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## NATIONAL REPORT

on

## Mangroves in South China Sea

## THAILAND



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**1. GEOGRAPHICAL DISTRIBUTION AT THE HABITAT LEVEL**

**1.1 Map**

Thailand covers an area of 512,820 square kilometres of land. The country has 2,614 kilometres of coastline, about 50% of which is fringed with mangrove forest. The extent of mangrove forestation has changed dramatically in Thailand over the past 30 years. A recent survey conducted in 1996 by Charupatt and Charupatt (1997) estimated the total remaining area of mangrove forest to be in the region of 167,582 hectares. Of this total mangrove area, approximately 80% is located on the peninsular west coast of the Andaman Sea. The GEF project for which this report has been prepared will focus on the remaining 20%, which is located at various points along the coastline of the Gulf of Thailand. Figure 1 represents locations of Mangrove Areas in Thailand.

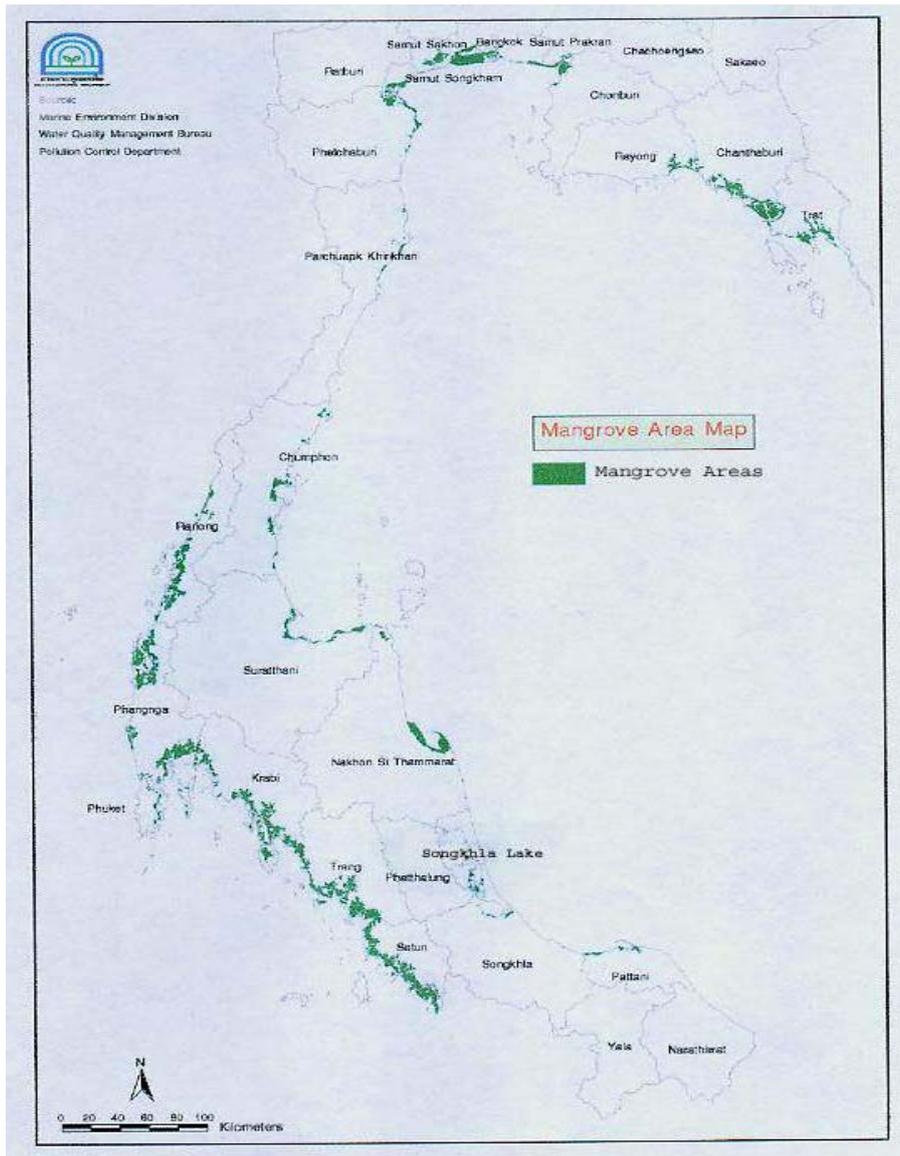


Figure 1 Locations of Mangrove Areas in Thailand.

## 1.2 Distribution Areas

Mangrove forests in the Gulf of Thailand are located on the sheltered muddy shores and low lying areas in the estuaries of rivers and streams which enter the Gulf. Geographically, mangroves in the Gulf of Thailand can be divided into three distinct groups (FAO, 1985): a group in the Eastern region, a Central group, and a group distributed along the Eastern coast of the Southern Thai Peninsula (Figure 1).

- 1) Eastern region: The Eastern region consists of the provinces located on eastern coast of the Gulf of Thailand - Trat, Chantaburi, Rayong and Chonburi. The coastline of this region is approximately 502km long.
- 2) Central region: The Central region is located around the upper part of the Gulf of Thailand, to the south of the Chao Phraya central plain. Provinces with coastline within this region are Chachoengsao, Samut Prakan, Bangkok, Samut Sakhon, Samut Songkhram, Petchaburi and Prachuab Khiri Khan. The total length of coastline in this region is about 439km.
- 3) Southern Thai Peninsula: This region runs south from the province of Chumphon along the eastern coastline of Surat Thani, Nakhon Si Thammarat, Songkhla and Pattani provinces. The total length of this coastline is about 932km.

Figure 2 shows a breakdown of the total area of mangroves in the Gulf of Thailand into both Regions and Provinces in 1996. Significantly larger areas of mangroves are found on the Western side of the Peninsula in the provinces of Ranong, Phangnga, Phuket, Krabi, Trang and Satun, bordering the Andaman Sea. These mangrove forests are not discussed in this report as they are not in the South China Sea region and are thus beyond the scope of the GEF project for which the report has been prepared. Table 1 shows the distribution of mangroves (Ha) in Thailand by region and province, from the period of 1961–2003.

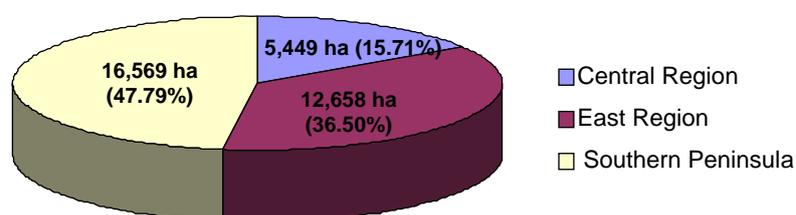


Figure 2 Areas of Mangroves in the Gulf of Thailand in 1996.

Table 1 Mangrove Areas (Ha) Distribution in Thailand by Region and Province, 1961–2003.

Province	1961	1975	1979	1986	1989	1991	1993	1996	2000	2003
<b>Central Region</b>										
Samut Prakan	12,616.9	60	1,04	103.0			31	298.8	319.8	519.8
Bangkok	1,90						20	197.7		1,154.5
Samut Sakhon	28,243.8	18,50	14,41	141.9			1,819.0	1,696.3	3,383.0	3,080.4
Samut Songkhram	10,934.0	8,20	7,64	48.9			92	1,144.9	2,456.1	2,553.1
Petchaburi	11,88	8,80	7,79	576.9	488.9	33	2,06	2,069.7	5,747.0	3,058.5
Prachuab Khi Khan	1,30	40	33	144.9	107.0	70.0	4	43.0	147.5	499.5
<b>Subtotal</b>	<b>66,890.0</b>	<b>36,50</b>	<b>31,23</b>	<b>1,015.8</b>	<b>59</b>	<b>406.0</b>	<b>5,363.0</b>	<b>5,450.7</b>	<b>12,053.6</b>	<b>10,874.0</b>
<b>Eastern Region</b>										
Trat	14,506.0	10,60	9,84	8,817.9	8,637.9	7,750.0	7,66	7,533.9	9,245.9	9,517.1
Chanthaburi	28,188.9	26,10	24,06	14,506.8	8,69	2,663.0	4,07	3,893.1	9,977.6	12,572.8
Rayong	4,42	5,50	4,60	2,417.9	1,757.9	154.0	68	656.4	1,331.5	1,882.2
Chonburi	3,824.9	3,80	3,31	1,497.9	1,04	150.0	9	9	1,043.0	713.7
Chachoengsao	3,900.9	3,00	2,32	74	568.9	367.0	535.6	482.4	1,142.8	1,746.8
<b>Subtotal</b>	<b>54,844.9</b>	<b>49,00</b>	<b>44,14</b>	<b>27,980.6</b>	<b>20,708.8</b>	<b>11,084.3</b>	<b>13,047.6</b>	<b>12,657.9</b>	<b>22,740.9</b>	<b>26,40</b>

Table 1 cont. Mangrove Areas (Ha) Distribution in Thailand by Region and Province, 1961–2003.

Province	1961	1975	1979	1986	1989	1991	1993	1996	2000	2003
<b>Region of Eastern Coast of Peninsula</b>										
Chumphon	10,63	7,40	68	3625.9	2,264.9	1,818.0	3,293.4	3,151.8	8,003.8	7,246.7
Surat Thani	11,803.0	3,70	5,80	4,283.8	3,767.0	2,20	3,16	3,133.7	3,532.4	9,300.3
Nakhon Sri Thammarat	21,616.9	15,485.6	12,83	8,835.8	8,520.9	8,024.9	7,96	8,416.1	9,874.8	9,580.1
Phatthalung	2,531.0	1,90	1,63	104.9	8	6	12	140.9	3,159.5	216.6
Songkhla	6,079.2	5,90	5,18	964.9	68	228.9	54	623.5	4,664.4	3,488.8
Pattani	3,787.0	1,10	1,39	1,82	1,759.0	1,64	1,295.2	1,105.1	3,573.2	4,230.4
<b>Subtotal</b>	<b>56,449.1</b>	<b>35,50</b>	<b>33,77</b>	<b>19,643.5</b>	<b>17,08</b>	<b>13,973.6</b>	<b>16,424.6</b>	<b>16,571.3</b>	<b>32,808.4</b>	<b>34,063.0</b>
<b>Region of Western Coast of Peninsula</b>										
Ranong	27,034.0	24,20	22,59	21,613.9	21,230.0	19,470.0	19,30	19,236.6	25,271.6	27,253.6
Phang-nga	43,979.0	51,10	48,71	36,42	35,626.0	33,510.0	30,716.1	30,442.4	39,696.0	42,037.9
Phuket	2,770.0	3,10	2,84	1,935.0	1,786.0	1,554.0	1,54	1,511.6	1,918.4	1,87
Krabi	39,918.0	33,00	31,76	30,31	29,643.0	31,915.0	28,526.7	28,273.4	34,996.3	35,094.0
Trang	39,892.9	34,00	32,86	26,27	25,04	30,848.9	24,32	24,095.5	33,50	35,788.3
Satoo	40,578.2	46,30	55,37	31,23	28,936.1	31,053.4	29,420.3	19,344.3	35,342.4	39,331.5
<b>Subtotal</b>	<b>194,172.3</b>	<b>191,70</b>	<b>194,15</b>	<b>147,795.8</b>	<b>142,218.2</b>	<b>148,351.6</b>	<b>133,847.2</b>	<b>132,90</b>	<b>170,726.8</b>	<b>181,381.4</b>
<b>Total area of country</b>	<b>372,356.4</b>	<b>312,700.0</b>	<b>303,308.0</b>	<b>196,435.8</b>	<b>180,607.0</b>	<b>173,822.0</b>	<b>168,682.5</b>	<b>167,584.0</b>	<b>238,329.9</b>	<b>252,751.3</b>

Source: Royal Forest Department, (2005).

