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"Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand"

National Reports on Mangroves in South China Sea

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Cover Photo: Propagules of *Rhizophora apiculata* in Koh Kong Province of Cambodia, by Mr. Ke Vong Wattana.

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NATIONAL REPORT

on

Mangroves in South China Sea

CAMBODIA

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Table of Contents

List of Tables, Figures and Annexes

1. GEOGRAPHIC DISTRIBUTION

1.1 Maps

Map of mangrove is not yet produced for specific mangrove protection and conservation or plan. It is just in the subcategories of the maps of forest covers or map of land use. This map is in the country scale as 1:500,000. The maps of forest cover were produced three times such 1993, 1997 and 2000. However, the method and approaches of interpretation, producing map and definition are different. Thus, it makes many troubles in the term of time series and spatial analysis for mangrove areas. Moreover, in the term of the planning and management purposes for mangrove on the specific site, it needs to be reproduced the new one with the detail scale that may be 1:50,000 or 1:25,000.

A degree of uncertainty surrounds current estimates on Cambodia's mangroves. The data were derived largely from a 1:25,000 aerial photographs taken in December 1994 that have not been systematically ground trusted due to safety and security constraints. The GIS land use maps that have been made by interpreting the 1991 aerial photographs were not systematically ground trusted either. Reports were based on small scale projects and on on-site reconnaissance of selected areas that are accessible by boat or road; there are very limited aerial reconnaissance in the vicinity of Koh Kong province. Figure 1 shows the map of mangrove distribution along the coastline of Cambodia.

