5 | Thale Noi Non-hunting Area |
| 6 | Lake Songkhala |
| 7 | Ao Pattani (Pattani Bay) |
| 8 | Pa Phru |
| 9 | Ao Phang-Nga (Phang-nga Bay) |
| 10 | East Coast of Phuket Island |
| 11 | Krabi Bay |
| 12 | Ko Libong Non-hunting Area and Hat Chao Mai |
| 13 | Palian-Langu |
| 14 | Tarutao Island |
| 15 | Sungei Burung Mangroves |
| 16 | Matang Forest Reserve |
| 17 | North Selangor swamp Forest |
| 18 | Kuala Selangor Mangrove Forests and Nature Park |
| 19 | Klang Islands |

| | |
|---|---|
| 20 | Tasek Bera |
| 21 | Southeast Pahang Swamp Forests |
| 22 | Sedili Kecil Swamp Forest |
| 23 | Kuala Jambu Air |
| 24 | Kuala Langsa |
| 25 | SM Karang Gadding Langkat Timur Laut |
| 26 | Sei Prapat |
| 27 | Tanjung Sinabo/Pulau Alang Besar |
| 28 | Bakau Selat Dumai |
| 29 | Giam-Siak Kecil |
| 30 | Pulau Padang dan Danau Tanjung Padang |
| 31 | Danau Bawah and Pulau Besar |
| 32 | Danau Belat, Besar Sekak and Sarang Burung |
| 33 | Sungai Kampar Peatswamp |
| 34 | Bakau Muara Kampar |
| 35 | Muara Sungai Guntung |
| 36 | Kerumutan Baru |
| 37 | Tanjung Datuk |
| 38 | Pulau Bakung, including Tanjung Bakung |
| 39 | Hutan Bakau Pantai Timor |
| 40 | Tanjung Jabung |
| 41 | Danau Toba |
| 42 | Singkil Barat |
| 43 | Pulau Simeulue |
| 44 | Taitai Batti / Pulau Siberut |
| 45 | Pulau Burung |
| 46 | Andaman Islands and Nicobar Islands |

# Strait of Malacca - Wetlands




KEY

- Mangrove
- Inland Swamp
- Important Wetland Areas

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**Ao Phang-Nga (Phang-nga Bay) (9)**

**Location:** 8°08'-8°26'N, 98°27'-98°45'E; in the Province of Phang-nga, on the west coast of Peninsular Thailand; enclosed to the west by the island of Phuket.

**Area:** c.65,000ha.

**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. Klankamsorn *et al.* (1981) give the area of mangrove as 21,181ha and that of intertidal mudflats as 4,048ha (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 Nang, 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 2,379.3mm, 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.1, 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 40,000ha. 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 fuciphagus1, 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:** 1b, 1e, 2b.
**Source:** Jira Jintanugool and Philip D. Round.

**East Coast of Phuket Island (10)**
**Location:** 7°50'-7°59'N, 98°25'E; 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:** 2,100ha.
**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 350ha of mudflats; the southern bay includes about 300ha 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 2,379.3mm. The wettest month is usually September (average 361.0mm) and the driest, February (24.9mm). 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 2,200ha 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 reseeding 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:** 1b, 2b, 2c.
**Source:** Jira Jintanugool and Philip D. Round.

**Krabi Bay (11)**
**Location:** 7°59'-8°03'N, 98°51'-99°00'E; extending up to 5km west and 10km 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.11,400ha; 26km 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 twokm offshore at low tide. Klankamsorn *et al.* (1981) list the area of mangrove and mudflat as 10,212ha and 1,200ha 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 springs tides.
**Climatic conditions:** Tropical monsoonal climate with an average annual rainfall of 2,379.3mm, most of which falls during the southwest monsoon, from May to October. The wettest month is usually September or October (361.0 and 348.6mm of rainfall respectively) and the driest February (24.9mm). 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, 60km 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 polewood. 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 waterbirds.

**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 phaeopus1, 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.

**Ko Libong Non-Hunting Area and Hat Chao Mai National Park (12)**

**Location:** 7°12'-7°22'N, 99°20'-99°29'E; the mainland coast and a large island (Ko Libong) 3.5km offshore, Trang Province, Peninsular Thailand.

**Area:** Ko Libong is approximately 3,400ha; Hat Chao Mai National Park is 23,100ha, 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 1,000ha of sand flats and mudflats are exposed around the island, and approximately 700ha 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 2,379.9mm; 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.1, 1982).*

***Principal vegetation:*** *Mangrove forest dominated in most areas by young Avicennia alba1; 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 sandplovers *Charadrius mongolus* and *C. leschenaultii* and:

| | | | |
|---|---|---|---|
| 600 | *Numenius phaeopus* | 200 | *N. arquata* |
| 1,180 | *Limosa lapponica* | 410 | *Tringa totanus* |
| 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:** Bijlsma & 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.

**Palian-Langu (13)**
**Location:** 6°50'-7°15'N, 99°35'-99°45'E; on the west coast of Peninsular Thailand; shared between Palian District, Trang Province and Langu District, Satun Province.
**Area:** 31,200ha of mangrove (in 1979); approximately 75km 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 metre 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 2,379.9mm, 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 50km 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 eightkm 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); Klankamsorn *et al.* (1981); Parish & Wells (1985).
**Criteria for inclusion:** 1b, 2b.
**Source:** Jira Jintanugool and Philip D. Round.

**Tarutao Island (14)**
**Location:** 6°30'-6°44'N, 99°36'-99°42'E; approximately 22km off the coast of Satun, western Peninsular Thailand.
**Area:** The total land area of Tarutao Island is 15,100ha of which no more than 2,000ha 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 149,000ha 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: 195ha; 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 Talo Lingai: 128ha; an area of relatively undisturbed mangrove (78ha) with a narrow fringe of mudflats and a grassy sand spit (50ha).
3.Ao Talo Wao: 198ha; an area of mangroves (72ha) and mudflats (126ha).
4.Ao Talo Dabu: 97ha; an area of mangroves (38ha) and mudflats (59ha).
5.Ao Talo Dang: c.810ha; an area of well developed mangroves (57ha), less disturbed than at Khlong Phante Malakaa and with many huge *Sonneratia* trees, adjacent grassy flats (55ha), and very extensive mudflats (c.700ha) around the southern shore of island.
6.An unnamed area on the northeast coast, south of Laem To Sen: 13ha; 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 2,614mm, 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 Talo Dang (Congdon, 1982). Some 60% of the island is covered with semi-evergreen rain forest. There are good examples of verious 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 Talo 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:** 1b, 2a, 2b.
**Source:** Jira Jintanugool and Philip D. Round.

## Peninsular Malaysian Sites

**Sungei Burung Mangroves (15)**
**Location:** 4°59'-5°02'N, 100°22'-100°25'E; adjacent to Sungei Burung, northwest of

Kuala Kurau, Perak State.
**Area:** 250ha.
**Altitude:** Sea level.
**Biogeographical Province:** 4.7.1
**Wetland type:** 02, 06, 07 & 11
**Description of site:** An area of mangrove forest and mudflats with a small river (Sungei Burung) and a few creeks. The site includes a small mangrove peninsula of 20-30ha which hosts a large breeding colony of Black-crowned Night-Herons *Nycticorax nycticorax*. A new mudbank almost onekm long was described in 1983, to the south of the site. This had grown to 2.5km in length and 0.5km in width by July 1986, the northern half having been colonized by *Avicennia marina*. This island may form an attractive breeding site for Night-Herons in the future. The rice-fields adjacent to the mangroves are important feeding grounds for the herons and other waterbirds. The water is brackish, and the median tidal range at Bagan Datoh is 4.3m. The entire area is inundated at spring tides.
**Principal vegetation:** Mangroves, principally accreting *Avicennia marina*
**Land tenure:** No information.
**Conservation measures taken:** None.
**Conservation measures proposed:** The site has been proposed as a Bird Sanctuary and Virgin Jungle Reserve. The peninsula, surrounding mangrove forest and inland rice-fields between Kuala Kurau and Bagan Serai have been proposed as a Biosphere Reserve.
**Land use:** The harvesting of crabs and shellfish, and collection of birds' eggs; cultivation of rice and oil palms in surrounding areas. The whole area has been classified in soil suitability class 4 (more than one serious limitation to crop growth and suitable for a very restricted range of agricultural and forest crops).
**Disturbances and threats:** Herons' eggs are collected by the local people and there is daily disturbance from crab-catchers. The use of pesticides in adjacent rice-fields may be affecting the breeding success of the Black-crowned Night-Herons. Virtually the whole area has been mapped as land alienated for agricultural purposes.
**Economic and social values:** No information.
**Fauna:** The mangroves support one of the largest breeding colonies of Black-crowned Night-Herons *Nycticorax nycticorax* in the world, with an estimated 5,000-6,000 nests. Small numbers of Milky Storks *Mycteria cinerea* feed in the area. Migratory shorebirds including *Numenius arquata* and *N. phaeopus* use the area for roosting and feeding, e.g. c.1,500 in 1983. Crabs and prawns are abundant, and there is a rich benthic fauna.
**Special floral values:** None known.
**Research and facilities:** Silvius *et al.* conducted a survey of the vegetation, fauna and current threats to the mangrove environment in 1985 and 1986. The Department of Wildlife and National Parks and Interwader carried out a survey of the night-heron colony in September 1986, to assess the effects of the colony on the vegetation.
**References:** EPU (1980); Silvius *et al.* (1987).
**Criteria for inclusion:** 1b, 2c, 3a, 3c.
**Source:** Asian Wetland Bureau.

**Matang Forest Reserve (16)**
**Location:** 4°40'-4°55'N, 100°34'-100°40'E; on the northwest coast of Peninsular Malaysia south from Kuala Gula for 51km, in the administrative district of Matang, Perak State.
**Area:** 40,711ha; along 51km of coastline and up to 13km wide.
**Altitude:** Sea level.
**Biogeographical Province:** 4.7.1
**Wetland type:** 01, 02, 07 & 11
**Description of site:** A large expanse of mangrove forest situated in a huge bay stretching from Kuala Gula in the north to Pengkalan Baharu in the south. The reserve includes

34,769ha of productive forest and 5,942ha of unproductive forest. Some 95% of the mangroves are tidal swamp dominated by Rhizophoreceae, with considerable local variation in quality. Some seven major estuaries divide the mangrove areas, which are further dissected by numerous other rivers and waterways. The water is brackish and at low tide is less than 6m deep. There are some small patches of forested dry ground inside the mangroves. There are five fishing villages within the forest reserve, the rest of the mangroves being more or less uninhabited. Two mangrove islands, Pulau Kelumpang and Pulau Terong, have permanently inundated lakes of great importance for feeding herons, storks and shorebirds.

**Principal vegetation:** Mangrove forest dominated by *Rhizophora apiculata, R. mucronata, Bruguiera parviflora, B. gymnorhiza, B. cylindrica, B. eriopetala, Avicennia sp, Sonneratia alba* and *Ceriops candolleana*.The main vegetation types are as follows:

*"Bakau" type (*Rhizophora* sp): more than 80% of the 34,769ha of productive forest has 60% bakau content following extensive reafforestation with *R. apiculata*

2."Api-api-Perepat" type (*Avicennia-Sonneratia*): this occurs mainly in the accreting zone, although in some areas, *Avicennia* covers large areas of forest.

3."Berus" type (*Bruguiera cylindrica*): this occurs close to the coast, mostly behind the Api-api-Perepat type.

4."Lenggadai" type (*B. parviflora*): often on river banks. In the wetter parts, it can form pure stands.

5."Tumu" type (*B. gymnorhiza*): the climax mangrove forest type, occurring at the landward margin where it precedes terrestrial forest types. Tumu is becoming very rare due to reclamation activities.

As a result of forest harvesting, the canopy is mostly under 20m high, the mean height being around 10m. Coastel accretion has increased the amount of dry land forest in the Sungei Kerang forest range, while in the Port Weld and Kuala Trong ranges, the area of dry land has decreased. *Acrostichum* spp and small areas of dry land forest occur in surrounding areas.

**Land tenure:** State owned (Perak State Government).

**Conservation measures taken:** Nineteen Forest Reserves of varying size divide up the area. These are protected areas, but may be used for commercial timber production on a sustainable yield basis. Some 180ha are used for research in the form of seed collection and trial plots. This aree is protected and undisturbed. The Department of Wildlife and National Parks maintains a ranger post at Kuala Gula.

**Conservation measures proposed:** The following measures have been proposed by Silvius *et al.* (1987):

*Certain forested areas should be protected in order to re-establish the natural climax vegetation. Such areas should be in unproductive Api-api-Perepat and in productive Bakeu and Tumu forest types. These areas would provide gene-pools and seed-banks of commercial tree species, nesting areas for large waterbirds and areas for scientific research.

2.Stork Lake I and Stork Lake II, situated respectively on Pulau Kelumpang and Pulau Terong, should be fully protected, together with generous surrounding zones. Stork Lake I should be protected as part of the proposed Kuala Gula Bird Sanctuary. Stork Lake II should be protected as a separate Bird Sanctuary, with a fringe of at least 500m of forest surrounding the lake as a buffer zone.

3.The proposed Kuala Gula Bird Sanctuary should be gazetted as soon as possible.

4.Scientific research in the proposed protected areas should not interfere with the aim of protecting the local populations of *Mycteria cinerea* and *Leptoptilos javanicus*.Disturbance of large waterbirds should be prohibited.

5.Any further reclamation of mangrove forests at Sungei Rubiah or elsewhere in Matang should be prohibited, since it is questionable whether reclamation for agriculture is more

economically viable than utilizing mangroves for sustainable forestry and fisheries.
6.Important feeding and roosting areas for migratory shorebirds should be protected. Protection should include the maintenance of mangrove forests adjacent to the important mudflat areas and prohibition of disturbance of roosting flocks, unless necessary for fishing or cockle-culture activities.
It is of great importance that established field study sites and forestry plots used by a variety of research institutions are protected from disturbance by forestry operations and other activities. Protection could be achieved through designating these areas as Virgin Jungle Reserves, Research Forests or Education Forests.
**Land use:** The current management objective of the Forest Reserve is to produce maximum sustained yield of raw materials (principally *R. conjugata* and *R. mucronata*) for fuel, mainly charcoal, and poles. Management consists of a 30-year crop rotation, harvested by clear-felling with retention of standards for natural regeneration. A total annual yield of around 990ha (890-900ha for charcoal, around 100ha for firewood) is planned for 1980-1989. The management objectives for 1980-1989 are as follows:
*To produce a sustained yield of quality greenwood for charcoal processing to meet local demand as well as for export.
2.To produce quality poles for local consumption and export.
3.To conserve and protect the coastal zones from erosion by the strong waves and wind.
4.To provide and preserve the breeding and nursery grounds for high-protein sea-foods.
5.To produce cheap firewood, fishing stakes and structural materials for the local communities.
6.To preserve sufficient forest for research and training in mangrove forestry.
Local fishing villages exploit the fisheries and take charcoal and firewood for their own use.
**Disturbances and threats:** The following threats have been identified:
*Over-exploitation of the mangrove resources. The major threat to the area is the likelihood that the management aimed at sustainable utilization will fail. Production records indicate a slow drop in yield, resulting in applications for new areas to exploit. Natural regeneration is declining and more replanting is necessary after several clear-felling cycles.
2.Decrease in the availability of nesting sites for large waterbirds. As a result of forestry practices, very few pristine mangrove areas remain which are suitable as nesting sites for storks and large herons. This may be the main reason for decreasing populations of large waterbirds in Matang, especially *M. cinerea* which normally breeds in large colonies and therefore needs a substantial area of suitable nesting habitat.
3.Disturbance of the Stork Lakes by crab-catchers.
4.Reclamation of mangrove forest. A large area at Sungei Rubiah is currently being reclaimed for agriculture.
5.Depletion of pristine mangrove habitats. Virtually no areas are left where the development of undisturbed vegetation can be studied.
6.Oil pollution is a potential threat.
7.Disturbance of breeding *M. cinerea* including the taking of eggs and young, has occurred in the past.
8.The use of motorboats in place of sampans.
9.Disturbance from the infrastructure associated with timber extraction.
**Economic and social values:** The area is of great economic importance, providing an annual revenue of US$6-9 million from forestry products and at least US$30 million from fisheries (Silvius *et al.* 1987). The area is a major supplier of sea-foods to the local and international markets. It provides employment in forestry, fishery and linked industries for a workforce of about 12,500 people. It is of great scientific value as one of the best examples in the world of large-scale mangrove forest utilization on a sustainable yield basis.
**Fauna:** Matang Mangrove Forest Reserve and its adjacent coastline are of major importance as a staging area for migratory shorebirds, and are the major remaining area

of suitable habitat in Malaysia for the Milky Stork *Mycteria cinerea* and Lesser Adjutant *Leptoptilos javanicus*.In 1985/86, the highest count of shorebirds approached 14,300 individuals. With a possible turnover rate of between three and six times this figure, it is likely that between 43,000 and 85,000 shorebirds utilize this area during migration. The most important feeding and roosting areas for shorebirds are Pantai Panchor (16.3% of peak count), the southern mudflats of Pulau Pasir Hitam (4.1%), Sungei Larut estuarine mudflats (12.9%), Pulau Terong and Stork Lake II (18.9%), Pulau Kelumpang mudflats (14.1%), Pulau Kelumpang and Stork Lake I (12.1%), and Sungei Rubiah lagoon and mudflats (12.7%). The most abundant species are *Tringa totanus* (22.3%), *Limosa limosa* (19.7%) and *Calidris ferruginea* (16.9%). Other common species include *Charadrius mongolus, Numenius phaeopus, Tringa stagnatilis* and *Xerus cinereus. Limnodromus semipalmatus* has been recorded at Pantai Panchor (24 in March 1986) and at Stork Lake I on Pulau Kelumpang (14 in March 1986).

Matang is the last remaining area in Peninsular Malaysia capable of supporting a viable breeding population of the Milky Stork *M. cinerea*.The Malaysian population is seriously endangered, having decreased to about 100 birds. There have been no signs of breeding or immature birds in recent years, and the population is now almost totally confined to this area. The lakes on Pulau Kelumpang and Pulau Terong are particularly important as feeding and roosting areas for the storks. The Lesser Adjutant *L. javanicus* is also endangered, but has a wider distribution in Peninsular Malaysia. Matang is believed to support about 50% of the total population of 150-200 birds and is therefore the most important area for the conservation of this species in the Peninsula. Breeding was recorded in Matang in 1986. Almost 1,400 herons and egrets (Ardeidae) of 12 species were recorded in 1985/86, the principal species being *Egretta garzetta, E. intermedia* and *E. alba. Butorides striatus* is also very common, and the total population has been estimated at 600-1,000 birds. Sungei Rubiah and Pulau Kelumpang are important as wintering and staging areas for the endangered Chinese Egret *Egretta eulophotes* and the rare Masked Finfoot *Heliopais personata* has been observed on a number of occasions in recent years. Matang formerly supported the large breeding colony of *Nycticorax nycticorax* presently situated at Sungei Burung. It is possible that the colony could move back to Matang in the future.

Special floral values: The largest intact tract of mangrove forest in Peninsular Malaysia, and one of the last mangrove areas with all major habitats and forest types.

Research and facilities: The Coordination Committee on Mangrove Forest Research and the University Pertanian Malaysia (Faculty of Forestry) have been involved in mangrove research. Suggestions for future research are mainly concerned with silviculture, but also include studies on the effects of monoculture on the mangrove ecosystem, the interrelationship between forestry and fishery requirements regarding mangrove conservation, and rehabilitation techniques in degraded or poor forest (Haron Haji Abu Hassan, 1981; Nor & Chan, 1987). Universiti Sains Malaysia has conducted extensive ecological research on the mangrove ecosystem in Matang Forest Reserve for many years. Interwader carried out shorebird studies and habitat surveys in 1983, 1984, 1985 and 1986. Perhilitan has conducted bird and mammal surveys and a study of otters in the Kuala Gula Bird Sanctuary.

References: Chapman (1976); Dixon (1959); Haronhaji Abu Hassan (1981); Jayerajasingram (1983); Karpowicz (1985); Mohd. Darus (1969); Noakes (1952); Nor & Chan (1987); Ong & Gong (undated); Parish & Wells (1984 & 1985); Sabrina M. Shariff (1984); Silvius *et al.* (1987 & in prep); Siti Hawa Yatim (1984); Watson (1928).

Criteria for inclusion: 123.

Source: Department of Wildlife and National Parks (Peninsular Malaysia), Forest Research Institute of Malaysia and Asian Wetland Bureau.

**North Selangor Swamp Forest (17)**

Location: 3°25'-3°42'N, 101°05'-101°27'E; north of Sungei Selangor and northeast of

Kuala Selangor, Selangor State.
**Area:** 74,823ha.
**Altitude:** Sea level.
**Biogeographical Province:** 4.7.1
**Wetland type:** 11 & 21
**Description of site:** 'A low-lying, flat, peat-swamp forest bordered on the eastern side by somewhat hillier land with oil palm and rubber plantations. In the northern part, the forest is crossed by Sungei Tengi. Much of the forest has already been extensively logged, but some virgin tracts remain. Freshwater swamp forest formerly occurred in the Sungei Tinggi area (Wyatt-Smith, 1963), but this has now disappeared. The swamp forests lie in the Kuala Selangor hydrological region, which is defined in general terms as having loose clayey and sandy deposits with the lowest category of potential water run-off (Goh, 1974). The soils are defined by Wong (1970) as being of the Inland Swamp Association. Peat depths of over 5.5m have been recorded in the Kuala Selangor area. In the deep peat areas, there is usually a metre or so of peaty water between the true fibrous peat and the alluvial clay below. Virtually the whole area has been classified in soil suitability class 4 (more than one serious limitation to crop growth and suitable for a very restricted range of agricultural and forest crops). At the edges of the area, the soil is classified in class 2 (moderate limitation to crop growth and suitable for a not too wide range of agricultural and forest crops), class 3 (one serious limitation to crop growth and suitable for a restricted range of agricultural and forest crops), and class 5 (at least one serious limitation to crop growth and best retained under forestry use).
**Climatic conditions:** Humid tropical climate with an average annual rainfall of less than 2,000mm. The wettest months are April and October-December, the driest, January-February and July. The climate is generally equatorial, with rain from both the northeast and southwest monsoons, although the latter is mitigated by the mountains of Sumatra.
**Principal vegetation:** Mixed swamp forest, according to the classification of Anderson (1961). Wyatt-Smith (1959) describes the west coast peat swamp forests as exceedingly rich and especially so where the peat is deep. The generalized forest structure consists of a fairly level upper tree storey which reaches a height of about 30 metres. The density of forest varies, but is less than that of lowland evergreen rain forest, and frequently has an open non-continuous canopy. Emergents are normally absent. The understorey consists of a fairly continuous canopy extending from about six to 18 metres above peat level. Beneath this is a shrub layer and relatively poor ground flora. The dominant larger trees are usually *Calophyllum scriblitifolium, Gonystylus bancanus, Koompassia malaccensis, Myristica lowiana, Shorea rugosa* and *Tetramerista glabra*.There are extensive oil palm and rubber plantations in adjacent areas, extensive rice-growing areas to the west, and lowland dipterocarp forest and marine alluvial swamp forest to the northeast.
**Land tenure:** The southern part is State Land (Government of Selangor); Sungei Dusun Game Reserve is state owned.
**Conservation measures taken:** The North Selangor Swamp Forest is in the process of being gazetted into two large Forest Reserves comprising a total of 74,823ha (the Sungei Karang and Raja Musa Forest Reserves). About 400ha of forest along the northeastern edge of the site overlap with the Sungei Dusun Game Reserve (Strict Nature Reserve). The Game Reserve was established in 1964 and covers 4,280ha.
**Conservation measures proposed:** The Sungei Karang and Raja Musa Forest Reserves would be suitable for classification as "Flood Control Forest" under the National Forestry Act 1984, in view of the vital role that peat swamps play in flood mitigation in northern coastal areas. This same function makes it essential that peat swamp forests never be cleared without a thorough environmental impact assessment of likely hydrological effects (SPSSM, in prep).
The presence of remnant virgin tracts provides an excellent opportunity for Jabatan

Perhutanan, perhaps with assistance from the Forest Research Institute of Malaysia, to plan a system of Virgin Jungle Reserves and Research Forest plots. These could include selected examples of forest where the peat extends to different depths and where different harvesting regimes (or no harvesting) have prevailed in the past (SPSSM, in prep). At present there are no Virgin Jungle Reserves or Research Forests in northern Selangor.
The site has particular value in being large enough to hold areas that might be conserved as representative natural communities. Virgin Jungle Reserves set within buffering production forest may play a role here, but wildlife protection would not be adequate without an extension of Sungei Dusun Game Reserve (SPSSM, in prep).
Future decisions on land use in the area should take a holistic planning approach, taking into account agricultural, forestry, conservation and hydrological considerations, amongst others.
**Land use:** Commercial timber production; cultivation of oil palms, rubber and rice in surrounding areas. The western and eastern edges of the area are gazetted as Malay Reserves. An area of about 400ha around 3°34'N, 101°9'E has been alienated for agricultural purposes (EPU, 1980).
**Possible changes in land use:** Conversion for agricultural uses and mining.
**Disturbances and threats:** The area is seriously threatened by over-exploitation and reclamation for agriculture. Much of the forest has already been extensively logged. In the southeastern corner, an area of about 3,600ha is covered by extant mining leases or mining certificates; this whole area is currently used for mining or has mining potential. The northern half of the area is mapped as potentially productive forest (EPU, 1980). Disruption of the water table will affect water supply to the nearby Sekincan rice paddies. There is some hunting with shotguns, probably for fruit bats at night.
**Economic and social values:** The site plays a critical role in the hydrology of the area, reducing local flooding and probably acting as an important water supply to the Sekincan rice paddies. The swamp forest also has significant forestry value, mainly in terms of timber production and forestry research. The area is of outstanding value for scientific research on peat swamp ecology, hydrology and forestry.
**Fauna:** The forest supports a considerable variety of bird species, including raptors such as *Haliaeetus leucogaster, Falco peregrinus, Microhierax fringillarius* and the hornbills *Buceros rhinoceros* and *Anthracoceros malayanus convexus.* Fruit bats (Pteropodidae) are common, and the highly endangered Sumatran Rhinoceros *Dicerorhinus sumatrensis* is still present on the eastern side. The adjacent Sungei Dusun Game Reserve supports healthy populations of *Cervus unicolor, Muntiacus muntjak, Sus scrofa, Tragulus javanicus* primates, civets and rodents. Other mammals present in the reserve in smaller numbers include *Panthera tigris, P. pardus, Tapirus indicus, Helarctos malayanus* and *D. sumatrensis*

**Special floral values:** The swamp forest contains many commercially valuable tree species. With virgin tracts still remaining, the site is a good example of a west coast peat swamp forest and is of great value as a gene pool.
**Research and facilities:** The Department of Wildlife and National Parks has conducted a study of the ecology of *Dicerorhinus sumatrensis* in Sungei Dusun Game Reserve. Few studies have been carried out on the vegetation, although detailed investigations have been made in the nearby Hutan Melintang Forest Reserve and in the south Selangor peat swamp forests.
**References:** Anderson (1961); EPU (1980); Goh (1974); IUCN (in prep); Marsh & Wilson (1981); Ministry of Forestry (1986); SPSSM (in prep); Whitmore (1984); Wong (1970 & 1974); Wyatt-Smith (1959).
**Criteria for inclusion:** 1b, 2a, 2b.
**Source:** Department of Wildlife and National Parks (Peninsular Malaysia), SPSSM and Asian Wetland Bureau.

**Kuala Selangor Mangrove Forest (18)**
**Location:** 3°15'-3°27'N, 101°08'-101°18'E; between Sungei Tengkorak in the north and Sungei Buloh in the south, north and south of Kuala Selangor, Selangor State.
**Area:** c.5,760ha.
**Altitude:** Sea level.
**Biogeographical Province:** 4.7.1
**Wetland type:** 01, 02, 06, 07, 08 & 11
**Description of site:** A coastal belt of mangrove forest with extensive intertidal mudflats, on the west coast of Peninsular Malaysia north and south of Kuala Selangor. The two main areas of mangrove forest and a recently established Nature Park at Kuala Selangor are described separately below as sites 18 contd.

**Mangrove Forest North of Kuala Selangor (18 contd)**
**Location:** 3°21'-3°27'N, 101°08'-101°14'E; between Kuala Selangor and Sungei Tengkorak, Selangor State.
**Area:** Over 3,000ha, mainly mudflats; Banjor North Forest Reserve, 268ha in September 1987 (reduced from an original 2,662ha).
**Altitude:** Sea level.
**Biogeographical Province:** 4.7.1
**Wetland type:** 01, 02, 06, 07 & 11
**Description of site:** A coastal fringe of mangrove forest with extensive intertidal mudflats, rapidly accreting near Kuala Selangor and stable or eroding in the north. The median tidal range at Kuala Selangor is 3.8m. The whole area has been classified in soil suitability class 4 (more than one serious limitation to crop growth, and suitable for a very restricted range of agricultural and forest crops).
**Climatic conditions:** Humid tropical climate with an average annual rainfall of less than 2,000mm. The wettest months are April and October-December, the driest, January-February and July. Rain comes with both the northeast and southwest monsoons, although the latter is mitigated by the mountains of Sumatra.
**Principal vegetation:** Good quality mangrove forest typical of the west coast of Peninsular Malaysia.
**Land tenure:** State owned (State Government of Selangor).
**Conservation measures taken:** A coastal fringe of mangroves 500-1,000m wide has been gazetted as a State Forest Reserve (the Banjar North Forest Reserve). By September 1987, the area of the reserve had been reduced from an original 2,662ha to only 268ha (SPSSM, in prep). Newly accreting mangrove and mangroves in the north near Sungei Tengkorak are not included in the Forest Reserve.
**Conservation measures proposed:** The area has been proposed as a non-exploitable forest reserve for wildlife conservation purposes, to link up with the Kuala Selangor Nature Park to the south. The forest class "Forest Sanctuary for Wild Life" would be suitable for the purpose. Possible impacts on mudflats should always be considered in environmental impact assessments of proposed developments that may impinge on riverine or coastal areas (SPSSM, in prep).
**Land use:** Fishing, harvesting of cockles and forestry; coconut plantations with some mixed horticulture adjacent to the bund.
**Disturbances and threats:** The wetland is threatened by proposed aquaculture schemes. Further loss of mangroves may affect the fisheries and cockle production, and therefore have a negative impact on the livelihood of coastal inhabitants. The proposed development of Sungei Selangor for water supplies (SMHB, 1986), involving the construction of several impoundments in the Selangor catchment, would reduce the water flow at Rantau Panjang from 5,482 million litres per day to only 300 million litres per day. If implemented, this development could be expected to jeopardize the mangrove ecosystem for several kilometres on either side of Kuala Selangor, and would probably eliminate the cockle beds.

Other potential upstream threats to the cockle beds include a proposed large-scale cattle feedlot scheme in the Rasa area (JPNHS, undated), use of pesticides in plantations, discharge of untreated sewage, and industrial discharges (SPSSM, 1987b).

**Economic and social values:** The mangrove ecosystem is important in maintaining the west coast fishery and cockle beds; it constitutes a locally important forestry resource and provides protection against coastal erosion.

**Fauna:** The Banjar North Forest Reserve supports one of only two known breeding colonies of *Ardea cinerea* remaining on the west coast of Peninsular Malaysia (about 50 individuals in recent years). The mudflats are an extremely important feeding area for migratory shorebirds (over 10,000 birds during the migretion seasons) and resident waterbirds such as Lesser Adjutant Stork *Leptoptilos javanicus, Butorides striatus* and egrets *Egretta* spp.

One of the most productive prawn fishing grounds in West Malaysia and the second largest cockle beds (*Anadara granosa*) in Peninsular Malaysia are located off Kuala Selangor.

**Special floral values:** No information.

**Research and facilities:** Surveys and shorebird counts were carried out by Interwader in 1983, 1985 and 1986 (Paris & Wells, 1984; Silvius *et al.* 1987).

**References:** EPU (1980); JPHNS (undated); Ministry of Agriculture (1974); Parish & Wells (1984); Silvius *et al.* (1987); SMHB (1986); SPSSM (1987b & in prep); Wong (1974 & 1979).

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

**Source:** Asian Wetland Bureau, Forest Research Institute of Malaysia and SPSSM.

**Mangrove Forest South of Kuala Selangor (18 contd.)**

**Location:** 3°15'-3°21'N, 101°13'-101°18'E; between Kuala Selangor and Sungei Buloh, Selangor State.

**Area:** Over 2,500ha, mainly mudflats. The area includes Banjor South Forest Reserve (111ha in September 1987, reduced from an original area of 1,261ha).

**Altitude:** Sea level.

**Biogeographical Province:** 4.7.1

**Wetland type:** 02, 06, 07 & 11

**Description of site:** Extensive intertidal mudflats backed by a small fringe of mangrove forest on the seaward side of the coastal bund extending south from Kuala Selangor. The forest has been severely reduced in size by reclamation for housing estates, industry and agriculture, and by uncontrolled logging. The contiguous area of Kuala Selangor Nature Park (site 8c) is located in a previously excised part of the Banjar South Forest Reserve. The median tidal range at Kuala Selangor is 3.8m. At a research site north of Sungei Buloh, salinities range from 26-36 p.p.t. and the pH from 6.48-7.25. A soluble hydrogen sulphide content of up to six p.p.m. has been recorded at this site. The area has been classified in soil suitability class 4 (more than one serious limitation to crop growth, and suitable for a very restricted range of agricultural and forest crops).

**Climatic conditions:** Humid tropical climate with an average annual rainfall of less than 2,000mm and a mean annual temperature of 26.6°C (monthly range 13°C). The wettest months are April and October-December, the driest, January-February and July. Rain comes with both the northeast and southwest monsoons, although the latter is mitigated by the mountains of Sumatra. The relative humidity falls during the day from an average of 95% at 0730 hrs to 65-75% in the afternoon.