Large areas of mangroves in the Gulf of Thailand have been destroyed as a result of human settlement, industrialization, and shrimp farming, and mangrove forests along the Gulf coast distribute mainly as isolated narrow strips. However, substantial mangrove areas remain at the following Gulf coast locations:

- Trat and Mu Koh Chang National Park, Trat province (11° 45' - 12° 10' N and 102° 15' - 31' E).
- Welu River estuary, Chantaburi province (10° 16' - 17' N and 100° 08' - 22' E).
- Khung Kraben Bay, Chantaburi province (12° 32' - 41' N and 101° 52' - 57' E)
- Don Hoi Lot mudflats and Klong Yeesan and Klong Kone estuaries, Samut Songkhram province (13° 17' - 25' N and 99° 55' - 100' E).
- Petchaburi River mouth, Petchaburi province (10° 6' N and 99° 7' E)
- Khao Sam Roi Yot National Park, Prachuab Khiri Khan province (12° 05' - 20' N and 99° 52' - 100° 02' E).
- Thung Kha Bay and Savi Bay, Chumphon province (10° 20' - 25' N and 99° 05' - 15' E).
- Ban Don Bay, Surat Thani province (9° 11' - 24' N and 99° 13' - 41' E).
- Pak Phanang Bay, Nakhon Si Thammarat province (8° 21' - 34' N and 95° 58' - 100° 15' E).
- Pattani Bay, Pattani province (6° 51' - 58' N and 95° 58' - 100° 16' E).

## 2. SPECIES DISTRIBUTION AND FORMATION

### 2.1 Species Distribution

According to Santisuk (1983) 71 species of trees and shrubs have been recorded from the mangrove forests of the Gulf of Thailand (Table 2). These species include 27 species which have been classified as "true mangroves" (species that are bound to saline or brackish water) and 44 species classified as "mangrove associates" (species of littoral vegetation that regularly occur in the rear, landward zone of mangrove forests). The most common mangrove species is *Rhizophora apiculata* while other common species belong to the families Verbenaceae (*Avicennia* spp.), Rhizophoraceae (*Rhizophora* spp., *Bruguiera* spp., *Ceriops* spp.) and Sonneratiaceae (*Sonneratia* spp.).

Distribution of mangrove species across the Gulf of Thailand is quite uniformed in nature with only minor differences in species distribution apparent between the groups from the East, the Central region, and the Southern peninsula (Table 2).

Table 2 Distribution and Characteristics of Mangrove Trees and Mangrove Shrubs found in the Gulf of Thailand.

	Scientific Name	Vernacular Name	Family	Habit	Distribution	
					C & S	E
1	<i>Acanthus ebracteatus</i>	Ngueak Plaamo	Acanthaceae	S	+	+
2	<i>A. ilicifolius</i>	Ee kreng	Acanthaceae	S	+	+
3	<i>Acrostichum aureum</i>	Prong thale	Pteridaceae	S	+	+
4	<i>A. speciosum</i>	Prong nuu	Pteridaceae	S	+	-
5	<i>Aglaia cuculatta</i> <sup>xx</sup>	Daeng nam	Meliaceae	T	+	+
6	<i>Aegiceras corniculatum</i>	Lep mue naang	Myrsinaceae	S	+	+
7	<i>Allophylus cobbe</i>	Tosai	Sapindaceae	S	+	+
8	<i>Ardisia elliptica</i>	Raamyai	Myrsinaceae	S/ST	+	+
9	<i>Avicennia alba</i>	Samae khao	Avicenniaceae	T	+	+
10	<i>A. marina</i>	Samae thale	Avicenniaceae	T	+	+
11	<i>A. officinalis</i>	Samae dam	Avicenniaceae	T	+	+
12	<i>Barringtonia asiatica</i>	Chik le	Barringtoniaceae	T	+	+
13	<i>B. racemosa</i>	Chik suan	Barringtoniaceae	ST	+	+
14	<i>Brownlowia tersa</i> <sup>xx</sup>	Nam Nong	Tiliaceae	S	+	+
15	<i>Bruguiera cylindrica</i>	Thua Khao	Rhizophoraceae	T	+	+
16	<i>B. gymnorhiza</i>	Kongkaanghua sum	Rhizophoraceae	T	+	+
17	<i>B. hainesii</i> <sup>xx</sup>	-	Rhizophoraceae	T	+	+
18	<i>B. parviflora</i>	Thua dam	Rhizophoraceae	T	+	+
19	<i>B. sexangula</i>	Prasak dok khao	Rhizophoraceae	T	+	+
20	<i>Calophyllum inophyllum</i>	Saraphee thale	Guttiferae	T	+	+
21	<i>Cerbera manghas</i>	Teepet saai	Apocynaceae	ST	+	+
22	<i>C. odollam</i>	Teenpet thale	Apocynaceae	T	+	+
23	<i>Ceriops decandra</i>	Prong khao	Rhizophoraceae	S/ST	+	+
24	<i>C. tagal</i>	Prong daeng	Rhizophoraceae	T	+	+
25	<i>Clerodendrum inerme</i>	Sammangaa	Verbenaceae	S	+	+
26	<i>Cynometra iripa</i>	Kaa tong	Leguminosae	S	+	-
27	<i>C. ramiflora</i>	Maang kha	Leguminosae	T	+	+
28	<i>Cycas rumphii</i>	Prong thale	Cycadaceae	ST	+	+
28	<i>Dendrolobium umbellatum</i>	Chamaep	Leguminosae	S	+	+
29	<i>Derris indica</i>	Yee nam	Leguminosae	T	+	+
30	<i>Diospyros ferrea</i>	Lambit thale	Ebenaceae	S	+	+
31	<i>D. areolata</i>	Maa plab	Ebenaceae	T	-	+
32	<i>Dolichandrone spathacea</i>	Khae Thale	Bignoniaceae	T	+	+
33	<i>Excoecaria agallocha</i>	Taatum thale	Euphorbiaceae	ST/T	+	+
34	<i>Ficus microcarpa</i>	Sai Yoi bai thuu	Moraceae	T	+	+
35	<i>Glochidion littorale</i>	-	Euphorbiaceae	ST	+	+
36	<i>Guettarda speciosa</i>	Kangkaang huuchang	Rubiaceae	ST	+	+
37	<i>Heritiera littoralis</i>	Ngonkai thale	Sterculiaceae	T	+	+
38	<i>Hibiscus tiliaceus</i>	Po thale	Malvaceae	T	+	+
39	<i>Horsfieldia irya</i>	Kruai	Myristicaceae	T	+	+
40	<i>Intsia bijuga</i>	Lumpho thale	Leguminosa	T	+	+
41	<i>Kandelia candel</i>	Rang ka thae	Rhizophoraceae	T	+	+
42	<i>Lumnitzera littorea</i>	Faat daeng	Combretaceae	ST/T	+	+
43	<i>L. racemosa</i>	Faat Khao	Combretaceae	S/ST	+	+
44	<i>Melaleuca cajuputi</i>	Samet	Myrtaceae	T	+	+
45	<i>Melastoma villosum</i>	Khlongkheng khom	Melastomaceae	S	+	-
46	<i>Myrsine porteriana</i>	Phrong nok	Myrsinaceae	S	+	+
47	<i>Nypa fruticans</i>	Chaak	Palmae	ST	+	+
48	<i>Oncosperma tigillaria</i>	Lao cha on	Plamae	T	-	+
49	<i>Pandanus odoratissimus</i>	Toei thale	Pandanaceae	ST	+	+
50	<i>Peltophorum pterocarpum</i>	Non see	Leguminosae	T	+	+
51	<i>Pemphis acidula</i>	Thian le	Lythraceae	S	+	+
52	<i>Phoenix paludosa</i>	Peng thale	Palmae	T	+	+
53	<i>Planchonella obovata</i>	Ngaa saai	Sapotaceae	T	+	+
54	<i>Pluchea indica</i>	Khluu	Compositae	S	+	+
55	<i>Premna obtusifolia</i>	Chaa lueat	Verbenaceae	S	+	+
56	<i>Rhizophora apiculata</i>	Kongkaang bailek	Rhizophoraceae	T	+	+
57	<i>R. mucronata</i>	Kongkaang baiyai	Rhizophoraceae	T	+	+
58	<i>Sapium indicum</i>	Samo thale	Euphorbiaceae	ST/T	+	+
59	<i>Scaevola taccada</i>	Rak Thale	Goodeniaceae	ST	+	+
60	<i>Scolopia macrophylla</i>	Takhob Thale	Flacourtiaceae	ST	-	+
61	<i>Scyphiphora hydrophyllacea</i>	Chee ngam	Rubiaceae	ST	+	+
62	<i>Sonneratia alba</i>	Paat	Sonneratiaceae	T	+	+
63	<i>S. caseolaris</i>	Lam phu	Sonneratiaceae	T	+	+

Table 2 cont. Distribution and Characteristics of Mangrove Trees and Mangrove Shrubs found in the Gulf of Thailand.

	Scientific Name	Vernacular Name	Family	Habit	Distribution	
					C& S	E
64	<i>S. griffithii</i>	Lam phaen hin	Sonneratiaceae	T	+	-
65	<i>S. ovata</i>	Lam phaen hin	Sonneratiaceae	T	+	+
66	<i>Sueda maritima</i>	Cha khraam	Chenopodiaceae	US	+	+
67	<i>Terminalia catappa</i>	Huu kwaang	Combretaceae	T	+	+
68	<i>Thespesia populnea</i>	Pho thale	Malvaceae	T	+	+
69	<i>Xylocarpus granatum</i>	Ta buun khao	Meliaceae	T	+	+
70	<i>X. rumphii</i>	Ta buun	Meliaceae	T	+	-
71	<i>X. moluccensis</i>	Ta buun dam	Meliaceae	T	+	+

Source: Modified from Santisuk, 1983.

Notes to Table 2: T = tree, S = shrub, ST = shrubby tree, US = under-shrub, C = Central area, S = Southern peninsula area, E = Eastern area, <sup>xx</sup> = classified in the IUCN Red Book as endangered. Shading indicates that the species is classified as a "true mangrove" bound to saline or brackish water. Unshaded species are mangrove associates, species of littoral vegetation that regularly occur in the landward zone of mangrove forests.

## 2.2 Formation

The distribution of mangrove species within mangrove forests across the Gulf of Thailand occurs in distinct zonation patterns with different species or combinations of species dominating different zones, resulting from the competitive advantages each species has along the gradient from mean sea level to above the high water line (corresponding to frequency of inundation) as well as the influence of other environmental factors at the site including soil type and soil salinity (Santisuk, 1983; Aksornkoae, 1985).