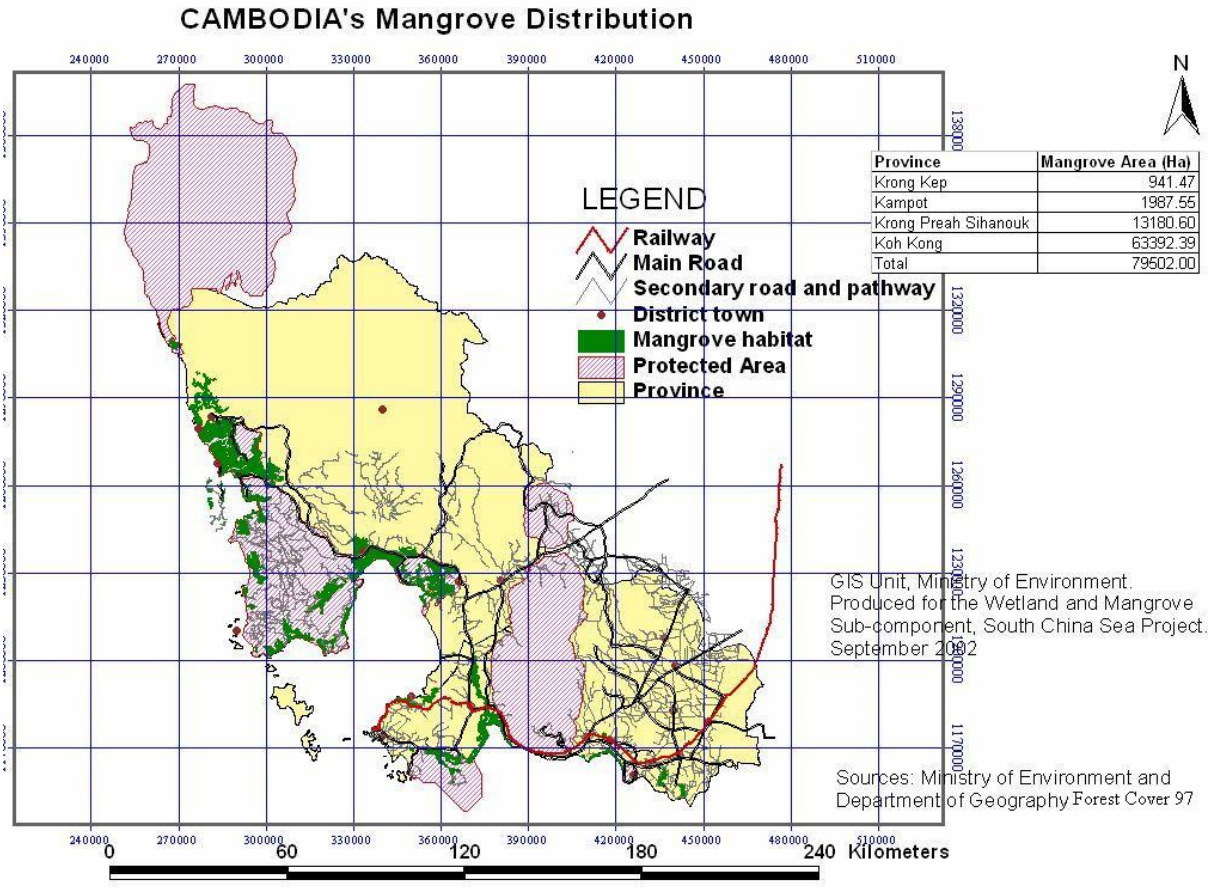

Figure 1 Map of Mangrove Habitat along the Coastline of Cambodia.

1.2 Areas

It was estimated in the past that mangrove forest covered only 37,000ha. The Land Cover maps published by the Mekong River Commission/UNDP/FAO (1994), however, show that in 1992/3, the mangroves consist of about 85,100ha. Of these land area, 63,700 ha are located in Koh Kong Province, 13,500ha in Sihanoukville and 7,900ha in both Kampot Province and Kep Resort City in fringe coastal areas along the Gulf of Thailand. The vast majority (63,700 hectares) are located in Koh Kong Province. While the total area of mangrove forest in Cambodia is small compared to

surrounding countries in the Gulf of Thailand, these forests have been relatively undisturbed until recently. However, Cambodia's mangroves are now under intense pressure from competing resource uses. Two important threats to the mangrove resource are the clearance of mangrove areas for intensive shrimp farming and charcoal production. Neighbouring countries such as Thailand and Viet Nam have seen widespread destruction of their natural coastal resources as a result of unmanaged exploitation. Sound management strategies for Cambodia's mangrove areas are urgently needed to avoid a similar outcome. Percentage of Mangrove Areas by province is presented in Figure 2.

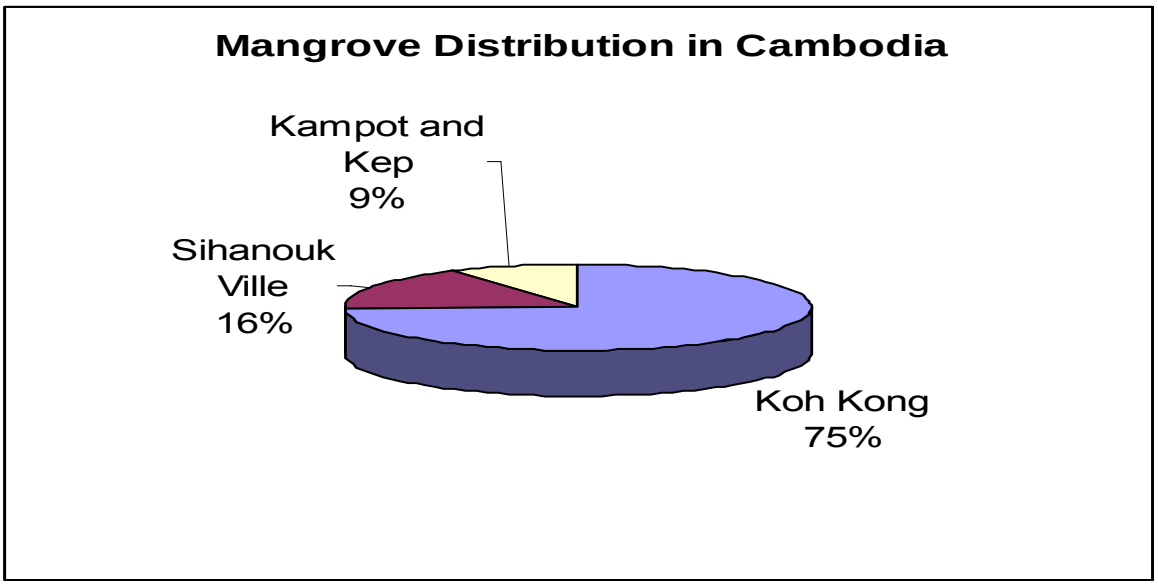

Figure 2 Percentage of Mangrove Areas by Province.