**Principal vegetation:** Mangrove forest. Tee (1982a) describes four distinct zones in the area north of Sungei Buloh. Progressing inland from the lower intertidal zone, these are:

**Avicennia* zone, with pure stands of *A. alba*

2.*Sonneratia* zone, dominated by *S. alba* with patches of the rare *Avicennia intermedia*

3.*Bruguiera* mixed forest zone, consisting of *S. alba, A. alba, A. intermedia, Rhizophora*

*mucronata* and the dominant *Bruguiera parviflora*
4.*Rhizophora* zone, consisting of monospecific stands of *R. mucronata*
**Land tenure:** State owned (State Government of Selangor).
**Conservation measures taken:** Part of the mangrove forest is included in the Banjar South Forest Reserve. The reserve was 1,261ha in extent when originally gazetted, but this had been reduced to 111ha by September 1987 (SPSSM, in prep).
**Conservation measures proposed:** It has been proposed that protection of the Banjar South Forest Reserve be strengthened as a non-exploitable forest reserve for wildlife conservation purposes, to link up with the contiguous Kuala Selangor Nature Park in the north. The forest class "Forest Sanctuary for Wild Life" would be suitable for this purpose. The research site north of Sungei Buloh is of particular importance as an example of a pristine ecosystem, and should be afforded the status of Virgin Jungle Reserve (SPSSM, in prep; Soo, 1979). Possible impacts on mudflats should always be considered in environmental impact assessments of proposed developments that may impinge on riverine or coastal areas (SPSSM, in prep).
**Land use:** Forestry, fishing and harvesting of mangrove produce; housing estates, industry and agriculture including mixed cropping and coconut and palm plantations in adjacent areas.
**Possible changes in land use:** Further reclamation for housing estates, industry, agriculture and aquaculture is possible.
**Disturbances and threats:** The site is threatened by further reclamation and uncontrolled logging, and the development of a new town in the area is likely to cause a considerable amount of disturbance. The proposed development of Sungei Selangor for water supplies (SMHB, 1986), involving the construction of several impoundments in the Selangor catchment, would reduce the water flow at Rantau Panjang from 5,482 million litres per day to only 300 million litres per day. If implemented, this development could be expected to jeopardize the mangrove ecosystem for several kilometres on either side of Kuala Selangor. Other potential threats upstream include a proposed large-scale cattle feedlot scheme in the Rasa area (JPNHS, undated), use of pesticides in plantations, discharge of untreated sewage, and industrial discharges (SPSSM, 1987b).
**Economic and social values:** The mangroves play an important role in coastal protection and sustaining local fisheries.
**Fauna:** The mudflats are an important feeding area for migratory shorebirds. Maximum counts at the shorebird roost on adjacent reclaimed land have ranged from 5,000 to 10,000 birds, and have included 30 species. Nordmann's Greenshank *Tringa guttifer* and Spoon-billed Sandpiper *Eurynorhynchus pygmeus* have been recorded in very small numbers. The area supports up to 30 feeding Grey Herons *Ardea cinerea* and up to 14 Lesser Adjutant Storks *Leptoptilos javanicus*.The Mangrove Pitta *Pitta megarhynchus* was recorded breeding in 1986, and other mangrove specialists such as Mangrove Blue Flycatcher *Cyornis rufigastra* mangrove Whistler *Pachycephala cinerea* and Brown-capped Woodpecker *Picoides moluccensis* occur.
The Silvered Leaf Monkey *Presbytis cristata* Long-tailed Macaque *Macaca fascicularis* and Smooth-coated Otter *Lutra perspicillata* are common, and the Short-tailed Mongoose *Herpestes brachyurus* has been recorded.
The mangrove forest supports an extremely rich tree-dwelling epifauna. The bivalve *Brachyodontes variabilis* forms dense colonies on the pneumatophores of the *Avicennia* forest zone. The carnivorous gastropod *Thais tissoti* predates on the bivalves.
**Special floral values:** A research site located to the north of Sungei Buloh is of exceptional importance as an example of a relatively undisturbed ecosystem, with rich encrusting fauna on the tree trunks and good stands of *Avicennia alba* and *Sonneratia*.The development of stilt roots from the bases of mature *Avicennia* trees is highly unusual. The patches of *Avicennia intermedia* are of particular interest, as this species is extremely rare in Peninsular Malaysia (Tee, 1982a). There are also some particularly good stands of

*Ceriops tagal*

**Research and facilities:** An area of mangroves north of Sungei Buloh in the southern part of the site has been intensively studied by the University of Malaya, Forest Research Institute of Malaysia and other bodies. The forest structure and composition have been especially well studied. Regular shorebird surveys have been carried out by Interwader since 1983, and some shorebirds have been banded by Perhilitan and the University of Malaya.

**References:** EPU (1980); JPHNS (undated); Ministry of Forestry (1986); Sasekumar & Loi (1983); Sasekumar *et al.* (1984); Silvius *et al.* (1987); SMHB (1986); Soo (1979); SPSSM (1987b & in prep); Tee (1982a & 1982b).

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

**Source:** Duncan Parish, R.C. Prentice, M.J. Silvius, A. Sasekumar, University of Malaya and SPSSM.

**Kuala Selangor Nature Park (18 contd.)**

**Location:** 3°20'N, 101°15'E; on the south side of Sungei Selangor near Kuala Selangor, Selangor State.

**Area:** 260ha.

**Altitude:** Sea level.

**Biogeographical Province:** 4.7.1

**Wetland type:** 07 & 08.

**Description of site:** The Nature Park is located in a previously excised section of the Banjar South Forest Reserve. It lies behind the coastal bund to the southwest of Kuala Selangor town, and is overlooked by the historic and very scenic Bukit Melawati (itself a wildlife reserve). It consists of degraded mangrove forest, overgrown in places with creepers and *Acrostichum* ferns. A shallow lake system has been created within the degraded mangrove area, consisting of four interconnecting lakes occupying a total area of about six ha. Several islands have been created in the lakes, and topped with shell grit. The salinity of the lake system can be controlled by operating a sluice gate on an adjacent drainage canal and by pumping water into the lake system from the canal. Stagnant water in the park area is alkaline; water in the lake system is neutral and that in the drainage canal slightly acidic. The median tidal range at Kuala Selangor is 3.8m.

**Climatic conditions:** Humid tropical climate with an average annual rainfall of less than 2,000mm. The wettest month is April (280mm), and the driest is January (120mm).

**Principal vegetation:** The inland edge of a coastal mangrove fringe, consisting mainly of *Bruguiera* mixed forest dominated by *B. cylindrica, B. parviflora* with some *Rhizophora* spp. The vegetation is largely degraded, with extensive areas which have been invaded by climbers and the fern *Acrostichum aureum*.Patches of *B. cylindrica* are affected by deprivation of tidal inundation. The area has been invaded by freshwater species such as *Ficus* spp and *Acacia* sp.

**Land tenure:** State owned (State Government of Selangor).

**Conservation measures taken:** The idea of a Nature Park was first conceived in January 1987 by members of the Malayan Nature Society and Asian Wetland Bureau. An area of 260ha was allocated for the park in May 1987, and the Malayan Nature Society was granted US$ 40,000 for its development. The Nature Park was officially opened on 27th September 1987. It has been gazetted as a Town Park under the Local Government Acts. Responsibility for management rests with the Malayan Nature Society. The nearby Bukit Melawati is a Wildlife Reserve.

**Conservation measures proposed:** A programme of replanting with suitable tree species, including species of particular value as food sources for monkeys and birds, is being drawn up. A management plan for the Nature Park is necessary to guide management decisions, especially with regard to maintenance of the lake system in such a way that it is attractive to roosting and feeding waterbirds. A permanent warden is required to coordinate the

management of the Nature Park and liaise with the appropriate local authorities. Enforcement of Federal and State laws relating to wildlife and environmental protection should be stepped up in the area, in order to prevent illegal logging of the mangrove forest and disturbance to wildlife. The adjacent Banjar North and Banjar South Forest Reserves are being considered for the status of "Forest Sanctuary for Wild Life". The protection of these two Forest Reserves is essential for the maintenance of the Nature Park's value for tourism, recreation and education, as they maintain the fauna of the area.

**Land use:** Nature Park designed for nature conservation, tourism, recreation and education.

**Disturbances and threats:** There is some illegal logging in the adjacent Banjar South Forest Reserve, and small-scale hunting of herons and migratory shorebirds has been noted in the general area.

**Economic and social values:** The Nature Park has good potential to attract both local and foreign tourists to Kuala Selangor. It also provides a recreational and educational resource for the local area. In the first two months after opening, the Nature Park attracted over 2,000 visitors, and several school parties were given guided tours.

**Fauna:** The Nature Park has been designed to provide an alternative high-tide roosting site for some 5,000-10,000 shorebirds which have previously roosted on an adjacent area of reclaimed land currently under development. Thirty species of shorebirds have been recorded at this roost, including Nordmann's Greenshank *Tringa guttifer* and Spoon-billed Sandpiper *Eurynorhynchus pygmeus*.The most abundant species during both northward and southward migration are *Charadrius mongolus, Tringa totanus* and *Calidris ferruginea*.The area supports up to 30 feeding Grey Herons *Ardea cinerea* and up to 14 Lesser Adjutant Storks *Leptoptilos javanicus*.The typical mangrove avifauna occurs in the area, including the White-bellied Sea-Eagle *Haliaeetus leucogaster* which has nested on Bukit Melawati for several years.

The Silvered Leaf Monkey *Presbytis cristata* is one of the most conspicuous inhabitants of the Nature Park. Bernstein (1968) notes that this species occurs at high population density at Kuala Selangor, with five troops of 20-50 individuals occupying territories of about 20ha each. The Long-tailed Macaque *Macaca fascicularis* and Smooth-coated Otter *Lutra perspicillata* are also common, and the Short-tailed Mongoose *Herpestes brachyurus* has been recorded. Reptiles include the Water Monitor *Varanus salvator* and Dog-faced Water Snake *Cerberus rhynchops*

The adjacent mangrove forest and mudflats are rich in invertebrates, including crabs, prawns, cockles and bivalves. Little information is available for the Nature Park, but the Mud Lobster *Thalassina anomala* is evident from its mounds.

**Special floral values:** None known.

**Research and facilities:** The Kuala Selangor population of the Silvered Leaf Monkey has been the subject of several studies (e.g. Bernstein, 1968; Wolf & Fleagle, 1977). Regular shorebird counts have been carried out by Interwader since 1983 (e.g. Silvius *et al.* 1987), and Perhilitan has banded some shorebirds and conducted heron research in the area. Preliminary surveys of the Nature Park have been carried out by the Asian Wetland Bureau (Silvius, 1987) and Malayan Nature Society. Facilities currently being developed in the Nature Park include a visitor centre in the main car park, observation hides, trails through the mangroves, and boardwalks through the contiguous Banjar South Forest Reserve to observation hides on the edge of the mudflats. Educational facilities will include a classroom, laboratory, various displays, audio-visual materials and guided tours.

**References:** Bernstein (1968); EPU (1980); Silvius (1987); Silvius *et al.* (1987); SMHB (1986); SPSSM (1987b); Wolf & Fleagle (1977).

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

**Source:** Duncan Parish, R.C. Prentice and M.J. Silvius.

**Klang Islands (19)**

**Location:** 2°53'-3°04'N, 101°13'-101°24'E; 50km southwest of Kuala Lumpur, Selangor State.
**Area:** c.23,000ha of mangrove islands, tidal mudflats and channels.
**Altitude:** Sea level.
**Biogeographical Province:** 4.7.1
**Wetland type:** 03, 06 & 07.
**Description of site:** A group of mangrove-covered islands and associated intertidal mudflats in the estuaries of the Sungei Klang and Sungei Langat, on the west coast of Peninsular Malaysia. The seven major islands are treated separately below:

**Pulau Ketam**

**Location:** 3°00'-3°05'N, 101°11'-101°17'E; one of the westernmost of the Klang Islands, 50km southwest of Kuala Lumpur, Selangor State.
**Area:** c.4,000ha (2,400ha of mangrove forest and 1,600ha of mudflats).
**Altitude:** Sea level.
**Biogeographical Province:** 4.7.1
**Wetland type:** 03, 06 & 07.
**Description of site:** A mangrove island in the estuaries of Sungei Klang and Sungei Langat, with associated mudflats extending to the north and west. The water is brackish due to the influx of riverine water (from Sungei Klang, Sungei Langat and several other rivers) flowing into marine waters. The mean tidal variation at Pelabuhan Klang is 4.1m. The whole area is in soil suitability class 4 (more than one serious limitation to crop growth and suitable for a very restricted range of agricultural and forest crops).
**Climatic conditions:** Humid tropical climate similar to Kuala Lumpur where the average annual rainfall is under 2,000mm. The driest month is January (120mm), and the wettest April (280mm).
**Principal vegetation:** The dominant mangrove species are *Acanthus ilicifolius, Acrostichum aureum, Avicennia alba, A. marina, Bruguiera cylindrica, Nypa fruticans, Rhizophora apiculata, R. mucronata* and *Sonneratia alba*
**Land tenure:** No information.
**Conservation measures taken:** None.
**Conservation measures proposed:** Silvius *et al.* (1987) have recommended that the undisturbed southwest side of the island be made into a Wildlife Sanctuary. The areas currently being logged should be managed as a Forest Reserve on a sustainable yield basis with a rotation period of 25-30 years. SPSSM (in prep) recommends that the mudflats off Pulau Ketam and Pulau Tengat should be seriously considered for Marine Park status.
**Land use:** Logging, mostly in the northern and eastern parts of the island. There is a major fishery to the north of Pulau Ketam; the crab *Scylla serrata* is harvested and there are some floating cage-culture fish farms.
**Possible changes in land use:** The Brackishwater Fisheries Research Centre of the Fisheries Research Institute has drawn up plans to develop aquaculture in the area. The development would involve the conversion of 1,016ha of mangrove forest to marine prawn and fish ponds, leaving a 200 metre wide mangrove buffer zone along the northern and northwestern sides and a 1,000 metre wide buffer zone along the southern and southeastern coasts of the island.
**Disturbances and threats:** Uncontrolled logging, oil pollution and heavy hunting pressure. The latter was probably responsible for the disappearance of the former heron colony.
**Economic and social values:** The mangrove ecosystem maintains a rich fishery (prawns and marine fishes), which supports a major fishing village and several cage-culture fish farms.
**Fauna:** The island supports large numbers of migratory shorebirds. The total shorebird population in early October 1985 was estimated to be 7,000 birds of at least 14 species. The most abundant were *Numenius phaeopus* (685) and *Tringa totanus* (618). One *Limnodromus semipalmatus* was present at this time. The maximum count of *Leptoptilos*

*javanicus* has been 18, making Pulau Ketam the most important site for this stork in Selangor. The island once held a breeding colony of herons and egrets, but this has disappeared, presumably as a result of heavy hunting pressure. However, the potential for breeding waterfowl still exists. Some 900 *Sterna hirundo* were recorded in mid November 1985. The mammalian fauna has not been investigated, but it is likely that *Macaca fascicularis* and *Presbytis cristata* are present. Several species of crabs are present, including *Scylla serrata*

**Special floral values:** None known.

**Research and facilities:** Aerial and ground surveys of the shorebird populations and vegetation have been carried out by Silvius *et al.* (1987).

**References:** EPU (1980); Silvius *et al.* (1987); SPSSM (in prep); Wong (1974).

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

**Source:** Asian Wetland Bureau.

**Pulau Tengah (19 contd)**

**Location:** 2°54'-3°01'N, 101°11'-101°16'E; one of the westernmost of the Klang Islands, 50km southwest of Kuala Lumpur, Selangor State.

**Area:** Forest Reserve recorded as 597ha, but in reality much larger because of rapid accretion; also approximately 2,000ha of intertidal mudflats and sand flats.

**Altitude:** Sea level.

**Biogeographical Province:** 4.7.1

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

**Description of site:** A mangrove island in the estuaries of Sungei Klang and Sungei Langat, with extensive adjoining mudflats and sand flats to the west and south. The island is the only known site in Peninsular Malaysia with a large sandy mudflat supporting a relatively high benthic biomass. This is the reason for its importance as a feeding area for migratory shorebirds. The mangrove is accreting in a generally southwesterly direction, and is in good condition. There is some evidence of erosion along the eastern side. A salinity of 30 p.p.t. has been recorded in tidal water to the southwest of Pulau Tengah, and a salinity of 10-20 p.p.t. in puddles on the flats (Sasekumar & Chong, 1986). The mean tidal variation at Pelabuhan Klang is 4.1m.

**Climatic conditions:** Humid tropical climate similar to Kuala Lumpur, where the average annual rainfall is under 2,000mm. The driest month is January (120mm), and the wettest April (280mm).

**Principal vegetation:** A major part of the southern half of the island consists mainly of *Sonneratia alba* and *Avicennia marina* forest. *A. marina* is a pioneering species, rapidly accreting over the adjoining southwestern mudflats. *Rhizophora mucronata* and *R. apiculata* dominate elsewhere. Other species of mangrove present include *Bruguiera parviflora* and *Avicennia alba.* Pulau Tengah is unusual in that *Rhizophora* takes over from *Avicennia* whereas at other sites in Peninsular Malaysia (e.g. Matang), *Bruguiera cylindrica* grows up in degenerating *Avicennia* areas to form a stable climax maritime forest (Watson, 1928; Silvius *et al.*, 1987).

**Land tenure:** State owned.

**Conservation measures taken:** The northern part of the island is a State Forest Reserve (Pulau Tengah Forest Reserve; recorded as 597ha). The newly accreted section of the southern part, formed since 1972, is unprotected.

**Conservation measures proposed:** The present undisturbed vegetated area (non-productive forest) on the south side of Pulau Tengah should be protected as Virgin Jungle Reserve. This reserve should include the creeks dissecting the area, and the mudflats and sand flats surrounding the forest should be fully protected. The best protection might be afforded by Bird Sanctuary or Game Reserve status. Logged areas and other parts of the designated Production Forest should be managed on a sustainable yield basis (Silvius *et al.*, 1987). SPSSM (1987a) recommends that under no circumstances

should conversion to brackish water aquaculture ponds or agriculture be allowed on Pulau Tengah. Forest Reserve status should be maintained, with a Virgin Jungle Reserve in the southern third of the island. Tourism potential should be assessed in conjunction with wildlife considerations. SPSSM (in prep) recommends that the mudflats off Pulau Ketam and Pulau Tengah should be serious considered for Marine Park status.

**Land use:** The island is uninhabited. All mangrove areas are under Forest Reserve status as production forest. There is recent evidence of pole-cutting (SPSSM, 1987a). The area is used for fishing, harvesting of the edible crab##Scylla serrata and collection of mangrove products. There is a considerable amount of cage-culture off the eastern side of the island, involving *Lutianus johni, Lates calcarifer* and *Epinephelus sexfasciatus* as well as mussels *Mytilidus viridus* (SPSSM, 1987a).

**Possible changes in land use:** None known. SPSSM (1987a) makes recommendations regarding the conservation issues associated with various potential changes in land use, including aquaculture, agriculture and tourism.

**Disturbances and threats:** Uncontrolled logging and oil pollution from discharges or traffic accidents in Singapore or the Straits of Malacca.

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

**Fauna:** Pulau Tengah is one of the most important staging and wintering areas for shorebirds, particularly *Limosa lapponica* and *Charadrius leschenaultii* in Peninsular Malaysia. Some 26 species of shorebirds have been recorded, and as many as 14,000 birds may be present at one time. Almost 13,000 shorebirds were counted in early October 1985 during the autumn migration, and some 10,000-12,000 were present in January and February 1986. The principal species are *Calidris ferruginea* (maximum 3,584), *Charadrius leschenaultii* (maximum 3,094) and *Xenus cinereus* (maximum 2,303). Up to 550 *Limosa lapponica* have been recorded; this species is rare elsewhere in Malaysia (except for nearby Pulau Ketam). The sandy substrate attracts *C. leschenaultii* in greater densities than elsewhere on the Peninsula, where *C. mongolus* is usually more abundant. Other common waders include *Tringa totanus, Numenius phaeopus* and *Pluvialis squatarola.*The sandy mudflat is an important roosting area for terns, seven species of which have been recorded. The principal species are:

*Sterna albifrons* (maximum 750) *S. hirundo* (maximum 225)
*S. bergii* (maximum 125) *S. bengalensis* (maximum 100)

*Hydroprogne caspia* and *Sterna saundersi* have been observed in very small numbers. The roosting flocks of *S. bergii* and *S. bengalensis* represent more than 50% of the known Malaysian wintering populations of these species. The island is a potential breeding area for *Leptoptilos javanicus* which is regularly observed on mudflats to the west. Up to 18 *Egretta sacra* and 261 *E. garzetta* have been recorded during the migration seasons and in winter.

Mammals include the Long-tailed Macaque *Macaca fascicularis* and reptiles include the Mangrove Snake *Cerberus rynchops*

There is a high benthic biomass in the mudflats. Bivalves include *Glauconome virens* and species of *Solen, Tellina, Anadara* and *Meretrix*. Hermit crabs and other crab species include *Scylla serrata, Dotillopsis brevitarsis, Macrophthalmus* sp and *Ilyoplax* sp; gastropods include *Cerithidea cingulata, Natica maculosa* and *Nassarius* spp.

**Special floral values:** One of the few undisturbed areas which has the complete spectrum of natural succession stages of estuarine mangrove vegetation from *Avicennia marina* through *Sonneratia alba* to *Rhizophora* forest. It is a particularly good example of the Indo-Malayan estuarine mangrove forest.

**Research and facilities:** Faunal and floral surveys have been carried out by Silvius *et al.* (1987). Sasekumar and Chong (1986) have studied the invertebrates.

**References:** Sasekumar & Chong (1986); Silvius *et al.* (1987); SPSSM (1987a & in prep); Watson (1928); Wong (1974).

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

**Source:** Asian Wetland Bureau and Forest Research Institute of Malaysia.

**Pulau Lumut (19 contd)**
**Location:** 2°53'-3°00'N, 101°17'-101°22'E; the innermost of the Klang Islands, approximately 50km southwest of Kuala Lumpur, Selangor State.
**Area:** Original area of Pulau Lumut Forest Reserve 6,258ha; 4,559he remained in September 1987, with several blocks planned for excision.
**Altitude:** Sea level.
**Biogeographical Province:** 4.7.1
**Wetland type:** 03, 06 & 07.
**Description of site:** A mangrove island in the estuaries of Sungei Klang and Sungei Langat, with a narrow fringe of associated mudflats at the southwestern tip. The waters surrounding the island are brackish because of the inflow of riverine water from Sungei Klang, Sungei Langat and several other rivers. The mean tidal variation at Pelabuhan Klang is 4.1m. Almost the whole of the island is classified in soil suitability class 4 (more than one serious limitation to crop growth and suitable for a very restricted range of agricultural and forest crops). About 1,600ha in the centre of the island are classified in soil suitability class 2 (moderate limitation to crop growth and suitable for a not too wide range of agricultural and forest crops).
**Climatic conditions:** Humid tropical climate similar to Kuala Lumpur. The average annual rainfall over the northern half of the island is 2,000-2,500mm, that over the southern half, under 2,000mm. The driest month is January (120mm) and the wettest April (280mm).
**Principal vegetation:** Mangrove forest dominated by *Rhizophora apiculata, Bruguiera parviflora* with smaller areas of *Ceriops tagal, Bruguiera gymnorhiza* and *B. caryophylloides*

**Land tenure:** No information.
**Conservation measures taken:** The island is a Forest Reserve.
**Land use:** Harvesting of mangrove products and fishing. Some small areas in the eastern and southeastern parts of the island are alienated for agricultural purposes. These areas include approved applications and land allocated for agricultural schemes in course of development, but exclude land held on temporary occupation licenses. The central part of the island is mapped as a coconut-producing area.
**Possible changes in land use:** Part of the island is to be converted for agricultural uses and housing.
**Disturbances and threats:** General over-exploitation of the mangrove resources, and logging exploitation followed by conversion to agricultural land.
**Economic and social values:** The mangroves sustain a major local fishery and are exploited for a variety of products, e.g. timber poles and charcoal.
**Fauna:** A staging and wintering area for a wide variety of shorebirds typical of the west coast of Peninsular Malaysia, and also a site for several egrets (*Egretta* spp) and kingfishers (Alcedinidae). No information is available on the mammals, but it is likely that *Macaca fascicularis* and *Presbytis cristata* are present. *Boliopthalmus* sp and *Periopthalmus* sp are common, and *Varanus salvator* and *Cerberus rynchops* may occur. The rich invertebrate fauna includes a wide variety of cockles, oysters, crabs and prawns.
**Special floral values:** None known.
**References:** Chan (1986); Engku Abu Bakar bin Engku Habit (1978); EPU (1980); Wong (1974).
**Criteria for inclusion:** 0.
**Source:** Pan Khang Aun.

**Pulau Klang (19 contd)**
**Location:** 2°57'-3°05'N, 101°15'-101°20'E; the most northerly of the Klang Islands, approximately 50km southwest of Kuala Lumpur, Selangor State.

**Area:** Pulau Klang Forest Reserve 8,785ha; increasing due to accretion.
**Altitude:** Sea level.
**Biogeographical Province:** 4.7.1
**Wetland type:** 03, 06 & 07.
**Description of site:** A mangrove island in the estuaries of Sungei Klang and Sungei Langat, with associated mudflats extending north and southwest. The surrounding waters are brackish because of the inflow of riverine water from Sungei Klang, Sungei Langat and other rivers. The mean tidal variation at Pelabuhan Klang is 4.1m. The whole area has been classified in soil suitability class 4 (more than one serious limitation to crop growth and suitable for a very restricted range of agricultural and forest crops).
**Climatic conditions:** Humid tropical climate similar to Kuala Lumpur. The average annual rainfall is 2,000-2,500mm in the northern part of the island and under 2,000mm in the southern part. The driest month is January (120mm), and the wettest April (280mm).
**Principal vegetation:** Mangrove forest.
**Land tenure:** State owned.
**Conservation measures taken:** The island is a Forest Reserve (8,785ha).
**Conservation measures proposed:** Compartment 13 has been proposed for Virgin Jungle Reserve status as a good example of island mangrove forest (older than on Pulau Tengah).
**Land use:** Fishing and harvesting of mangrove products.
**Disturbances and threats:** Over-exploitation of mangroves by illegal loggers is a major problem. There is also some oil and other water pollution.
**Economic and social values:** The mangrove forest sustains a very important local fishery and is a source of timber poles and charcoal.
**Fauna:** The area probably supports a considerable number of shorebirds typical of the west coast of Peninsular Malaysia, but no information is available. It is likely that *Macaca fascicularis; Presbytis cristata, Varanus salvator* and *Cerberus rhynchops* are present on the island.
**Special floral values:** An excellent example of island mangrove forest. Compartment 13 contains forest which is older than that on Pulau Tengah and shows a different succession (Soo, 1979).
**Research and facilities:** Compartment 13 has been a particularly important site for research and student training for well over a decade (Soo, 1979). The Forest Research Institute of Malaysia maintains study plots on the natural succession of *Rhizophora* forest following clear-felling.
**References:** Coordinating Committee on Mangrove Research (1982); EPU (1980); Soo (1979); SPSSM (in prep); Wong (1974).
**Criteria for inclusion:** 0.
**Source:** See references.

**Pulau Selat Kering (19 contd)**
**Location:** 2°55'-2°59'N, 101°13'-101°16'E; one of the Klang Islands, between Pulau Tengah, Pulau Che Mat Zin and Pulau Pintu Gedong, about 50km southwest of Kuala Lumpur, Selangor State.
**Area:** 1,220ha. Approximately one third intertidal mudflats and two thirds mangrove forest.
**Altitude:** Sea level.
**Biogeographical Province:** 4.7.1
**Wetland type:** 03, 06 & 07.
**Description of site:** A mangrove island in the estuaries of Sungei Klang and Sungei Langat with extensive intertidal mudflats to the north and west. The water is brackish because of inflow of river water from Sungei Klang, Sungei Langat and several other rivers. The tidal variation at Pelabuhan Klang is 4.1m. The whole area has been classified in soil suitability class 4 (more than one serious limitation to crop growth and suitable for a very

restricted range of agricultural and forest crops).
**Climatic conditions:** Humid tropical climate similar to Kuala Lumpur, with an average annual rainfall of under 2,000mm. The driest month is January (120mm), and the wettest April (280mm).
**Principal vegetation:** Mangrove forest.
**Land tenure:** No information.
**Conservation measures taken:** The island is a Forest Reserve.
**Land use:** Fishing and extraction of timber for poles and charcoal.
**Disturbances and threats:** Clearance of the area for development, over-exploitation of the mangrove resources, oil pollution and other water pollution.
**Economic and social values:** The mangrove forest sustains a very important local fishery and provides timber for poles and charcoal.
**Fauna:** The island probably supports a considerable number of shorebirds during the migration seasons and northern winter, but no data are available.
**Special floral values:** No information.
**References:** EPU (1980); Wong (1974).
**Criteria for inclusion:** 0.
**Source:** See references.

**Pulau Pintu Gedong (19 contd)**
**Location:** 2°54'-2°57'N, 101°13'-101°16'E; one of the Klang Islands, south of Pulau Selat Kering, Selangor State.
**Area:** c.1,115ha, including 600ha of mangrove forest and 515ha of intertidal mudflats.
**Altitude:** Sea level.
**Biogeographical Province:** 4.7.1
**Wetland type:** 03, 06 & 07.
**Description of site:** A mangrove island in the estuaries of Sungei Klang and Sungei Langat, with extensive adjacent mudflats to the west and south. The water is brackish because of inflow of river water from Sungei Klang, Sungei Langat and several other rivers. The mean tidal variation at Pelabuhan Klang is 4.1m.
**Climatic conditions:** Humid tropical climate similar to Kuala Lumpur, where the average annual rainfall is under 2,000mm. The driest month is January (120mm) and the wettest, April (280mm).
**Principal vegetation:** Mangrove forest.
**Land tenure:** No information.
**Conservation measures taken:** The island is a Forest Reserve.
**Land use:** Fishing and exploitation of mangroves for poles and charcoal.
**Disturbances and threats:** Over-exploitation of the natural resources, forest clearance, oil pollution and other water pollution.
**Economic and social values:** The mangrove forest sustains a very important local fishery, and provides timber for poles and charcoal.
**Fauna:** A staging and wintering area for a variety of shorebirds typical of the west coast of Peninsular Malaysia.
**Special floral values:** No information.
**References:** Wong (1974).
**Criteria for inclusion:** 0.
**Source:** See references.

**Pulau Cha Mat Zin (19 contd)**
**Location:** 2°55'-2°59'N, 101°16'-101°19'E; one of the Klang Islands, between Pulau Selat Kering, Pulau Klang and Pulau Lumut, Selangor State.
**Area:** c.1,338ha; mostly mangroves with c.50ha of intertidal mudflats.
**Altitude:** Sea level.

**Biogeographical Province:** 4.7.1
**Wetland type:** 03, 06 & 07.
**Description of site:** A mangrove island in the estuaries of Sungei Klang and Sungei Langat, with some intertidal mudflats to the west and east. The water is brackish because of the inflow of fresh water from Sungei Klang, Sungei Langat and several other rivers. The mean tidal variation at Pelabuhan Klang is 4.1m. The whole area has been classified in soil suitability class 4 (more than one serious limitation to crop growth and suitable for a very restricted range of agricultural and forest crops).
**Climatic conditions:** Humid tropical climate similar to Kuala Lumpur, where the average annual rainfall is under 2,000mm. The driest month is January (120mm) and the wettest, April (280mm).
**Principal vegetation:** Mangrove forest.
**Land tenure:** No information.
**Conservation measures taken:** The island is a Forest Reserve.
**Land use:** Fishing and exploitation of mangroves for timber poles, charcoal and other mangrove products.
**Disturbances and threats:** Over-exploitation and clear-felling of mangroves, oil pollution and other water pollution.
**Economic and social values:** The mangrove forest sustains a very important local fishery and provides timber for poles and charcoal.
**Fauna:** A staging and wintering area for species of shorebirds typical of the west coast of Peninsular Malaysia.
**Special floral values:** No information.
**References:** EPU (1980); Wong (1974).
**Criteria for inclusion:** 0.
**Source:** See references.

**Indonesian Sites**

23 **Kuala Jambu Air** - no site sheet available
24 **Kuala Langsa** - no site sheet available

**Belawan (Timur Laut) (25)**
**Location:** 3°45'N, 98°45'E; north of Medan, Kabupaten Langkat, on the east coast of Sumatra Utara Province, Sumatra.
**Area:** 15,765ha.
**Altitude:** Sea level.
**Biogeographical Province:** 4.2.12.
**Wetland type:** 05 & 07.
**Description of site:** A large area of mangrove forest (9,000ha), with adjacent sandy beaches and remnants of dry beach forest. The terrestrial forests inland from the site have now been cleared for agriculture.
**Climatic conditions:** Humid tropical climate.
**Principal vegetation:** Mangrove forest; some *Casuarina equisetifolia* forest in sandy areas.
**Land tenure:** State owned (Indonesian Government).
**Conservation measures taken:** The area has been protected as a Wildlife Reserve since 1980.
**Conservation measures proposed:** It has been recommended that the wardening of the reserve be improved, and that degraded portions of the reserve be reafforested.
**Land use:** Fishing for prawns in surrounding areas.
**Disturbances and threats:** Clearance of mangroves for agriculture.
**Economic and social values:** The mangrove is important in maintaining the local prawn fishery.
**Fauna:** No information is available on the waterfowl. Sea-turtles are reported to nest on the sandy beaches.

**Special floral values:** One of the few surviving large stands of mangrove forest on the east coast of Sumatra Utara Province.
**References:** MacKinnon & Artha (1982a); Salm & Halim (1984).
**Criteria for inclusion:** 0.
**Source:** Marcel J. Silvius.