Aksornkoae (1975) studied the dominant species associations of mangrove forests in Eastern Thailand and summarised the zonation patterns from the river edge to inland sites as follows: "*Rhizophora apiculata* and *Rhizophora mucronata* are the dominant species along river and channel banks. *Avicennia* and *Bruguiera* are associated with *Rhizophora* along the channels, but form a distinct zone further inland. *Xylocarpus* and *Excoecaria* dominate on sites adjacent to the *Avicennia* and *Bruguiera* zone that have drier soils and are less subject to tidal inundation; *Ceriops* and *Lumnitzera* are also found within this zone. *Melaleuca* reaches its greatest dominance further inland on even drier and more elevated sites that are still less subject to tidal flooding".

### Eastern Region

In the Eastern region province of Chantaburi, the mangrove forests can be divided into three principal classes (National Research Council and Royal Forest Department, 1985).

#### Central region

In Samut Sakhon province the important species have been recorded as *Rhizophora* spp., *Avicennia* spp., *Sonneratia* spp., *Xylocarpus* spp., *Lumnitzera* spp. and *Nypa fruticans*. Currently only a few species are found within the mangrove forests along the Tha Chin estuary and the dominant species are *Avicennia marina* and *A. alba*. A greater number of species were observed in mangrove forests on the river banks, and common species recorded included *Avicennia alba*, *Sonneratia caseolaris*, *Xylocarpus granatum*, *Cerbera odollam* and *Nypa fruticans* (Aksornkoae and Eiumnoh 1988).

#### Southern Peninsula

At Khanom district in Nakhon Si Thammarat province, where a high species diversity is found, the most common species are *R. apiculata*, *R. mucronata*, *X. moluccensis*, *A. alba*, *C. tagal*, *Lumnitzera* sp., *E. agallocha*, *Bruguiera gymnorrhiza*, *B. cylindrica*, *Heritiera littoralis*, *Acrostichum aureum*, *S. alba* and *Phoenix paludosa* (Aksornkoae and Eiumnoh 1988).

## 3. ENVIRONMENTAL STATE

### 3.1 Physical

#### 3.1.1 Climate

Thailand's climate is dominated by the influence of the powerful South and Southeast Asian monsoons which result from the seasonal differences in temperatures between land masses and the oceanic body, alternately blowing south-westerly and north-easterly over the country. The surrounding waters and the physiographic terrain contribute much to modifying the monsoon effects on various localities of the country. Characteristics of the climate in each of the three mangrove forest zones of the Gulf of Thailand are shown in Table 3.

Table 3 Summary of Climatic Conditions in Each of the Three Mangrove Forest Regions of the Gulf of Thailand.

Region	Climatic type	Rainfall	Temperature	Humidity
Eastern	Rayong-Trat: Tropical monsoon climate.  Rayong-Chonburi: Tropical savanna climate.	Average annual rainfall is 2,663.7mm. Maximum monthly rainfall in September (505.5mm), minimum in December (6.1mm).	Average annual temperature is 27.6 C. Highest in April (29.4 C) and lowest in December (26.1C).	Annual average relative humidity is 78.5%. Highest in September (84.7%) and lowest in January (69.8%).
Central	Tropical savanna climate.	Average annual rainfall is 1,555.9mm. Maximum monthly rainfall in September (378.3mm), minimum in December (4.6mm).	Average annual temperature is 27.7 C. Highest in April (29.9 C) and lowest in January (25.3 C).	Annual average relative humidity is 76.1%. Highest in October (81.4%) and lowest in January (70.0%).
Southern Peninsula	Petchaburi – Prachuab Khiri Khan: Tropical savanna climate.  Prachuab Khiri Khan - Surat Thani: Tropical monsoon climate.  Surat Thani – Narathiwat: Tropical rainforest climate.	Average annual rainfall is 2,003.3mm. Maximum monthly rainfall in November (409.9 mm), minimum in March (52.5mm). This coastline receives the full impact of the northeast monsoon. Provinces located along the seashore, especially Narathiwat, have a maximum annual rainfall of 2,585.3mm.	Average annual temperature is 27.6 C. Highest in May (28.6 C) and lowest in December (25.5C).	Annual average relative humidity is 80.7%. Highest in November (84.8%) and lowest in April (77.9%).

Source: Meteorological Department (1987).

Notes to Table 3:

- Tropical savannah climate: Little rainfall and severe drought during winter and summer, but forests nevertheless present.
- Tropical monsoon climate: High rainfall throughout the year and a short dry period
- Tropical rainforest climate: High humidity and rainfall throughout the year.

### 3.2 Biological

#### 3.2.1 Aquatic Fauna

##### **Phytoplankton**

Many efforts have been made to study the composition and distribution of phytoplankton in the mangroves of the Gulf of Thailand (Boonrang, 1985, and Marumo *et al.*, 1985). Suvapepun *et al.* (1979) reported on the species composition and distribution of zooplankton communities in the mangrove forest at Laem Phak Bia in Petchaburi province. Copepod and decapod larvae were the dominant groups. Marumo *et al.* (1985) also found that copepods dominated in the epipelagic zooplankton community at Khung Kraben, Chanthaburi province.

##### **Macrofauna**

Mangrove macrofauna have been intensively studied emphasizing the distribution, abundance and biomass of major species or groups such as crustaceans, molluscs, and polychaetes, and many reports have been published studying the macrobenthos of mangrove areas in the Gulf of Thailand. It was described the benthic communities in the mangrove forests at Khlung district, Chantaburi province, recording thirty-five species of macrofauna, mostly crustaceans and polychaetes annelids. Total organic content, tidal inundation and salinity were the three factors controlling animal distribution and species composition and richness. Distribution of mangrove organisms was also related to soil characteristics. More recently several studies have been completed on the impact of mangrove reforestation on benthic communities and production (Piyakarnchana, 1988; Paphavasit *et al.*, 1996; Suzuki *et al.*, 1997 (a) Suzuki *et al.*, 1997 (b)). It was found 116 species of benthic fauna in a long-term study of a mangrove area in Samut Songkhram.

##### **Crabs**

A survey of crabs in mangroves and adjacent areas at Laem Phak Bia, Petchaburi province, was carried out by Naiyanetr (1979). Seven families with 54 species were recorded. The majority of these mangrove crabs belonged to the families Grapsidae and Ocypodidae. The genera commonly found from the Grapsidae family were *Sesarma*, *Parasesarma*, *Chiromentos*, *Sarmatium* and *Metaplox*. Those from the family Ocypodidae consisted mostly of the genera *Macrophthalmus*, *Ilyoplax* and *Uca*. A few species were found belonging to the families Portunidae, Gecarcinidae, Paguridae, Coenobitidae and Xiphosuridae.

### Molluscs

Mangrove molluscs in Thailand, both gastropods and pelecypods (bivalves), have been studied by Isarankura (1976). Molluscs were observed to be either attached to stems, roots and leaves of mangroves or living on the mangrove soil (floor). The predominant snail species included those from the genera *Littorina*, *Cerithidae*, *Telescopium*, *Terebralis* and *Nerita*, with the latter being the most abundant. There were 10 species of gastropods and three species of bivalves living on trees and eight species of gastropods and two species of bivalves living on mangrove soils. Two species of gastropods (*Cassidula aurisfelis* and *Onchidium* sp.) were found at both habitats investigated but only one species of bivalve (*Isognomon ehippium*) was observed. Bivalves such as oysters and cockles are found buried in the mud or attached to the roots and stems of plants. Boring bivalves (*Teredo* spp.) live on rotten stems of dead trees. Four species of bivalves are found in mangrove forests, and of these *Crassostrea commercialis* is of particular commercial importance.

### Shrimps

Chaitiamvong (1983) reported on species of shrimps found in the mangroves in Thailand and observed that these species mainly belong to the genera *Metapenaeopsis*, *Metapenaeus*, and *Parapenaeopsis*. About 16 species of shrimps migrate from marine waters to brackish water mangrove areas and the main genera which do so are *Metapenaeus*, *Penaeus* and *Acetes*. The species of shrimps most commonly found in the mangrove forests are *Macrobrachium equidens*, *Palaesnder* sp. and *Palaemonetes* sp. Chaitiamvong recorded few species of shrimp migrating from fresh water to brackish water mangrove areas but those most commonly doing so were *Macrobrachium rosenbergii* and *Leptocarpus potamiseus*.

### Fish

The shallow waterways characteristic of mangrove forests are of immense and traditional importance for fisheries as they provide food and shelter for many species and serve as nursery areas for juvenile fish and shrimps. Several studies of mangrove-associated fish populations in Thailand provide evidence that Thai mangrove forests are used by fish as a) nursery grounds; b) permanent habitats or c) breeding grounds in the case of some coastal species (Paphavasit 1995). Numerous studies have been undertaken to assess the diversity of fish species and the results of some of these studies are summarised in Table 4.

Table 4 Fish Diversity in the Mangrove Forests of Thailand.

Location	Total species recorded
Laem Phak Bia, Petchaburi	More than 30 families of fish larvae of Economic importance such as snappers, Milkfish, groupers and mullets.
Klong Wan, Prachaub Khiri Khan	31 species of fish larvae with tarpon, lady fish, milkfish, and snappers as dominant groups.
Klong Klone, Samut Songkhram	55 species in 32 families with <i>Ambassidae</i> , <i>Clupeidae</i> and <i>Engraulidae</i> as dominant Groups.
Trat Bay, Trat	111 species of fish from 47 families, with <i>Cypridinae</i> , <i>Gobididae</i> , <i>Sigainindae</i> and <i>Engraulidae</i> as dominant groups.

Sources: Vatanachai (1979) and Singkran and Sudara (1999).

### 3.2.2 Terrestrial Wildlife Species

Terrestrial fauna inhabiting the mangrove forests in Thailand include birds, amphibians, reptiles and mammals. Surveys of mangrove vertebrates (excepting fishes) were reported a total of 106 species of mangrove mammals. Two groups of mammals are found: true mangrove species and other terrestrial species found at the forest margin. Among the former group are species found in large numbers which are well adapted to mangrove life, such as rats, squirrels and bats. The latter group consists of species that enter the forests in search for food, including bandicoot rats, spotted cats, civets, wild boars, crab-eating macaques, and otters. Nabhitabhata (1982) reported that six amphibian species are known to occur in mangroves, including the crab-eating frog (*Rana cancrivora*), but only two of these species are true residents. Nabhitabhata (1982) in his ecological studies of birds in Songkhla Lake, Southern Thailand noted that there were 25 families with 90 species of birds in the area. Of these, 70% and 20% respectively were residents and seasonal migrants. Kongsangchai and Prayoonsit (1990) found that vertebrates visited mangroves in search of food and/or for residence, with a total number of 278 species (not including fish) recorded. These included 36 mammals, 204 birds, 32 reptiles and 6 amphibians.

### 3.2.3 Threatened species

A number of the species observed in the mangrove forests of the Gulf of Thailand are designated as endangered species either nationally or globally. Endangered species which have been recorded during survey work are listed in Table 5.