Based on a detailed study CZM-DANIDA (2001) covering of some districts in Kampot province the following were mapped:

- Kampot district
  - Koh Toch commune: 500 hectares in 4 villages (Prek Ampil, Koh Toch, Prek Chek, Kilometer No 12)
  - Beung Touk commune: 300 hectares in 4 villages (O Roluos, Koh Rokar, Beung Tuok, Totoeng Thngai)
  - Chum Kreal commune: 100 hectares in 3 villages (Kampong Treak, Chum Kreal, Kampong Kandal)
  - Koun Satt commune: 21 hectares in one village (Kampong Nung)
  - Trapeng Sangke commune: 71.93 hectares in 2 villages (Trapeng Sangke, Trapeng Thom)
  - Kampong Samrong commune: 5 hectares in a village
  - Prek Thanot commune: 275 hectares (Changhoun, Prek Thanoat, Prek Kreng)
  - Total area in the district was 1,273ha.
- Kampong Bay district
  - Treuy Koh commune: 105 hectares in one village
  - Beung Tapream: 105 hectares.
- Kampong Trach district
  - Russei Srok Khang Thbong 136 hectares (Thakov, Lork and Koh Sna).
  - Sihanoukville: Mangroves can be found in the estuaries, along the muddy seashore and on the swamps and river systems and some coastal areas. Based on information from eh seventies and early nineties there are some indications of changes in the mangrove distribution.
  - Koh Kong: the information received from local areas indicated that mangrove areas have decreased over the past few years. Mangroves are a priceless resource, having important roles inn the fisheries and environment and providing protection of coastal environment. Mangroves of Koh Kong stretch along the coastal areas covering 637 Km^2. There are 64 species of mangroves.

Table 1 presents different figures of mangrove coverage found by different institutions and organisations.

Table 1 Mangrove Forest Coverage in (Ha) in Cambodia.

Province/Municipality			Whole Country
Koh Kong	Sihanoukville	Kampot	
16,000	3,600	17,400	37,000
63,200	7,300	17,400	83,600
			83,700
31,000	3,600	3,700	38,300
31,100	2,300	2,300	37,000
63,700	13,500	7,900	85,100
			17,234
63,700	13,500	7,900	85,100

Source: FAO, 1973.

2. DISTRIBUTION OF SPECIES AND FORMATION

Mangrove communities can be classified into different types: riverine, basin or fringing. Mangrove species are generally arranged in zones from sea to land since they have adapted to a slightly different range of physical conditions. The mangorve zones in Cambodia are categorised into:

a) The *Avicennia-Sonneratia* zone

b) The *Rhizophora* zone

c) The *Bruguiera-Kandelia-Ceriops* zone and

d) The *Lumnitzera-Xylocarpus-Bruguiera* zone.

In most mangrove forests, different species dominate certain zones. The characteristic zonation pattern results from differences in the rooting and growth of seedlings and competitive advantages which each species has along the gradient from mean sea level to above the high water lines. The dominant species in this forest type belong to the family of Rhizophoraceae, such as *Rhizophora conjugata* (Kongkang Nhy), *Rhizophora mucronata* (Kongkang Chmul), *Ceriops* spp., *Bruguiera* spp., *Caralia* sp. and the families of Verbenaceae (*Avicennia* sp.), Sonneratiaceae, and Palmae (*Nypa fruticans*).

The average annual growth rate of Cambodia's mangrove forests was estimated to be 7.2m^3/ha. In some areas, this amount is as large as 9.2-9.9m^3/ha. *Rhizophora conjugata* and *R. mucronata*. *Rhizophora* spp. reach a height of 15 to 20m and diameters measured at 1.3m high from ground vary from 30-40cm, depending on natural factors (soil condition, location etc.), compared to 30m high with diameter of 70cm in Viet Nam. Due to illegal logging in mangrove forests, the recent mangrove inventory shows that the growing stock of all standing trees within DBH greater than 5cm is 98m^3/h.

2.1 Species Distribution

There are reported to be 74 species of plants in the mangrove systems of Cambodia, from 53 genera and 35 families, however this number has yet to be verified. An initial list of 42 mangrove flora species belonging to 20 families has been identified during field surveys carried out from October to December, 1994 (IDRC, 1995). The dominant species belong to the genera *Rhizophora* (*R. mucronata, R. apiculata*) *Avicennia, Lumnitzera, Bruguiera, Ceriops* and *Xylocarpus*. In addition to mangrove trees, other associated species include the mangrove palm, *Nypa fruticans*.

An initial field study found 42 species of trees and shrubs belonging to 20 families in the mangrove forest of Koh Kong (DNCP[1], 1995). The most dominant species are of the family Rhizophoraceae (species *mucronata* and *apiculata*); family Combretaceae with genera *Lumnitora*; and, family Avicenniacae with genera *Avicennia*.