26 **Sei Prapat** - No site sheet available
27 **Tanjung Sinabo/Pulau Alang Besar** - No site sheet available

**Bakau Selat Dumai (28)**
**Location:** 1°35'N, 101°25'E; on the mainland coast near Pulau Rupat, Kabupaten Bengkalis, Riau Province, Sumatra.
**Area:** 60,000ha.
**Altitude:** Sea level.
**Biogeographical Province:** 4.2.12.
**Wetland type:** 07 & 21
**Description of site:** A large area of rich and almost undisturbed mangrove forest (20,000ha) and peat swamp forest (40,000ha) on the mainland coast of Sumatra, opposite the island of Pulau Rupat.
**Climatic conditions:** Humid tropical climate.
**Principal vegetation:** Mangrove forest and peat swamp forest.
**Land tenure:** No information.
**Conservation measures taken:** None.
**Conservation measures proposed:** The area has been proposed as a Wildlife Reserve (Suaka Margasatwa).
**Land use:** Fisheries and coastal protection.
**Disturbances and threats:** There are some new coastal settlements in the area, and plans have been made to exploit the forestry resources.
**Economic and social values:** The mangroves provide breeding and nursery grounds for economically important marine fishes and crustaceans.
**Fauna:** The area is known to be rich in waterbirds and other wildlife, including the Estuarine Crocodile Crocodylus porosus but no details are available.
**Special floral values:** No information.
**References:** MacKinnon & Artha (1982a).
**Criteria for inclusion:** 1b, 2a, 3b.
**Source:** Marcel J. Silvius.

30 **Pulau Padang dan Danau Tanjung Padang** - No site sheet available

**Bakau Muara Kapuas (34)**
**Location:** 00°30'N, 102°50'E; north of the Sungai Kampar, Kabupaten Bengkalis and Kampar, Riau Province, Sumatra.
**Area:** c.70,000ha.
**Altitude:** Sea level.
**Biogeographical Province:** 4.2.12.
**Wetland type:** 07 & 21
**Description of site:** An excellent complex of mangrove formations backed by peat swamp forests, still in a relatively undisturbed condition.
**Climatic conditions:** Humid tropical climate.
**Principal vegetation:** 20,000ha of mangrove forest and 50,000ha of peat swamp forest.
**Land tenure:** State owned (Government of Indonesia).
**Conservation measures taken:** None.
**Conservation measures proposed:** The area has been proposed as a Wildlife Reserve

(Suaka Margasatwa).
**Land use:** No information.
**Disturbances and threats:** There are plans to log the area.
**Economic and social values:** No information.
**Fauna:** The wetland is an important breeding area for the Estuarine Crocodile *Crocodylus porosus*.The forests support a rich bird life and some primates.
**Special floral values:** No information.
**References:** MacKinnon & Artha (1982a).
**Criteria for inclusion:** 1b, 2a.
**Source:** Marcel J. Silvius.

35 **Muara Sungai Guntung** - No site sheet available

**Tanjung Datuk (37)**
**Location:** 0°00'N/S, 103°45'E; on the equator, 15km east of Desa Bekawan and 50km south of Sungai Guntung, Riau Province, Sumatra.
**Area:** The proposed reserve covers c.25,000ha of mangrove forest.
**Altitude:** 0-0.5m.
**Biogeographical Province:** 4.2.12.
**Wetland type:** 06 & 07.
**Description of site:** A rich mangrove area consisting of almost untouched *Rhizophora* forest, extensive mudflats and several unspoiled tidal creeks. There are several brackish lakes in the interior of the mangrove forest. The tidal range is about 2.0-2.5m.
**Climatic conditions:** Humid tropical climate.
**Principal vegetation:** Mangrove forest with *Avicennia* as the accreting species and *Rhizophora* dominating further inland.
**Land tenure:** State owned (Government of Indonesia).
**Conservation measures taken:** None.
**Conservation measures proposed:** Silvius *et al.* (1986) have recommended that the entire area be protected as a Nature Reserve (Cagar Alam). Salm and Halim (1984) have proposed the establishment of a Marine Sanctuary of 5,000ha.
**Land use:** Fisheries, crocodile hunting and small-scale logging; fisheries and some agriculture in surrounding areas.
**Possible changes in land use:** There is a possibility that some of the mangrove forest, especially around the small lakes, will be reclaimed for agriculture by spontaneous transmigrants from local villages. Further reclamation of mangrove forest is likely in adjacent areas.
**Disturbances and threats:** Crocodile hunting, illegal logging and spontaneous reclamation projects.
**Economic and social values:** The mangrove forest is very important as a nursery and breeding area for commercially important species of fish and shellfish.
**Fauna:** An important area for both resident and migratory waterfowl, notably *Mycteria cinerea* and shorebirds. Over 10,000 migratory shorebirds were present on the mudflats in November 1984, along with over 190 *Mycteria cinerea* and smaller numbers of *Egretta sacra, E. alba* and *Leptoptilos javanicus*.The lakes within the mangrove forest may support breeding colonies of large waterbirds including *M. cinerea*
The creeks are still inhabited by the Estuarine Crocodile *Crocodylus porosus* making this area one of the last refuges for this endangered species in Riau Province.
**Special floral values:** No information.
**Research and facilities:** The area has been surveyed only once, in November 1984.
**References:** Karpowicz (1985); Salm & Halim (1984); Silvius *et al.* (1986).
**Criteria for inclusion:** 1b, 2a, 2c, 3a.
**Source:** Marcel J. Silvius.

**Tanjung Bakung (38)**
**Location:** 0°13'-0°24'S, 103°35'-103°48'E; on Pulau Baso, Riau Province, Sumatra.
**Area:** The proposed reserve covers c.40.000ha of mangrove forest.
**Altitude:** 0-0.5m.
**Biogeographical Province:** 4.2.12.
**Wetland type:** 06 & 07.
**Description of site:** Tanjung Bakung, a promontory of Baso Island, has extensive mudflats and primary mangrove forests. Several small lakes are present. The outermost tip of the promontory is accreting extremely rapidly. The tidal mudflats comprise very unripe clay sediments over 15m deep in places.
**Climatic conditions:** Humid tropical climate.
**Principal vegetation:** Primary mangrove forest and *Nypa fruticans* swamp.
**Land tenure:** No information.
**Conservation measures taken:** None.
**Conservation measures proposed:** Silvius *et al.* (1986) have recommended that the area be protected as a Nature Reserve (Cagar Alam).
**Land use:** No information.
**Disturbances and threats:** Small-scale logging and reclamation; possible disturbance of breeding colonies of waterbirds by egg collectors (for consumption).
**Economic and social values:** The mangrove forest is important as a nursery and breeding area for commercially important species of fish and shellfish.
**Fauna:** An important area for migratory shorebirds and resident large waterbirds; 10,000 shorebirds were present in November 1984, along with 190 *Egretta alba* over 360 *Mycteria cinerea* and over 60 *Threskiornis melanocephalus*. According to local villagers, there may still be some breeding colonies of egrets and storks around the small lakes in the mangrove forests.
The Estuarine Crocodile *Crocodylus porosus* may still occur in the area.
**Special floral values:** None known.
**Research and facilities:** Silvius *et al.* carried out a preliminary waterfowl survey in November 1984.
**References:** Karpowicz (1985); Silvius *et al.* (1986).
**Criteria for inclusion:** 1b, 2a, 2c, 3a.
**Source:** Marcel J. Silvius.

**Hutan Bakau Pantai Timor (39)**
**Location:** 0°50'S, 103°30'E to 1°02'S, 104°07'E; on the coast between Desa Pemusiran and Kuala Tungkal, 70km north of Jambi, Jambi Province, Sumatra.
**Area:** c.6,700ha.
**Altitude:** 0-10m.
**Biogeographical Province:** 4.2.12.
**Wetland type:** 06 & 07.
**Description of site:** An extensive fringe of mangrove forest 20-500m wide, and adjacent large area of intertidal mudflats, stretching for 70km along the northeast coast of Jambi Province. The forest contains several breeding colonies of large waterbirds. It is bisected by nine major mangrove creeks and rivers and numerous small creeks. There are six coastal fishing villages situated at the mouths of creeks. The tidal range is about 2.0-2.5m.
**Climatic conditions:** Humid tropical climate.
**Principal vegetation:** Mangrove forest containing up to 30 species of trees; agricultural land in adjacent areas.
**Land tenure:** The wetland is state owned (PHPA); adjacent areas are privately owned farmland.
**Conservation measures taken:** The area has been protected as a Nature Reserve (Cagar Alam) since 1976. The boundaries are currently being marked in the field and are supposed

to follow the present division of mangrove forest and arable land.
**Conservation measures proposed:** The mangrove fringe near Desa Pemusiran, at present unprotected, should be included in the reserve as it contains important breeding colonies of the Grey Heron *Ardea cinerea*
**Land use:** Some illegal cutting for firewood and poles for construction purposes. There are rice paddies and coconut plantations inland from the mangroves, and inshore fisheries (with standing nets and small boats) along the coast.
**Disturbances and threats:** Further encroachment of the coastal villages into the mangrove fringe, illegal logging, and collection of eggs in the breeding colonies of storks, herons and egrets.
**Economic and social values:** The mangrove forest is a very important nursery and breeding area for many species of prawns and fishes of commercial value.
**Fauna:** A very important breeding, feeding and roosting area for a wide variety of waterbirds. The area is particularly important for the rare Milky Stork *Mycteria cinerea* supporting the largest known breeding colony of this species in the world. At least 74 active nests were located at Kuala Betara in 1985. (The colony at the Banyuasin Musi River Delta may be larger, but has never been adequately surveyed). Other breeding species include several species of *Egretta, Ardea cinerea* (one of the few colonies in Sumatra) and possibly *Threskiornis melanocephalus.* Other waterfowl recorded in the area include *Anhinga melanogaster, Ardea sumatrana, Leptoptilos javanicus* and *Anas querquedula*
Up to 19,000 shorebirds of 21 species have been recorded, including over 1,500 Asian Dowitchers *Limnodromus semipalmatus* and two Nordmann's Greenshank *Tringa guttifer.* Other species include *Pluvialis squatarola, Charadrius mongolus, C. leschenaultii, Limosa limosa, L. lapponica, Numenius phaeopus, N. arquata, N. madagascariensis, Tringa totanus, T. stagnatilis, T. nebularia, T. glareola, Xenus cinereus, Actitis hypoleucos, Arenaria interpres, Calidris canutus, C. ruficollis, C. ferruginea* and *Limicola falcinellus*
Reptiles include the monitor lizard *Varanus salvator*
**Special floral values:** No information.
**Research and facilities:** Waterfowl surveys have been carried out by Danielson and Skov (1986 & 1987) and Silvius *et al.* (1986).
**References:** Danielson & Skov (1986 & 1987); Karpowicz (1985); Silvius (1986); Silvius *et al.* (1986).
**Criteria for inclusion:** 1b, 2a, 2b, 2c, 3a.
**Source:** Marcel J. Silvius.

**Tanjung Jabung (40)**
**Location:** 1°01'S, 104°22'E; between the mouth of the Batang Hari River and Sungai Jambat, just northeast of the Berbak Game Reserve, Jambi Province, Sumatra.
**Area:** c.3,000ha.
**Altitude:** 0-0.5m.
**Wetland type:** 06 & 07.
**Description of site:** A coastal fringe of mangrove forest, approximately 200-500m wide, with some soft mudflats. The site lies to the east of the mouth of the Batang Hari River. The tidal range is about 2m. **Climatic conditions:** Humid tropical climate.
**Principal vegetation:** Mangrove forest; *Avicennia marina* dominates where the mangrove fringe is narrowest, and *Rhizophora* sp where the fringe is wide. Coconut plantations and rice paddies in adjacent areas.
**Land tenure:** The wetland is state owned; surrounding areas are owned by the local villages.
**Conservation measures taken:** The area was protected until the late 1970s when the boundaries of the Berbak Game Reserve were relocated following large-scale reclamation of land behind the mangrove fringe.

**Conservation measures proposed:** Silvius (1986) has recommended that the area be protected as a Nature Reserve (Cagar Alam), to link up with the Hutan Bakau Pantai Timor Nature Reserve.
**Land use:** Some cutting of mangrove poles and inshore fisheries. There are large coconut plantations behind the mangrove fringe.
**Disturbances and threats:** Illegal logging and spontaneous reclamation schemes.
**Economic and social values:** The mangrove is an important nursery and breeding area for species of prawns and marine fishes which are important for the inshore fisheries of the region.
**Fauna:** Many species of prawns and marine fishes use the mangrove swamps as a nursery and breeding area.
The mudflats are used by many thousands of migratory shorebirds of at least 24 species. Some 12,000 shorebirds were present in autumn 1984, 7,500 in summer 1985, and 5,300 in spring 1986. The area is particularly important for the rare Asian Dowitcher *Limnodromus semipalmatus* 100 were present in autumn 1984, and 474 in spring 1986. The shorebird counts in April 1986 also included:

| | |
|---|---|
| 370 *Charadrius mongolus* | 105 *C. leschenaultii* |
| 2,760 *Limosa limosa* | 140 *Numenius phaeopus* |
| 110 *N. madagascariensis* | 475 *Tringa totanus* |
| 130 *T. stagnatilis* | 115 *Xenus cinereus* |
| 50 *Arenaria interpres* | 44 *Calidris canutus* |
| 130 *C. ferruginea* | |

Other waterbirds present at the same time included 245 *Mycteria cinerea* Milky Storks, thirty-five *Ardea cinerea* two *A. sumatrana* twenty-six *Leptoptilos javanicus* and sixty *Anas querquedula*
**Special floral values:** No information.
**Research and facilities:** The area has been surveyed three times: in 1984, 1985 and 1986. The area is readily accessible by speed-boat from the village of Nipa Panjang.
**References:** Danielson & Skov (1986 & 1987); Silvius (1986); Silvius *et al.* (1986).
**Criteria for inclusion:** 1b, 2a, 2c, 3a.
**Source:** Marcel J. Silvius.

**Pulau Burung (45)**
**Location:** 0°25'N, 103°34'E; east of the mouth of the Kampar River, 12km NNW of the village of Sungai Guntung, Riau Province, Sumatra.
**Area:** c.200ha.
**Altitude:** Sea level.
**Biogeographical Province:** 4.2.12.
**Wetland type:** 06, 07 & 08.
**Description of site:** A small mangrove island, surrounded by intertidal mudflats and with a shallow, brackish lake in the centre. There are extensive sandy mudflats on the north and southeast coasts of the island, which is separated from the mainland by a channel several hundred metres wide. The lake is probably not more than 50cm deep. Its salinity appears to be dependent on precipitation and varies with the seasons. The lake is linked with the sea at very high tides. The average tidal variation is about 2m.
**Climatic conditions:** Humid tropical climate. There are five or six months with over 200mm of rainfall, and two or three months with less than 100mm.
**Principal vegetation:** Mangrove forest dominated by *Rhizophora mucronata* and *R. apiculata* with some *Bruguiera parviflora, B. gymnorhiza, B. cylindrica* and *Avicennia* sp.
**Land tenure:** State owned (PHPA).
**Conservation measures taken:** The area is protected as a Nature Reserve (Cagar Alam), established in 1968.

**Conservation measures proposed:** There is a need for regular patrols in the area.
**Land use:** Nature reserve.
**Disturbances and threats:** Some illegal logging of mangrove poles was reported in April 1984.
**Economic and social values:** The mangrove swamps are important in maintaining the local fishery. The lake is very rich in fish and is likely to be a breeding and nursery area for marine fishes and crustaceans.
**Fauna:** According to local people, the mangrove forest around the lake is used as a breeding site by large waterbirds, including the Milky Stork *Mycteria cinerea.* Small numbers of migratory shorebirds were observed on the mudflats in April 1984.
**Special floral values:** The *Rhizophora* forest is very tall and healthy, and is one of the best examples of primary mangrove forest in the region.
**Research and facilities:** M.J. Silvius *et al.* carried out a brief survey of the island in April 1984.
**References:** Silvius *et al.* (1986).
**Criteria for inclusion:** 1b, 2a, 2c.
**Source:** Marcel J.

**Andaman Islands and Nicobar Islands (46)**

**Location:** 7°00'-15°00'N, 92°00'-94°00'E; in the Bay of Bengal between continental India and Burma.
**Area:** Approximately 115,000ha of mangrove forest; total area of islands 813,600ha.
**Altitude:** Sea level to 70m.
**Biogeographical Province:** 4.20.12.
**Wetland type:** 01, 03, 05, 06, 07, 08 & 15.
**Description of site:** The 348 islands of the Andaman and Nicobar archipelagos are the peaks of a marine extension of the Arakkan Yomas in Burma and the mountains of Sumatra. Biogeographically, they form a link between the greater Sunda and Indo-Burmese faunas. Until recently, these islands constituted an almost undamaged and highly diversified natural environment, with luxuriant rain forests extending down from the hills to deserted beaches, fringing reefs and rich coastal waters almost unpolluted by soil erosion or industrial activity. Conditions have, however, changed considerably in recent years, with the recent colonization of the islands by large numbers of immigrants and refugees. Some unique natural environments persist, but the indigenous groups of hunter-gatherers are in immediate danger of cultural and/or physical annihilation.
Much the most extensive wetland habitats in the Andaman and Nicobar Islands are mangrove swamps, but there are many small freshwater ponds and marshes throughout the islands of considerable interest in a regional context.
**Climatic conditions:** Humid tropical monsoon climate, with an average annual rainfall of between 2,750mm and 4,550mm. The islands receive precipitation from both the Southwest and Northeast Monsoons which together account for nine to ten months of the year. The dry months are February and March. Temperatures range from 19-32°C.
**Principal vegetation:** There are an estimated 115,000ha of mangrove forest in the islands, with a zonation greatly resembling that of the Pichavaram and Kaveri systems in southern India. *Rhizophora mucronata* is the commonest species and together with *R. apiculata* forms a canopy 10m high along the principal water courses. Tidal mangrove forest is replaced upstream by riverine or lowland evergreen forest. *Cerbera manghas, Heritiera littoralis, Brownlowia lanceolata* and *Scyphiphora hydrophyllacea* are widespread transitional species. Towards the interior of the mangrove forest, *Bruguiera parviflora* and *B. gymnorhiza* are abundant, the trees occasionally exceeding 25m in height. Commonly there is an undergrowth of *Ceriops tagal.* The Rhizophoraceae form a distinct coastal fringe in which *Aegiceras corniculatum* and *Xylocarpus granatum* may also be found. This

zonation varies in slight detail from one bay to another. These are the only mangrove formations in India where the Nipa Palm *Nypa fruticans* is common.
Large areas of primary forest remain on some of the islands, but most of the lowland areas have now been cleared for agriculture. The flora has strong affinities with that of Southeast Asia. In all, some 3,000 species of plants have been identified, including about 150 species endemic to the islands.
**Land tenure:** No information.
**Conservation measures taken:** Six National Parks and five Wildlife Sanctuaries have been established in the islands. The following reserves include some coastal habitat and mangrove forest:

1. South Butten Island Sanctuary: 12°13'-12°19'N, 93°01'-93°52'E; 300ha; 0-70m above sea level.
2. Middle Butten Island National Park: 4,400ha; 0-70m above sea level; established in 1979.
3. Andaman Crocodile Sanctuary: 10,200ha; 0-15m above sea level; established in 1983.
4. North Reef Sanctuary: 13°04'-13°06'N, 92°36'-92°38'E; 348ha; 0-30m above sea level.
5. South Sentinel Island Sanctuary: 10°44'-10°47'N, 92°05'-92°07'E; 161ha; 0-40m above sea level; established in 1977.

The Andaman Forest Department initiated a project on the conservation of the Estuarine Crocodile *Crocodylus porosus* in 1979, with the assistance of the Government of India.
**Land use:** Formerly subsistence agriculture in small areas and extensive hunter-gatherer utilization of the forested areas. These activities are now yielding to intensive commercial exploitation. Selective felling is widespread in the mangrove forest, and there is some clear-felling in 40m strips. Two thirds of the strips are felled and the rest are left for coastal protection and as a source of seed.
**Possible changes in land use:** Increasing external pressure on the islands is likely to result in further degradation of the remaining terrestrial ecoystems with concomitant damage to the mangrove forest, coral reefs and fisheries. The islands have been designated as a "specially backward" region where industry can claim general financial concessions in order to establish itself.
**Disturbances and threats:** Since the 1970s, a vast expansion of the logging operations has clear-felled large areas with devastating ecological repurcussions. For example, Little Andaman is already reported to be 75% deforested. The effects of this massive deforestation on the estuarine, mangrove and coral ecosystems has not been investigated. Some 12,000ha of mangroves have been clear-felled, mainly for firewood, with detrimental effects on the offshore fisheries. Unrestricted persecution of Estuarine Crocodiles by local people in the past has greatly reduced their numbers. Choudhury and Bustard (1980) recorded 97% destruction of crocodile nests in the 1977 nesting season, almost entirely as a result of egg-robbing by settlers. Seventeen per cent of the nest-guarding females were killed in that year alone. The creation of an Andaman Island Free Port has been proposed in order to accelerate the development of the islands; the outcome of meetings in Central Government on this topic are unknown. The immense potential of the forests for renewable resource utlization has been largely ignored in a rush to exploit the standing timber for power house, matchwood and plywood factories.
**Economic and social values:** Under proper management, the terrestrial and mangrove forests of the Andaman and Nicobar Islands would be capable of supporting a major forestry industry on a sustainable basis. The mangrove forests are breeding and nursery grounds for many commercially important fishes and crustaceans, and are thus of crucial importance in maintaining the region's fisheries. The mangrove forest also provides valuable coastal protection from cyclonic storms. Many of the islands are of great scenic beauty and have tremendous potential for tourism.

**Fauna:** The wetlands support several rare and endangered wildlife species including the Dugong *Dugong dugon*, an endemic race of the Grey Teal *Anas gibberifrons albogularis*, the Estuarine Crocodile *Crocodylus porosus* and several species of marine turtles. The Grey (or Andaman) Teal was once abundant in the Andaman Islands, but numbers have fallen drastically in recent years. Little is known of the ecology of this bird. Many endemic species and races of terrestrial vertebrates remain in the unexploited forests of both island groups.

**Special floral values:** There are about 130 species of ferns and 100 species of orchids in an estimated 700,000ha of forest (1984).

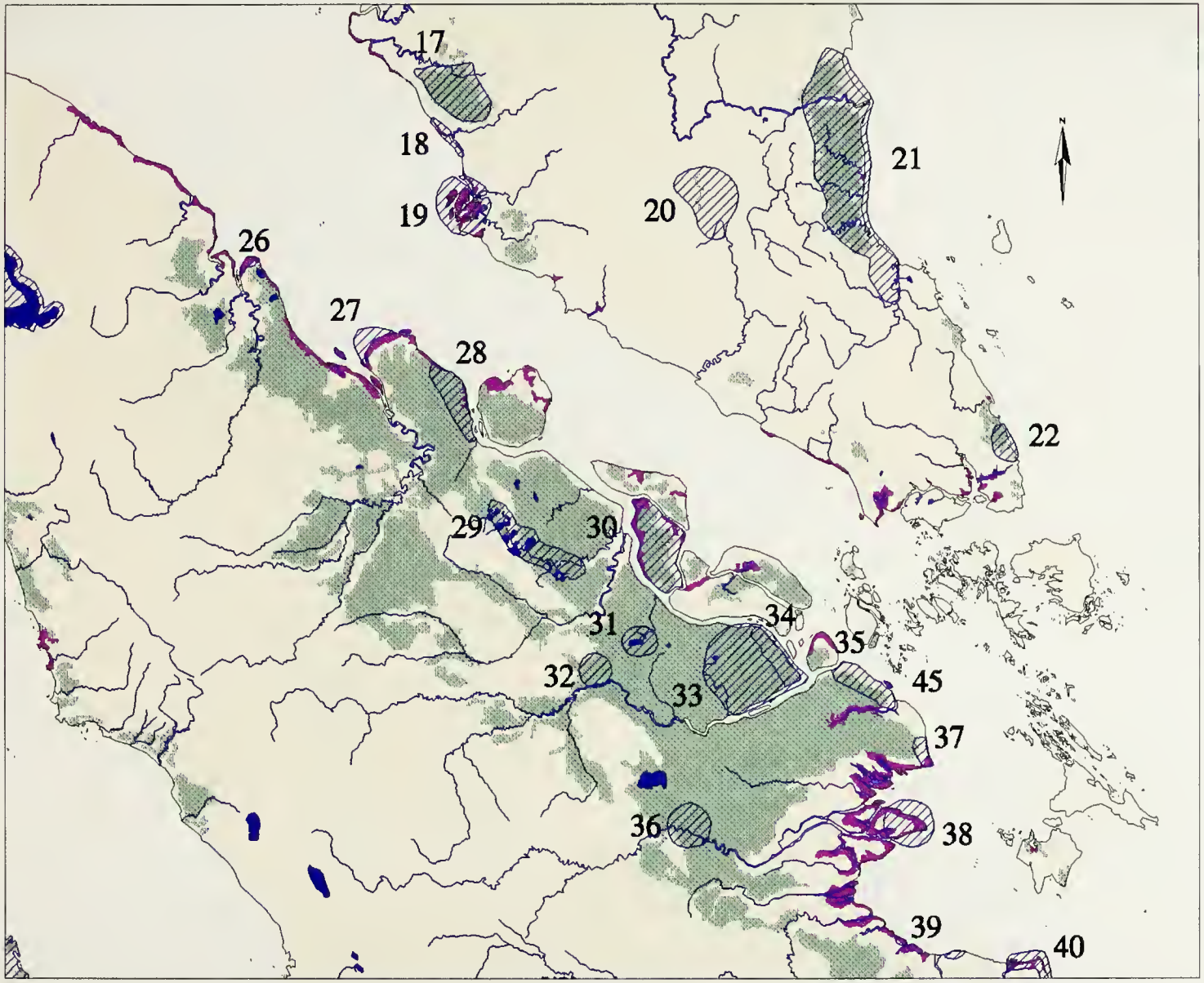
**Research and facilities:** The Bombay Natural History Society and Zoological Survey of India launched several expeditions to the Andaman Islands during the 1960s and 1970s.

**References:** Chatterjee (1977); Choudhury & Bustard (1980); FAO (1984); Fernandes (1987); Kar (1984); Untawale (1985); Whitaker (1985).

**Criteria for inclusion:** 123.

**Source:** See references.

# Strait of Malacca - Wetlands inset




KEY

- Mangrove
- Inland Swamp
- Important Wetland Areas

WORLD CONSERVATION MONITORING CENTRE

## Section 4. CORAL REEFS

Coral reef resources in this region as a whole are not highly developed. Most of the eastern coastline of Sumatra is dominated by silt-laden waters, with high sedimentation rates. There is also fluctuating salinity over large areas. Similar conditions apply over much of the west coast of Peninsular Malaysia, although here there are several offshore islands where important coral reef communities have developed.

Reefs occur around Pulau Weh Marine Park at the north-west tip of Sumatra but do not occur on the northern part of the east coast of Sumatra. They are, however, widespread around the offshore islands to the south such as the Riau and Lingga islands, Pulau Bangka and Pulau Belitung which are important for the collection of reef invertebrates, including *Tridacna gigas*. To the north of the Strait of Malacca, in the Andaman Sea, there are a number of well developed reefs and reef communities along the west coast of Thailand.

Some important sites for coral reefs are:

**Pulau Paya/Segantang Islands Fishery Protected Area and proposed Marine National Park**
Description: four islands with diverse finging reef communities, especially off the southwest tip of Pulau Paya and the north and northeast sides of Pulau Kaca. Important for tourism and for local fisheries.

**Pulau Perak**
Description: isolated conical rocky island, dense patches of coral development. Relatively low diversity.

**Sembilan Islands**
Description: group of islands in relatively muddy water, corals consequently growing in patches or outcrops on a rubble, sandy or muddy bottom.

**Tanjong Tuan (see map of conservation areas)**
Description: one of the only areas where corals have developed on the mainland coast, with suprisingly high coral cover and diversity despite the turbid conditions.

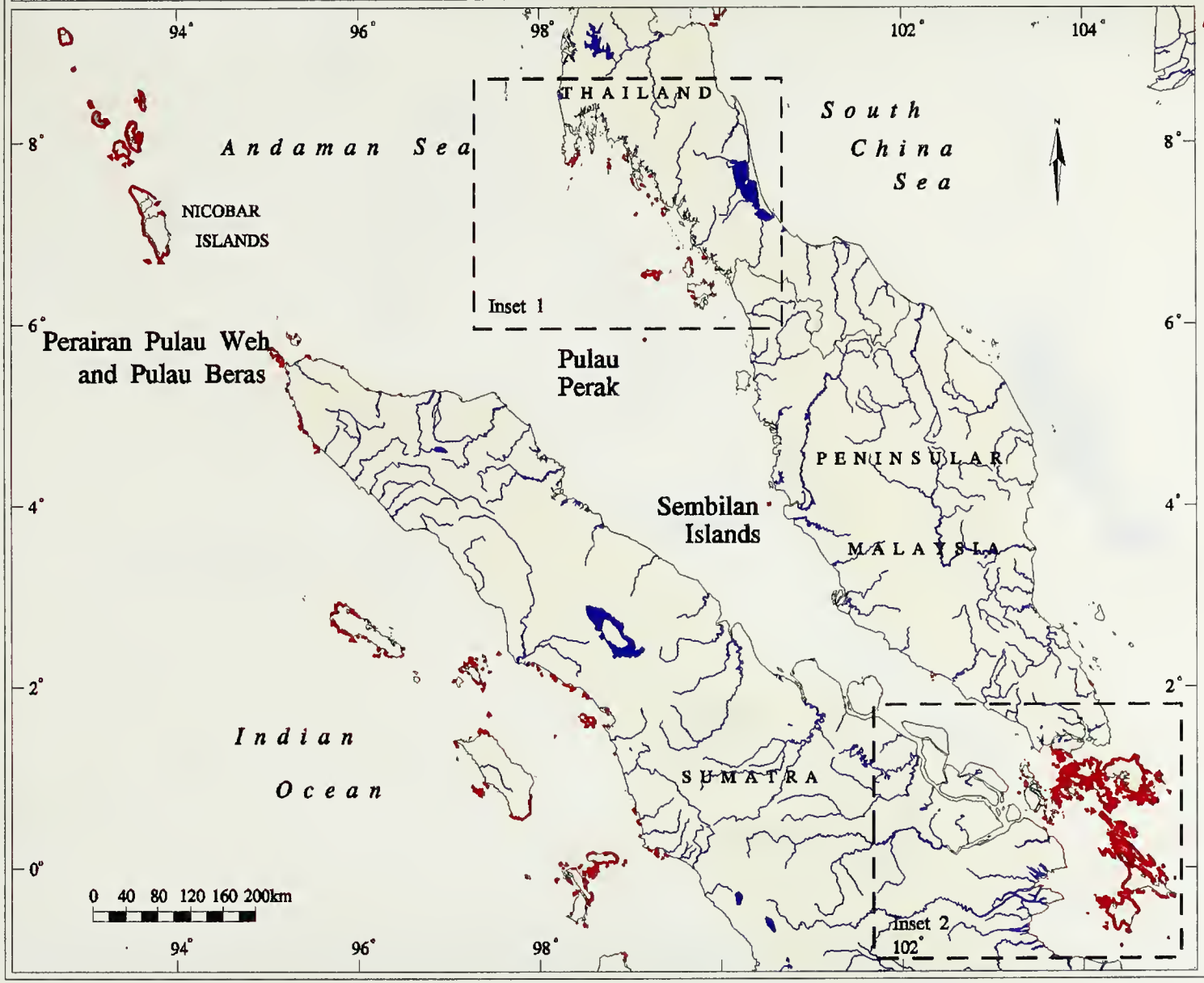
**Perairan Pulau Weh and Pulau Beras**
Description: coral reefs and islands off the northwest coast of Sumatra.

**Tarutao National Park**
Description: west coast of Thailand, includes 51 islands and rocky outcrops, fringe reefs, with high coral diversity. reef flats which are exposed at low tide. Four species of marine turtle are found and tourism is being developed.

**Islands south of Singapore**
Description: Pulau Hantu, Pulau Sudong, Pulau Salu, Pulau Semakau, Sudong, Pawai, Senang St John's and Raffles Lighthouse. Despite the extensive reclamation activity which has taken place, these reefs are considered to have quite high coral cover, although coral diversity is low.

**Kepulauan Riau Selatan-Lingga Utara**
Description: east coast of of Sumatra, south of Singapore comprising reefs, mangrove islands and nesting turtles.