Table 5 Bird and Fish Species at Risk which have been Recorded in Mangrove Areas in the Gulf of Thailand.

Scientific name	Common name	Status	Location
<b>Birds</b>			
<i>Aquila clanga</i>	Greater spotted eagle	Globally threatened	Khao Sam Roi Yot National Park
<i>Aythya baeri</i>	Baer's pochard	Globally threatened	Khao Sam Roi Yot National Park
<i>Charadrius peronii</i>	Malaysian plover	Globally threatened	Khao Sam Roi Yot National Park Ban Don Bay, Pattani Bay
<i>Columba punicea</i>	Pale-capped pigeon	Globally threatened	Khao Sam Roi Yot National Park
<i>Eurynorhynchus pygmaeus</i>	Spoon-billed sandpiper	Globally threatened	Khao Sam Roi Yot National Park
<i>Heliopais personata</i>	Masked finfoot	Globally threatened	Ban Don Bay, Pattani Bay
<i>Leptoptilos dubius</i>	Greater adjutant	Globally threatened	Khao Sam Roi Yot National Park
<i>Limnodromus semipalmatus</i>	Asian dowitcher	Globally threatened	Khao Sam Roi Yot National Park Pak Phanang Bay
<i>Pelecanus philippensis</i>	Spot-billed pelican	Globally threatened	Khao Sam Roi Yot National Park
<i>Tringa guttifer</i>	Spotted greenshank	Globally threatened	Khao Sam Roi Yot National Park
<i>Anous stolidus</i>	Brown noddy	Critically endangered	Mu Koh Chang National Park
<i>Bubo coromandus</i>	Dusky eagle-owl	Critically endangered	Khao Sam Roi Yot National Park
<i>Leptopilos javanicus</i>	Lesser adjutant	Critically endangered	Klong Kone and Klong Yeesan Pak Phanang Bay
<i>Acrocephalus tangolium</i>	Manchurian reed warbler	Endangered	Khao Sam Roi Yot National Park
<i>Aquila heliaca</i>	Imperial eagle	Endangered	Khao Sam Roi Yot National Park
<i>Ardea cinerea</i>	Grey heron	Endangered	Khao Sam Roi Yot National Park Thung Kha Bay / Savi Bay, Don Hoi Lot
<i>A. purpurea</i>	Purple heron	Endangered	Khao Sam Roi Yot National Park Thung Kha Bay / Savi Bay
<i>Ciconia nigra</i>	Black stork	Endangered	Khao Sam Roi Yot National Park
<i>Egretta eulophotes</i>	Chinese egret	Endangered	Klong Kone and Klong Yeesan
<i>Milvus migrans</i>	Black kite	Endangered	Khao Sam Roi Yot National Park
<i>Myeteria leucocephala</i>	Painted stork	Endangered	Klong Kone and Klong Yeesan Khao Sam Roi Yot National Park
<i>Phalacrocorax carbo</i>	Great cormorant	Endangered	Klong Kone and Klong Yeesan Khao Sam Roi Yot National Park
<i>Sterna bergii</i>	Great crested tern	Endangered	Mu Koh Chang National Park Khao Sam Roi Yot National Park
<i>Threskionis melanocephalus</i>	Black-head ibis	Endangered	Khao Sam Roi Yot National Park
<i>Aerodramus fuciphagus</i>	Edible-nest swiftlet	Near-threatened	Mu Koh Chang National Park Khao Sam Roi Yot National Park Pak Phanang Bay, Don Hoi Lot
<i>Amandava amandava</i>	Red avadavat	Near-threatened	Khao Sam Roi Yot National Park
<i>Aquila nipalensis</i>	Steppe eagle	Near-threatened	Khao Sam Roi Yot National Park
<i>Botaurus stellaris</i>	Great bittern	Near-threatened	Khao Sam Roi Yot National Park
<i>Buceros bicornis</i>	Great hornbill	Near-threatened	Mu Koh Chang National Park
<i>Burhinus oedichnemus</i>	Eurasian thick-knee	Near-threatened	Khao Sam Roi Yot National Park
<i>Coturnix chinensis</i>	Blue-breasted quail	Near-threatened	Khao Sam Roi Yot National Park
<i>Ducula bicolor</i>	Pied imperial pigeon	Near-threatened	Mu Koh Chang National Park Khao Sam Roi Yot National Park
<i>Emberiza aureola</i>	Yellow-breasted bunting	Near threatened	Khao Sam Roi Yot National Park
<i>Falco severus</i>	Oriental hobby	Near-threatened	Khao Sam Roi Yot National Park Thung Kha Bay / Savi Bay
<i>Ficedula narcissina</i>	Narcissus flycatcher	Near-threatened	Khao Sam Roi Yot National Park
<i>Gallinago cinerea</i>	Watercock	Near-threatened	Khao Sam Roi Yot National Park
<i>Gallinago megala</i>	Swinhoe's snipe	Near-threatened	Khao Sam Roi Yot National Park
<i>Gorsachius melanolophus</i>	Malayan night-egret	Near-threatened	Thung Kha Bay / Savi Bay
<i>Haliaeetus leucogaster</i>	White bellied sea eagle	Near-threatened	Mu Koh Chang National Park Khao Sam Roi Yot National Park Thung Kha Bay / Savi Bay, Ban Don Bay, Pattani Bay
<i>Haliastur indus</i>	Brahminy kite	Near-threatened	Welu River Estuary, Mu Koh Chang National Park Khao Sam Roi Yot National Park Ban Don Bay, Pattani Bay Don Hoi Lot

Table 5 cont. Bird and Fish Species at Risk which have been Recorded in Mangrove Areas in the Gulf of Thailand.

Scientific name	Common name	Status	Location
<i>Ixobrychus eurhythmus</i>	Schrenck's bittern	Near-threatened	Khao Sam Roi Yot National Park
<i>Nettapus coromandelianus</i>	Cotton pygmy-goose	Near-threatened	Khao Sam Roi Yot National Park
<i>Numenius madagascariensis</i>	Eastern curlew	Near-threatened	Khao Sam Roi Yot National Park
<i>Ploceas philipinus</i>	Baya weaver	Near-threatened	Khao Sam Roi Yot National Park
<i>Rhyticeros subruficollis</i>	Plain-pouched hornbill	Near-threatened	Mu Koh Chang National Park
<i>Sterna albifrons</i>	Little tern	Near-threatened	Khao Sam Roi Yot National Park Pak Phanang Bay, Don Hoi Lot
<i>Treron bicincta</i>	Orange breasted pigeon	Near-threatened	Khao Sam Roi Yot National Park
<i>Vanellus cinereus</i>	Grey-headed lapwing	Near-threatened	Khao Sam Roi Yot National Park
<i>Aythya nyroca</i>	Ferruginous pochard	Vulnerable	Khao Sam Roi Yot National Park
<i>Garrulax merulinus</i>	Spot-breasted laughing thrush	Vulnerable	Mu Koh Chang National Park
<i>Ploceas manyar</i>	Streaked weaver	Vulnerable	Khao Sam Roi Yot National Park
<i>Terpsiphone atrocaudata</i>	Japanese paradise-flycatcher	Vulnerable	Khao Sam Roi Yot National Park
<b>Fish</b>			
<i>Hippocampus kuda</i>	Seahorse	Endangered	Welu River Estuary
<i>Anodontostoma chacunda</i>	Chawnda gizzard-shad	Vulnerable	Welu River Estuary
<i>Chiloscyllium burgeri</i>	Bambooshark	Vulnerable	Welu River Estuary
<i>C. indicum</i>	Slender bambooshark	Vulnerable	Welu River Estuary
<i>Clarius batrachus</i>	Walking catfish	Vulnerable	Khao Sam Roi Yot National Park
<i>Pampus argenteus</i>	Silver pomfret	Vulnerable	Welu River Estuary
<i>P. chinensis</i>	Chinese pomfret	Vulnerable	Welu River Estuary

Critically Endangered/Endangered = designated as an critically endangered or endangered species in Thailand.

#### 4. SOCIAL USE AND OWNERSHIP

##### 4.1 Ownership

###### 4.1.1 Reserve Forests

The great majority of Thailand's mangrove forests are owned by the Thai government and reserved as National Reserve Forests. Until recently mangrove forests were the responsibility of the Royal Forest Department and were used for logging for the production of charcoal, but since 2002 the management and conservation of mangroves has been carried out by the Department of Marine and Coastal Resources, part of the new Ministry of Natural Resources and the Environment.

###### 4.1.2 Private Mangrove Plantation

Mangrove plantations have been established in some coastal areas by private individuals as well as the Royal Forest Department. *Rhizophora apiculata* and *Rhizophora mucronata* are the two species most commonly planted on a large scale. Trees are grown for 10 years, after which time they are harvested and the wood used for production of charcoal (90%) or as posts or firewood (10%). There are approximately 17,500 rai (2,800 ha) of private mangrove plantations (Havanond, 1994) predominantly located in the Central region provinces of Samut Sakhon, Samut Songkhram, and Samut Prakan. Small plantations also exist in the Southern provinces of Chumphon and Pattani, focusing principally on the production of *Bruguiera spp.* and *Ceriops tagal* for stakes used in culturing mussels. In the past assistance in the establishment and operation of private plantations has been provided by the Royal Forest Department, particularly in planting, maintenance, and harvesting techniques.

###### 4.1.3 Community Mangrove Forests

In recent years villages and community groups living inside and adjacent to the mangrove forests of the Gulf of Thailand have become involved in the planning and implementation of mangrove rehabilitation projects and the management of mangrove forests close to their villages. These activities are usually initiated by local NGOs, often with external donor funding and technical support from academic institutes. Community mangrove forests have proved successful in some areas in reducing illegal encroachment into these areas for economic activities such as shrimp farming, and in improving the success of mangrove rehabilitation efforts. Some internationally recognised examples of community mangrove forestry projects have been associated with the Yadfon Association, a non government organisation which has assisted villages in establishing community forests to conserve

the mangroves of Trang on the Andaman Sea and also in the provinces of Surat Thani, Nakhon Si Thammarat, Songkhla, and Pattani (Charnsoh, 1999; Erfteimeijer & Bualang, 1998). In the Central region examples of community involvement in the management of mangrove forests can be seen in Samut Songkhram Province, where local communities at Klong Kone have now successfully rehabilitated a very large area of mangroves in the vicinity of their village. Key factors leading to the success of this community forest are a high level of public participation and awareness, strong community organization, and support from provincial government officers, academics and non government organisations (Paphavasit, 1999).

The emergence of community forestry in Thailand has led to the drafting of a Community Forestry Bill, which has been under consideration by the Thai government for several years. Once the Bill is approved the trend towards community management and ownership of mangrove forests in Thailand is likely to accelerate.

## 4.2 Present Uses

Significant numbers of people depend on the wide range of products and services that mangroves of the Gulf of Thailand provide. Most mangrove dwellers live in houses clustered in small village communities at the edge of forests or along channels within mangrove estuaries (Aksornkoae, 1985).

### 4.2.1 Food Items

Mangrove forests in the Gulf of Thailand have traditionally provided a source of food for villagers, especially in the monsoon season when fishing activity has to be reduced. Food from the mangrove forests comes in various forms, which are summarised in Table 6.

Table 6 Food Items Obtained from Different Mangrove Species.

Species	Local name	Products	Uses
<i>Avicennia</i> spp.	<i>Samae</i>	Fruits	Food
<i>Bruguiera</i> spp.	<i>Thoa</i>	Fruits	Food
<i>Nypa fruticans</i>	<i>Jaak</i>	Leaves, flowers, fruits	Sugar Production, vinegar alcohol production, foods
<i>Phoenix paludosa</i>	<i>Pang</i>	Young leaves	Food
<i>Sonneratia</i> spp.	<i>Lume-Paan</i>	Young flowers, fruits	Food

Source: Bamroongruga and Koaesinaul (1995).

Villagers living close to mangrove areas typically use these areas to collect seaweed. In Pattani Bay, for example, there is an abundance of *sarai-pomnang* seaweed which villagers collect in February-April (Bamroongruga and Koaesinaul 1995).

### 4.2.2 Medicine

Mangrove vegetation with healing properties has been used traditionally by villagers as a source of medicine. Known medicinal properties of mangrove vegetation are summarised in Table 7.

Table 7 Medicinal Properties of Some Common Mangrove Species.

Species	Local name	Medicinal parts	Medicinal use
<i>Acrostichum</i> spp.	<i>Prong-talae</i>	Rhizomes	Extract from rhizomes is an antiseptic.
<i>Acanthus ebracteatus</i> <i>A. ilicifolius</i>	<i>Ngueak-Plaamo-Dokkaw</i> <i>Ngueak-Plaamo-Dokmuang</i>	All parts of the plant	Cures skin allergies, treats malaria (mixed with ginger), treats abscesses. Extract of boiled barks and roots helps to reduce cold symptoms.
<i>Avicennia alba</i> <i>A. officinalis</i>	<i>Samae-Kaw</i> <i>Samae-Dum</i>	Fruits, heart wood, seeds, bark, roots	Extract from fruits is an antiseptic and extract from fresh heart wood soothes stomach pains, has tonic properties, and treats abscesses.
<i>Barringtonia racemosa</i>	<i>Chick-Suan</i>	Roots, fruits	Anti-diarrhoeal.
<i>Bruguiera sexangula</i> <i>B. parviflora</i>	<i>Phangka-Huasum-Dokkaw</i> <i>Thua-Dum</i>	Bark	Anti-inflammatory.
<i>Cerbera manghas</i>	<i>Teen-Peed</i>	Seeds	Treats heart problems.
<i>Ceriops decandra</i> <i>C. tagal</i>	<i>Prong-Kaw</i> <i>Prong-Dang</i>	Shoots, bark	Anti-diarrhoeal, anti-inflammatory, treats malaria.
<i>Excoecaria agallocha</i>	<i>Taatum-Talae</i>	Roots, latex	Extract from roots treats skin Allergies. Latex used for treating sea cat fish stings.

Table 7 cont. Medicinal Properties of Some Common Mangrove Species.

Species	Local name	Medicinal parts	Medicinal use
<i>Hibiscus tiliaceus</i>	Po-Talae	Roots, leaves, flowers	Laxative. Fresh flowers boiled with fresh milk can treat ear infections.
<i>Heritiera littoralis</i>	Ngonkai-Talae	Seeds	Anti-diarrhoeal.
<i>Phoenix paludosa</i>	Khluu	Leaves	Antiseptic.
<i>Phoenix paludosa</i>	Pang	Shoots	Sooths stomach pains.
<i>Rhizophora apiculata</i> <i>R. mucronata</i>	Kong-Kang	Barks, roots	Extract from bark is anti-diarrhoeal and extract from roots is provides nourishment.
<i>Scaevola taccada</i>	Rak-Talae	Leaves	Treats colds and headaches.
<i>Xylocarpus granatum</i> , <i>Moluccensis</i>	Taboon-Kaw, Taboon-Dum	Seeds, bark	Extract from seeds is an antiseptic and extract from bark is anti-diarrhoeal.

Source: Aksornkoe (1993).

#### 4.2.3 Wood Products

The traditional uses of mangrove wood in Thailand are for charcoal burning, firewood, use as poles and construction materials, production of fishing gear, and tannin collection (Aksornkoe, 1985).

##### Charcoal

The harvest of mangrove wood for the production of charcoal has traditionally been a major industry in the mangrove forests of the Gulf of Thailand, with 90% of the wood harvested used for this purpose (Aksornkoe, 1995). The depletion of forest resources and a recent change in government policy banning the harvesting of mangroves for this purpose has reduced charcoal production greatly (Havanond, 1994). At the present time only limited production of charcoal occurs using wood from private mangrove plantations.

##### Firewood

Wood from Thai mangrove forests is widely used as firewood by local villagers. Species commonly used are *Avicennia*, *Xylocarpus*, *Excoecaria*, *Bruguiera* and *Lumnitzera* (Aksornkoe, 1995).

##### Building / fishing materials

Wood from mangrove harvesting is commonly used as foundation pilings during construction work. The species most commonly used to make poles are *Rhizophora apiculata*, *R. mucronata*, *Ceriops* sp., *Bruguiera* sp., *Excoecaria agallocha* and *Rhizophora* spp. (Aksornkoe, 1993). *Nypa* palm is also important as a source of roof shingles and is an important source of income for many coastal villagers (Bamroongruga and Koaesinaul 1995).

Various types of fishing gear are used by mangrove dwellers, and some of this equipment is constructed from mangrove wood. Most of the mangrove poles from *Rhizophora* spp. are used for crab traps. Other types of fishing gear made from mangrove posts are drift gill-nets and the winged set-bag (Aksornkoe, 1985).

##### Tannin

In former times the bark of *Rhizophora* spp., *Ceriops* spp., *Bruguiera* spp., and *Xylocarpus* spp. was important as a source of tannin and dyes. These products were used in the manufacture of leather and ink used for dyeing fish nets, ropes, sails and textiles (Aksornkoe, 1993). At the present time tannin is rarely used for dyeing because the introduction of nylon net fishing equipment has made this use redundant (Aksornkoe, 1993).

#### 4.2.4 Artisanal Fisheries

The mangroves of the Gulf of Thailand support large numbers of small-scale or subsistence capture fishermen who use the mangrove forests on a daily basis. Subsistence fishermen take many different species of fish and invertebrates using numerous fishing techniques such as push nets, barrier nets, crab net traps, gill nets, winged set-bag nets, hooks and lines, stake nets, cast nets, and hand picking. The most important species in the fish catch are mullet (*Mugil dussumieri*), sea bass (*Lates calcarifer*), tilapia (*Tilapia mossambica*), snake eel (*Ophichthys microcephalus*), catfish eel (*Plotosus canius*), and milk fish (*Chanos chanos*); the most commonly caught species of shrimp are *Penaeus merguensis*, *P. monodon* and *Metapenaeus* spp. There is only one important species of crab in the catch - *Scylla serrata* - while important molluscs are *Nerita* sp., *Anadara* sp. and *Crassostrea commercialis*. Villagers also catch a number of invertebrate species such as bivalve molluscs, gastropods and brachiopods by hand (Aksornkoe, 1993).

#### 4.2.5 Mariculture

In addition to capture fisheries, the mangrove forests in the Gulf of Thailand are used by local people as a location for aquaculture facilities, particularly shrimp farm ponds but also aquaculture cages. Species typically cultured include shrimp, shellfish and various fish species.

##### **Shrimp culture**

Intensive shrimp farming is the main form of coastal aquaculture in the Gulf of Thailand. Shrimp farms are common in the Central region provinces bordering the Inner Gulf, the Eastern coastal provinces of Chonburi, Chantaburi, and Trat, and the Southern provinces of Surat Thani, Nakhon Si Thammarat, and Songkhla. The majority of farms culture the black tiger shrimp (*Penaeus monodon*), which are purchased as young post-larval shrimp and stocked in shrimp ponds for a period of four to five months (Rungreungwudhikrai and Tongdee, 1999). The culture period depends on a variety of factors, including market price, growth rate, pond water quality, and the prevalence of disease. Shrimp are fed several times daily with artificial food pellets, and the ponds are usually aerated using paddle wheel aerators. Lime and dolomite may be added to improve water quality. Issues and threats to mangroves posed by intensive shrimp farming are discussed in further in section 7.

##### **Shellfish culture**

Shellfish, particularly mussels, are often cultured on poles or ropes suspended from rafts floating on canals within and adjacent to mangrove forests, with the mangroves providing an important source of dissolved and suspended nutrients for the shellfish (Rungreungwudhikrai and Tongdee, 1999). The occurrence of shellfish culture is quite limited, being restricted to Rayong, Chantaburi and Chumphon provinces. The most important species of shellfish cultured in the Gulf of Thailand are the horse mussel (*Modiola senhousenii*), green mussel (*Perna veridis*), blood cockle (*Anadara granosa*) and oyster (*Crassostrea commercialis*).

##### **Fish culture**

Groupers (*Epinephelus* spp.) are the principal species of fish cultured in the Gulf of Thailand mangrove areas. Fish are raised in floating cages along the canals of the mangrove areas, with work usually being done by family members rather than hired workers. The fish are harvested when they reach a marketable size and many live groupers are exported for sale in Hong Kong (Rungreungwudhikrai and Tongdee, 1999).

### 4.3 Potential Uses

#### 4.3.1 Ecotourism

The Gulf of Thailand's mangrove forests have the potential to be utilized as locations for ecotourism activities. Ecotourism activities are commonplace in the mangrove forests of Trang, Krabi, Phangnga and Phuket on the Andaman sea coast and lessons learnt from experiences in these provinces could be applied to the mangrove forests of the Gulf of Thailand. Activities could possibly include canoeing, bird watching tours, fishing, and visits to villages located in mangrove forests to observe traditional lifestyles. Ecotourism activities could provide benefits to local communities from enhanced employment opportunities and opportunities to sell local produce and could serve as an incentive for these communities to protect forest resources.

#### 4.3.2 Sustainable Forestry

Although the Thai experience with mangrove forestry for charcoal and wood production has not proved sustainable, many examples of mangrove based charcoal/ wood production industries exist around the world which is able to operate successfully on a sustainable basis. In Matang, Malaysia, a large mangrove forest area has been continuously harvested for the last 30 years with minimal impacts on the environment and is lauded as an example of how it is possible to combine economic harvesting of mangrove timber alongside maintenance of the environmental services that mangrove forests provide (Chan, 1996). Lessons learnt from Matang and similar experiences from around the world could be applied by local community leaders with the assistance of Thai government agencies to develop sustainable mangrove forestry in Thailand.

## 4.4 Current Management Regime

### 4.4.1 Institutional Structure

#### ***Department of Marine and Coastal Resources, Ministry of Natural Resources and Environment***

The principal responsibility for management of mangroves in Thailand lies with the Department of Marine and Coastal Resources, part of the newly formed Ministry of Natural Resources and Environment. Prior to October, 2002, when the Ministry was formed, responsibility for the management of Thailand's mangroves was with the Royal Forest Department. The Department of Marine and Coastal Resources is charged with co-operating with other relevant government departments which have an interest in mangrove management. These departments include the Royal Forest Department, the National Parks Department, the Office of Environmental Policy and Planning, and the Fisheries Department.