# Strait of Malacca - Coral Reefs

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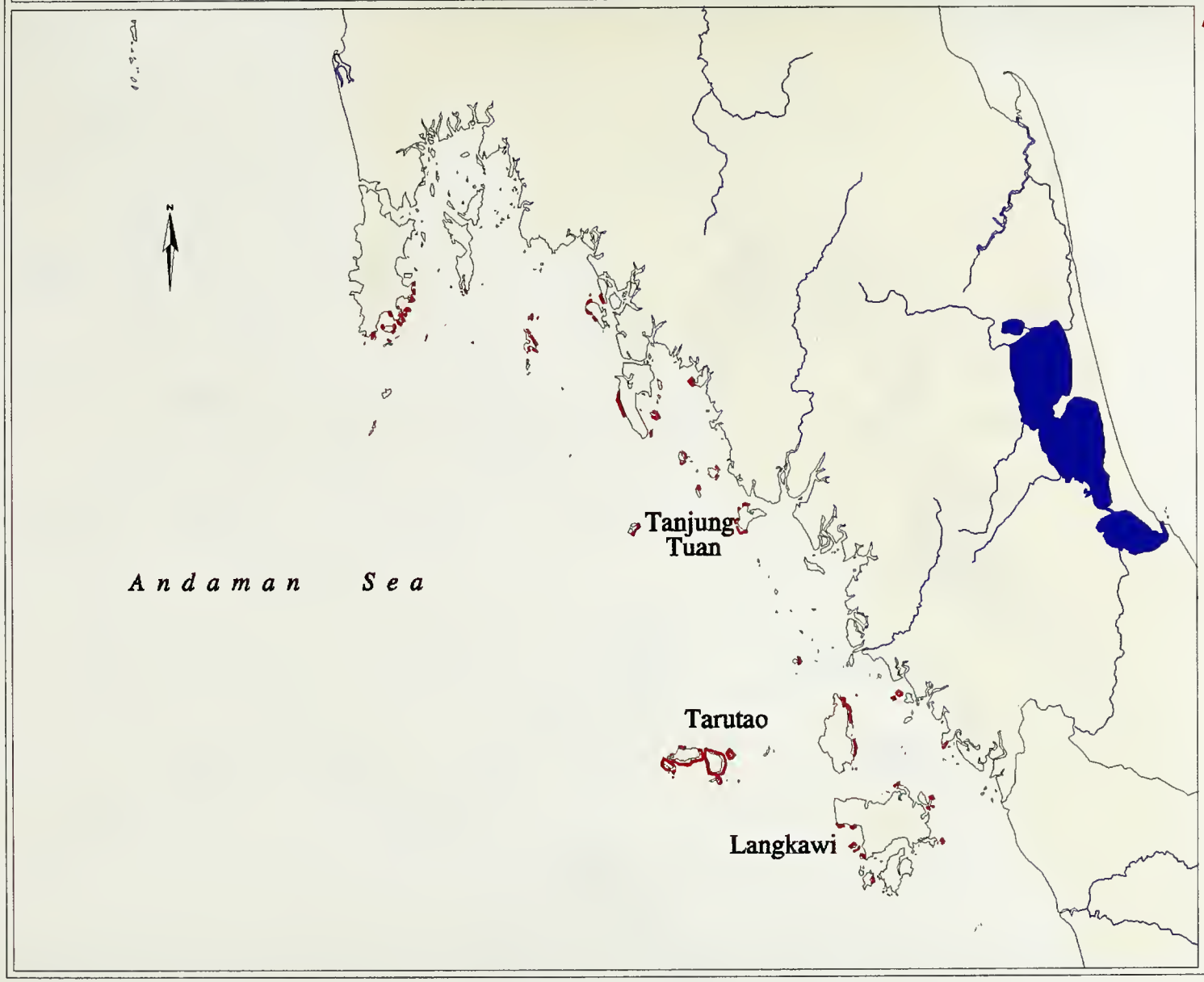
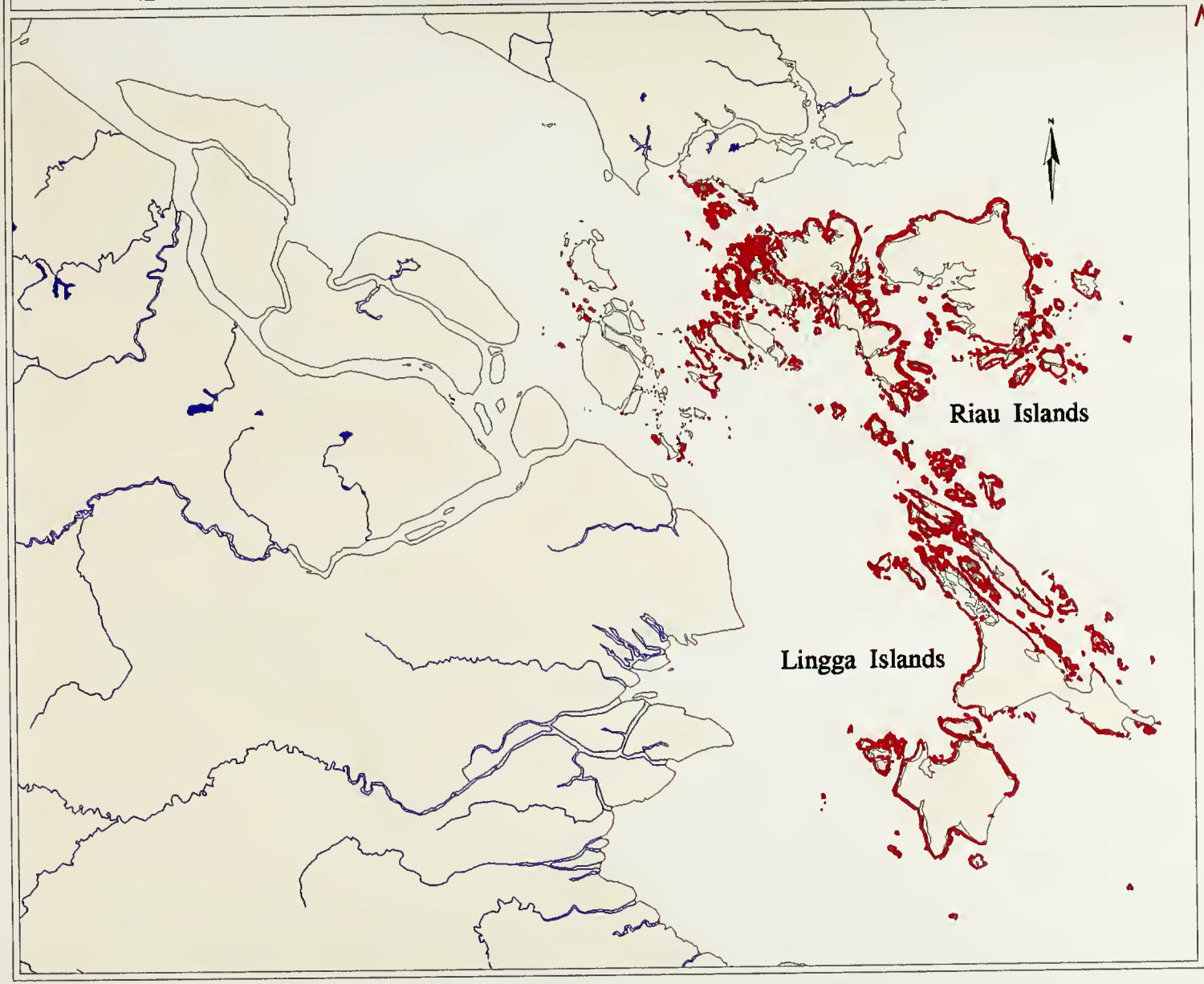
# Strait of Malacca - Coral Reefs inset (1)



# Strait of Malacca - Coral Reefs inset (2)




KEY

Coral reefs

WORLD CONSERVATION MONITORING CENTRE

## Section 5. PROTECTED AREAS

The following list of protected areas is derived from the WCMC Protected Areas Database. Over 35,000 records of sites throughout the world are maintained on this database. For some records, where information is available, individual site sheets have been compiled. These data are less comprehensive in world coverage terms than the database, but provide more detailed information on the status, importance, management and threats to individual protected areas. See below the site sheets available for the protected areas relevant to the Strait of Malacca.

Detailed information for important Nicobar sites is also included. Of particular importance for coral reefs is Tarutao National Park in Thailand - this site was nominated by the Government of Thailand for international recognition under the Unesco World Heritage Convention in 1991.

(Please note that WCMC provides a key service to the IUCN Commission on National Parks and Protected Areas (CNPPA) and the conservation community as a whole and produces the *United Nations List of National Parks and Protected Areas*.)

**Protected Areas for the Strait of Malacca (see Map)**

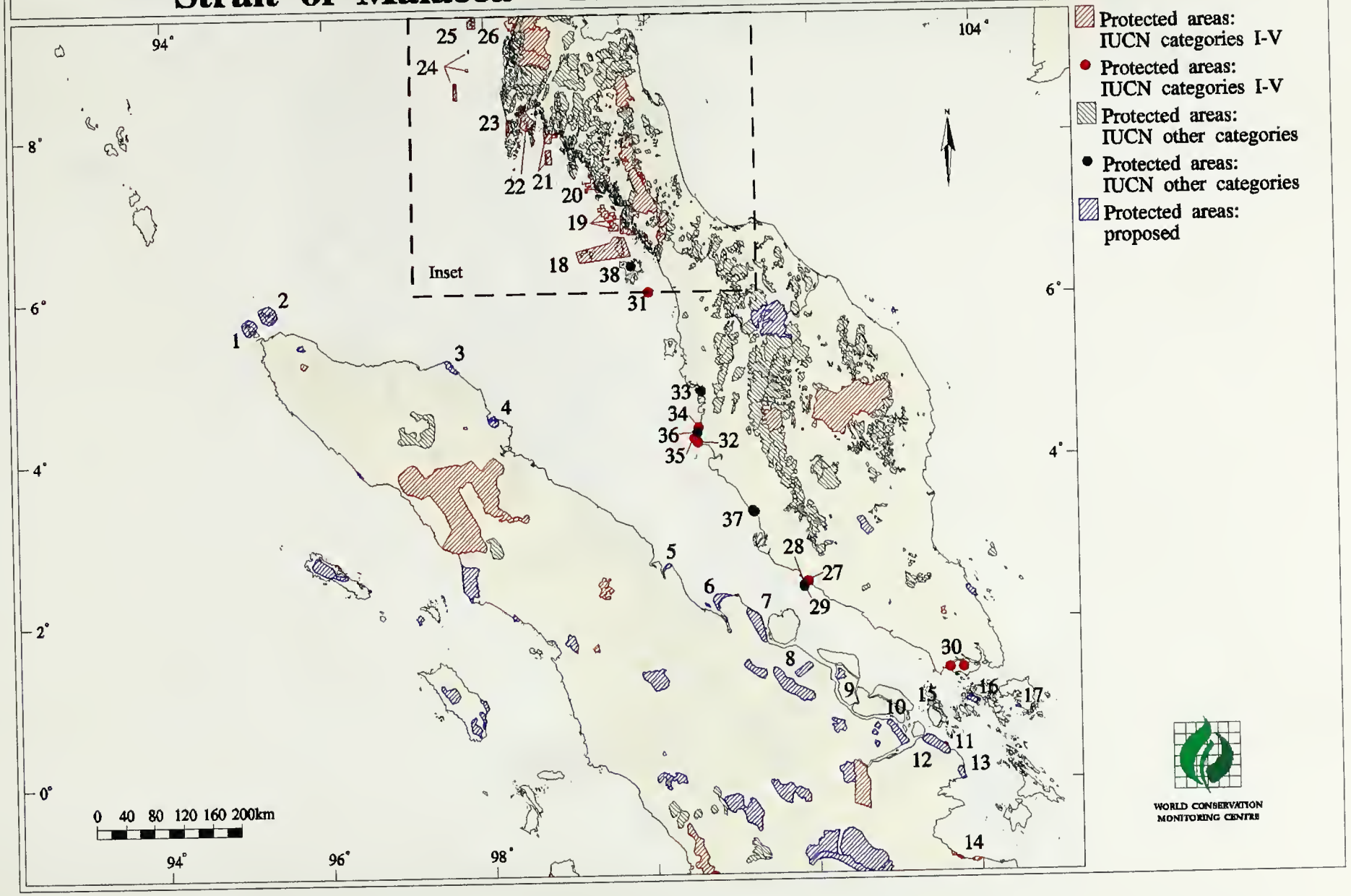
| MAP NUMBER | NAME OF PROTECTED AREA (* - Accompanying site sheet) | ACTUAL BOUNDARY OR POINT LOCATION |
|---|---|---|
| 1 | Perairan Pulau Weh & P. Beras | BOUNDARY |
| 2 | Aneuk Laut | BOUNDARY |
| 3 | Kuala Jambu Aye/Air | BOUNDARY |
| 4 | Kuala Langsa | BOUNDARY |
| 5 | Sei Prapat Simandulang | BOUNDARY |
| 6 | Pulau Alang Besar/ Sinebu | BOUNDARY |
| 7 | Bakau Selat Dumai | BOUNDARY |
| 8 | Bukit Batu | BOUNDARY |
| 9 | Danau Tanjung Padang | BOUNDARY |
| 10 | Bakau Muara Kampar | BOUNDARY |
| 11 | Pulau Burung | BOUNDARY |
| 12 | Muara Sungai Guntung | BOUNDARY |
| 13 | Tanjung Datuk | BOUNDARY |
| 14 | * Kelompok Hutan Bakau Pantai Timur | BOUNDARY |
| 15 | Pulau Pasir Panjang | BOUNDARY |
| 16 | Pulau Bulan | BOUNDARY |
| 17 | Pulau Penyengat | BOUNDARY |
| 18 | * Tarutao | BOUNDARY |
| 19 | Mu Ko Phetra | BOUNDARY |

| MAP NUMBER | NAME OF PROTECTED AREA (* - Accompanying site sheet) | ACTUAL BOUNDARY OR POINT LOCATION |
|---|---|---|
| 20 | * Hat Chao Mai | BOUNDARY |
| 21 | * Hat Nopharat Thara - Mu Ko Phi Phi | BOUNDARY |
| 22 | * Ao Phangnga | BOUNDARY |
| 23 | * Hat Nai Yang | BOUNDARY |
| 24 | * Mu Ko Similan | BOUNDARY |
| 25 | * Mu Ko Surin | BOUNDARY |
| 26 | Laem Son | BOUNDARY |
| 27 | * Sungai Menyala | POINT |
| 28 | * Tanjung Tuan | POINT |
| 29 | * Cape Rachado | POINT |
| 30 | * Bukit Timah | POINT |
| 31 | Pulau Lembu, Kacha, Paya, Segatang | POINT |
| 32 | Pangkor (South) | POINT |
| 33 | Pulau Kechil | POINT |
| 34 | Segari Melintang | POINT |
| 35 | Pangkor | POINT |
| 36 | Tanjong Hantu | POINT |
| 37 | Kuala Selangor | POINT |
| 38 | Pulau Langkawi (around Langkawi Islands) | POINT |

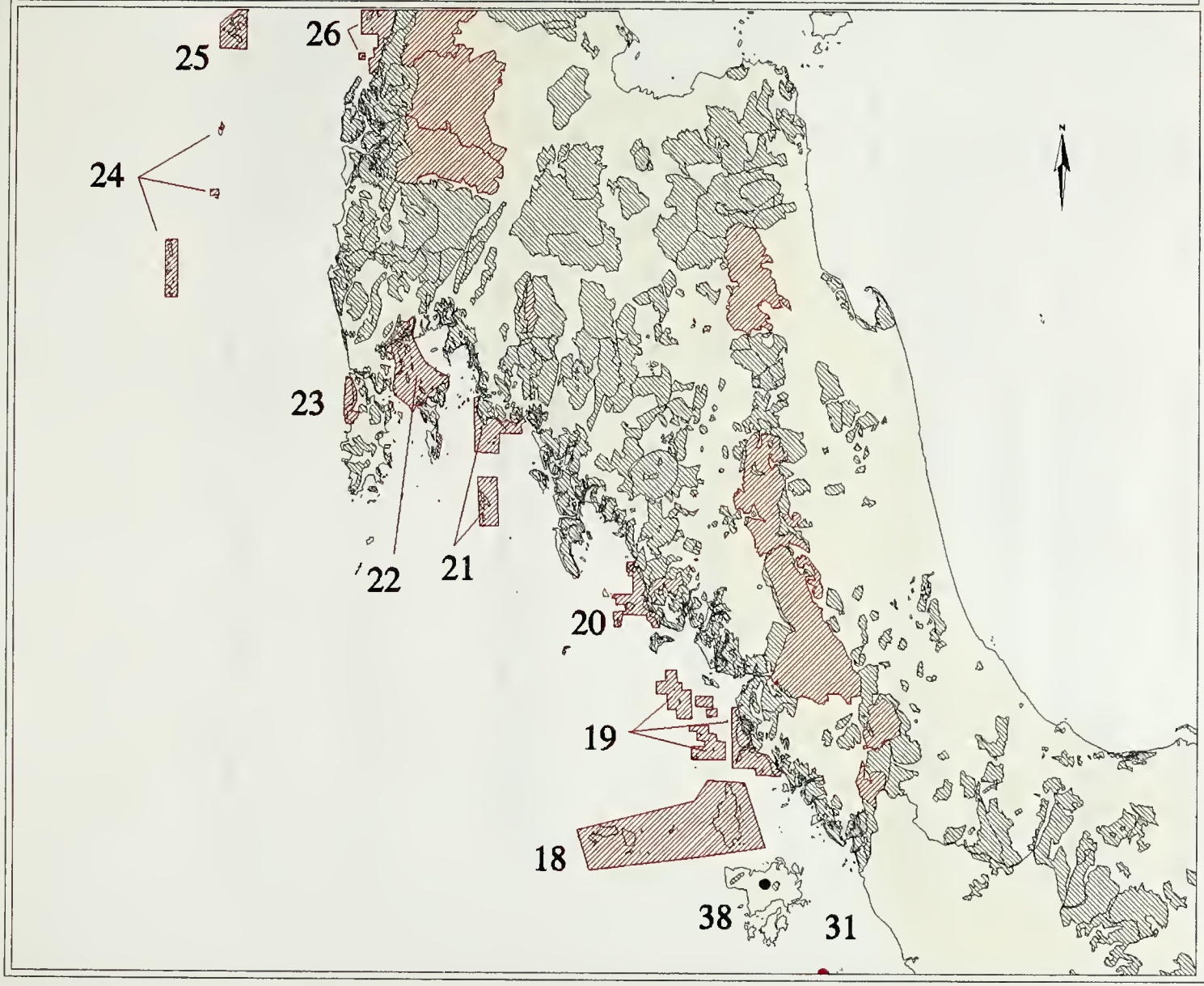
**Sites for Peninsular Malaysia**

**NAME** Sungai Menyala Virgin Jungle Reserve
**IUCN MANAGEMENT CATEGORY** I
**BIOGEOGRAPHICAL PROVINCE** 4.7.1
**LEGAL PROTECTION** Forest Enactment 1934 (Cap. 153) of Federated Malay States.
**DATE ESTABLISHED**
**GEOGRAPHICAL LOCATION** State of Negri Sembilan, compartments 9 (part), 10 (part)

# Strait of Malacca - Protected Areas



# Strait of Malacca - Protected Areas inset




KEY

- Protected areas: IUCN categories I-V
- Protected areas: IUCN categories I-V
- Protected areas: IUCN other categories
- Protected areas: IUCN other categories

WORLD CONSERVATION MONITORING CENTRE

and 11 (part).
**LATITUDE LONGITUDE**
**AREA** 18ha; based around 3 ecological plots.
**LAND TENURE** State land.
**PHYSICAL FEATURES**
**VEGETATION** A lowland dipterocarp forest with a high diversity of plants.
**FAUNA**
**CULTURAL HERITAGE**
**CONSERVATION MANAGEMENT**
**STAFF**
**BUDGET**
**LOCAL ADMINISTRATION** State Director, Forestry Department, Seremban, Negri Simbilan, Malaysia.
**VISITOR FACILITIES**
**SCIENTIFIC RESEARCH AND FACILITIES** Ecological plots have been established by the Forest Research Institute to obtain basic data to interpret the growth and dynamics of primary rainforest. A preliminary analysis was completed by Wyatt-Smith (1966).
**LOCAL POPULATION**
**DISTURBANCES, DEFICIENCIES AND MANAGEMENT PROBLEMS** The pressure by loggers, agriculturists and land developers is severe.
**PRINCIPAL REFERENCE MATERIAL**
Putz, F. E. (1978). A Survey of Virgin Jungle Reserves in Peninsular Malaysia. Forest Research Institute Research Pamphlet No. 73. The Forestry Department, Peninsular Malaysia. 89pp.
**DATE**

**NAME** Cape Rachado (Tanjong Tuan) Virgin Jungle Reserve
**MANAGEMENT CATEGORY** VI
**BIOGEOGRAPHICAL PROVINCE** 4.7.1
**LEGAL PROTECTION** Forest Ordinance (Cap. 147) of the Straits Settlements.
**DATE ESTABLISHED**
**GEOGRAPHICAL LOCATION** State of Malacca.
**LATITUDE LONGITUDE**
**AREA** 120ha
**LAND TENURE** State land
**PHYSICAL FEATURES** Well drained coastal hill.
**VEGETATION** Rich coastal hill flora of seraya *Shorea curtisii*, meranti tembaga *Shorea tembaga*, keruing gondol *Dipterocarpus kerrii* and kempas *Koompassia malaccensis*.
**NOTEWORTHY FAUNA**
**CULTURAL HERITAGE**
**CONSERVATION MANAGEMENT**
**STAFF**
**BUDGET**
**LOCAL ADMINISTRATION** State Director, Forestry Department, Seremban, Negri Simbilan, Malaysia.
**VISITOR FACILITIES**
**SCIENTIFIC RESEARCH AND FACILITIES**
**LOCAL POPULATION**
**DISTURBANCES, DEFICIENCIES AND MANAGEMENT PROBLEMS** Visitors to this area

annually number in the thousands, mostly school children.

**PRINCIPAL REFERENCE MATERIAL**

Putz, F. E. (1978). A Survey of Virgin Jungle Reserves in Peninsular Malaysia. Forest Research Institute Research Pamphlet No. 73. The Forestry Department, Peninsular Malaysia. 89pp.

**DATE**

## Singapore Sites

**NAME** Bukit Timah Nature Reserve, Central Catchment Nature Reserve

**IUCN MANAGEMENT CATEGORY** Bukit Timah: IV (Managed Nature Reserve)
Central Catchment: IV (Managed Nature Reserve)

**BIOGEOGRAPHICAL PROVINCE** 4.07.01 (Malayan Rainforest)

**GEOGRAPHICAL LOCATION** Bukit Timah Nature Reserve lies adjacent to, and south west of, Central Catchment Nature Reserve in the central part of the island of Singapore, 8km from the city.

**DATE AND HISTORY OF ESTABLISHMENT** Bukit Timah first received protection in the 1840s as a 'climatic reserve', and in 1884 became Singapore's first forest reserve (Polunin, 1981). In 1930 the forest reserve was revoked and reconstituted so as to include only 72ha of forest. In 1936 it was taken over by the Gardens Department as a nature reserve, although there was no legislation to provide for this (Corlett, 1988). In 1939 it was regazetted as a forest reserve of only 66 hectares under the control of the Gardens Department, the Director of the Botanic Gardens being gazetted as Conservator of Forests. In 1951, Bukit Timah was declared a nature reserve under the Nature Reserves Act.

**AREA** Bukit Timah: 71ha
Central Catchment: 2,434ha

**LAND TENURE** State

**ALTITUDE** 20-165m

**PHYSICAL FEATURES** Bukit Timah is located on the highest hill in Singapore. The Central Catchment Area occupies an area with low ridges and knolls, and includes Pierce Reservoir, Selatar Reservoir and Mac Ritchie Reservoir. Bedrock is granite, probably of post-lower Jurassic age (Wong, 1969). The soils belong to the Rengam series: well-drained and characterised by a dark, greyish-brown topsoil 10-20cm deep with a yellowish-brown subsoil grading to a yellowish-red firm horizon below 1.5m (Ives, 1977). Topography ranges from gradual to steep, and in places the land falls to merge with steep-sided gulleys with granite outcrops and boulders (Wong, 1987).

**CLIMATE** Conditions are equatorial, with a mean annual rainfall of 2579mm and a minimum monthly rainfall of 140mm. Mean temperature is 26°C, with almost no seasonal variation (Corlett, 1988).

**VEGETATION** The protected areas complex is an isolated patch of tropical forest, surrounded by non-forest land, in which more than 850 species of vascular plants have been recorded since the last century (Corlett, 1988). Bukit Timah Nature Reserve still comprises about 60% primary forest, commonly classified as coastal hill forest (Wong, 1987), although much of this has been considerably disturbed in the past. The rest is secondary forest, which has not been invaded by exotic or native weedy species except along road margins and artificial openings. Secondary vegetation covers most of the Central Catchment Nature Reserve, with regenerating high forest fringing MacRitchie Reservoir. The secondary forest is often dominated by tiup tiup *Adinandra dumosa* (Choo-Teh *et al.*, 1990). Dipterocarps are the dominant canopy species in the primary forest (e.g. *Shorea curtisii*, endemic to the Malay Peninsular, *Dipterocarpus kerri* and *D. sublamellatus*).

Other canopy species include jambu *Eugenia* sp., jelutong *Dyera costulata*, oaks *Lithocarpus* spp. near the summit, renges *Melannorrhoea* sp. and *Dracaena maingayi*. Crescent tree *Aporosa benthamiana*, *Agrostistachys sessilifolia*, *Garcinia parviflora* and *Calophyllum* sp. make up the lower canopy with a rich abundance of epiphytes, including bird's nest fern *Asplenium nidus*, stag horn fern *Platycerium coronarium*, aroids (e.g. *Epipremnum giganteum*) and lianes (e.g. *Rourea mimosoides*). The ground flora is sparse with tree seedlings, shrubs (e.g. *Anisophyllea disticha*), elephant ferns *Angiopteris evecta* and creeping fig *Ficus pumila*. About 100 species of ferns occur today in Singapore, of which about 80 are found only in Bukit Timah Nature Reserve (Choo-Toh *et al.*, 1990). Although there are probably no endemic plant species at Bukit Timah, an estimated 15% of the flora is at its southern limit and likely to be genetically different from other populations (Corlett, 1988). A complete list of tree species for Bukit Timah is given by Wong (1987). An illustrated detailed account of flora is given in the guide to Bukit Timah Nature Reseve (Choo-Toh *et al.*, 1990).

**FAUNA** Present knowledge of the mammalian fauna is incomplete, particularly as regards nocturnal species. Certainly extinct in Bukit Timah Nature Reserve are tiger *Panthera tigris* (E), leopard *Panthera pardus* (T), clouded leopard *Neofelis nebulosa* (V), pig-tailed macaque *Macaca nemestrina*, sambar *Cervus unicolor*, barking deer *Muntiacus muntjak*, and wild boar *Sus scrofa*. Either extinct or rare are slow loris *Nycticebus coucang*, common porcupine *Hystrix brachyura*, leopard cat *Felix bengalensis* and mousedeer *Tragulus javanicus*. Mammals that can still be seen include common tree-shrew *Tupaia glis*, long-tailed macaque *Macaca fascicularis*, Singapore rat *Tikus annandalei*, flying lemur *Cynocephalus variegatus*, common flying fox *Pteropus vampyrus*, red giant flying squirrel *Petaurista petaurista*, common red-bellied squirrel *Callosciurus notatus*, large Indian civet *Viverra zibetha* and pangolin *Manis javanica* (Choo-Toh *et al.*, 1990). Comparison of lists of bird species compiled in 1949 and 1985 suggests that more than half of Bukit Timah's avifauna has been lost, including all the trogons, hornbills,and broadbills, all but one barbet, more than half of the babblers and woodpeckers, and a variety of other species (Corlett, 1988). An illustrated detailed account of fauna is given in the guide to Bukit Timah Nature Reseve (Choo-Toh *et al.*, 1990).

**CULTURAL HERITAGE** No information

**LOCAL HUMAN POPULATION** Five hectares have been added to Bukit Timah Nature Reserve in the south-west corner, more than half of which are occupied by two Malay villages (Corlett, 1988).

**VISITORS AND VISITOR FACILITIES** Bukit Timah Nature Reserve is readily accessible from the city and is a popular weekend spot, being visited by 78,000 people in the last year reported (Corlett, 1988). It has an extensive system of nature trails, providing access to all parts of the reserve. Many of the bigger trees are labelled. Drinks and snacks are available at the reserve entrance, and a visitor centre has been planned (Anon., 1989).

**SCIENTIFIC RESEARCH AND FACILITIES** Few, if any, other areas of rain forest in South-east Asia have been studied in such detail as Bukit Timah. It is botanically famous, being the type locality for a number of plant species and many insects and invertebrates (A.R. Wallace made major collections there last century). Various studies on the fauna and flora are conducted by the students and staff of tertiary institutions in Singapore. Current research projects include studies of angiosperms, ferns, bryophytes, Algae, mycorrhizal fungi, macaques, birds, insects, and freshwater crabs. There are no scientific facilities (Corlett, 1988).

**CONSERVATION VALUE** Bukit Timah contains the only virgin rain forest in Singapore and is possibly the oldest small rain forest reserve in the world. Despite more than 130 years of isolation and considerable disturbance, the reserve still retains much of its original diversity. It contains more than 40% of Singapore's native flora, much of which is not found elsewhere on the island, as well as an extremely rich invertebrate fauna (Corlett, 1988; Choo-Toh *et al*, 1990).

**CONSERVATION MANAGEMENT** No record exists of when the forest on Bukit Timah first became isolated. Following its designation in the 1880s as a forest reserve, Bukit Timah's boundaries were demarcated by a firebreak. Although never logged, timber was extracted illegally. The largest area (133ha) was under 'grass and fern', and the rest (88ha) under 'brushwood'. In 1895 both areas were transferred to the control of the Collector of Land Revenue at the Land Office. Again there was no legal extraction of timber, but illicit felling continued to be a major problem. However, little more than a third of the 343ha reserve was under timber. New paths were cut and signposted, trees were labelled, timber thefts were stopped, devastated areas were planted and a thorough botanical survey was started. Some damage occurred during the Japanese invasion in 1942 and the subsequent occupation until 1945, with some trees being felled and excavations made for defensive purposes, but on the whole the reserve was not seriously damaged. More serious, post war, was the quarrying adjacent to the reserve, and which in places encroached into it. A Select Committee, appointed to investigate these activities, recommended that the quarries be closed. Despite their recommendations, two quarries are still active although they are no longer being extended horizontally (Corlett, 1988).

**MANAGEMENT CONSTRAINTS** Until recently, Bukit Timah was essentially part of the Central Catchment Area, being separated only by a pipe-line carrying water. With the completion of the six-lane Pan Island Expressway east of the reserve, however, it is now entirely isolated except for that small portion of the Central Catchment Area lying between the expressway and the summit of Bukit Timah, on which the integrity of Bukit Timah Nature Reserve now depends. Elsewhere, villages and farms border Bukit Timah Nature Reserve. Villagers harvest firewood and pole-sized trees near the reserve's fringes, and domestic chickens, dogs and cats enter the reserve. So far as is known, no commercial exploitation of timber has taken place. In 1982 it was reported that a stretch of quarry road, 200m long and 3m wide, had been ploughed right beside the reserve fence, damaging it and some of the trees, and possibly leading to erosion of the immediate reserved area. The Parks and Recreation Department has since prohibited any further clearing (Corlett, 1988). In 1989 a new National Parks Board was created, to include the existing Nature Reserves Board, with responsibility for Bukit Timah and Central Catchment nature reserves (Anon, 1989).

There is a police radio station on the summit and a VHF telecommunication transmitter on a 2ha plot of land overlooking the southernmost quarry. Shot-blasting of the telecommunication tower has led to the deposition of up to a centimetre of copper slag, highly toxic to most organisms, over several hectares of primary forest. These buildings are served by tarmac roads which are not open for use by private vehicles. An additional area of about one hectare on the summit, cleared last century, is grassed and planted with exotics. There are smaller cleared areas around some of the shelters provided for visitors, and several views have been 'improved' by felling trees (Corlett, 1988).

**STAFF** Five permanent rangers supervise Bukit Timah Nature Reserve (Corlett, 1988).

**BUDGET** No information

**LOCAL ADDRESSES**

National Parks Board, Singapore Botanic Gardens, Cluny Rd, Singapore 1025 (Tel: 4741165; Fax: 4754295)

**REFERENCES**

Anon. (1989). *Ministry of National Development Annual Report.* Singapore. 46 pp.

Corlett, R.T. (1988). Bukit Timah: the history and significance of a small rain forest reserve. *Environmental Conservation* 15: 37-44.

Ives, D.W. (1977). Soil map of Republic of Singapore. Scale

1:63360. *New Zealand Soil Survey Report* 36. 15 pp. (Unseen)
Murphy, D.H. (1973). Animals in the forest ecosystem. In: Chuang, C.H. (Ed), *Animal life and nature in Singapore*. Singapore University Press, Singapore. Pp. 53-73.
Polunin, N. (1981). Bukit Timah Nature Reserve, Singapore. *Environmental Conservation* 8: 274.
Choo-Toh, G.T., Hails, C.J., Harrison, B., Wee, Y.C. and Wong, Y.K. (1990). *A guide to Bukit Timah Nature Reserve*. Singapore Science Centre, Singapore. 138 pp.
Swan, F.R. (Jr.) (1988). Tree distribution patterns in the Bukit Timah Nature Reserve. *Garden's Bulletin, Singapore* 41: 59-81.
Wong, P.P. (1969). The surface configuration of Singapore Island, a quantitative description. *Journal of Tropical Geography* 29: 64-74. (Unseen)
Wong, Y.K. (1987). Ecology of the trees at Bukit Timah Nature Reserve. *Garden's Bulletin, Singapore* 40: 45-76.
DATE November 1980, reviewed January 1991

**Sites for Sumatra**

**NAME** Cagar Alam Kelompok Hutan Bakau Pantai Timor Jambi (Kelompok Hutan Bakau Pantai East Jambi Nature Reserve)
**IUCN MANAGEMENT CATEGORY** I (Strict Nature Reserve)
**BIOGEOGRAPHICAL PROVINCE** 4.21.13 (Sumatra)
**GEOGRAPHICAL LOCATION** Lies on the east coast of central Sumatra within the administrative province of Jambi. The city of Jambi lies to the south. The boundaries follow the present division between mangrove forest and arable land. 0°50'-1°20'S, 103°30'-104°07'E
**DATE AND HISTORY OF ESTABLISHMENT** Established as a nature reserve in 1981
**AREA** 6,500ha
**LAND TENURE** State
**ALTITUDE** 0m-10m
**PHYSICAL FEATURES** The reserve encompasses part of the extensive tract of coastal wetland that fringes Sumatra's east coast. The intertidal mudflats are intersected by numerous creeks and rivers (Silvius, 1989).
**CLIMATE** Lies within climatic zone B, with between five and seven consecutive wet months and three or less consecutive dry months (Whitten et al., 1984).
**VEGETATION** Mangrove forest
**FAUNA** The reserve supports a rich avifauna, with shorebirds and waterfowl being particularly well represented. Notable species include milky stork *Mycteria cinerea* (V), of which the reserve supports the largest breeding colony in the world, with some 10% of the total population. In addition, some 1,500 Asian dowitcher *Limnodromus semipalmatus* (R), over half the world's population, are present during their northward and southward migrations, as well as grey heron *Ardea cinerea* and possibly black-headed ibis *Threskornis melanocephalus*. Other species of note include lesser adjutant stork *Leptoptilos javanicus* (V) and Nordmanns greenshank *Tringa guttifer* (I). Shorebirds include black-bellied plover *Pluvialis squatarola*, Mongolian plover *Charadrius mongolus*, greater sand plover *C. leschenaultii*, black-tailed godwit *Limosa limosa*, bar-tailed godwit *L. lapponica*, whimbrel *Numenius phaeopus*, curlew *N. arquata* and far-eastern curlew *N. madagascariensis*. Reptiles include monitor *Varanus salvator* (Silvius, 1986, 1989).
**CULTURAL HERITAGE** No information
**LOCAL HUMAN POPULATION** There are a number of coastal villages behind the mangrove

fringe (Silvius, 1989).
**VISITORS AND VISITOR FACILITIES** No information
**SCIENTIFIC RESEARCH AND FACILITIES** Avifaunal surveys have been carried out by Danielson and Shov (1986, 1987, cited in Silvius, 1989) and Silvius (1986).
**CONSERVATION VALUE** The reserve and surrounding area are of national and international importance as breeding and roosting grounds for a number of threatened species of waterfowl (Silvius, 1986).
**CONSERVATION MANAGEMENT** Silvius (1986) makes a number of management recommendations, including boundary marking, regular patrols and monitoring, and the implementation of a conservation education programme for the local population. It is further recommended that the mangrove fringe near Desa Pemusiran be included in the reserve as it contains two important heronries. Boundaries are currently being marked in the field (Silvius, 1989).
**MANAGEMENT CONSTRAINTS** Principal management problems are encroachment of coconut and rice plantations into the mangrove back swamps. Other problems include small-scale illegal logging and collection of eggs (Silvius, 1986, 1989).
**STAFF** No information
**BUDGET** No information
**LOCAL ADDRESSES** PHPA headquarters are located at Bendahara
**REFERENCES**

Silvius, M.J. (1986). *Survey of coastal wetlands in Sumatra Selatan and Jambi, Indonesia*. For the proposed PHPA-Interwader project. Report No. 1. Pp. 70-73.