The management of Thailand's mangrove forests by the Department of Marine and Coastal Resources is based on the following principles:

1. To manage mangroves as a renewable resource on a sustainable use basis for production of direct and indirect products.
2. In terms of direct products, to manage mangroves as an important and potentially sustainable source of wood and charcoal to meet increasing needs for domestic use and export.
3. In terms of indirect products, to manage mangroves as an important primary food source for aquatic organisms in estuaries, a habitat for various important fishery species, spawning grounds and nurseries for marine animals, and a means of protection against coastal erosion.
4. To manage mangroves as an integral part of the coastal zone ecosystem rather than as an isolated ecosystem. Management of mangroves will therefore be conducted on the bases of sustainable use and maintenance of the ecological balance of coastal resources.

#### ***Department of National Parks, Ministry of Natural Resources and Environment***

The management of mangrove areas lying within Marine National Parks in Thailand is the responsibility of the Department of National Parks. Along the coast of the Gulf of Thailand, the only Marine National Parks containing mangrove areas are Mu Koh Chang National Park, an island off Trat province, and Khao Sam Roi Yot National Park in Prachuab Khiri Khan Province.

#### ***Office of Environmental Policy and Planning (OEPP), Ministry of Natural Resources and Environment***

The Office of Environmental Policy and Planning (OEPP) is responsible for establishing environmental policies and plans for Thailand in accordance with the Enhancement and Conservation of National Environmental Quality Act 1992. In undertaking this role, OEPP also co-ordinates the work of various other environmental agencies, and provides a secretariat to the National Environment Board. OEPP is responsible for the development of national resource management policies and plans relating to mangrove forests.

#### ***Office of the National Environmental Board (ONEB), Ministry of Natural Resources and Environment***

A further government agency playing an important role in mangrove conservation and development in Thailand is the Office of the National Environment Board (ONEB). ONEB has a direct responsibility for examining the directly or indirect affects of development activities on environmental quality along the coastal zone, including mangrove areas. In the past ONEB has cooperated with the Royal Forest Department, the Fisheries Department, the Royal Thai Navy, and Provincial Administration Organisations to develop and implement mangrove conservation initiatives and introduce mangrove ecology into the educational curriculum at the primary, elementary, and pre-university school levels and at universities across Thailand.

#### ***National Committee on Mangrove Resources (NATMANCOM)***

In 1977, the Thai Cabinet adopted a resolution to establish the National Committee on Mangrove Resources (NATMANCOM) with a membership of 19 organisations with an interest in mangroves, including non-government organizations. The committee was assigned the following roles:

1. Coordinate with the National Committee on Marine Science on matters pertaining to mangrove resources.
2. Advise the office of the National Research Council of Thailand (NRCT) on the programming of mangrove research projects.
3. Provide advice on the planning and implementation of development projects in mangrove areas and the identification of any problems which might result from such projects.
4. Identify problems relating to mangrove conservation.
5. Coordinate with other national and international organisations with an interest in mangrove resources.

#### **Office of the National Economic and Social Development Board (NESDB)**

The Office of the National Economic and Social Development Board (NESDB), part of the Office of the Prime Minister, is responsible for overall national development planning as well as the formulation national economic and social development policy. NESDB is responsible for setting the direction and framework of natural resource and environmental policies in Thailand. The framework sets criteria for budget allocation and investment in all development projects in Thailand

#### **4.4.2 Legislation and Regulations relevant to Management of Mangroves**

##### **Enhancement and Conservation of National Environmental Quality Act (NEQA 1992)**

The NEQA provides a foundation for the legal framework governing environmental protection and management in Thailand.

##### **Forestry Act 1960**

This Acts regulates the use of timber and forest products in national forests. It provides guidelines for the Royal Forest Department in supervising the exploitation of forests as well as in supervising various activities concerning timber forest products, from the time of harvesting to the sale of the final products. The scope of the act covers mangrove forests, for which a principal use has traditionally been the harvesting of wood for charcoal production and timber.

##### **National Reserve Forest Act 1964 and predecessor Acts**

All mangrove forests are designated as reserve forest areas under this Act (article 6) or earlier Reserve Forest Acts. The act controls all activities carried out in mangrove forests and other reserve forests.

##### **National Parks Act 1961**

Mangrove forests lying with the boundaries of National Parks are protected by the National Parks Act, under which all natural resources in park areas are to be strictly conserved.

##### **Regulations and Cabinet Resolutions relevant to mangrove forests**

The Thai government has taken steps to address the degradation of mangroves in Thailand through issuance of a series of Cabinet resolutions (Table 8). These resolutions must be followed by Government agencies when carrying out their activities.

Table 8 Summary of Thai Government Cabinet Resolutions relating to Mangrove Conservation and Management.

<b>Date</b>	<b>Summary of Resolution</b>
27 July 1978	Establishment of the National Mangrove Committee (NATMANCOM), with a duty to screen development projects planned for mangrove areas and to propose policy on mangrove issues to the government. NATMANCOM and the National Environment Board have the role of reviewing and screening all development projects proposed by government agencies which relate to mangrove areas so as to maintain optimum sustainable productivity without degrading the integrity of ecosystems.
19 August 1980	All development projects planned for mangrove areas must undergo an environmental impact assessment. Private land holding and the issue of secure land titles in mangrove areas no longer allowed.
1 May 1984	Mangrove zonation to be clearly implemented following study of the ecosystems involved. Rehabilitation of degraded mangrove forest by government agencies and private sector to be encouraged.
15 December 1987	Implementation of a Zonation system for Thailand's mangroves classifying mangroves either as a conservation Zone, economic zone (type A), or economic zone (type B).

Table 8 *cont.* Summary of Thai Government Cabinet Resolutions relating to Mangrove Conservation and Management.

Date	Summary of Resolution
1 August 1989:	Cabinet approved proposals presented by the Ministry of Science, Technology, and Environment to undertake rehabilitation and protection of all remaining mangrove areas in Surat Thani and Nakhon Si Thammarat provinces, with financial support provided for the establishment of additional mangrove management and protection units.
6 February 1990	In an attempt to curtail problems associated with shrimp farming in mangrove areas, the Cabinet declared that no further shrimp farming would be permitted within economic zone A of mangrove forests.
4 June 1991	<p>Five-year action plan approved for recovery and establishment of mangrove areas, together with a 750 million baht (US\$30 million) budget. Actions included:</p> <ul style="list-style-type: none"> <li>• Provincial mangrove management plans to be drawn up. Plans to take local conditions and requirements into account.</li> <li>• Mangrove areas to be defined and marked.</li> <li>• Remote sensing techniques to be applied.</li> <li>• Ground surveys and marking to be conducted every two years.</li> <li>• Mangrove propagation to be encouraged through replanting.</li> <li>• Degraded forests to be restored and replanted.</li> <li>• Privately owned mangrove plantations to be supported.</li> <li>• Seed source areas to be developed in conservation forests and plantations.</li> <li>• Encroachment into mangrove areas to be reduced.</li> <li>• Patrolling to be intensified and public awareness increased.</li> <li>• Support to be requested from the Navy and Navy officers designated as additional forestry officers according to the Forestry Act.</li> <li>• Intensive aquaculture to be promoted away from mangrove areas.</li> <li>• Programme evaluations to be conducted by inspectors from the Prime Minister's Office.</li> <li>• Budget needed for plan implementation to be allocated by the Budget Bureau.</li> </ul>
23 July 1991	Permission to convert mangrove forest land into other uses to be no longer given. Committees of officials from all departments concerned established at provincial level to prevent illegal encroachment and address mangrove use problems.
2 September 1997	<p>Provincial Mangrove Management Units ordered to:</p> <ul style="list-style-type: none"> <li>• Monitor whether mangrove concessionaires follow conditions of their concessions.</li> <li>• Monitor the licensing of land use in mangrove areas granted after 1991.</li> <li>• Monitor the licensing of shrimp farm operators in mangrove areas.</li> <li>• Persuade concessionaires to surrender their concessions after the expiry date.</li> </ul>
10 March 1998	Logging and charcoal concessions in mangrove areas to be permitted to continue only until concessions expire.
22 August 2000	Cabinet approved recommendations presented by the Ministry of Science, Technology and Environment and the Ministry of Agriculture and Cooperatives to commit to mangrove conservation by confirming the cabinet resolution of 23 July 1991. Logging and mining in mangrove forest areas to continue only until the termination of concessions, with contracts to be strictly enforced. Remaining forest to be reclassified for conservation or development-related activities. Aquaculture to be permitted only in areas behind mangrove forests. Department of Fisheries, Royal Forest Department and Department of Pollution Control to co-operate in promoting sustainable management of aquaculture operations without detriment to surrounding ecosystems or mangroves.

#### 4.4.3 Thai Government Policy

##### ***Ninth National Economic and Social Development Plan***

The Ninth National Economic and Social Development Plan for the period 2002-2006 (NESDB, 2002) sets the following goals for mangrove conservation in Thailand: Conserve and restore conservation forests, so that at least 30% of the country is covered by forest, with mangrove forests covering an area of at least 1.25 million rai (2,000 km<sup>2</sup>). Protect and restore marine resources and coastal ecosystems. Preserve, conserve and protect biodiversity in highly diverse areas.

In terms of environmental and natural resource management, the plan sets the following objectives: Improve the process of strategic environmental and natural resources management, with emphasis on participation from all parties. Strengthen enforcement and take actions to ensure compliance, including prescribing legislative measures for the protection of flora and fauna. Preserve the ecological balance while supporting the basic socio-economic profile of the area. Support a reduction in waste quantities, support the reuse of waste, and develop technology for pollution management.

### **National Environmental Quality Enhancement and Conservation Policy and Plan for 1997 to 2016**

In 1997 the Office of Environmental Policy and Planning (OEPP) published its National Environmental Quality Enhancement and Conservation Policy and Plan for 1997 to 2016. This plan was prepared under section 13 of NEQA 1992 and includes policies and guidelines on environmental management looking forward over a 20 year period. The purpose of the plan is the “integration of the management and enhancement of natural resources and the conservation of national environmental quality with sustainable economic and social development to maintain the quality of life”.

Policies included in the document (and strategies) aim to accelerate the rehabilitation of renewable resources and address water pollution, air pollution, noise and waste problems. Of particular relevance to mangroves are policies on natural resources, natural and cultural environments, and communities and the environment. For each of these policies, the plan lists goals, specific policy measures, and guidelines for their implementation.

The plan lists the following national targets relating specifically to mangrove management:

- 1) Preserve at least 1 million rai (160,000 hectares) of mangrove forest.
- 2) Conserve and rehabilitate all type of coastal resources in order to maintain the natural balance of this ecosystem.

### **Policies on the protection of mangrove ecosystems**

The December 1987 Cabinet Resolution classified mangrove areas into two classes: conservation zones and economic zones. Economic zones are divided into 2 sub-zones: economic zone A and economic zone B.