Silvius, M. (1989). Indonesia. In: Scott, D.A. (Ed.), *A directory of Asian wetlands*. IUCN, Gland, Switzerland and Cambridge, UK. Pp. 1004-1005.

Whitten, A.J., Damanik, S.J., Anwar, J. and Hisyam, N. (1984). *The Ecology of Sumatra*. Gadjah Mada University Press, Indonesia. 555 pp.

**DATE** January 1991

## Sites for Thailand

**NAME** Hat Chao Mai National Park
**MANAGEMENT CATEGORY** II (National Park)
**BIOGEOGRAPHICAL PROVINCE** 4.05.01 (Indochinese Rainforest)
**GEOGRAPHICAL LOCATION** Located on the western mainland coast of peninsular Thailand in Trang Province. The nearest major town is Trang, about 15km to the east. The boundary encompasses marine areas. 7°14'-7°30'N, 99°14'-99°28'E
**DATE AND HISTORY OF ESTABLISHMENT** 14 October 1981
**AREA** 23,088ha. Comprises 9,366ha terrestrial and 13,722ha marine.
**LAND TENURE** Government
**PHYSICAL FEATURES** Includes coastal beach, offshore islands, steep forested hills and degraded mangrove areas (Round, 1985).
**CLIMATE** No information
**VEGETATION** Comprises evergreen forest on limestone hills inland, beach scrub and small areas of mangrove in coastal areas (Round, 1985).
**FAUNA** There are recent, unconfirmed reports of blackneck stork *Ephippiorhynchus asiaticus* which formerly bred in the area (Round, 1985). The park is an important roost site for 8-10,000 wintering waders which commute to the adjacent Mu Ko Libong Non-hunting area (P.D. Round, pers. comm.).
**CULTURAL HERITAGE** No information

**LOCAL HUMAN POPULATION** No information
**VISITORS AND VISITOR FACILITIES** Accommodation is available for 50 people in bungalows and an indeterminate number of large tents are also available. There is a visitor centre although details are not available (Kasetsart University, 1987).
**SCIENTIFIC RESEARCH AND FACILITIES** No information
**CONSERVATION MANAGEMENT** No information
**MANAGEMENT PROBLEMS** No information
**STAFF** Includes two forest technicians, two National Parks Division officers, a single clerk and up to 26 seasonally employed workers (Kasetsart University, 1987).
**BUDGET** 429,300 baht (US$ 16,000) in 1986.
**REFERENCES**
Kasetsart University, 1987. *Assessment of national parks, wildlife sanctuaries and other preserves in Thailand.* Draft Report. Faculty of Forestry, Kasetsart University, Royal Forest Department, Office of the National Environment Board, USAID. 124 pp.
Round, P. (1985). *Status and conservation of resident forest birds in Thailand.* Association for the Conservation of Wildlife. Bangkok. 143 pp.
**DATE** June 1987

**NAME** Ao Phangnga National Park
**MANAGEMENT CATEGORY** II (National Park)
**BIOGEOGRAPHICAL PROVINCE** 4.05.01 (Indochinese Rainforest)
**GEOGRAPHICAL LOCATION** Located on the western mainland coast of peninsular Thailand in Phangna Province and some 3km north-east of Phuket Island. The Phuket to Phangnga road passes close to the north-east boundary. 8°03'-8°30'N, 98°27'-98°38'E
**DATE ESTABLISHED** 29 April 1981
**AREA** 40,000ha
**LAND TENURE** Government
**ALTITUDE** Sea level to 439m
**PHYSICAL FEATURES** The Park comprises a large, shallow marine component (34,700ha) in Phangnga Bay and a small terrestrial area (5,300ha). More than 40 limestone islands rise steeply from the sea, many with poorly developed soils. There are a few areas of coral in the west and some islands have beaches (UNEP/IUCN, 1987).
**CLIMATE** The climate is monsoonal with heavy rain and strong winds during the May to October south-west monsoon. Mean annual rainfall is 2380mm and the mean annual temperature is 28°C with only slight seasonality (Dobias, 1982).
**VEGETATION** There are considerable areas of mangrove forest in good condition, although the most extensive areas are outside the Park boundary (Round, 1985). Much of it is secondary growth managed under concessions for timber production. Small patches of rainforest occur on some of the flatter islands, although most support only stunted trees (Dobias, 1982; UNEP/IUCN, 1987; Sayer, 1987).
**FAUNA** Dugong *Dugong dugong* (V) occur but are uncommon (Sayer, 1981), whilst dolphins are seen quite frequently in groups of 15 or 20 individuals (Dobias, 1982). Crab-eating macaque *Macaca fascicularis* are common, whilst reports of serow *Capricornis sumatraensis* remain moot. A number of caves are inhabited by bats. A mammal species list is given in MacKinnon and MacKinnon (1987). Birds include reef egret *Egretta sacra*, little green herons *(Egretta garetta* or *Butorides striates* and hornbills *Bucerotidae* sp., are seen frequently (Dobias, 1982; Sayer, 1981) and *Haliaeetus leucogaster*, Pied imperial pigeon *Ducula bicolor*, *Pelargopsis amauroptera* and *Pitta pregarhyncha* are reported (Round, 1985).
**CULTURAL HERITAGE** A shallow cave near Ko Panyi contains prehistoric drawings thought

to be about 3,000 years old (Dobias, 1982).

**LOCAL HUMAN POPULATION** There is a large Muslim fishing village on Ko Panyi in the north of the Park (Dobias, 1982) and the number of people in a number of other villages in the Park built on stilts. These are a major tourist attraction which makes a sizeable contribution to the livelihood of local people (Sayer, 1981).

**VISITORS AND VISITOR FACILITIES** There are no details of visitor numbers available, although quite large numbers arrive by road, or by boat, from Phuket (Sayer, 1981). However, accommodation is available for more than 100 people (Kasetsart University, 1987). Tourist boats offer 3-4 hour trips to Tham Lot, Khao, Phingkan and Ko Panyi, visiting limestone caves (Dobias, 1982). Interpretation material appears limited to information signs (Kasetsart University, 1987).

**LOCAL ADMINISTRATION** Headquarters is near Ban Chap Phrae at the extreme north end of the park, 96km on a paved road from Phuket, and considerably less by boat.

**SCIENTIFIC RESEARCH AND FACILITIES** The avifauna has not been studied in detail (Round, 1985), although the Park is described in Dobias (1982) and Sayer (1981).

**CONSERVATION MANAGEMENT** The Park headquarters are near Ban Chap Phrae at the extreme north of the Park. There are no details concerning management activities, although a system of zonation and regulation of exploitation has been recommended (Sayer, 1981). A management plan is scheduled for preparation in 1990 (Kasetsart University, 1987).

**MANAGEMENT PROBLEMS** There is little control of access into the Park, nor of the people who live inside the park (Sayer, 1981). Tin dredging used to be carried out, but is no longer an important activity. However, mine tailings are still washed into the Park (UNEP/IUCN, 1987). Local fishing is not considered deleterious. There is a lack of freshwater in the Park (Sayer, 1981).

**STAFF** One technical officer, two forest technicians, three other permanent workers and 35 seasonal workers (Kasetsart University, 1987).

**BUDGET** 862,000 baht in 1986, excluding allocations for construction materials and durables (Kasetsart University, 1987).

**LOCAL ADMINISTRATION** No information

**REFERENCES**


Dobias, J. (1982). The Shell Guide to the national parks of Thailand. The Shell Company of Thailand Limited. Bangkok. 137 pp.

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MacKinnon, J. and MacKinnon, K. (1987). Review of the protected areas systems in the Indomalayan Realm. IUCN, Cambridge.

Round, P. (1985). Status and conservation of resident forest birds in Thailand. Association for the Conservation of Wildlife. Bangkok. 143 pp.

Sayer, J.A. (1981). A Review of the Nature Conservation and policies of the Royal Forest Department, Thailand. FAO, Rome.


**DATE** June 1987

**NAME** Hat Nai Yang National Park

**MANAGEMENT CATEGORY** II (National Park)

**BIOGEOGRAPHICAL PROVINCE** 4.05.01 (Indochinese Rainforest)

**GEOGRAPHICAL LOCATION** Situated on the north-west coast of Phuket Island, facing the Andaman Sea and in Phuket Province. Phuket International Airport adjoins the Park boundary and the major access route is via the Phuket to Phangnga road. The boundary encompasses

hills to the south, a 10km stretch of beach to the north and extends between 1.5km and 3km offshore. The nearest major town is Phuket, 32km to the south-east. 8°02'-8°12'N, 98°14'-98°20'E

**DATE AND HISTORY OF ESTABLISHMENT** 13 July 1981

**AREA** 9,000ha, comprising 2,200ha terrestrial and 6,800ha marine.

**LAND TENURE** Government

**ALTITUDE** Ranges from marine areas to 335m.

**PHYSICAL FEATURES** Comprises 13km of coastline, with a narrow strip of beach to the north and coastal hills and rocky headlands to the south. The bulk of the park is the marine inshore area which includes 3-4 small islands and largely undisturbed corals some 1.4km offshore (Dobias, 1982; Sayer, 1981).

**CLIMATE** The Park is exposed to the May to October south-west monsoon with rough seas and a mean monthly of 23 wet days during the monsoon. The mean annual temperature is 28°C with a hot season from February to May and a cool season from September to December (Dobias, 1982).

**VEGETATION** The vegetation has been greatly modified, although remnants of coastal forest and mangrove are found. The beach area is open with some *Casuarina* sp., *Terminalia catappa* and *Barringtonia* sp. The forest on hills to the south is secondary, having been subject to clearance for maize, bananas and rubber cultivation (Sayer, 1981).

**FAUNA** The major points of interest are the coral formations and local nesting turtles. More than 200 coral species have been recorded in the Phuket area and the formations in the park are largely undisturbed; an account is given in UNEP/IUCN (1987). The park is an important nesting area for leatherback turtle *Dermochelys coriacea* (E) and Olive Ridley *Lepidochelys olivacea* (E), hawksbill turtle *Eretmochelys imbricata* (E) and green turtle *Chelonia mydas* (E) also occur. An estimated 15,000 eggs are laid on the beach annually during the November to February nesting season (Dobias, 1982). The park supports some common bird and small mammal species, but it does not have conservation importance on this account (Round, 1985; Sayer, 1981).

**CULTURAL HERITAGE** No information

**LOCAL HUMAN POPULATION** Although there appear to be no permanent residents within the park, the island is generally heavily settled.

**VISITORS AND VISITOR FACILITIES** Some 20,000 people annually visit the Park, frequently from a number of holiday resorts adjacent to the southern boundary, to use the beach. However, it seems likely that many visitors are unaware that they are entering a protected area (Paine, 1987). Accommodation facilities include bungalows for up to 150 people with tents available for a further 90 people. Other services include a visitor center, souvenir shop, information signs and a catering facilities (Kasetsart University, 1987).

**SCIENTIFIC RESEARCH AND FACILITIES** The corals of Phuket Island are the best studied in Thailand, due to the presence of the Phuket Marine Biological Centre on the Laem Phan Wa peninsular. The results of numerous studies, several of which include work within the park are published in the Phuket Marine Biological Centre Research Bulletin. An account of ongoing studies is given in UNEP/IUCN (1987).

**CONSERVATION MANAGEMENT** It is not known if the National Parks Act (1961) specifically protects marine resources. However, the presence of a police station overlooking the best coral flats has deterred dynamite fishing. The park is valued for its corals, breeding turtle populations and for recreation on an island that is a major domestic and international tourist destination. An indeterminate number of turtle eggs are collected by park staff, taken to Phuket Marine Biological Centre in the south of the island for hatching and then subsequently returned to the park for release in an annual ceremony held on 13 April. A total of some 3,000 individuals are released, although figures of egg and hatching mortality are unknown.

Furthermore, it is not known whether this practice is beneficial or detrimental to the local breeding population (Paine, 1987).

**MANAGEMENT PROBLEMS** Phuket Island is heavily developed with a major tourist industry which inevitably threatens the integrity of the park (Sayer, 1981). Local tin dredging has caused extensive resuspension of sediment to the detriment of corals. Crown of thorns starfish *Acanthaster planci* became common on the reefs of the west coast of Phuket in 1983 although it is not known if the park itself was affected (UNEP/IUCN, 1987). The park has no guard stations or boats (Kasetsart University, 1987).

**STAFF** Includes three technical officers, three guards end up to 40 seasonally employed workers.

**BUDGET** 557,000 baht (US$ 12,800) in 1986. This does not include allocations for construction materials and durables (Kasetsart University, 1987). The budget is supplemented by a further 200,000 baht (US$ 7,300) income from tourism (Paine, 1987).

**LOCAL ADMINISTRATION** No information

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**DATE** June 1987

**NAME** Mu Ko Similan National Park

**MANAGEMENT CATEGORY** II (National Park)

**BIOGEOGRAPHICAL PROVINCE** 4.05.01 (Indochinese Rainforest)

**GEOGRAPHICAL LOCATION** Situated in the Andaman Sea in Phangnga Province, 60km from the nearest mainland and about 110km north of Phuket town. 8°28'-8°41'N, 97°39'-97°41'E

**DATE AND HISTORY OF ESTABLISHMENT** 1 September 1982

**AREA** 12,800ha, comprising a 1,400ha terrestrial component and an 11,400ha marine component (Kasetsart University, 1987).

**LAND TENURE** Government

**ALTITUDE** Water depths of 30-60m can be found inshore whilst the maximum elevation is attained on Ko Similan at 244m. Maximum elevations on Ko Paya, Ko Miang, Ko Payang, and Ko Huyong are 199m, 145m, 130m and 170m, respectively.

**PHYSICAL FEATURES** The park encompasses six small islands and several small islets and semi-submerged rocks. The islands comprise coarse-grained crystalline rocks and lie on a north-south axis, with the highest in the north. There are some sandy beaches to the north and east of some islands and occasionally limited, shallow reef flats. Fresh water is only available intermittently (Sayer, 1981).

**CLIMATE** The climate on the nearest mainland is characterised by a mean annual rainfall of

3000-4000mm and a mean annual temperature of 27-28°C (Lekagul and McNeely, 1977).
**VEGETATION** Semi-evergreen rain forest, poor in species and with few large trees, covers most of the islands. This is probably a natural condition resulting from isolation, exposure and water stress towards the end of the dry season. *Dipterocarpus costatus* is common and is the only dipterocarp present,. The only palms are rattans which have been harvested in some areas. The beach forest canopy is undisturbed and comprises *Barringtonia asiatica*, *Terminalia catappa* and *Cordia subcordata*. These support luxuriant growths of the epiphytes *Drynaria* spp. and *Pyrrosia* spp., *Pandanus* sp., *Crinum* sp., *Ficus microsperma* and *Eugenia grandis* also occur in this zone (Sayer, 1981).
**FAUNA** The islands are very poor in terrestrial species, and no large land mammals have been recorded. The bird fauna is typical of small islands in the region with almost no resident forest species and few coastal birds. The pied imperial pigeon *Ducula bicolor* is very common and the green imperial *Duculea aenea* somewhat less so (Sayer, 1981). The Nicobar pigeon *Caloenas nicobarica* also occurs (P.D. Round, pers. comm.). By contrast the marine fauna is very rich and includes cetaceans. Marine turtles including the leatherback *Dermochelys coriacea* (E) nest on the islands. Little is known of the numbers of the different species but it seems likely that the park is one of the most important nesting areas in Thailand. Fish populations in the park are reported to be denser, more diverse and comprise larger individuals than those found in similar habitats elsewhere in the Andaman sea. This is attributed to the close proximity of deep water and possible local upwelling of cool, nutrient-rich waters. The coral reefs are not extensive but are rich in species (Sayer, 1981). Details are given in UNEP/IUCN (1987).
**CULTURAL HERITAGE** Chao Lay marine gypsies have exploited the park area in the past, gathering molluscs, including giant clams (Sayer, 1981).
**LOCAL HUMAN POPULATION** No information
**VISITORS AND VISITOR FACILITIES** Accommodation facilities are restricted to small, rented tents for some 100 people, and camping grounds. Other services, some operated by private concessions, include catering facilities, a general store, visitor centre, nature trails and information signs (Kasetsart University, 1987).
**SCIENTIFIC RESEARCH AND FACILITIES** The islands have been visited by staff of the Phuket Marine Biological Centre and a Thai-Danish expedition visited the islands briefly in about 1975 (Sayer, 1981).
**CONSERVATION MANAGEMENT** The principal values of the park are nesting marine turtles, coral reefs and potential tourist development (Sayer, 1981). Furthermore, the site is important for the conservation of the Nicobar pigeon Caloenas nicobarica (P.D. Round, pers. comm.). There are no guard stations (Kasetsart University, 1987). A number of management recommendations are made in Sayer (1981).
**MANAGEMENT PROBLEMS** In the mid 1980s, crown of thorns starfish *Acanthaster planci* population was low although significant coral damage was recorded in protected coves on west coasts (UNEP/IUCN, 1987). Some coral reefs have been damaged by dynamite fishing but this is not extensive (Sayer, 1981).
**STAFF** Consists of a single forest technician, five part-time forest patrol staff and up to 15 seasonal workers (Kasetsart University, 1987).
**BUDGET** 413,000 baht (US$15,000) in 1986, excluding allocations for construction materials and durables (Kasetsart University, 1987).
**LOCAL ADMINISTRATION** No information
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DATE August 1987

NAME Mu Ko Surin National Park
MANAGEMENT CATEGORY II (National Park)
BIOGEOGRAPHICAL PROVINCE 4.05.01 (Indochinese Rainforest)
GEOGRAPHICAL LOCATION Lies in the Adaman Sea, 53km off the west coast of peninsular Thailand in Ranong Province. 9°23'-9°29'N, 97°50'-97°55'E
DATE ESTABLISHED 9 July 1981
AREA 13,500ha, consisting of a 3,300ha terrestrial component and a 10,200ha marine component (Kasetsart University, 1987).
LAND TENURE Government
ALTITUDE Ranges from sea level to 350m on Ko Surin Tai and about 240m in Ko Surin Nua (Brockelman and Nadee, 1977).
PHYSICAL FEATURES The park includes two larger, granitic islands, Ko Surin Nua and Ko Surin Tai, or North Surin Island and South Surin Island, and two rocky islets. Lying within the 50 fathom depth line, the islands were connected to the Sunda Shelf land mass during the most recent Pleistocene glaciation and are currently separated by a shallow strait about 200m wide.
The shorelines of the north and south islands, measuring 36.9km and 23km respectively, are highly irregular and feature numerous isolated coves, separated by ridges up to 100m in elevation, and peninsulars. Sandy beaches above the high tide mark are confined to coves whilst the remaining shoreline comprises granite. Level terrain is restricted to the cove areas. At least 30 perennial springs are found on the two islands, located at the bases of ravines and small brooks descend through the lower reaches of larger valleys (Brockelman and Nadee, 1977).
CLIMATE The west coast of the mainland at its closest proximity receives a mean annual rainfall in excess of 4000mm and has a mean annual temperature of between 27°C and 28°C (Lekagul and McNeely, 1977).
VEGETATION Vegetation can be classified into four types, comparable to similar formations on the mainland. Tropical rainforest forms the main cover on steeper slopes and ridges and is typically three-storied, with three speciation zones on the lower, middle and upper ridges. The lower zone is found between 10m and 100m elevation, on steep slopes with granitic boulders, with a continuous canopy of sterculiaceous trees, such as *Pterocymbium tinctorium* and *Pterygota alata* some 25-35m high. The middle storey forms a broken canopy at about 20m and a very dense lower storey attains 10-15m. Creepers, rattans, bamboo entangle the lowest storey and a sparse herbaceous ground flora occurs. The middle zone rainforest occurs from 100-160m on lower ridges and gentle slopes with an anacardiaceous top storey at 25-35m dominated by *Parishia insignis, Swintonia griffithii* and *Dracontomelum mangiferum* with *Dipterocarpus grandiflorus, Vatica cinera* and *Endospermum diadenum* in association. The middle storey attains 15-20m, the lowest storey 8-12m. Numerous shrubs such as *Lasianthus andamanicus, Rinorea homeri, Microtropis* sp. and *Glycosmis* spp. occur along with a limited number of palms. Climbers, bamboo, creepers, undershrubs and herbaceous species

are also present. The upper forest zone at 160-250m is a primeval, dense formation with a continuous crown canopy up to 30m high. Dipterocarpaceous tree species such as *Anisoptera oblonga*, *Dipterocarpus grandiflorus*, *D. costatus* and *Vatica cinera*, together with *D. mangiferum*, *Swintonia griffithii*, *Parishia insignis* and *E. diadenum*. The two lower stories attain 15-20m and 7-15m, respectively. Shrub species are well represented along with undershrubs, ferns, palms and herbaceous species; climbers are sparsely distributed (Smitinand, 1977). Isolated coves contain the greatest variety of habitats, such as small freshwater marshes and swamps, beach vegetation, a variety of secondary formations and some parches of mangrove (Brockelman and Nadee, 1977). Along sandy beaches a strand flora that includes *Hernandia nymphaefoliae*, *Calophyllum inophyllum*, *Cerbera odollam*, *Casuarina equistetifolia*, *Barringtonia asiatica* and others occurs. On raised beaches some 2m above the high tide level and behind the strand and mangrove forests, a dense stand of two-storied forest occurs. The upper storey at 20-25m height includes *Adenanthera microsperma*, *Artocarpus rigidus*, *V. cinerea*, *Hopea odorata* and others. Climbers, frequent palms and epiphytes are found. Exposed, rocky headlands support a stunted formation of trees and shrubs with *Atalantia monosperma*, *Cratoxylum formosum*, *Ochna integerrima*, *Memecylon plebejum*, *Grewia umbellata* and *Scolopia spinosa* being common. Narrow strips of poor mangrove forest covering about 6ha exist in sandy or muddy shores and estuaries although the typical mainland formations are largely absent. Characteristic species are *Rhizophora apiculata*, *R. mucronata*, *Bruguiera gymnorhiza*, *Xylocarpus granatum* and *Sonneratia griffithii*. A number of epiphytic ferns and orchids thrive on mangrove trees. Logging operations and storm damage has lead to limited areas of secondary formation, covering 10-20% of the forest area and comprising *Macarang tanarius*, *Mallotus dispar*, *Canthium umbellatum*, *Cratoxylon formosum* and others. The remaining two islets are largely rocky and support only a sparse vegetation (Smitinand, 1977). A vegetation description and species list is given in Smitinand (1977).

**FAUNA** Faunal communities are similar to those found in Tarutao and Mu Ko Similan national parks. Noteworthy mammals include pig-tailed macaque *Macaca nemestrina*, flying lemur *Cynocephalus variegatus* and mouse deer *Tragulus* sp. Reptiles include python *Python reticulatus*, monitor lizard *Varanus salvator* and one or two turtle species including olive Ridley turtle *Lepidochelys coriacea* (E) (Brockelman, 1977). A preliminary survey of birds indicate the presence of at least 54 land and freshwater residents including pied imperial pigeon *Ducula bicolor*, green imperial pigeon *D. aenea*, Nicobar pigeon *Caloenus nicobarica*, wreathed hornbill *Rhyticeros undulatus* and ruddy kingfisher *Halcyon coromanda* (Brockelman and Nadee, 1977; Round, 1985). A partial, annotated species list is given in Brockelman and Nadee (1977).

**CULTURAL HERITAGE** No information

**LOCAL HUMAN POPULATION** The islands are unpopulated although small shelters in some coves indicate that fishermen are probably occasional temporary residents (Brockelman and Nadee, 1977).

**VISITORS AND VISITOR FACILITIES** Accommodation facilities include dormitories and small, rented tents for 90 and 100 people, respectively. Other services include a general store, catering facilities and information signs (Kasetsart University, 1987).

**SCIENTIFIC RESEARCH AND FACILITIES** A preliminary survey and biogeographic analysis of birds (Brockelman and Nadee, 1977) and a preliminary vegetation study (Smitinand, 1977) were carried out in 1977. Freshwater algae are described by Buri (1977) and a brief coral reef description is given by Kohn (1971).

**CONSERVATION MANAGEMENT** The principal conservation values of the islands, in addition to their natural beauty, are an unusual terrestrial fauna, coral reefs, as a site for research into island community dynamics, a turtle breeding ground and as a potential control area for

pollution studies (Brockelman, 1977). The islands are identified as a key site for forest bird conservation (Round, 1985). There is one guard station and staff have access to four motor boats (Kasetsart University, 1987).

**MANAGEMENT PROBLEMS** The islands have been subjected to some selective logging, with yang *Dipterocarpus* spp. and Takhian *Hopea* spp. mainly being taken. Dynamite fishing has occurred (Brockelman, 1977; Smitinand, 1977).

**STAFF** Comprise a single forest technician and up to 20 seasonal workers (Kasetsart University, 1987).

**BUDGET** 413,000 baht (US$15,000) in 1986, excluding allocations for building materials and durables (Kasetsart University, 1987).

**LOCAL ADMINISTRATION** No information

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**DATE** August 1987

**NAME** Tarutao National Park

**IUCN MANAGEMENT CATEGORY** II (National Park); ASEAN Heritage Park

**BIOGEOGRAPHICAL PROVINCE** 4.07.01 (Malayan Rainforest)

**GEOGRAPHICAL LOCATION** Lies off the extreme south-west coast of peninsular Thailand in the Straits of Malacca of the Andaman Sea at Tambon Ko Sarai, Amphoe, Satun Province. Ko Tarutao, the main island, is situated about 22km south-west of the mainland town of Pak Bara, Amphoe Langu. The park boundary extends 68km from east to west and 34km from north to south and encompasses 51 islands. The international border with Malaysia is contiguous to the south-east boundary. 6°30'-6°44'N, 99°09'-99°44'E

**DATE AND HISTORY OF ESTABLISHMENT** 6 April 1974

**AREA** 149,000ha. Comprises a marine component (approximately 126,400ha) and a terrestrial component with five main islands, viz. Ko Tarutao (15,100ha), Ko Ko Rawi

(3,100ha) and Ko Adang (3,000ha), Ko Lipe (400ha) and Ko Klang (300ha)

**LAND TENURE** Government. At present there are 10 disputed land title claims under investigation (NPD, 1990).

**ALTITUDE** Sea level to 721m on Tarutao. Adang and Rawi attain 703m and 463m, respectively.

**PHYSICAL FEATURES** The park includes 51 islands and rocky outcrops of the Sunda Shelf which were separated from the mainland about 7,000 years ago. The major islands include Ko Tarutao, Ko Adang, Ko Rawi, Ko Lipe, Ko Klang, Ko Batong and Ko Bissi, forming two major island groups: Mu Ko Tarutao and Mu Ko Adang-Rawi to the west. Sea water tends to be turbid around Ko Tarutao, but of much higher quality around Mu Ko Adang-Rawi, and shorelines vary from sandy beaches, rock beaches, mud beaches, cliffs, sunken estuaries with mangroves to landward reef flats and seaward reef slopes with a narrow, intervening reef edge. Water depth increases rapidly in places, whilst in others, coral gardens have formed in shallows between islands (UNEP/IUCN, 1987; Anon., 1985). Tarutao Island measures 26km by 11km in length and breadth and is dominated by north-south oriented hills, frequently attaining 600m, with intervening perennial stream valleys. The west coast is characterised by extensive sandy beaches, mangroves and densely forested hillsides descending directly to the sea. The east coast features limestone cliffs and small islands. Approximately 65% of the island comprises Cambrian sandstone and siltstone of the Tarutao Formation, whilst lower Ordovician limestone of the Thung Song Formation dominates the north and east. Quarternary alluvia fill the broad valleys behind Chak, Son and Talo Udang bays, where a number of small streams enter the sea. Limestone caves are found to the north, and islets to the south and east consist of sheer pinnacles and vertical cliffs descending into the sea. Adang and Rawi, located about 45km west of Tarutao are geologically distinct and comprise Triassic granite with a small amount of Quarternary alluvia. Of the two islands, Rawi is the less hilly, possessing some flat terrain and a number of gently sloping hills. Deep, fertile soils occur on gentle slopes and lowlands of the three largest islands (Congdon, 1982).

**CLIMATE** The climate is dominated by the May to October south-west monsoon, during which strong winds and heavy seas occur. The September to June north-east monsoon causes short, sharp seas which can prohibit access to easterly coasts; violent storms are rare but may arise at any time of the year. Climate data for the period 1978-87, measured at Satun, indicate a mean annual temperature of 32.4°C, rising to a maximum of 37.7°C and falling to a minimum of 23.7°C. Mean annual precipitation was 2208mm, with a distinct dry season from December to March (NPD, 1990).

**VEGETATION** Ko Tarutao supports six forest types, namely moist evergreen forest, dry evergreen forest, mixed deciduous forest, mangrove forest, secondary forest and beach forest (NPD, 1990). The predominant formation, covering some 67% of Tarutao and 80-90% of Adang and Rawi, is forest that has structural and floristic affinities with Thailand rather than Malaysia. Canopy species, reaching 30-40m, with emergents at 40-45m, include members of the Anacardiaceae, Dipterocarpaceae, Leguminosae, Meliaceae and Sterculiaceae. Small trees form a second story at 15-20m and include Anacardiaceae, Annonaceae, Ebenaceae, Euphorbiaceae, Guttiferae and Myrisiticaeceae. A third storey of small trees, saplings and shrubs is present, and a sparse herbaceous layer that includes few grasses. Abundant and conspicious *Aglaonema simplex* is found along streambeds and ferns *Angiopteris evecta* and *Cephalomanes javanicum* are common. Other groups in the rainforest formation include palms, woody climbers, vines, climbing shrubs and epiphytes. On dry and rocky hillsides the forest is lower and *Hopea ferrea* and *Vatica cinerea* tend to replace the other dipterocarps. Larger lowland tree species are usually restricted to below 200m. From 550m to 700m, climbers, spiny palms and small trees become very dense and a scrub and heath flora develops on open rocky areas. Congdon (1982) identifies nine other distinct formations and

estimates of cover by the variuos formations on Ko Tarutao, Ko Adang and Ko Rawi are given in NPD (1990). Mangrove and brackish-water forest cover 3.5% of the park, mostly around Ko Tarutao, Ao Talo Lingai, Ao Talo Udang and Ao Talo Wao (NPD, 1990). Mangrovres on Tarutao feature *Rhizophora* sp., in particular *R. apiculata* and *R. mucronata*, *Bruguiera* sp., *Ceriops* sp. and *Sonneratia* sp., sometimes in pure stands. Freshwater swamp occurs in very limited areas along flat streambeds, dominated by the spiny palm *Salacca conferta* on Tarutao and *Barringtonia acutangula spicata* on Rawi. Freshwater marsh is found at Talo Udang Bay where perennial springs moisten the soil and sedges, ferns and herbaceous species occur. A Pes-caprae formation is found on sandy shores just above the high water mark and features creeping, herbaceous species adapted to growing across, and rooting, in sand. The dominant species is *Ipomea pes-caprae*, in addition to *Canavalia* spp., *Cassytha filiformis*, *Cyperus* spp. and others. The woody vegetation behind the beaches and along rocky shores is very uniform with large, dominant *Barringtonia asiatica*, *Calophyllum inophyllum* and *Terminalia cattappa*. Coastal heath forest, at up to 6m height, occurs in small areas at Phante and Son Bays and elsewhere on old beaches which are now 1-2m above the highest tides. *Melaleuca cajuputi* is the dominant tree with abundant *Eugenia spicata*. The limestone of north and east Tarutao and offshore islands supports a very distinctive vegetation. Exposed, rocky areas, for example in northern Tarutao, with little or no soil, support stunted, thorny vegetation with few herbaceous species and no large trees. However, where soil and moisture is more plentiful a tall forest up to 25m in height occurs, typically with *H. ferrea*, *Pentaspadon curtisii*, *Sapium insigne* and *Terminalia triptera*. Scrub forest has developed in exposed sites, with shrubs, bamboo and a limited number of scattered trees closely following the land contours. Secondary vegetation covers approximately 10% of Tarutao Island in areas previously logged, cultivated or disturbed in some manner. All sites have been abandoned since 1976 and *Negrandia reynaudiana* and *Imperata cylindrica* occur in pure stands. However, most formerly cultivated areas support a typical secondary forest of fast-growing, light-demanding trees (Congdon, 1982). A list of 869 vascular species and a vegetation description is given in Congdon (1982).