In **conservation zones** all human utilization and disturbance are prohibited. Conservation zones include:

- Areas for preservation of economic plants and animals.
- Nursing grounds for plant and animals.
- Areas susceptible to damage and erosion.
- Historic areas.
- Area with unique local characteristics.
- National parks, tourist areas, wildlife sanctuaries, and non-hunting areas.
- Wind shield areas.
- Area with significant research importance.
- Area with significant importance for environmental and ecological preservation.
- Areas within 20 meters of natural rivers or streams or within 70 meters of the sea coast.

In **economic zone A** only sustainable uses of mangrove trees are permitted. This includes:

- Concession areas.
- Community forests.
- Mangrove plantations.

**Economic zone B** consists of degraded mangrove areas in which other land uses and development are allowed, although the environmental implications of these uses must be considered. Such activities include:

- Agriculture (cash crops, husbandry, fisheries, salt farms).
- Industry (mining, factories).
- Urban areas.
- Trading and commercial areas.
- Piers and harbours.
- Other uses.

### **Policies on mangrove rehabilitation**

In June 1991 the Thai Cabinet resolved to allocate a budget of approximately 450 million baht to rehabilitate 40,000 hectares of Thailand’s mangrove forest area over the period 1992 - 1996. During this period 13,569 hectares of mangrove forest were successfully planted. Mangrove restoration activities have been largely concentrated on the direct planting of nursery grown or elongate propagules of *Rhizophora* species on unvegetated mudflats or degraded forest areas. The species most commonly planted are *Rhizophora apiculata* and *R. mucronata*, with some planting of species of *Ceriops* and *Bruguiera*. Mangroves are typically planted at higher levels within forests.

Coastal areas on the Gulf of Thailand which are suitable for mangrove planting consist of the landward strip behind tidal mudflat areas, degraded mangrove forest areas, and abandoned shrimp farms. Efforts to rehabilitate mangroves in Thailand have only been partially successful, with the exception of cases where a community management approach has been applied. This has largely been a result of centralized, top-down planning which has failed to recognize local environmental factors or practical issues at sites selected for replanting. Some of the causes of unsuccessful replanting schemes are inappropriate choice of species for planting, inappropriate choice of sites, use of unsuitable planting techniques, monoculture planting, and lack of maintenance and aftercare at replanting areas. Community based projects which recognize the rights of communities to use forest projects sustainably provide an important incentive for local people to become involved not just in replanting but also in maintenance and follow-up schemes.

#### ***Policies on education and training***

One of the root causes of mangrove depletion and degradation in the Gulf of Thailand is a general lack of understanding at all levels in society about the importance of mangrove resources. Recognising this, the Thai government has started encouraging the public to participate in mangrove restoration programmes and has organized numerous seminars and prepared a wide range of articles, films, and educational materials to raise awareness about the value of mangroves. Policies for mangrove area protection and conservation and public awareness campaigns aim to present an overall positive picture regarding mangroves. In the long term, it is hoped that such initiatives will contribute to the restoration and sustainable development of mangrove ecosystems.

#### ***Policies on mangrove research***

Various agencies such as the National Research Council of Thailand, the National Environment Board, the Royal Forest Department, the Fisheries Department, and Thai universities receive support by the government to conduct research into mangrove ecosystems and management. A considerable number of international organizations, including CIDA, AIDAB, USAID, JSPA, RECOFTC, UNDP, UNESCO and FAO have sponsored research programs on mangrove management and conservation. Information obtained from these research programs has been instrumental in the formulation of the government policies outlined above.

### **5. ECONOMIC VALUATION OF MANGROVE FORESTS IN THE GULF OF THAILAND**

The economic valuation of mangroves has been the subject of a number of studies. For mangrove forests in Thailand, Sathirathai (1998) has carried out a valuation study of mangroves in Surat Thani province on the Southern Thai peninsula, which estimated the total economic use value provided by mangroves to be in the range of 13,339 to 17,122 baht per rai per year (US\$2,084 to 2,675 per hectare). Kantangkul (1997) has calculated the economic values of some aspects of mangrove use in Trang province on the Andaman sea coast.

#### **5.1 Use Values**

##### **5.1.1 Direct Use Value**

Direct use values of mangroves relate to the direct benefits that local communities derive from mangrove forests, for example through collection of timber and mangrove products, gathering of food, or recreational use. Kantangkul (1997) estimated the value of mangroves in supporting livelihoods of coastal dwellers as 1,710 baht per rai per year at 1990 prices (US\$267 per hectare per year).

##### **5.1.2 Indirect Use Value**

Indirect use values of mangrove forests represent the indirect contribution mangroves make in support of a broader range of economically beneficial activities, including the provision of environmental services. Examples include the role mangroves play in supporting offshore fisheries, providing coastal protection and flood control, enhancing water quality, and contributing to carbon sequestration.

#### ***Offshore fisheries***

The use value estimated for the role of mangroves in supporting offshore fisheries productivity has been estimated by Sathirathai (1998) as ranging from 33.5 baht to 187 baht per rai per year (US\$5.2 – 29.2 per hectare per year). Kantangkul (1997) gave a higher figure for the fishery value of mangroves, estimating the value as 1782 baht per rai per year at 1990 prices (US\$278 per hectare).

**Coastal protection**

The value of mangroves in acting as a wind break and contributing to erosion control has been estimated by Sathirathai (1998) by reviewing expenditure by the Thai Harbour Department in constructing replacement breakwaters in areas where mangroves have been destroyed. The estimated value provided by mangroves for this purpose was 12,444 baht per rai per year (US\$1,944 per hectare per year).

**Carbon sequestration**

To estimate the monetary value of carbon sequestered by a mangrove forest, Sathirathai (1998) applied a price of 141.7 baht per tonne of carbon. This figure combined with an estimate of the amount of carbon sequestered by mangroves each year allows calculation of the indirect value provided by mangroves through carbon fixation as 342 baht per rai per year (US\$53 per hectare per year).

**Nutrient release**

Kantangkul (1997) calculated the value of nutrient release from mangrove forests as 798 baht per rai per year (US\$125 per hectare per year).

**5.2 Non-use Values**

Non-use values relate to the essential nature of a mangrove forest and the value that is placed on it for qualities such as its biodiversity, cultural and heritage importance, or social significance. The authors are not aware of any comprehensive studies which have been carried out to date reporting non-use values for mangrove forests in Thailand.

**6. THREATS, PRESENT AND FUTURE****6.1 Threats****6.1.1 Human Pressure**

The mangrove forests of the Gulf of Thailand have been degraded significantly over recent decades by a number of different human activities, with 86,000 hectares lost since 1975, representing more than 70% of the original area. As can be seen from Figure 3, the greatest degree of mangrove clearance occurred over the period 1979 - 1986, when 60,600 hectares (more than 50% of the original area) were cleared. Comparison of the degree of loss of mangrove areas across different provinces and regions shows that in some provinces, particularly provinces close to Bangkok and some of the Eastern provinces, the mangrove area was almost completely lost, while other provinces have managed to retain a large proportion of their original mangrove area (Figure 4).

Since 1991 the area of mangroves in the Gulf of Thailand has begun to increase as a result of restoration programs in the Central region of the Gulf of Thailand, greater Government efforts to control mangrove clearance, and migration of shrimp farmers away from the Gulf of Thailand towards provinces on the Andaman sea coast.

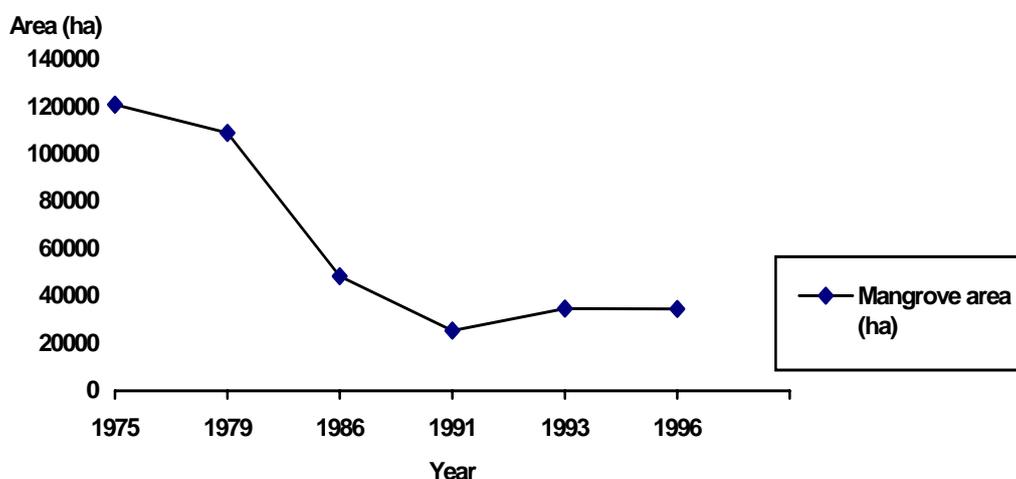


Figure 3 Change in Mangrove Areas in the Gulf of Thailand from 1975-1996.

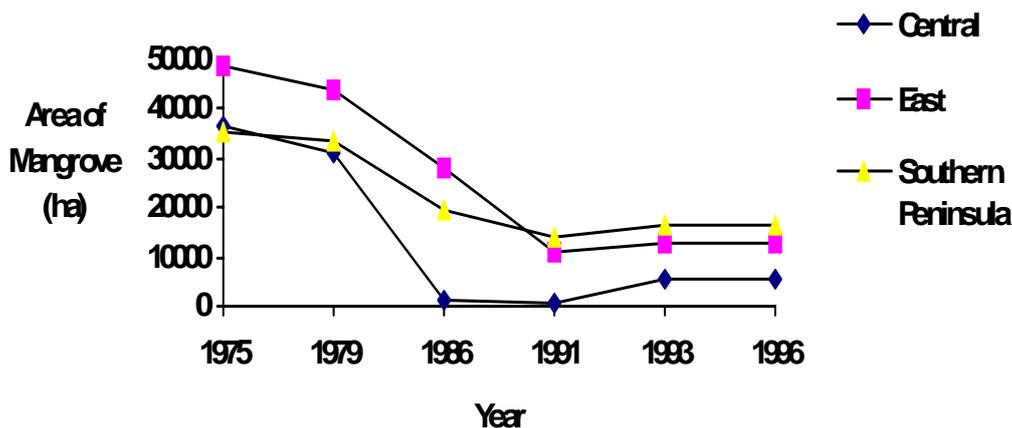


Figure 4 Change in Mangrove Areas around the Gulf of Thailand Coast from 1975 – 1996.

Activities which have resulted in the loss of mangroves include logging for the production of charcoal, the conversion of mangrove land to shrimp aquaculture ponds, agriculture, salt production, urban development, and industrial development. The proportion of the total mangrove area cleared for each of these activities is difficult to estimate, but a study by Charupatt and Charupatt (1997) gives an indication of the main activities that have led to significant loss of mangrove forest area in the Gulf of Thailand (Table 9). This chapter discusses the nature of each of these threats and the extent of mangroves lost through each activity.

Table 9 Land Uses in Areas which were originally Mangrove Areas in the Gulf of Thailand.

Land use type	Region			Total (ha)
	1. Central	2. Eastern	3. Southern Peninsula	
1. Mangrove	5449	12,658	16,570	34,677
2. Shrimp Farm	15,629	24,295	21,920	61,844
3. Urbanisation	3,100	4,957	1,001	9058
4. Others	42,803	13,935	16,957	73,695
<b>Total</b>	<b>66,981</b>	<b>55,845</b>	<b>56,448</b>	<b>179,274</b>

Adapted from Charupatt and Charupatt (1997).

#### 6.1.1.1 Mangrove Forestry

One of the major causes of the degradation of mangroves along the Gulf of Thailand has been harvesting for the production of charcoal. In the past, up to ninety percent of the mangrove wood harvested in Thailand was used for charcoal production (Aksornkoae, 1993), an activity which continued from the 1960s until 2001 when the Thai government introduced new regulations revoking charcoal concessions. To support this industry, areas of mangrove were leased to concessionaires for fifteen year periods under the condition that concessionaires would rehabilitate the forest at their own expense following specified silviculture management practices. Significant problems arose as a result of poor practices by concession holders, who seldom operated according to the regulations or conditions of their concession and often carried out logging in areas outside the concession areas. As a result of this over-harvesting, former concession areas were often left in a degraded state, depleted of large trees and dominated by weed species (Tragulkumjai, 1993).

#### 6.1.1.2 Conversion for Shrimp Farming

Significant areas of mangrove forest in the Gulf of Thailand have been lost as a result of conversion for shrimp aquaculture. Destruction is caused by clear cutting during preparation of land for shrimp farms, embankment construction, or from the modification of water flows which block saline and fresh water from reaching the mangrove forests (Aksornkoae, 1993).

Extensive culture of shrimp has been practiced for over 50 years in the Central Region provinces of Samut Songkhram, Samut Sakhon, and Samut Prakan, all close to Bangkok, while further loss of mangrove area in these provinces resulted from the adoption of semi-intensive and intensive farming techniques from the mid-1970s onwards (Jitsanguan et al., 1993). A characteristic of the shrimp farming industry in the Gulf of Thailand has been its boom and bust nature and transience. In 1990, for example, shrimp farming in the Central Region suffered a crash in production caused by disease and other production problems related to acid sulphate soils and water pollution, forcing migration of

the industry from the Inner Gulf area to the Eastern provinces of Chonburi, Chantaburi and Trat and the Southern provinces of Nakhon Sri Thammarat, Surat Thani and Songkhla (Flegel 1998; Funge-Smith 1997). Likewise, disease and production problems in these newly established areas has subsequently resulted in further movement of the shrimp aquaculture industry from the Gulf of Thailand to the provinces bordering the Andaman Sea (Plathong and Sitthirach, 1998, Jitsanguan et al., 1993). In the Gulf provinces where shrimp farming was formerly prevalent, large areas of land which was until recently covered by mangrove forests lie abandoned as wasteland.

Estimates of the area of mangroves in the Gulf of Thailand lost as a result of shrimp farming vary significantly. Studies for the whole of Thailand using satellite imaging (Landsat, TM5, 1:50,000) in 1993 concluded that only 17.25% of mangrove areas had been invaded for marine shrimp farming (Budget Bureau 1990: Kongsangchai (1993): Charupatt and Ongsomwang (1995): Research Council of Thailand 1995) while other studies (Platong, 1998) claim that a much greater area has been cleared for this activity. The controversy over the exact area of mangroves in the Gulf of Thailand that has been cleared for construction of shrimp ponds stems from the fact that in many cases shrimp farms were developed from areas already cleared for other purposes, e.g. salt farms and rice paddies.

A study by Charupatt and Ongsomwang (1995) has identified that large areas of shrimp farms still remain in the conservation and economic zone A areas despite the 1987 Cabinet resolution prohibiting shrimp farming in these zones (Table 10).

Table 10 Areas and Percentage of Total Numbers of Shrimp Farms Occupying Conservation and Economic Zone A Areas along the Gulf of Thailand Coast.

Region	Identifiable shrimp farms (ha) in conservation and economic zone A areas	Percentage of identifiable shrimp farms in zones where shrimp farming prohibited
Central	927	19
Eastern Coast	18,952	52
Southern Peninsula	3,882	15
Gulf of Thailand Total	23,761	37

Source: Charupatt and Ongsomwang, 1995.

#### 6.1.1.3 Urbanisation and Coastal Development

Loss of mangrove forests in the Gulf of Thailand has resulted from urban expansion and infrastructure development including the construction of fishing ports, solid waste disposal schemes, industrial power plant development, road construction, and dredging. Human settlements in the mangrove areas of the Gulf of Thailand are widespread, covering many provinces but particularly prevalent in Chonburi, Rayong, and Surat Thani. Human habitation in these areas consists mainly of permanent fishery villages varying in size from a few houses built on platforms raised on stilts of mangrove wood to highly urbanised settlements and industrialized cities.

As well as urban development, mangrove areas in the Gulf of Thailand, by virtue of their strategic coastal location and general reputation as wasteland areas, have also been an easy target for satisfying the shortage of relatively cheap land for industrial estates and ports. The mangrove forests of provinces in the Central region such as Samut Prakan, Samut Songkhram, and Samut Sakhon, and the Eastern region provinces of Chacheongsao, Chonburi, and Rayong have been particularly impacted by industrial development. In Samut Prakan province, for example, mangrove land was claimed for the development of various industries such as textiles, chemicals and battery manufacturing. There are no appropriate waste treatment systems serving the industrial areas and waste is discharged directly into the mangroves, eventually discharging as a result of tidal action into the upper Gulf (Piyakarnchana, 1979).

Once such development centres have been constructed, migration of a large rural population soon follows, resulting in an acute shortage of houses and other urban amenities. This, in turn, creates additional pressure on the adjacent mangrove areas.

#### 6.1.1.4 Agriculture

Some mangrove areas in the Gulf of Thailand have been converted for agricultural use, including the cultivation of coconuts, oil palms, and rice, although this is not a common practice because of the presence of acidic soils which result in low productivity. No estimate of the total area of mangroves converted to agricultural land is available. In the provinces of Samut Songkhram and Samut Sakhon construction of salt pans has resulted in widespread mangrove destruction.

### **6.1.1.5 Major Infrastructure Projects**

The Thai government and private developers are currently considering a number of major infrastructure development programmes which may have implications for coastal zones or river water quality. These include:

- Further expansion of the Eastern Seaboard industrial zone in the coastal area of Rayong province.
- Construction of a major North – South highway through the country.
- A coast-to-coast ‘landbridge’ across the Southern Thai peninsular.
- Schemes to divert water from the Mae Klong and Tha Chin catchment basins into the Chao Phraya basin to meet agricultural and urban needs in the Chao Phraya basin.

Thailand’s Prime Minister has promised that no damage will be caused to mangrove areas as a result of such projects, but as yet no details have been provided as to how impacts will be avoided.

### **6.1.2 Natural Phenomena**

As well as the impacts that humans have on mangrove forests in the Gulf of Thailand, these areas are also subject to impacts associated with natural phenomena such as cyclones and severe storms. In recent years, the provinces of Nakhon Sri Thammarat, Surat Thani and Chumphon have been hit by major tropical depressions resulting in significant damage to mangrove forests in these provinces. Deforestation in catchment areas has increased the risk of fluvial flooding in recent years, as well as contributing to higher rates of soil erosion and sedimentation.

Sea level rises caused by global climate change are predicted to have an impact on mangrove forests in the Gulf of Thailand in the future, pushing the inner and outer margins towards the land, and shifting mangroves inland. Most mangrove forests in Thailand are now bordered by developed land on their landward side, and so a rise in sea level will reduce or completely destroy many mangrove areas.

Severe coastal erosion occurs along major stretches of the coastline in the Inner Gulf of Thailand. Erosion is in some cases exacerbated by construction work on the shoreline. One of the areas where erosion is most serious is to the west of the Chao Phraya river mouth, where a length of over 30 km of coastline and an area of 700 hectares of coastal land was lost as a result of erosion over the period 1967 – 1987, with a maximum eroded distance of 500 m. Severe erosion has also been recorded at the area of Ban Bang Kaew in Petchaburi province, where over 135 hectares of land was lost to erosion with a maximum eroded distance of about 200 metres.

## **7. PRESENT AND FUTURE STATUS OF MANGROVE ACTION PLANNING**

### **7.1 Present Situation**

Thailand’s policies on mangrove forests currently prioritise three main areas for action: rehabilitation, conservation and sustainable management. Policies on sustainable management emphasise non-timber productive uses and environmental protection. Wood from mangrove forests can only be used by communities, and not by industry as previously. In order to meet national objectives on mangroves, action is planned in the following areas:

#### **Area 1: Conservation and sustainable management**

1. Revision of classification of mangrove land use;
2. Assessment of existing silvicultural systems;
3. Assessment of mangrove rehabilitation in different areas: success and failure;
4. Experimentation with eco-friendly management systems: mangrove conservation and aquaculture.

#### **Area 2: Mangrove information and awareness**

1. Gathering existing mangrove information and establish a database;
2. Review of research work for dissemination and application of knowledge to sustainable mangrove management;
3. Establishment of a range of effective educational tools and programmes for public awareness campaigning on mangrove importance.

**Area 3: Socio-economic aspects**

1. Experimentation on community management of mangrove forests;
2. Assessment of local participation in conserving and utilizing mangrove forest resources;
3. Experimentation on mangrove plantation management.

**Area 4: Mangrove ecosystem function and health**

1. Establishment of a demonstration site for mangrove biodiversity conservation;
2. Establishment of demonstration sites to assess or monitor specific aspects of mangrove management, e.g. ecotourism.

**Area 5: Cooperation and capacity building**

1. National training on strategies for conservation and sustainable management of mangrove ecosystems;
2. Review of national cooperation on mangrove ecosystems.

**Area 6: Policies and legislation**

1. Review of institutions, laws, and regulations related to conservation and management of mangrove ecosystems;
2. Assessment of policies and political initiatives concerning conservation and sustainable management of mangrove ecosystems: success and failure.

**7.2 Future Perspectives**

It is envisioned that in future mangrove forests will be managed sustainably and utilized for the production of non-timber products, with environmental protection as a high priority. Only local communities will be permitted to use wood from mangrove forests. Community management of mangrove forests will be expanded, with increased participation of local people in decision making and implementation of conservation and management initiatives. Mangrove rehabilitation programmes will be the highest priority for future action.

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In the South China Sea, incidents such as island disputes, land reclamation, confrontations, clashes between maritime law enforcement vessels, freedom of navigation operations by US Navy (USN) and threats from the People's Liberation Army Navy (PLAN) against them are heightening tensions in the region. In particular, China's aggressive actions to expand its maritime control have attracted widespread attention. In the East China Sea, numerous close encounters have occurred. This includes helicopters and other aircraft flying close to destroyers belonging to Japan's Maritime Self-Defense Force (JMSDF), PLAN destroyers illuminating fire-control system radars on a JMSDF warship, and Chinese fighter jets approaching Japanese and U.S. aircraft at unsafe distances.