**FAUNA** Only a limited diversity of terrestrial vertebrates occurs in the park. Larger mammals include dusky langur *Presbytis obscura*, crab-eating macaque *Macaca fascicularis*, wild boar *Sus scrofa* , mouse deer *Tragulus javanicus*, and possibly fishing cat *Felis riverrinus*. Dolphin *Delphinus delphis*, Malayan dolphin *Stenella malayana*, Irrawaddy dolphin *Orcaella brevirostris*, Sotalia dolphins, dugong *Dugong dugon* (V), sperm whale *Physeter catodon* and minke whale *Balaenoptera acutorostrata* occur (NPD, 1990. Feral water buffalo and cattle are both found on Tarutao, whilst the latter also occurs on Adang. Domestic goats and a limited number of stump-tailed macaques are kept by sea gypsies.

The bird community is largely restricted to species associated with secondary vegetation, mangrove, coastal or marine habitat. Pied imperial pigeon *Ducula bicolor* is quite common on the outer islands and pale-capped pigeon *Columba punicea* may occur (P.D. Round, pers. comm.). Hornbill species include *Rhyticeros undulatus*, *Buceros bicornis* and others. Coastal birds include reef heron *Egretta sacra* and white-bellied sea-eagle *Haliaeetus leucogaster*, and less frequently frigate bird *Fregata* sp., dusky grey heron *Ardea sumatrana* and masked finfoot *Heliopais personata*. Other species include green imperial pigeon *Ducula aenea*, brown-winged kingfisher *Pelargopsis amauroptera*, ruddy kingfisher *Halcyon coromanda*, blue-winged pitta *Pitta megarhyncha* and possibly ashy wood-pigeon *Columba pulchricollis* (Round, 1985). A partial species list is given in Round (1985).

Reptiles include green turtle *Chelonia mydas* (E), Pacific Ridley *Lepidochelys olivacea* (E) and Pacific hawksbill *Eretmochelys imbricata* (E). Pacific Ridley turtles begin nesting in early November and are restricted to the west coast of Tarutao whilst the earlier nesting green turtles use several islands. Hawksbill nesting sites are limited to Rawi and Adang. Surveys

of nesting females indicate that populations have declined since the park was esatblished (Dobias, 1982), whilst the relatively large size of adults suggest very low recruitment levels (Ginsberg, 1981). Fifty-seven butterfly species have been identified (WWF/IUCN, 1982b). Over 130 fish species have been recorded in the coral reefs of Adang, Hin Nagram and Chabang islands including 20 species of Pomacentridae, 13 species of Labridae, 12 species of Chaetodontidae and six species of Scaridae. Reef invertebrates include polyclad, nudibranch, chiton, bivalve, gastropod, crustacean, sea urchin, brittle star, sea lily, peanut worm and polychaete representatives (WWF, 1983). Recent studies have identified 140 coral species in the Adang-Rawi group (UNEP/IUCN, 1987) whilst 205 species have been listed for the whole park (Tantichdok, 1986).

Studies in 1988 (NPD, 1990) indicated that reefs remain around Ko Tarutao; a small reef occurs at the north-east corner of the island. Most reefs occur in the Mu Ko Adang-Rawi and Ko Khai area. The condition of these reefs is variable and is summarised as follows. Reefs south of Ko Adang at Laem Son; north-east of Ko Lipe; and reefs south of Ko Rawi have been completely destroyed, due to dynamiting, corwn-of-thorns starfish infestation and monsoon storms. Reefs south east of Ko Adang and at Ao Talo Ripa have been extensively degraded by dynamiting and crown-of-thorns starfish infestation, but are still of ecological value and could recover if given adequate protection. Reefs around Ko Kata, north of Ko Hin Ngam, north-west of Ko Rawi, and Ko Adang, and to the north-west and south of Ko Lipe are mostly in good condition with more than 50% cover. Soft coral in deep water east of Ko Chabang are little disturbed. In total, more than half of reefs surveyed were classified as either heavily degraded or destroyed beyond reasonable hope of recovery (NPD, 1990).

**CULTURAL HERITAGE** The park area has been inhabited for many generations by proto-Malay Moken sea gypsies (Alexander, 1983; Sayer, 1981). A prison was operated on Tala Oudang and Tala Wao in the south of Tarutao until 1947 and numerous artefacts remain from this period (Sayer, 1981).

**LOCAL HUMAN POPULATION** Ko Adang and Ko Lipe are inhabited by some 627 Moken, who have annual population increase of 3.7%. The Moken have their own language and customs and support themselves through fishing and collecting coral and reef fish. They also exploit some terrestrial resources, such as timber, and there is a permanent settlement on Ko Lipe. A further 23,185 people living on the mainland exploit the park's fisheries resources (NPD, 1990).

**VISITORS AND VISITOR FACILITIES** Access to the park and its interior is by boat from the coastal village of Pak Bara or Satun on the mainland (Dobias, 1982). There are 30km of paved roads on Tarutao Island (ASEAN, 1983). Bungalow and dormitory accommodation is available for over 200 people, in addition to rented tents and camping grounds (Kasetsart University, 1987). Accommodation for 80 people is available on Adang. Visitor centres are located at Pak Bara and at the park office on Tarutao, and nature trails, information signs and interpretive programmes and catering facilities are provided. The principal visitor attractions are the large beaches on Tarutao and the extensive coral reefs around Adang and other islands (Dobias, 1982). The number of visitors is small in relation to those who visit the general area as tourists. Thus in 1987 only 18,195 visits were made, roughly 2% of those who visited the Hat Yai area, although this was a significant increase over the 5,743 in 1982. Overseas visitors accounted for just 5% of the total, and Thai nationals from Bangkok made up the bulk of the visitors. Visitors during 1990 numbered 10,140 (S. Wongpakdee, pers. comm., 1991). Annual visitation is expected to increase to 45,000 in 1992 (NPD, 1990)

**SCIENTIFIC RESEARCH AND FACILITIES** Congdon (1982) describes the park vegetation and enumerates 869 vascular plant species; a bibliography is given. Turtle studies were carried out in 1980-1981 (Ginsberg, 1981; WWF/IUCN, 1982). The WWF/IUCN project 1816 was initiated in 1982 with the objectives of: conserving terrestrial and marine resources, with an

emphasis on the controlled development and protection of habitats critical to the survival of endangered species, notably sea turtles and coral reefs; formulating a reef management plan; and promoting public awarenass (WWF, 1982a, 1982b). A partial inventory of the bird community has been compiled (Round, 1985). Inventories of fish and marine invertebrates, investigations of zonation and mangrove productivity studies have been made (WWF/IUCN, 1982a). Further studies of marina fauna, the impact of dynamite fishing and the rate of reef recovery have also been made (UNEP/IUCN, 1987). A popular account of the park is given in Dobias (1982).

**CONSERVATION VALUE** Principal conservation values of the park include nesting turtles (Sayer, 1981), relatively undisturbed rain forest, coral reefs and recreation (Congdon, 1982; Dobias, 1982). The park has been assessed by Round (1988) to be a key site for the conservation of forest birds in Thailand.

**CONSERVATION MANAGEMENT** A management plan has been prepared (NPD, 1990), which five objectives. First, to preserve and protect natural and cultural resources as sites for general nature study and education, and as important components in local and regional socio-economic development. Second, to promote and support recreation and tourism develoment that is in harmony with the parks's natural systems and environment. Third, to promote and support public education programmes that will build awareness and understande of the coastal environment and of the parks's importance to local and regional communities. Fourth, to promote and support significant distribution of direct and indirect benefits from park authorities to local people. Five, to make opportunities available for local people, the provincial government, and other concerned government agencies to participate in park management in order to enhance local and regional benefits. Major goals are enhanced conservation and sustained utilisation of park resources, espacially those resources that support the region's tourism and fishing industries. To achieve these recommendations, the management plan presents a schedule of recommended actions for the implementation over five years (1990-1994), with an emphasis on increased park management by local government officials, local residents, and the private sector. The plan also defines a number of specific managment :objectives and activites covering coastal resourcs, tourism, socio-economic factors, administration and zoning.

The park has four administrative sections, viz. administration, law enforcement, park management and maintenance and accommodation. The headquarters are at Khlong Pante Malaka, with outstations at Talo Wao and Tala Oudang Bays and Adang and Rawi islands. Commercial fishing is permitted within 1km of Tarutao Island, in contrast to the prevailing national 3km limit. Moken sea gypsies are officially tolerated (Alexander, 1983) although several large villages on Tarutao were relocated during 1974 to 1977 (Sayer, 1981). Zonation includes the marking of reefs around Talo-Ayang on Adang Island and those around Hin Ngarm Island for visitor use, whilst others are reserved for research (WWF/IUCN, 1982a). Management activities include law enforcement and the preparation and national disemination of monthly information pamphlets. A turtle hatching and head-starting programme operates at the park headquarters (Dobias, 1982; Ginsberg, 1981). Attempts have been made to provide Moken with official employment within the park (Alexander, 1983).

**MANAGEMENT CONSTRAINTS** Significant management issues are dynamite fishing and channel digging in reefs by the Moken; reef damage by tour boat anchors and indiscriminate refuse disposal; and natural causes such as crown-of-thorns starfish predation which have all combined to severely degrade the reef resources. Water quality in the vicinity of the headquarters and major tourist developments is poor, indicative of uncontrolled waste disposal. Spawning grounds are under threat from illegal trawling, whilst reef fish are illegally and in some case excessively, collected at Mu Ko Adang-Rawi for the international tropical fish trade. Although forest cover is extensive there is concern over felling both of upland

communities and mangroves. Nesting turtles have declined by 90% in six years through egg collection and the impact of trawling. Edible-nest swiflet nests are collected under permit, although there is no understanding of how this will affect the staus of the speceis. Tourist servcies provided by the park are seen as inadequate, and, as an example, many tour boats do meet minimum safety requirements. The disbursement of socio-economic burdens to local communities, especially the Moken, is poor, largrly due to the presence of private sector monopolies dominating the tourist industry and the Moken fishinh activities. Local people are not generally aware of park regulations, and in 1988 three staff were killed during a dispute with fishermen. Policy and managment strategies are generally lacking, and the National Park Act is especially weak in the case of marine areas. There are also shortcomings in the administrative structure in the park, the number of personnel, budget, coordination between the park authorities and other private and public sector bodies (NPD, 1990).

In 1987 the park was temporarily closed for military manoeuvres (B. Saisorn, pers. comm.). There is a considerable level of illegal commercial fishing activity in the park, with up to 700 people employed (NPD, 1990).

**STAFF** Comprised 2 technical officers, 2 forest technicians, 16 guards, 7 other workers, and up to 54 other staff in 1988 (NPD, 1990). Staff during 1991 included 1 chief, 3 subordinate officers, 13 permananent park guards and 127 temporary workers (S. Wongpakdee, pers. comm., 1991).

**BUDGET** 2,590,000 baht (US$ 94,000) in 1986, excluding allocations for construction materials and durables, increasing to 14,921,100 baht during 1987, which included 8,342,270 baht for tourism development, 2,494,000 baht in 1988, 3,143,000 baht in 1989 and 3,540,000 baht in 1990. Park income ranged from 1,006,575 in 1986 to 1,212,425 in 1988 (NPD, 1990). Fees from visitors during 1990 amounted 10 179,629 baht (S. Wongpakdee, pers. comm., 1991).

**LOCAL ADDRESSES** Tarutao National Park, Parkbara, Muang District Satul Province

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DATE August 1987, reviewed March 1991

NAME Hat Nopharat Thara - Mu Ko Phi Phi National Park
MANAGEMENT CATEGORY II (National Park)
BIOGEOGRAPHICAL PROVINCE 4.07.01 (Malayan Rainforest)
GEOGRAPHICAL LOCATION The marine and island component of the Phi Phi islands lies in the Andaman Sea off the south-west peninsular coast, some 40km south-west of Krabi and a similar distance south-east of Phuket Island. The terrestrial Hat Nopharat Thara component comprises a mainland coastal area and adjoining sea due west of Krabi, in Krabi Province.
Marine and island component: 7°39'-7°50'N, 98°45'-98°49'E
Coastal component : 7 55'-8°08'N, 98°45'-98°56'E
DATE AND HISTORY OF ESTABLISHMENT 6 October 1983
AREA 38,996ha. Comprises 32,900ha marine and 6,096ha coastal
LAND TENURE Government. Private enclaves are located on Phi Phi Don Island and along the western coast of the mainland component.
ALTITUDE No information
PHYSICAL FEATURES The park includes two limestone archipelagoes viz., the Poh Dah Group, some 1-2km south of Hat Nopharat Thara and the Phi Phi Group, approximately 8km further south. The former group can be reached on foot from the mainland during low tide (Anon., n.d.; Warren *et al.*, 1987). The latter group is dominated by the largely limestone Phi Phi Don to the north and the smaller Phi Phi Lae to the south. Both islands feature precipitous and heavily weathered cliffs. Phi Phi Don has a number of extensive sand beaches, inlets and areas of relatively level land; Phi Phi Lae has no level areas (Anon., n.d.; Paine, 1987). Vertical cliffs descend to 20-30m depth along most of Phi Phi Lae and around the southern part of Phi Phi Don (UNEP/IUCN, 1987). Mainland coastal features include extensive beds of fossilised molluscs accumulated during the Mesozoic eera, some 75 million years ago; Pra Nang Beach, composed of sand and sea shells; and Nopharat Thara Beach, which includes extensive beds of seashells (Anon., n.d.; Warren *et al.*, 1987).
CLIMATE The park is located in a region with a mean annual mainland temperature of 27-28°C. Mean annual rainfall around Krabi is 1400-2000mm and 3000-4000mm on Phuket Island (Lekagul and McNeely, 1977). Mean surface sea temperatures off south Phuket Island during 1979-80 fluctuated from 28.6°C in December and January to 30.2°C in June (Yesaki and Jantarapagdee, 1981).
VEGETATION Includes mangrove and beach formations (Kasetsart University, 1987). The vegetation on Phi Phi Don is well developed relative to the sparser formations on Phi Phi Lae. However, a number of areas on the northern island have been cleared for cultivation (Paine, 1987).
FAUNA Corals on the east of Phi Phi Don have 30-40% cover of alcyonaceaus, hard corals and sponges. Spiny lobster *Panulirus longipes* and *P. versicolor* are found (Bhatia, 1974). A number of caves on Phi Phi Lae house edible-nest swiftlets *Aerodramus* sp. (Anon., n.d.) although birds are not generally abundant (Paine, 1987).
CULTURAL HERITAGE The Viking Cave on Phi Phi Lae features ancient cave paintings depicting Viking long boats (Anon., n.d.)
LOCAL HUMAN POPULATION A community has been established on Phi Phi Don for several

decades (H. Chansang, pers. comm.). Principal livelihoods include agriculture, fishing and tourism (H. Chansang, pers. comm.; J.R. Paine, personal observation).

**VISITORS AND VISITOR FACILITIES** Access to the mainland component is via the Krabi to Nai Sra road and to the islands by boat from Chao Fah wharf on Phuket Island or from Krabi (Anon., n.d.). Accommodation includes bungalows for 50 people and small rented tents for 80 people (Kasetsart University, 1987). There are at least three resorts established on Phi Phi Don (H. Chansang, pers. comm.). The Pee Pee Island Village resort comprises some 50 chalets, a restaurant, diving equipment hire shop and other facilities (Paine, 1987). There is an official visitor centre (Kasetsart University, 1987).

**SCIENTIFIC RESEARCH AND FACILITIES** The reefs were surveyed in a Unesco assessment of coral reef survey methods (Unesco, 1984).

**CONSERVATION MANAGEMENT** The park is valued for tourism and the unusual fossil formations on the mainland (Anon., n.d.; H. Chansang, pers. comm.). Two enclaves have been established on Phi Phi Don for private settlements and one on the mainland (Anon., n.d.). There is at present little management activity (H. Chansang, pers comm.).

**MANAGEMENT PROBLEMS** There is some disturbed vegetation on the north island. Popular bays, such as May-Yah on Phi Phi Lae, attract large numbers of tourists with consequent damage to reef formations down to about 8m depth, with soft corals dominant in deeper water. Edible-nest swiftlet nests are collected by private concessionaires. Crown of thorns starfish *Acanthaster planci* is present in the southern bay of Phi Phi Don and in limited numbers in Ma-Yah Bay (Paine, 1987). Some dynamite fishing has occurred (H. Chansang, pers. comm.).

**STAFF** Two technical officers, one guard and up to 30 seasonal workers (Kasetsart University, 1987).

**BUDGET** 413,000 baht (US$15,000) in 1986, not including allocations for construction materials and durables (Kasetsart University, 1987).

**LOCAL ADMINISTRATION** No information

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**DATE** September 1987

## Other information concerning those sites without site sheets

Map number: not mapped here (no data available)
Name: Sibolangit
Area: 25ha
Designation: recreation park
Description: no information

Map number: Not mapped here (no data available)
Name: Pulau Berkeh
Area: 500ha
Designation: nature reserve
Description: island with casuarina and mangrove, important for bird life and local fisheries

Map number: 31
Name: Pulau Lembu, Kacha, Paya, Segatang
Area: 130ha
Designation: marine park
Description: no information

Map number: 32
Name: Pangkor (South)
Area: 104ha
Designation: virgin jungle reserve
Description: no information

Map number: 33
Name: Pulau Kechil
Area: 32ha
Designation: virgin jungle reserve
Description: mangroves

Map number: 34
Name: Segari Melintang
Area: 28ha
Designation: virgin jungle reserve
Description: beach forest

Map number: 35
Name: Pangkor (North)
Area: 78ha
Designation: virgin jungle reserve
Description: beach forest/strand vegetation

Map number: 36
Name: Tanjong Hantu
Area: 364ha
Designation: virgin jungle reserve

| | |
|---|---|
| Description: | beach forest/coastal heath forest |
| Map number: | 37 |
| Name: | Kuala Selangor |
| Area: | 44ha |
| Designation: | wildlife reserve |
| Description: | mangroves, commercially important shellfish |
| Map number: | 38 |
| Name: | Pulau Langkawi (around Langkawi islands) |
| Area: | 4000ha |
| Designation: | (Proposed) marine park |
| Description: | no information |

# Directory of National Parks and Sanctuaries in Andaman and Nicobar Islands

## MANAGEMENT STATUS AND PROFILES


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*Sponsored by the Wildlife Institute of India, Dehradun*

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NEW DELHI
1991

A&N/S/BAT

# BATTIMALV ISLAND SANCTUARY

**This island sanctuary has no human population, and is one of the last strongholds of the Nicobar pigeon. It is a small flat island with low vegetation, and coconut groves which are all bent to one side by centuries of forceful sea winds. The island was used by the Navy for shelling practice until the 1960's.**

**Remotely situated in the midst of rough seas, the island is not only difficult to approach but almost impossible to land on, as there are no beaches and inlets where ordinary craft can be used. Like all of Nicobar's sanctuaries, Battimalv has hardly been studied.**

LEGAL STATUS: Declared a sanctuary on January 1985 vide notification no. CF/WL/50—Vol.I [notif].

AREA: 223 ha. (2.23 sq. km) [notif]

LOCATION: *District* Nicobar; *Latitudinal Range* 08°48'45" to 08°50'29" N [Tp]; *Longitudinal Range* 92°50'12" to 92°51'11" E [Tp]; *Nearest Town* Car Nicobar (30 km); *Nearest Airport* Car Nicobar (30 km); *Helipad* Car Nicobar (30 km)

APPROACHES: From Port Blair by ship or air to Car Nicobar (282 km) and on to the sanctuary by ship (30 km) [fv & NA]. The island is not serviced by public ferry.

TOPOGRAPHY: *Altitude* 0 to 83 m [Tp]

FLORA: Forest types include Andaman Tropical Evergreen 1A/C2, Andaman Semi-Evergreen 2A/C1, Littoral Forest 4A/L1, Mangrove Forest (Tidal Swamp Forest) 4B/TS2 [QI, Chaudhuri 1987].

*Trees* [QI, Chaudhuri 1987]

| | |
|---|---|
| *Areca triandra* | *Manilkara littoralis* |
| *Barringtonia asiatica* | *Rhizophora mucronata* |
| *Canarium euphyllum* | *Pandanus spp.* |
| *Cocos nucifera* | *Pterygota alata* |
| *Hibiscus spp.* | *Terminalia catappa* |

*Other Vegetation* [QI, Chaudhuri 1987]

| | |
|---|---|
| *Calamus andamanicus* | *Calamus palustris* |

There is no information on threatened species of flora.

FAUNA:

*Mammals*

Boar, Indian Wild

*Birds* [QI, Tikader and Das 1985, Butler 1899, fv]

| | |
|---|---|
| Eagle, Whitebellied Sea | Pigeon, Nicobar |
| Megapode | Pigeon, Pied Imperial |
| Petrel, Duskyvented Storm | Tropic-bird, Longtailed |

*Reptiles* [QI, Khan undated]

| | |
|---|---|
| Lizard, Green Forest | Skink, Tytler's |

*Insects* (Butterflies)

| | |
|---|---|
| Birdwing, Common | Mormon, Common |
| Clubtail, Andaman | Rose, Crimson |
| Jay, Tailed | Swordtail, Fivebar |

Listings of fish, amphibians, and other fauna found in the sanctuary are not available.

The Nicobar pigeon is reported to be threatened.

**OCCURRENCE AND CONTROL OF DISEASE:** None

**OTHER FACTORS AFFECTING HABITAT:** Gales, cyclones and hailstorms occur occasionally.

**WATER RESOURCES:** None

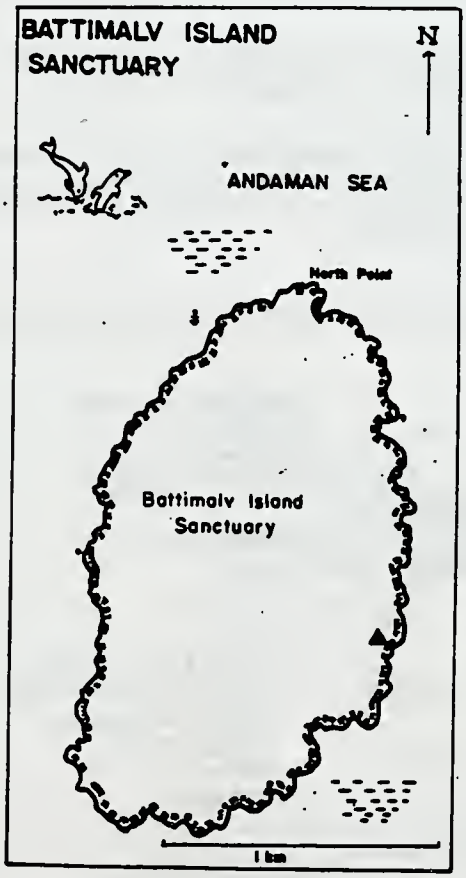
**PERSONNEL:** None

**EQUIPMENT:** None

**RESEARCH AND MONITORING:** None

**HUMAN PRESENCE:** None

Nicobar pigeon *Caloenas nicobarica*

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A&N/S/MEG

# MEGAPODE ISLAND SANCTUARY

**India's southernmost wildlife sanctuary, this is one of the last strongholds of the greatly endangered Megapode. It is a tiny island just off the south-western coast of Great Nicobar Island, thickly vegetated and ringed by sponge and coral beds. Unfortunately it is far easier to approach than most of the other island sanctuaries of Andaman and Nicobar, as one can walk across from the main island during low tide. It is therefore susceptible to greater human interference. The Megapode population is reported to be threatened due to poaching and egg collection by local people.**

LEGAL STATUS: Declared a sanctuary in January, 1985 vide notification no. CF/WL/50-Vol. I [notif].

AREA: 12.5 ha. (0.12 sq. km) [notif]

LOCATION: *District* Nicobar; *Latitudinal Range* 06°50'39" to 06°50'56" N [Tp]; *Longitudinal Range* 93°46'51" to 93°47'10" E [Tp]; *Nearest Town* Campbell Bay (42 km); *Nearest Airport* Car Nicobar (342 km); *Helipad* Campbell Bay (42 km)

APPROACHES: From Port Blair by ship to Campbell Bay. On by the north-south road to Chingenh (approx. 30 km), then on foot to Piloboha hamlet (approx. 6 km), across the bay on boat to Inhinloe hamlet, then again on foot to Pulo Bakka (approx. 4 km), and on to Megapode Island (2 km), the final short stretch by boat, or on foot at low tide [fv].

TOPOGRAPHY: *Altitude* 0 to 10 m

FLORA: Forest types include Andamans Semi-Evergreen 2A/C1, Littoral Forests 4A/L1, and Mangrove (Tidal Swamp) Forests 4B/TS2.

*Trees* [Ql, Chaudhuri 1987]

| | |
|---|---|
| *Areca triandra* | *Rhizophora mucronata* |
| *Barringtonia asiatica* | *Pandanus spp.* |
| *Canarium euphyllum* | *Pterygota alata* |
| *Cocos nucifera* | *Terminalia catappa* |

*Other Vegetation* [Ql, Chaudhuri 1987]

| | |
|---|---|
| *Calamus andamanicus* | *Calamus palustris* |

There is no information on any threatened species of flora.

FAUNA:

*Birds* [Ql, fv]

| | |
|---|---|
| Drongo, Greater Racket-tailed | Pigeon, Green Imperial |
| Eagle, Whitebellied Sea | Pigeon, Greyfronted Green |
| Koel | Pigeon, Pied Imperial |
| Megapode | Starling, Glossy |
| Myna, Hill | Swallow |
| Oriole, Blacknaped | Whimbrel |
| Pigeon, Andaman Wood | |

*Reptiles*

Monitor, Water

*Insects* (Butterflies)

| | |
|---|---|
| Birdwing, Common | Mime, Common |
| Jay, Tailed | Swordtail, Fivebar |

There is no information on mammals, amphibia, fish, and other fauna found in this sanctuary. The Megapode is reported to be a locally threatened species due to egg collection and trapping [fv].

OCCURRENCE AND CONTROL OF DISEASE: None

OTHER FACTORS AFFECTING HABITAT: Gales, cyclones and occasional hailstorms occur.

WATER RESOURCES: Several seasonal streams [fv].

PERSONNEL: One Forester, one Forest Guard [PCCF fax 1991].

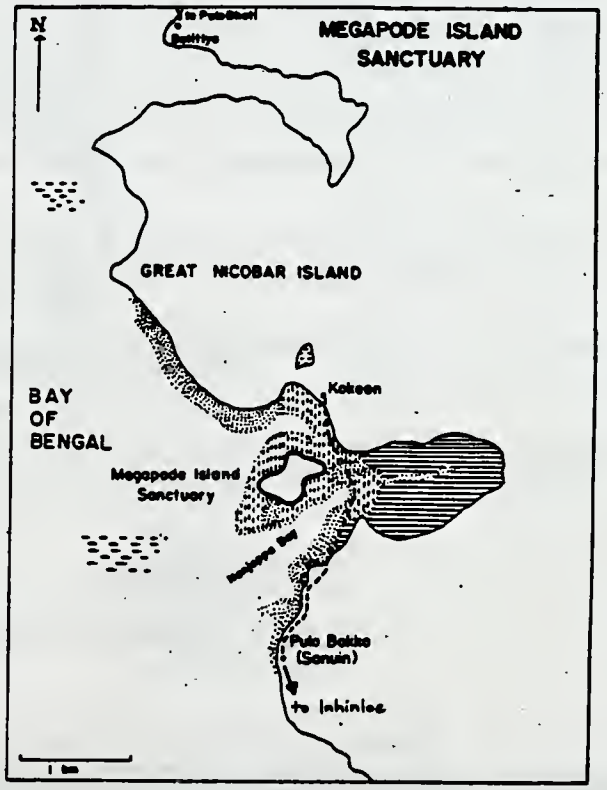
EQUIPMENT: None

RESEARCH AND MONITORING: None

HUMAN PRESENCE:

*Rights* and *Leases*: None specifically in the sanctuary. However, the Nicobarese tribals are allowed, under the Wildlife (Protection) Act, 1972, Section 65, to hunt any wildlife (for further details, see KEY TO THE DIRECTORY SHEETS above).

*Habitation*: The sanctuary itself is an uninhabited island bu. in the surrounding area there are 3 villages, on Great Nicobar Island, with an estimated population of 95.

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The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate base line
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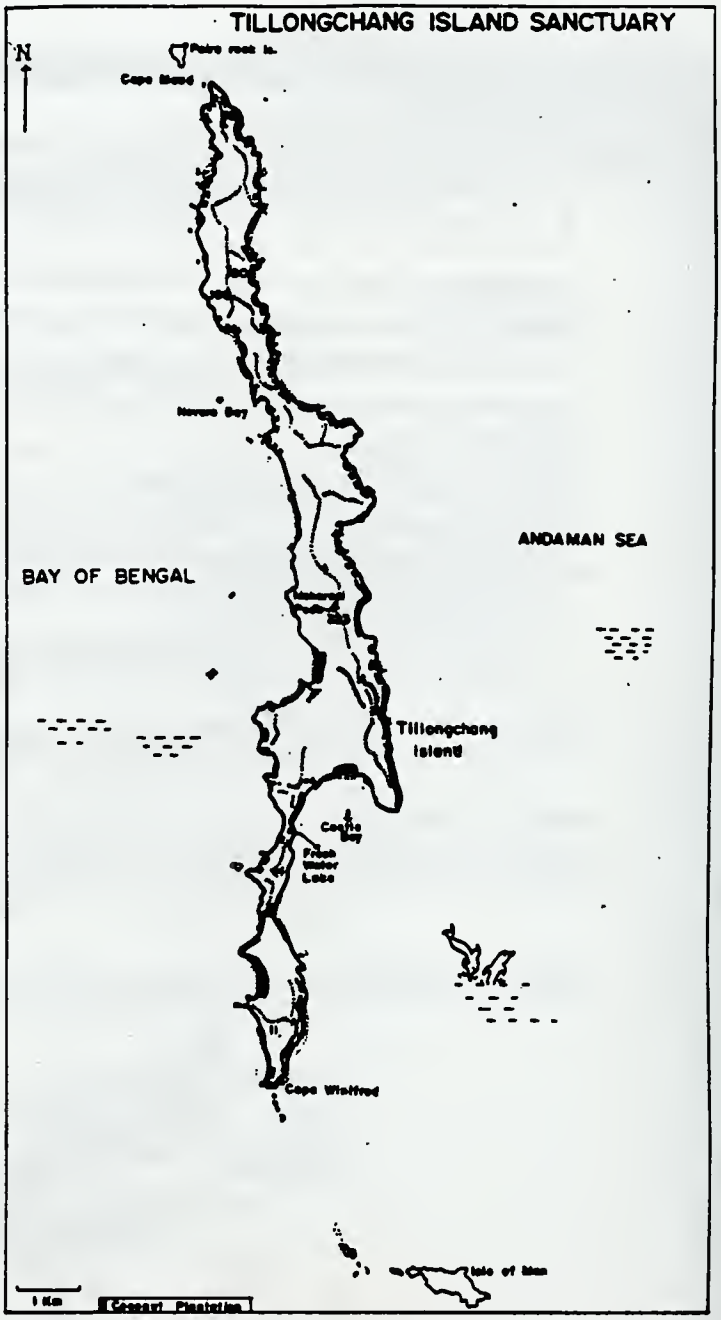



Based upon Survey of India map with the permission of the Surveyor General of India.
The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate base line.

# TILLONGCHANG ISLAND SANCTUARY

Set up to protect the rare and endangered northern subspecies (*nicobariensis*) of the Megapode, this remote island has no human population. Apart from the Megapode the island also harbours the Nicobar pigeon and the very rare Nicobar tiger bittern [Tikader and Das 1985]. Relative to most other island sanctuaries in Andaman and Nicobar, Tillongchang has considerable diversity of topography. Sheer cliffs, thickly vegetated rolling hills, mangrove patches, and long beaches combine into a remarkable blend which still remains largely unstudied.

With rough seas around it most of the year, and only one or two suitable landing spots, it is difficult to approach except by a good seafaring vessel and an appropriate landing craft. However, Nicobarese tribals of the nearest inhabited islands of Camorta, Teressa, and Trinkat, wizards as they are at sea travel, do manage to get here often. There is evidence of some poaching and illegal coconut extraction by them, and perhaps occasionally by passengers and crew of passing ships. The Nicobarese who land here have reported the continued abundance of pigs, crocodiles, snakes, and other wildlife [Anon 1981].

LEGAL STATUS: Declared a sanctuary in January 1985 vide notification no. CF/WL/50—Vol. I [notif].

AREA: 1683 ha. (16.83 sq. km) [notif]

LOCATION: *District* Nicobar; *Latitudinal Range* 08°25'11" to 08°34'32" N [Tp]; *Longitudinal Range* 93°36'15" to 93°38'07" E [Tp]; *Nearest Town* Car Nicobar (approximately 112 km); *Nearest Airport* and *helipad* Car Nicobar (approximately 112 km).

APPROACHES: From Port Blair by ship or air to Car Nicobar Island (282 km), then to the sanctuary (approximately 112 km) by ship [fv]. No public ferry available.

TOPOGRAPHY: *Altitude* 0 to 323 m [Hyd. map].

FLORA: Forest types include Andaman Tropical Evergreen 1A/C2, Andaman Semi-evergreen 2A/C1, Littoral Forest 4A/L1, and Mangrove Forest (Tidal Swamp Forest) 4B/TS2 [QI, Chaudhuri 1987].

*Trees* [QI, Chaudhuri 1987]

*Areca triandra*
*Avicennia spp.*
*Bruguiera spp.*
*Calamus palustris*
*Canarium euphyllum*
*Ceriops spp.*
*Cocos nucifera*
*Hibiscus spp.*
*Manilkara spp.*
*Pandanus spp.*
*Pterygota alata*
*Rhizophora spp.*
*Terminalia catappa*

There are three coconut plantations [Tp]. However, there is no information on by whom, or when, they were started. There is no information on threatened species of flora in the sanctuary.

FAUNA:

*Mammals* [QI, Chaudhuri 1987, fv]

Bat, Lesser Shortnosed Fruit
Boar, Indian Wild
Deer, Spotted *
Flying Fox, (Nicobar) **
Shrew, Nicobar Spiny

*Birds* [QI, Chaudhuri 1987, Tikader and Das 1985, fv]

Bittern, Tiger
Drongo, Lesser Racket-tailed
Eagle, Crested Serpent
Eagle, Whitebellied Sea
Heron, Reef
Megapode
Parakeet, Redcheeked
Pigeon, Andaman Wood
Pigeon, Green Imperial
Pigeon, Nicobar
Pigeon, Pied Imperial

*Reptiles* [QI, Biswas 1984, Anon 1981]

Crocodile, Estuarine
Lizard, Green Forest
Monitor, Water

*Insects* (Butterflies)

Birdwing, Common
Jay, Great
Jay, Tailed
Mormon, Andaman
Swordtail, Fivebar

No listings are available of the amphibian, fish, and other fauna found in the sanctuary. The Megapode is reported to be threatened, due to poaching by local people [fv].

OCCURRENCE AND CONTROL OF DISEASE: None

OTHER FACTORS AFFECTING THE HABITAT: Gales, cyclones and occasional hailstorms are reported.

WATER RESOURCES: There is one perennial lake, and 67 streams [QI, Tp]. It is not known how many, if any, of these streams are perennial.

PERSONNEL: None

EQUIPMENT: None

RESEARCH AND MONITORING: None

HUMAN PRESENCE:

*Illegal Activities:* Coconut extraction and poaching are reported [fv].

---

* Authentic sightings of Spotted deer are only from the Andaman islands. Its occurrence in the Nicobars is doubtful, as there is no record of its having been introduced there [Tikader and Das 1985].

** See Appendix 3, footnote 1

APPENDIX 7

# THREATENED ANIMALS OF ANDAMAN AND NICOBAR ISLANDS[1]

| *Common name* | *Scientific name* | *Distribution*[2] |
|---|---|---|
| MAMMALS | | |
| Dolphin, Common | *Delphinus delphis* | A, N |
| Dugong or Sea cow | *Dugong dugon* | A, N |
| Macaque, Crab-eating | *Macaca fascicularis* | N |
| Pig, Andaman Wild[3] | *Sus scrofa andamanensis* | A |
| Whale, Blue | *Balenoptera musculus* | A, N |
| Whale, Sperm | *Physeter catodon* | A, N |
| BIRDS | | |
| Eagle, Whitebellied Sea | *Haliaeetus leucogaster* | A, N |
| Falcon, Peregrine | *Falco peregrinus* | N |
| Hornbill, Narcondam | *Rhyticeros narcondami* | A |
| Megapode | *Megapodius freycinet* | N |
| Osprey | *Pandion haliaetus* | A |
| Pigeon, Nicobar | *Caloenas nicobarica nicobarica* | A, N |
| Teal, Grey or Andaman | *Anas gibberifrons albogularis* | A |
| REPTILES | | |
| Crocodile, Estuarine | *Crocodylus porosus* | A, N |
| Monitor, Andaman Water | *Varanus salvator andamanensis* | A, N |
| Python, Reticulated | *Python reticulatus* | N |
| Turtle, Green | *Chelonia mydas* | A, N |
| Turtle, Hawksbill | *Eretmochelys imbricata* | A, N |
| Turtle, Leathery | *Dermochelys coriacea* | A, N |
| Turtle, Olive Ridley | *Lepidochelys olivacea* | A, N |

Sources: Tikader 1983, Rao 1989

1 The term 'threatened' has been used in accordance with the internationally accepted usage coined by the International Union for Conservation of Nature and Natural Resources (IUCN). This term is used for species which are in one of the following categories [Jain and Sastry 1980]:
Endangered: Species/taxa in danger of extinction and whose survival is unlikely if factors threatening them continue to operate.
Vulnerable: Species/taxa likely to move into the endangered category in the near future if threatening factors continue to operate.
Rare: Species/taxa with small world populations that are not at present endangered or vulnerable, but are at risk of becoming so.

2 A = Andamans N = Nicobars

3 A subspecies of Indian wild boar

APPENDIX 8

# GREAT NICOBAR BIOSPHERE RESERVE

*Biosphere Reserves*

The Indian Man and Biosphere (MAB) Programme, modeled after the UNESCO (MAB) Programme, envisages the conservation of representative ecosystems which are genetically and ecologically rich. Such ecosystems are designated Biosphere Reserves, with the "objectives of

a. conserving the diversity and integrity of plants and animals within natural ecosystems,
b. safeguarding genetic diversity of species on which their continuing evolution depends,
c. providing areas for ecological and environmental research, and
d. providing facilities for education and training." [Ministry of Environment and Forests, 1989c].

The model followed internationally also envisages the designation of several zones in each Biosphere Reserve:

"a. Natural or Core Zone: Managed for minimum human interference to serve as a baseline for the biological region; research, educational and training activities are carefully controlled and must be non-manipulative."
b. Manipulative or Buffer Zone: Managed for research, education and training activities, and manipulative methods and techniques are permitted. Traditional activities including timber extraction, hunting, fishing, and grazing are permitted in a controlled manner.
c. Reclamation or Restoration Zone: Managed to study and reclaim lands and natural resources where heavy natural or human-caused alteration has passed ecological threshold or where biological processes have been interrupted or where species have become totally extinct.
d. Stable Cultural Zone: Managed to protect and study ongoing culture and land use practices which are in harmony with the environment. Local residents and their activities be strictly controlled." [Ministry of Environment and Forests, 1989c].

So far, the designation of Biosphere Reserves is not done under any law. It is now proposed to introduce a clause allowing for this, in the Wildlife (Protection) Act of 1972. Alternatively, in the long run, a specific law on this may be considered [Ministry of Environment and Forests, 1989c]. At the moment, management of the Reserves is in the hands of the concerned State Government, while the Central Government extends full financial assistance for approved activities, technical expertise and know-how, and detailed guidelines for management.

*The Great Nicobar Biosphere Reserve*

On January 6, 1989, the Ministry of Environment and Forests, Government of India, designated a major part of Great Nicobar Island as a Biosphere Reserve, by Government Order No. J.22010/14/89-CSC [Ministry of Environment and Forests, 1989c]. The Reserve extends, in two parts, over 88,500 ha. (885 sq. km), or about 85% of the island. The area covered is not part of, nor does it contain, any existing national park or sanctuary, though the designation of the biosphere reserve as a park or sanctuary has been suggested by the Wildlife Institute of India (please see Appendix 9 for the proposal).

Reproduced below are extracts from the Project Document on the Great Nicobar Biosphere Reserve, prepared by the Ministry of Environment and Forests [Ministry of Environment and Forests, 1989a]. The report is based primarily on work done by the Botanical Survey of India.

[*Editorial Note*: Minor editorial changes have been made in the text, which is otherwise reproduced verbatim. For greater details on the summary points made below, please see the original document. An outline map of the Reserve is also included here.]

*Introduction*

Great Nicobar Island, the southern most island of this archipelago and in fact the southern most land piece of India, is situated between 6°45'N and 7°15'N latitudes and 93°38' and 93°55'E longitudes. The island lies about 482 km. south of Port Blair and 145 km. north of the northern tip of Sumatra. The island is about 55 km. long between Murray point in the north to Pygmalion Point (now called Indira Point) in the south. It has a width of about 30 km. in the north but the island narrows down to only about 3 km. in the southern tip. The total geographical area approximates to 1045 sq. km.

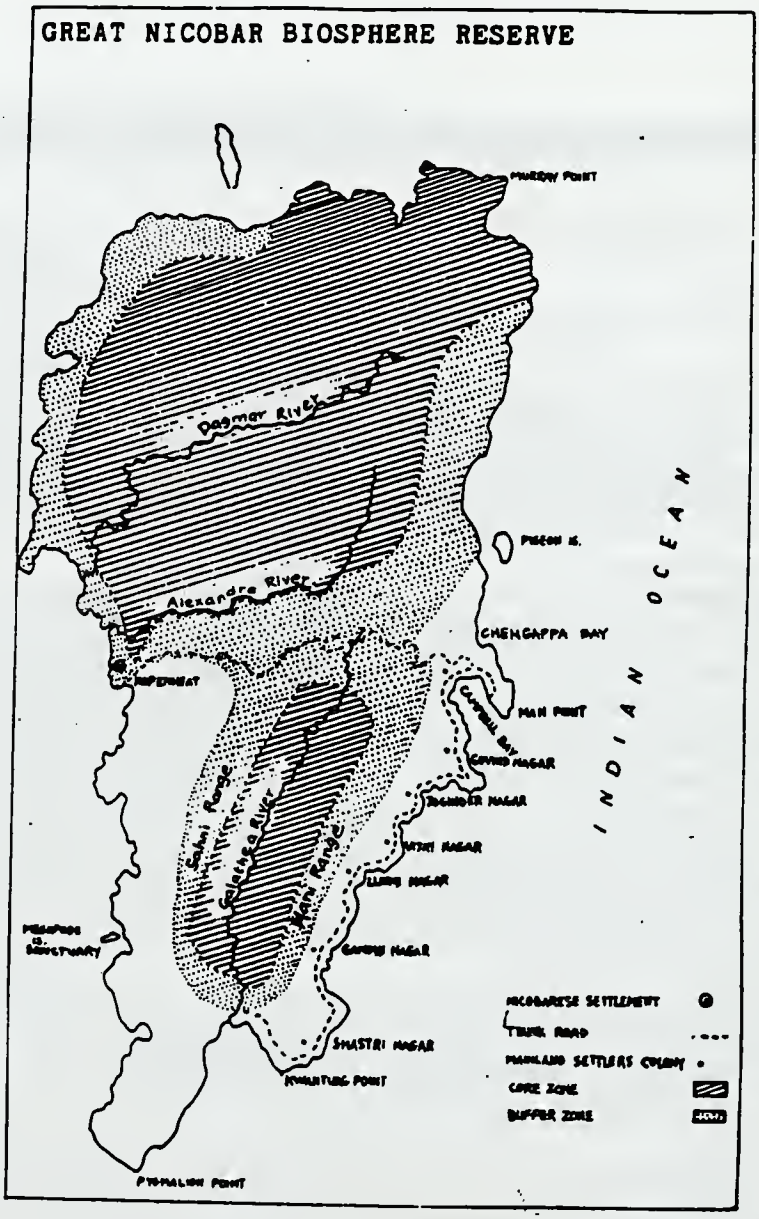
*Need for Biosphere Reserve*

The following is a summary of the justification for establishment of a Biosphere Reserve in this island.

(1) The island is situated at a phytogeographically strategic point.
(2) About 85% of primary forest areas of the island are still virgin and rich in species content.
(3) Endowed with immense genetic resources of wild plant species such as timber trees, fruit trees, ornamental plants, medicinal plants, etc. the island harbours rich genetic germplasm resources.
(4) About 11% of the vascular flora (so far surveyed) are endemic to these islands.
(5) About 30% of the flora are extra-Indian i.e. occurring (elsewhere) only in S.E. Asian countries.
(6) Details of faunistic survey certainly show endemism among animals in the island, as well as their interrelationship with plants.
(7) About 30 species of plants are rare among the known flora, and are endangered and confined to one or few localities each on this island.
(8) *Cyathea albo-setacea*, a characteristic tree fern and *Phalaenopsis speciosa*, a beautiful ornamental orchid are endemics, and found only in this and adjacent islands.
(9) Similarly, some endemic birds are characteristic of the island ecosystem (e.g. the Megapode *Megapodus freycinet nicobariensis*).
(10) The Shompens, an aboriginal tribe with very limited population, are a source of much valuable information regarding the usefulness of many unknown species.
(11) Impact of external forces, especially tourism, is practically nil at present.
(12) Politically the island is at a strategic position, and grave danger looms over the flora or fauna from accelerated developmental activities in the near future.

*Zonation of the Reserve*

Entire northern part of the island starting from the Alexandra river (west coast) to Chengappa Bay (east-coast) i.e. between 7°N and 7°20'N latitude, and 93°37'E and 93°56' E longitudes as Core Zone I. (Area-520 sq. km. as Core Zone-I and 90 sq. km. as its Buffer Zone). The southern part between the two hilly ranges (Sahni range and Mani range) including the river Galathea (6°60' N and 7°N. latitude and 93°37'E. and 93°56'E longitudes) as Core Zone II. (Area-185 sq.km. as Core Zone-II. and 90 sq.km. as its Buffer Zone). (Please see map for zonation).


GREAT NICOBAR BIOSPHERE RESERVE
INDIAN OCEAN
Alexandra River
Galathea River
Pillomilo River
Shastri Nagar
Pulomilow Point
Pigeon Is.
Chengappa Bay
Main Point
Govind Nagar
Nicobarese Settlement
Tribal Road
Mainland Settlers Colony
Core Zone
Buffer Zone

## CONSERVATION PROPOSALS

Proposals discussed in this report are of four types:

a: those designed to upgrade the status of existing ProtectedAreas (PAs)
b: the creation of major conservation units in each province
c: the establishment of smaller representive PAs in each biogeographic sub-division.
d: general suggestions for increased conservation efficiency.

These proposals are detailed below:

a) Only 3 tiny islets out of 97 protected areas[2] are parks (and they total less than 1 sq km); all others are sanctuaries. Some of these do have values of international significance and warrant full park status. These are :
   - : **Narcondam Island** (7 sq km), the only area for Narcondam hornbill.
   - : **North Reef Island** (3 sq km), with the largest population of Grey or Andaman teal, plus a Saltwater crocodile population.[3]
   - : **South Sentinal Island** (2 sq km), one of two islands[4] which may still have robber crabs, plus a very large green turtle nesting beach.
   - : **Barren Island** (2 sq km), an isolated volcano, with little closed forest cover. This is at present a sanctuary which is listed as protecting "feral goats"! There is NO merit in protecting ecologically disastrous goats. Their impact on natural values should be investigated and, if necessary they should be removed and the island's ecological succession monitored.
   - : It is proposed to give park status to all islets in the west coast **Shearme group** (11), the northern **Landfall group** (4) and the east coast **Table - Brush group** (12) as representatives of their respective situations.[7]

b) Three major protected area units are recommended:

   i) In the Middle Andamans, the area around **Mount Diavolo** to the east of the Grand Trunk Road is proposed as a 200 sq km park with a surrounding 200 sq km sanctuary buffer. The PA should include the mountain peak and sizeable areas of coastal forest.

   ii) In the **Little Andamans**, a 300 sq km National Park is proposed for the entire south-western half of the island.
   This area of the Little Andamans may be the largest extent of undisturbed forest left in the whole Andaman group. Specific values include saltwater crocodile, turtle beaches, robber crabs etc. on the coast, and many of the Andaman endemic bird species including the Grey or Andaman teal in the forest. A core and buffer zone arrangement will be necessary to accommodate the few Onge tribe people who still live in these forests.

   iii) In the Nicobars, the northern portion of Great Nicobar and all Little Nicobar should be protected as follows. All of **Little Nicobar** and surrounding islets (Pulo Milo, Trees, Trak, Mecen) to be a National Park (160 sq km). In Great Nicobar the northern area, north of **Casuarina Bay-Dogma River** and **Mount Thullier** to be a wildlife sanctuary (200 sq km), with a core area around Mount Thullier and Laful to be a 100 sq km National Park.[5]

c) Representative protected areas are proposed as follows:

   1) North Andamans : The northern-most peninsula past Shyam Nagar as a WLS.
   A proportion of the central ridge from Nischintapur to Swarajgram as a WLS.
   An area of mangrove in the south-west near Austin to Kishorinagar as a WLS.

   2) South Andamans : Extension of Mount Harriett NP north to cover all of the small peninsula, an extra 70 sq km.[6]
   Creation of a sanctuary in West Rutland from Mount Ford, and to act as a buffer for the Marine National Park.

3) Ritchie's Archipelago : To add adjacent Outram Island, which has 20 sq km of almost intact forest, to the existing Button National Park of 1 sq km.

4) Central Nicobars : To create a 50 sq km sanctuary on Kamorta Island.

d) General suggestions

i) The present number of tiny individual island sanctuaries be amalgated into ten logical groups for more efficient administration. Suggestions are:

| *West Coast*[7] | *North East, South Coast*[7] |
|---|---|
| Shearme Group of 11 islands (to be Park) | Landfall Group of 4 islets (to be Park) |
| Interview Islet Groups of 10 islets (note N & S Reef become Parks) | Table - Brush Group of 12 islets (to be park) |
| Spike Group of 6 islets | Kyd Group 4 islets |
| Defence Group of 4 islets | Sound Islet Group 12 islets |
| | Oyster Group 3 islets |
| | Cinque Island Group 6 islets |

ii) The larger block of mangroves be surveyed with a view to bringing a greater proportion into the protected area network.

iii) The forest territorial divisions develop a much larger number of 'preservation plots' in natural forest communities.

iv) The status of the tribal reserves to be clearly thought out and recommendations acted upon. There are 742[8] sq km of Jarawa Reserve in Middle and South Andamans. There are (or were!) Reserves for the Onge in Little Andaman and Shompen in Great Nicobar, but these have fallen into "disuse".

Giving all or part of these reserves sanctuary status under the wildlife act can allow traditional people to pursue their way of life, but gives a strong legal deterrent to any form of non-compatible land use.

## DISCUSSION

*Priorities*

The scale of biological values in the Andaman and Nicobar Islands is so great that all protected area proposals must be seen as a major priority. However it is still possible to see proposals that are of extreme significance for protected area planning. Priority classes are as follows.

| *National Priority* | *Zonal Priority* | *State Priority* |
|---|---|---|
| (Andamans) | | |
| North Andaman Peninsula WLS | North Andaman Ridge WLS | None |
| Mount Diavolo NP & WLS | South West Mangrove WLS | |
| Mount Harriett NP (Extension) | Barren Island NP | |
| West Rutland NP | Landfall Island Group NP | |
| Little Andaman NP | Table - Brush Group NP | |
| South Sentinal NP | Shearme Island Group NP | |
| Outram & Button Island NP | | |
| Narcondam Island NP | | |
| North Reef Island NP | | |
| (Nicobars) | | |
| Mount Thullier NP | Kamorta WLS | |
| Great Nicobar WLS | | |
| Little Nicobar NP | | |

*Management Inputs*

This report is not primarily concerned with management issues. However the scale of resource values in the Andaman and Nicobar is so great that some comment on important management issues must be made.

a) **Outposts.** The placing of outposts of security personnel on remote islands does create serious impact on natural resources. Where possible such outposts should be manned by wildlife staff.
b) **Patrolling.** The wildlife wing must be given greater marine patrolling ability with large and small boats. Wildlife personnel should be placed on all police, coastguards, forest patrolling vessels.
c) **Tourist rights within National Parks.** Tourism in NPs must be regulated. Coral collecting, beach camping etc. must be prevented.
d) **Hunting.** Hunting, especially by Karen people, is an increasing problem which requires strict control.
e) There is an immediate need for more wildlife staff and management resources to instigate proper control and monitoring activities.

## NOTES

1 The protected areas of A&N Islands cover substantial stretches of marine waters also. Discounting this, the land mass under national parks and sanctuaries at present is about 5.80% of the total area of the union territory. Unfortunately it is not clear from the WII report, how much area should similarly be discounted from its total. The proportion of protected land area to total U.T. area, as proposed by WII, will correspondingly be smaller.
2 It is unclear why the figure of 97 has been used. The total number of national parks and sanctuaries in A&N is 100. Of these, 96 are full islands, two (Marine National Park and Salt Water Crocodile Sanctuary) are a mix of islands, marine waters, and coastal strips, and two (Mount Harriett and Saddle Peak National Parks) are parts of the 'mainland' islands of Great Andaman. The "3 tiny islets" being referred to are probably the North, Middle, and South Button National Parks.
3 Also a stronghold of the Water monitor.
4 The other being Great Nicobar Island [Tikader, Daniel, and Rao 1986].
5 The northern portion of Great Nicobar Island has recently been designated a Biosphere Reserve [Ministry of Forests and Environment 1989c] However, this does not accord it any legal status, and the implications of this declaration, in terms of protection, are as yet unclear. See Appendix 8.
6 The Forest Department of A&N is proposing extension of Mount Harriett National Park on all but the northern side [PCCF fax 1991] (please see directory sheet and maps of Mount Harriett National Park, pp. 49-52).
7 The report does not specify which islands comprise the Groups listed. We can deduce, on the basis of our maps, that their composition is as follows :

| | | |
|---|---|---|
| Shearme Group | : | Mayo, Paget, Point, Reef, Shearme, West, White Cliff, Rowe, Shark, and Kwangtung Islands (11th island not clear). |
| Interview Group | : | Surat, Spike-1, Roper, Ranger, Entrance, Buchanan, Bondoville, Sea Serpent, Snake-1, and Benett Islands. |
| Spike Group | : | Spike-2, Bingham, Bluff, Mangrove, Stoat, and Talabaicha Islands. |
| Defence Group | : | Clyde, Defence, Montogemery, and Patric Islands. |
| Landfall Group | : | Landfall, Chanel, East, and Peacock Islands. |
| Table-Brush Group | : | Brush, Table (Delgarno), Table (Excelsior), Jungle, North, Ox, Ross, Temple, Tree, Trilby, Turtle, and Wharf Islands. |
| Kyd Group | : | Duncan, James, Kyd, and Potanma Islands. |
| Sound Group | : | Dot, Bamboo, Blister, Curlew, Gander, Goose, Oliver, Oyster-1, Swamp, Curlew (B.P.), Orchid, and Girjan Islands. |
| Oyster Group | : | Cone, Oyster-2, and Parkinson Islands. |
| Cinque Group | : | Cinque (North and South), Passage, Sisters, North Brother, and South Brother Islands. |

8 The area of the Jarawa reserve as notified is 63886 ha.

APPENDIX 9

# PROPOSALS FOR AN IMPROVED WILDLIFE PROTECTED AREA NETWORK IN ANDAMAN AND NICOBAR ISLANDS

In 1984, the Government of India commissioned the Wildlife Institute of India, Dehradun, to evaluate the adequacy of the existing network of wildlife protected areas and to propose a network that covers the range of biological diversity in the country. The Institute's report, released in 1988, includes recommendations for an improved protected area network in each state (Rodgers and Panwar 1988b). This is based on a biogeographical classification of the country's ecosystems into several distinct zones and provinces (Rodgers and Panwar 1988a).

For Andaman and Nicobar Islands, the report recommends the creation of four new national parks and seven new sanctuaries, upgradation of four existing sanctuaries and three clusters of existing sanctuaries into national park status, extension in area of two national parks, and the clustering of several other existing sanctuaries into compact units for more efficient management. It also suggests that all or part of the tribal reserves in both Andaman and Nicobar be given sanctuary status.

If the suggestions made by the Wildlife Institute of India are accepted, the total area covered by the protected area network in A&N will become 2,31,300 ha.(2313 sq. km.), as against the present 73,311.53 ha. (733.12 sq. km.). This will be 27.8% of the total area of the union territory, compared to about 5.8% at present.[1]

**(Editorial note: The text given below is reproduced almost verbatim from Rodgers and Panwar (1988a); any changes made are only for the sake of clarity. Spellings of existing national parks or sanctuaries have been changed, wherever necessary, according to the relevant notifications, to match the usage in the rest of the directory. Our own comments are given in footnotes.)**

## BIOGEOGRAPHICAL DIVISIONS

The zone is split into two distinct units:

9A Andaman Islands (with Barren and Narcondam Islands)
9B Nicobar Islands

The Andaman group is by far the largest, with 324 islands totaling 6,491 sq km. Most of the land mass is taken up by 'Great Andaman', which is really 5 islands separated by creeks. Little Andaman is some distance to the south. For conservation planning several sub-divisions or biogeographic regions are recognized. These are:

1. North Andaman
2. Middle Andaman
3. South Andaman, Baratang and Rutland
4. Little Andaman
5. Ritchie Archipelago (geologically recent with calcium rich soils)
6. Off-shore Volcanics
7. East Coast Islands
8. West Coast Islands

The Nicobar group is much smaller, with only 24 islands. Three sub- divisions are recognized:

1) North group - Car Nicobar and Battimalv
2) Teressa, Tillongchang, Kamorta etc.
3) Little Nicobar and Great Nicobar.

## Section 6. SPECIES

**Turtle nesting sites**

Sea turtles are particularly susceptible to disturbance at their nest sites. It is difficult to estimate population size and trends in sea turtles; the best estimates are obtained from the number of mature females that emerge on a given nesting beach. It is apparent that four species of marine turtle are important in the Andaman and Nicobar Islands and Strait of Malacca area. From the best data available, WCMC have compiled a map database of marine turtle nesting sites. The occurrence of some of these is shown on the accompanying maps and list.

The Andaman and Nicobar Islands are extremely important as both a feeding and breeding area for turtles. Four species are known to nest: Green turtle *Chelonia mydas* (which breeds from June-September in the Meroc and Katchall Islands); Hawksbill *Eretmochelys imbricata* (which breeds from April to January, Pygmalion Point); Leatherback *Dermochelys coriacea* (November to February); and Olive ridley *Lepidochelys olivacea* (probably June to September). The Andaman and Nicobar Islands are the most important breeding area in the northern Indian Ocean for the Leatherback.

In the Strait of Malacca, *Chelonia mydas*, regarded as the most common sea turtle in Indonesia, is found in and around the Riau and Lingga Islands off the east coast of Sumatra and in Lampung Province. Some nesting also occurs along the west coast of Peninsular Malaysia, albeit sparse. Turtle nesting is rare on the west coast because the coast has few suitable sand beaches, instead consisting mainly of mudflats and mangroves. Tanjong Kling (west of Melaka) was used by *C. mydas* in 1975, but the beach is now unsuitable for turtles; the nearby islands Pulau Besar and P. Upeh may still be used. Similarly, Pangkor Island, Pulau Sembilan and a few other islands off the Perak coast, also P. Pinang and P. Langkawi further north, now have only sporadic turtle nesting. The only substantial remaining mainland nesting site is Pasir Panjang Beach, near Pantai Remis, Perak, but this is subject to very heavy egg collection.

*Eretmochelys imbricata*, the second most common, also occurs in the Riau Province (including the Riau and Lingga Islands) and in Acah Province in the north of Sumatra. Again, relatively few *E. imbricata* nest in Peninsular Malaysia. A very small number arrive regularly on beaches north of Melaka and two species of turtle have been reported to have nested at Pantai Pasir Panjang on the west coast.

Turtles also nest on the west coast of Thailand. Tarutao National Park is important for *Chelonia mydas*, *Lepidochelys olivacea* and *Eretmochelys imbricata*. Olive ridley turtles begin nesting in early November and are restricted to the west coast of Tarutao whilst the earlier nesting Green turtles use several islands. Hawksbill nesting sites seem to be limited to Rawi and Adang.

**Birds in the Strait of Malacca**

**Sea birds**

The Strait of Malacca is not a particularly rich area for sea bird breeding colonies. The major species involved are the Brown Booby, Brown Noddy, Black-naped, Bridled and Roseate Terns, and the Milky Stork. Locations of the main colonies are given in Table 1. The Nicobar Islands have no major breeding colonies of sea birds.

Other sea birds found in the area include: White-capped noddy *Anous tenuirostris,* Greater frigatebird *Fregata minor,* Stints *Calidris* spp., Lesser frigatebird *F. ariel,* Dusky-vented storm petrel *Oceanites oceanicus,* Red-tailed tropicbird *Phaethon rubricauda,* Lesser crested tern *S. bengalensis,* White tropicbird *P. lepturus,* Grey pelican *Pelicanus philippensis,* Sooty tern *S. fuscata,* Reef heron *Egretta sacra,* White-winged black tern *Chlidonias leucopterus,* White-bellied sea eagle *Haliaetus leucogaster,* Javan gull-billed tern *Gelochelidon nilotica,* Osprey Pandion haliaetus and Noddy tern *Anous stolidus.*

**Milky Stork** *Mycteria cinerea*
Classified as Threatened in *Birds to Watch.* There are two known colonies at **Hutan Bakau,** and **Matang,** with populations of 74 and 21 pairs respectively. A further three colonies, totalling over 1000 nests, are reported in the 'coastal swamps of South Sumatra'.

**Brown Booby** *Sula leucogaster*
Declining in the region. Nesting only on **Pulau Perak** which was formerly the one of the largest colonies in the region but, by 1980, was declining and held fewer than 125 pairs. Formerly nested at Tokong in **Aruah,** but became extinct there before 1949.

**Masked Booby** *Sula dactylatra*
Formerly nested at **Pulau Perak** but now extinct. The only remaining breeding location in Indonesia is in the Banda Sea.

**Brown Noddy** *Anous stolidus*
Nesting only at **Pulau Perak,** where the colony (500 pairs in 1976) was thought to be relatively stable, and at **Damar,** where there are over 1000 pairs.

**Roseate Tern** *Sterna dougallii*
Of global conservation concern; quite commonly observed in Indonesian waters but few recorded breeding sites. Breeding only at **Ko Tarutoa,** where the population is unlikely to exceed 100 pairs, and occasionally at **Aruah.**

**Black-naped Tern** *Sterna sumatrana*
Probably the commonest seabird in Indonesia, nesting at over 50 sites on small cays, reef, sandspits and rocky islets in small colonies (generally fewer than 100 pairs). Nesting recorded at **Ko Phi Phi, Ko Tarutoa, Fairway Rock, White Rock** and **Aruah.** Malaysian population estimate: 1000-2000 pairs.

**Bridled Tern** *Sterna anaethetus*
Widespread in Indonesia, often breeding in association with the Black-naped Tern. Nesting recorded at **Ko Phi Phi** (50 pairs?), **Ko Tarutoa, Pulau Perak,** (30 pairs in 1976) **Fairway Rock, White Rock, Berhala Kecil, Aruah, Kayu Ara, Mandariki** and **Damar** (10-100 pairs). Malaysian population estimate: 2000-3000 pairs, mostly in the South China Sea.

**Table 1 Sea Bird colonies in the Strait of Malacca**

| Site name | Species | Status | Numbers |
|---|---|---|---|
| Ko Phi Phi | *Sterna sumatrana* | B | |
| | *Sterna anaethetus* | B | |
| Ko Tarutao NP | *Sterna sumatrana* | B | |
| | *Sterna dougallii* | B | |
| | *Sterna anaethetus* | B | |
| Pulau Perak | *Sula dactylatra* | E | |
| | *Sula leucogaster* | B | |
| | *Anous stolidus* | B | |
| | *Sterna anaethetus* | B | |
| Fairway Rock | *Sterna sumatrana* | B | |
| | *Sterna anaethetus* | B | |
| White Rock | *Sterna sumatrana* | B | |
| | *Sterna anaethetus* | B | |
| Berhala Kecil | *Sterna anaethetus* | B | |
| Aruah | *Sula leucogaster* | E | Order 3 |
| | *Sterna sumatrana* | B | |
| | *Sterna dougallii* | P | |
| | *Sterna anaethetus* | B | |
| Kayu Ara | *Sterna anaethetus* | B | |
| Mandariki | *Sterna anaethetus* | B | |
| Damar | *Anous stolidus* | B | Order 4 |
| | *Sterna anaethetus* | B | Order 2 |
| Hutan Bakau | *Mycteria cinerea* | B | 74 |
| Matang, Perak | *Mycteria cinerea* | B | 21 |

Notes: B = breeding, E = extinct. Order 2 = 10-100 pairs, Order 3 = 100-1000 pairs, Order 4 = 1000-10,000 pairs. No entry in this column = no data.

**Waterfowl**

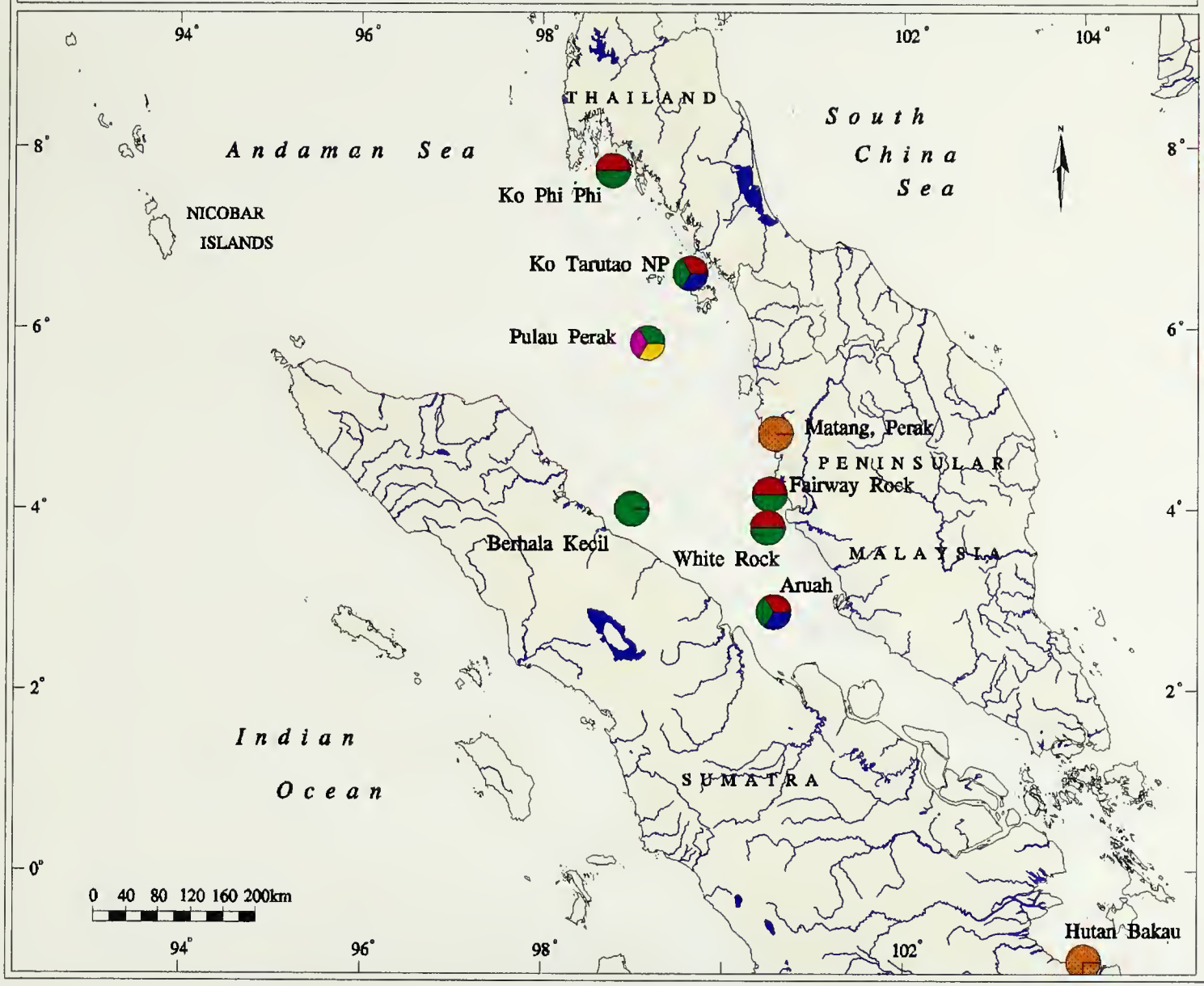
The west coast of Peninsular Malaysia is an extremely important area for wintering shorebirds, especially on the coasts of Selangor and Perak. Pulau Tengah was the largest known shorebird roost in the area, with a total count of 17,600 in 1990. Survey work in Sumatra and the west coast of Thailand is more patchy. Summary data for the largest waterfowl sites in Malaysia derived from the International Waterfowl and Wetlands Research Bureau/Asian Wetland Bureau *Asian and Australasian waterfowl census 1992* are shown on the map.

Marine Turtles in the Strait of Malacca and Adjacent Areas.

| ID | SPECIES | COUNTRY | SITE NAME | NESTING | | REFERENCE | REF.YEAR |
|---|---|---|---|---|---|---|---|
| IN-1 | Eretmochelys imbricata | India | Pygmalion Point, Great Nicobar | | | Bhasker | 1984 |
| IN-2 | Dermochelys coriacea | India | between R.Dagmar and R.Alexandra | | | Bhasker | 1984 |
| IN-3 | Chelonia mydas | India | Meroe Island | 6 | 9 | Bhasker | 1984 |
| IN-4 | Chelonia mydas | India | South Bay, Katchell Island | 6 | 9 | Bhasker | 1984 |
| ID-33 | Chelonia mydas | Indonesia | Kep.Banyak, Aceh Province | | | Salm | 1984 |
| ID-37 | Chelonia mydas | Indonesia | Pasaman | | | Schulz | 1984 |
| ID-38 | Chelonia mydas | Indonesia | South of Padang, West Sumatra Prov. | | | Schulz | 1984 |
| ID-50 | Eretmochelys imbricata | Indonesia | Kep.Banyak, Aech Province, Sumatra | | | Salm | 1984 |
| ID-51 | Eretmochelys imbricata | Indonesia | P.Musala, North Sumatra Province | | | Salm | 1984 |
| ID-53 | Eretmochelys imbricata | Indonesia | P.Durai, Riau Province, Sumatra | | | Salm | 1984 |
| ID-60 | Eretmochelys imbricata | Indonesia | P.Pasaman, West Sumatra Province | | | Salm | 1984 |
| ID-62 | Eretmochelys imbricata | Indonesia | S. of Padang, West Sumatra Province | | | Salm | 1984 |
| ID-74 | Lepidochelys olivacea | Indonesia | S. of Padang, West Sumatra Province | | | Salm | 1984 |
| ID-77 | Chelonia mydas | Indonesia | Kep Anambas, Riau Province, Sumatra | | | Schulz | 1984 |
| ID-119 | Dermochelys coriacea | Indonesia | Pasaman | | | Schulz | 1984 |
| ID-120 | Dermochelys coriacea | Indonesia | South of Padang, West Sumatra Prov. | | | Schulz | 1984 |
| MY-2 | Chelonia mydas | Malaysia | Pulau Upeh | | | Siow & Moll | 1982 |
| MY-3 | Chelonia mydas | Malaysia | Pangkor Island | | | Siow & Moll | 1982 |
| MY-4 | Chelonia mydas | Malaysia | Pulau Pinang | | | Siow & Moll | 1982 |
| MY-5 | Chelonia mydas | Malaysia | Pulau Langkawi | | | Siow & Moll | 1982 |
| MY-6 | Chelonia mydas | Malaysia | Pulau Sembilan | | | Siow & Moll | 1982 |
| MY-7 | Chelonia mydas | Malaysia | Pasir Panjang beach | | | Siow & Moll | 1982 |
| MY-8 | Chelonia mydas | Malaysia | Tioman Island | 3 | 12 | Leong & Siow | 1984 |
| MY-9 | Chelonia mydas | Malaysia | Pulau Perhantian | 3 | 12 | Leong & Siow | 1984 |
| MY-10 | Chelonia mydas | Malaysia | Pulau Redang | 3 | 12 | Leong & Siow | 1984 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| MY-11 | Chelonia mydas | Malaysia | Kampong Tanjong Batu-Kuala Pahang | 1 | 10 | Seng & Moll | 1980 |
| MY-12 | Chelonia mydas | Malaysia | Kampong Tanjong Batu- Thailand | 3 | 12 | Siow & Moll | 1982 |
| MY-13 | Chelonia mydas | Malaysia | Kuala Pehang to Mersing | 3 | 12 | Siow & Moll | 1982 |
| MY-14 | Eretmochelys imbricata | Malaysia | Pulau Redang | 1 | 9 | Siow & Moll | 1982 |
| MY-15 | Eretmochelys imbricata | Malaysia | Tg. Geliga Tengah | 2 | 6 | Siow & Moll | 1982 |
| MY-16 | Eretmochelys imbricata | Malaysia | Tioman Island | | | Leong & Siow | 1984 |
| MY-17 | Eretmochelys imbricata | Malaysia | Tanjung to Kg.K.Lingii Melaka | | | Mortimer | 1989 |
| MY-18 | Eretmochelys imbricata | Malaysia | Pantai Pasir Panjang beach | | | Anon. | |
| MY-19 | Lepidochelys olivacea | Malaysia | Kuala Keluang to Merang | 1 | 10 | Seng & Moll | 1980 |
| MY-20 | Dermochelys coriacea | Malaysia | Rantau Abang | 5 | 9 | Mortimer | 1989 |
| MY-22 | Chelonia mydas | Malaysia | Pantai Remis | | | Mortimer | 1989 |
| TH-3 | Chelonia mydas | Thailand | Ko Kra | 3 | 9 | Polunin | 1975 |
| TH-4 | Eretmochelys imbricata | Thailand | Ko Kra | 3 | 9 | Polunin | 1975 |
| TH-5 | Chelonia mydas | Thailand | Pattani | 3 | 9 | Polunin | 1975 |
| TH-9 | Eretmochelys imbricata | Thailand | Songkhla, Pattani | 3 | 9 | Polunin | 1975 |
| TH-10 | Chelonia mydas | Thailand | Ko Adang Group | 12 | 3 | Polunin | 1975 |
| TH-11 | Eretmochelys imbricata | Thailand | Similan Islands | 12 | 3 | Polunin | 1975 |
| TH-12 | Chelonia mydas | Thailand | Similan Islands | 12 | 3 | Polunin | 1975 |
| TH-13 | Eretmochelys imbricata | Thailand | Surin Islands | 12 | 3 | Polunin | 1975 |
| TH-14 | Chelonia mydas | Thailand | Surin Islands | 12 | 3 | Polunin | 1975 |
| TH-15 | Chelonia mydas | Thailand | Pha Nga Province coast | 12 | 3 | Mortimer | 1988 |
| TH-16 | Chelonia mydas | Thailand | Ko Phunket | 12 | 3 | Mortimer | 1988 |
| TH-17 | Eretmochelys imbricata | Thailand | Ko Klang | 12 | 3 | Mortimer | 1988 |
| TH-18 | Eretmochelys imbricata | Thailand | Ko Kai | 12 | 3 | Mortimer | 1988 |
| TH-19 | Lepidochelys olivacea | Thailand | Surin Islands | 12 | 3 | Mortimer | 1988 |
| TH-20 | Lepidochelys olivacea | Thailand | Similan Islands | 12 | 3 | Mortimer | 1988 |
| TH-21 | Lepidochelys olivacea | Thailand | Son Bay | 12 | 3 | Mortimer | 1988 |
| TH-25 | Lepidochelys olivacea | Thailand | Pha Nga Province coast | 12 | 3 | Mortimer | 1988 |
| TH-26 | Lepidochelys olivacea | Thailand | Ko Phunket | 12 | 3 | Mortimer | 1988 |
| TH-27 | Dermochelys coriacea | Thailand | Pha Nga Province coast | 12 | 3 | Mortimer | 1988 |
| TH-28 | Dermochelys coriacea | Thailand | Ko Phunket | 12 | 3 | Mortimer | 1988 |

# Strait of Malacca - Seabird Colonies




SPECIES

Seabird Colonies

- Sterna sumatrana
- Sterna anaethetus
- Sterna dougallii
- Sula leucogaster
- Anous stolidus

Milky Stork
*classified as threatened in "Birds to Watch"

- Mycteria cinerea

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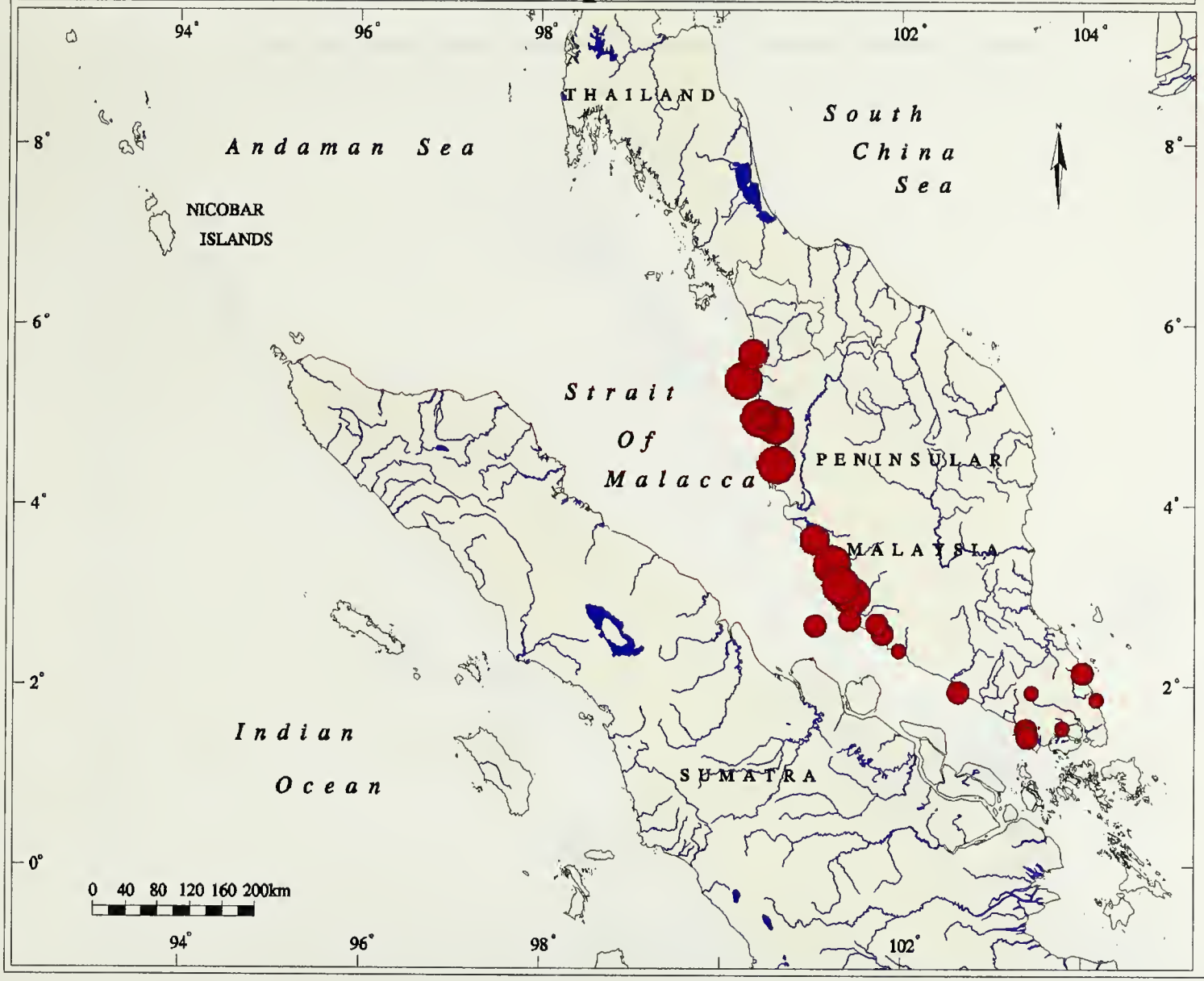
# Strait of Malacca - Important Waterfowl Sites

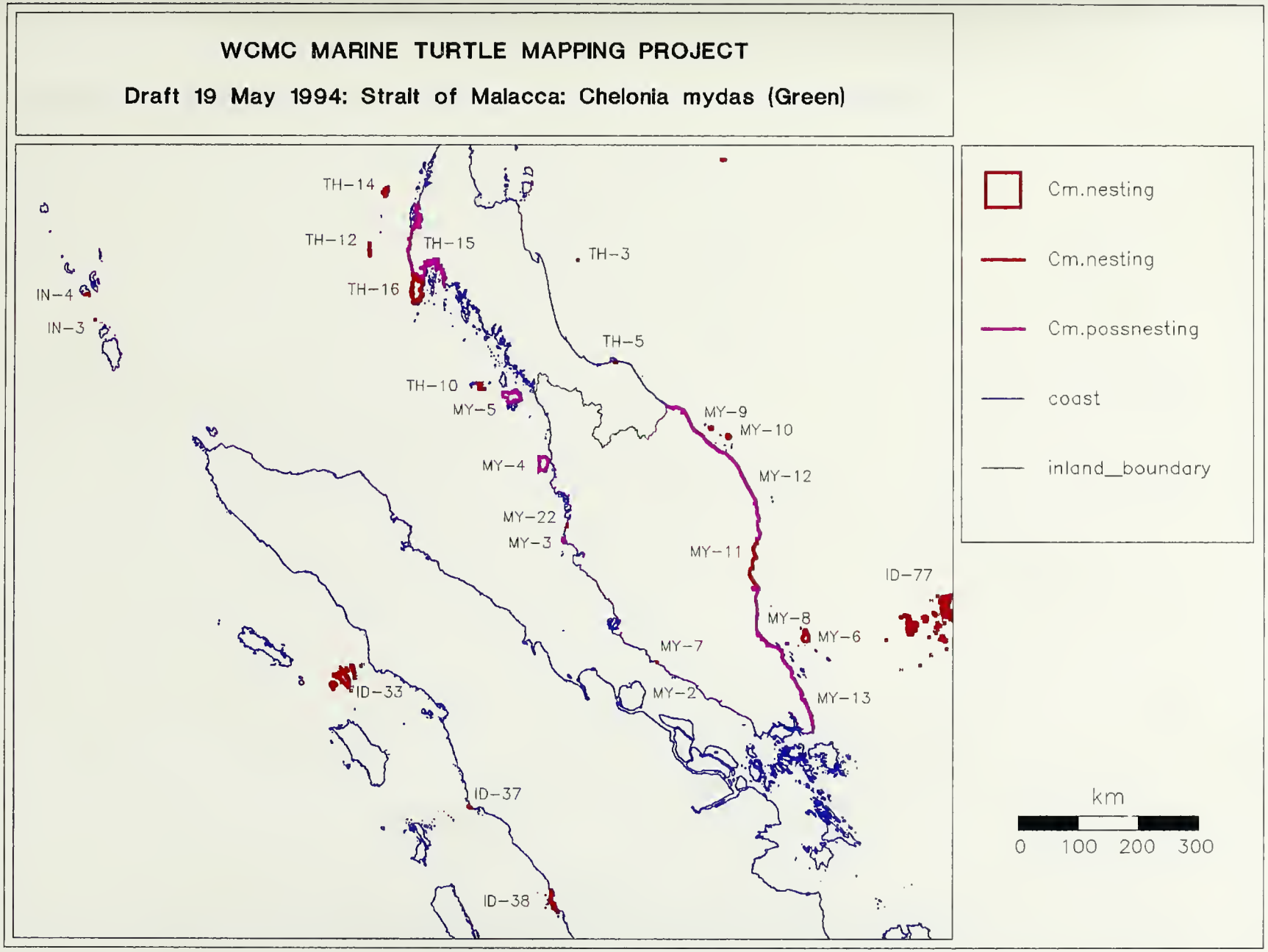


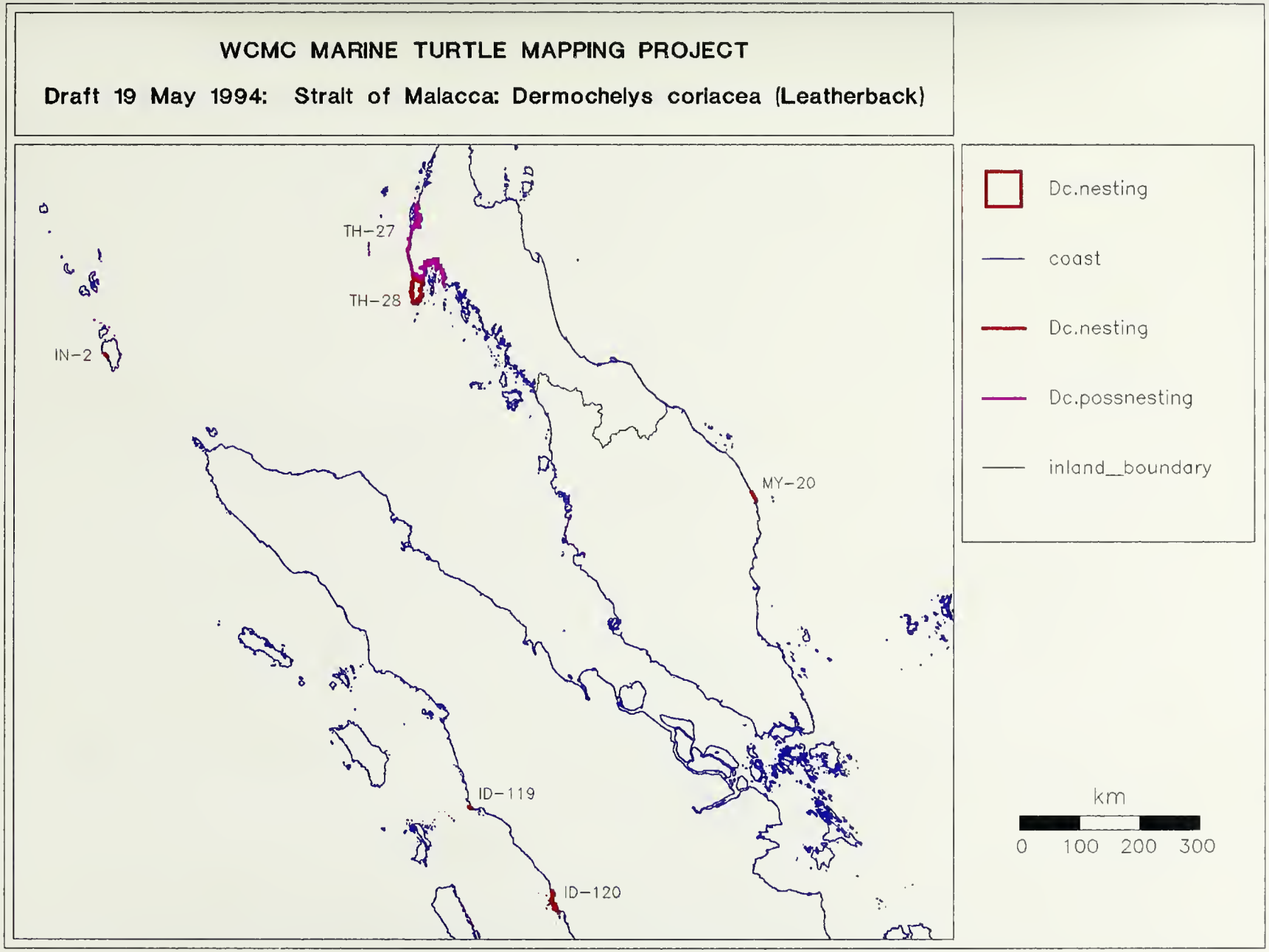

COUNT (76 species)

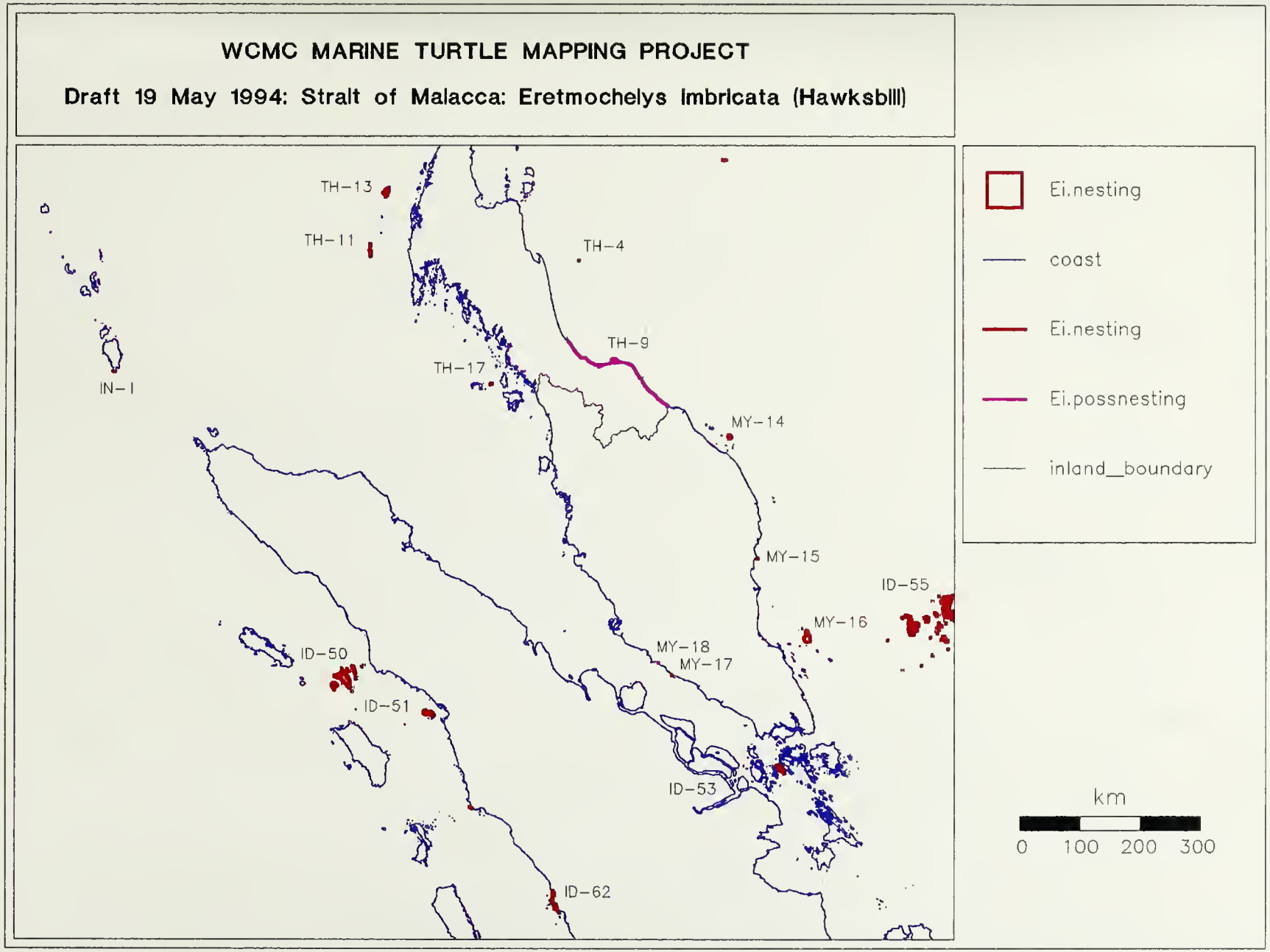
- 1 - 100
- 100 - 500
- 500 - 1000
- 1000 - 10000

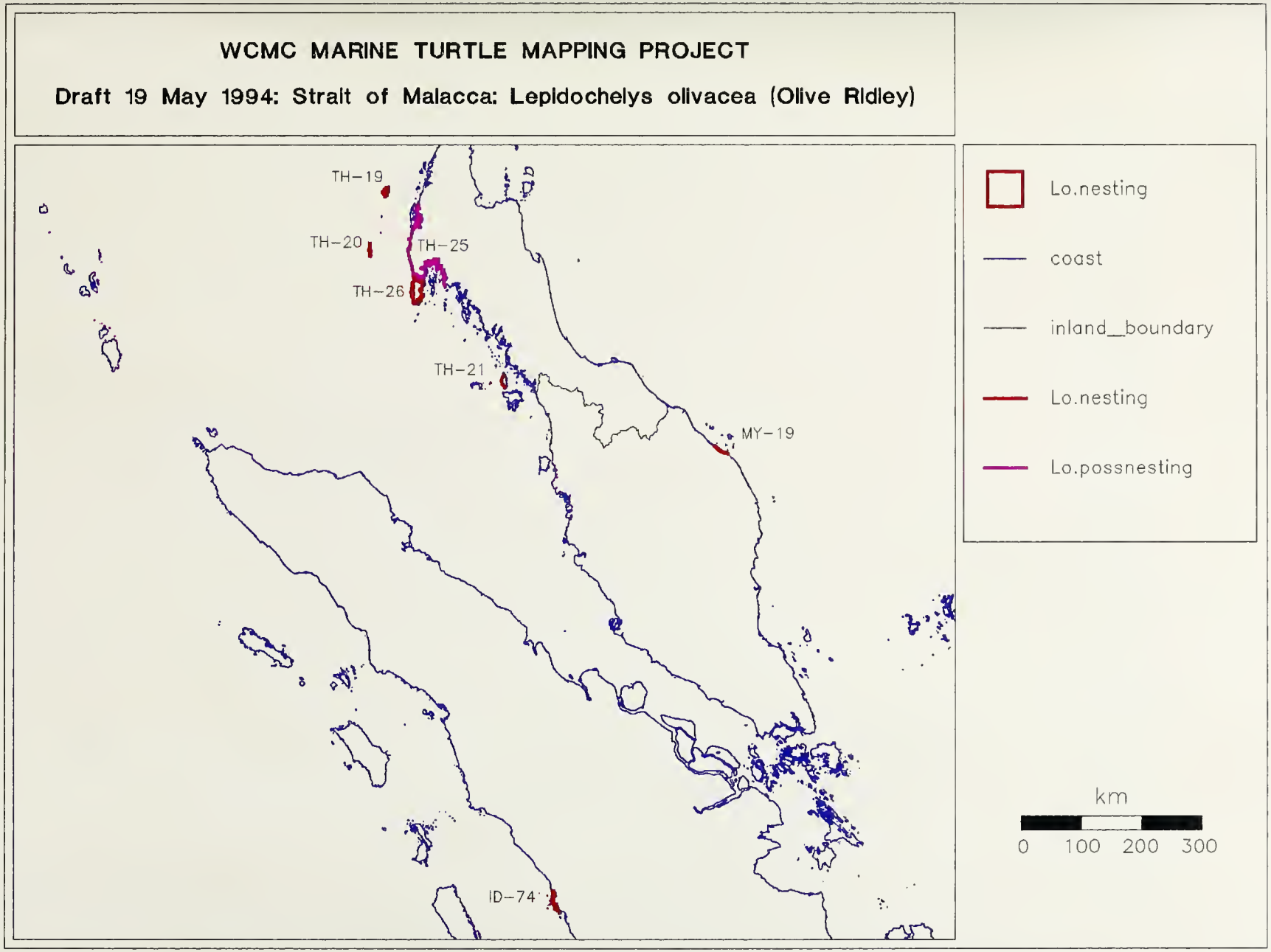
Source: 1992 Census Department of Wildlife and National Parks, Malaysia. And The Asian Wetland Bureau

WORLD CONSERVATION MONITORING CENTRE


WCMC MARINE TURTLE MAPPING PROJECT
Draft 19 May 1994: Strait of Malacca: Chelonia mydas (Green)
TH-14
TH-12
TH-15
TH-3
TH-16
IN-4
IN-3
TH-5
TH-10
MY-5
MY-9
MY-10
MY-4
MY-12
MY-22
MY-3
MY-11
ID-77
MY-8
MY-6
MY-7
ID-33
MY-2
MY-13
ID-37
ID-38
Cm.nesting
Cm.nesting
Cm.possnesting
coast
inland_boundary
km
0
100
200
300


WCMC MARINE TURTLE MAPPING PROJECT
Draft 19 May 1994: Strait of Malacca: Dermochelys coriacea (Leatherback)
TH-27
TH-28
IN-2
MY-20
ID-119
ID-120
Dc.nesting
coast
Dc.nesting
Dc.possnesting
inland_boundary
km
0
100
200
300

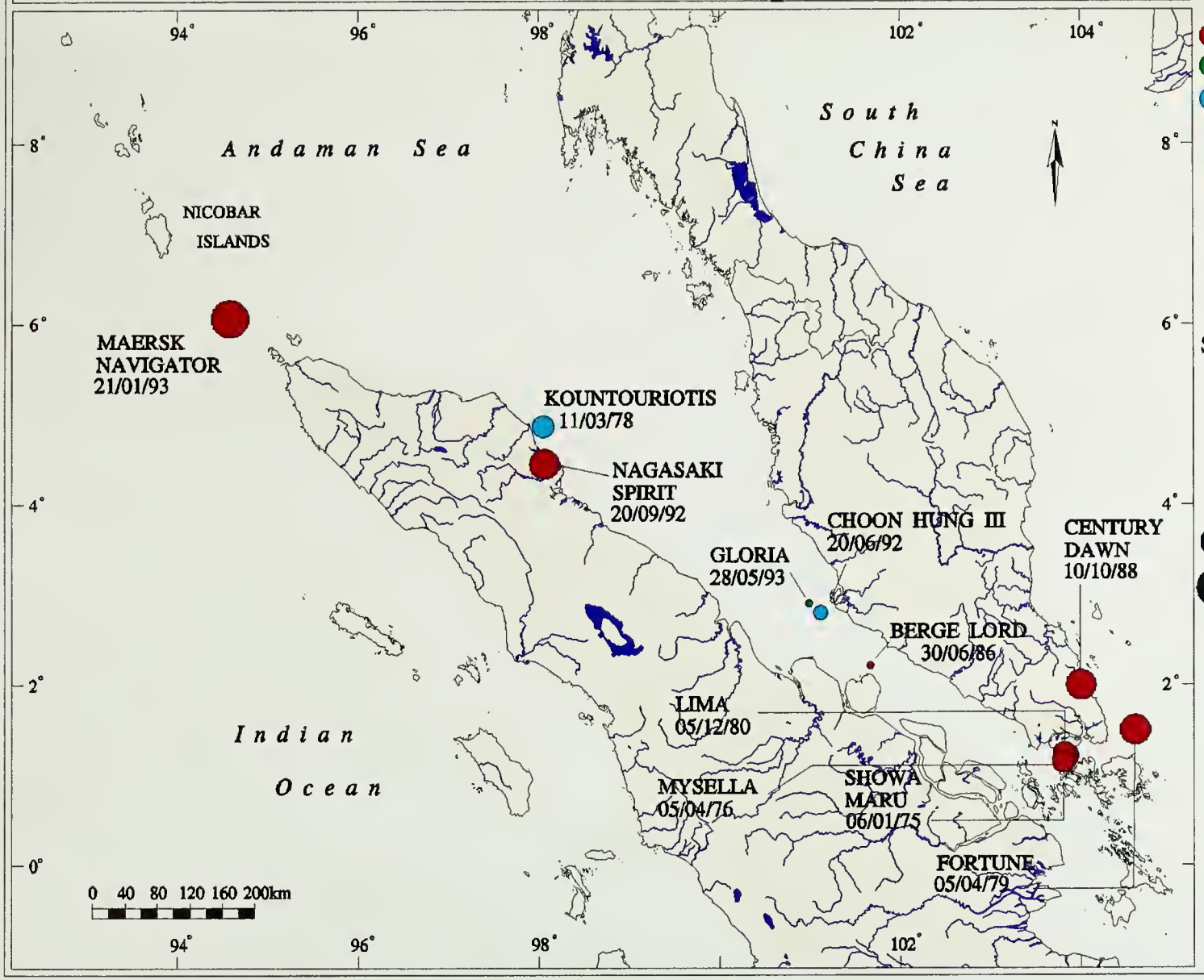

WCMC MARINE TURTLE MAPPING PROJECT
Draft 19 May 1994: Stralt of Malacca: Eretmochelys Imbricata (Hawksbill)
TH-13
TH-11
TH-4
TH-9
TH-17
IN-1
MY-14
MY-15
ID-55
MY-16
MY-18
MY-17
ID-50
ID-51
ID-53
ID-62
Ei.nesting
coast
Ei.nesting
Ei.possnesting
inland_boundary
km
0
100
200
300


WCMC MARINE TURTLE MAPPING PROJECT
Draft 19 May 1994: Strait of Malacca: Lepidochelys olivacea (Olive Ridley)
TH-19
TH-20
TH-25
TH-26
TH-21
MY-19
ID-74
Lo.nesting
coast
inland_boundary
Lo.nesting
Lo.possnesting
km
0
100
200
300

## Section 7. OIL SPILL SITES

The following map has been compiled from data provided by The International Tanker Owners Pollution Federation Ltd and comprises data on spills over 50 barrels from tankers, combined carriers and barges in the Malacca Straits since the early 1970s.

# Strait of Malacca - Oil Spill Sites




TYPE OF SPILL

- Crude
- Bunker
- White product

SIZE OF SPILL (BBL)

- 50 - 500
- 500 - 5000
- 5000 - 50000
- 50000 - 100000
- > 100000

Source: International Tanker Owner's Pollution Federation

WORLD CONSERVATION MONITORING CENTRE

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IUCN
The World Conservation Union

UNEP

WWF

The World Conservation Monitoring Centre is a joint-venture between the three partners who developed the *World Conservation Strategy* and its successor *Caring for the Earth*: IUCN-The World Conservation Union, UNEP- United Nations Environment Programme, and WWF-World Wide Fund for Nature.