[1] *Department of Natural Resource Conservation and Protection, Ministry of Environment.*

Mangrove forest zonation in Koh Kong is believed to be similar to plant community structure in Chattaburi Province, Thailand. The edges of the estuaries and canals are dominated by *Rhizophora apiculata* and *R. mucronata*. Further inland are *Avicennia* and *Bruguiera* followed by *Xylocarpus*, *Ceriops* and *Lumnitzera*. Finally, a combination of *Nypa fruticans* and others can be found in the transitional zones between true mangroves at the seaward edge and inland forest (rear mangroves) which are dominated by *Melaleuca* trees.

Referred to the research of the CZM-DANIDA (1999) in November 1999 on the "Assessment of Sustainable Livelihood Alternative to Mangrove Exploitation", the mangrove forests are the prevailing ecosystem in many coastal zones of Cambodia. They commonly occur in estuarine systems and as fringing belt on near shore creeks, lagoons, and in marine sheltered bays. A total of some 30 true mangrove and about one dozen of mangrove associate species were identified during the field observations conducted by two different groups please see the attached Annex 1.

The *Rhizophora apiculata* is the predominant tree along most estuaries systems, while a mix of mangrove species each adapted to the soil and salinity condition forms the inners parts of extensive mangrove their tallest size (e.g. In Koh Kapik River system, where still some *Bruguiera* spp. And *Xylocarpus* trees remain intact at height of 25-30 meters. Typically, the mangrove vegetation changes gradually into freshwater riverine vegetation and/or terrestrial forest types, (e.g. *Melaleuca* or dense lowland evergreen forest) on the landward side what tidal influence is decreasing. Where infertile muddy/silt river banks occur in this part of the estuary, extensive stands of *Nypa* palms frequently occur, often accompanied by dense growth of mangrove ferns (*Acrostichum* spp.), which also can form dense aggregation as undergrowth in the higher portions of the rear mangrove communities, the so-called backmangal zone.

A part from common pattern of zonation of predominant species parallel to the riverine border, there is conspicuous variety of patchy distribution of specific stands of the certain mangrove species, e.g. *Ceriops* spp. and *Excoearia agallocha*. In some near shore sandy elevated areas *Heritiera* develops in both Koh Kong and in Sihanoukville. It is note that many of these trees are affected by the natural decay, the so-called top-dying disease.

In coastal flats with highly saline sandy soils, like in areas where extensive slat farm development takes place (e.g. Kampot Province) the predominant mangrove species are *Avicennia* on the seaward side and *Lumitzera* in the landward side. In the latter environment, fringing mangroves tend to have stunted growth which is attributed to physiological stress for the vegetation which has to cope with infertile saline soils, fine sand accumulation and high evaporation rates due to wind exposure.

2.2 Formation

The mangrove communities in Cambodia were classified by the forest classification of the Ministry of Agriculture, Forestry and Fisheries and it is similar to what Viboth and Aswell classified as four types as following:

Mangrove: Most of the members of the mangrove community are characteristic of areas which are inundated only at some high tides and where there is a large degree of freshwater influence. The islands and creeks are typically fronted by *Rhizophora apiculata and Rhizophora mucronata*, two of the most common of the mangrove species present, and stands of *Nypa* palms. Immediately behind this fairly narrow strip of *Rhizophora* is an interesting mixture of other mangrove species, the most common of which are: *Brugiera gymnorrhiza*, *B. sexangula*, *Ceriops tagal*, *Lumnitzera littorea*, *Heritiera littoralis*, *Xylocarpus granatum*, *Hisiscus tiliaceus*, *Phoenix palludosa*, *Acrosthicum speciosum*, *Aegialitis sp*. and, *Acanyus sp*.

Rear mangrove' community: On some of the islands and on the mainland between Prek Khlang Yai and Prek Thnot, the mangrove community forms a narrow band. It is followed by a community above the high tide mark and probably only subject to freshwater inundation during the wet season. This community is dominated by *Melaleuca leucodendron*.

Beach strand vegetation: At the south side of Koh Kapik, and on the sandy areas of some of the islands, there are small areas of typical beach strand vegetation dominated by *Casuarina equisitifolia* with some *Terminalia catappa*.

3. ENVIRONMENTAL STATE

As mentioned previously, the coastal areas in Cambodia are formed into two municipalities as Krong Kep and Sihanoukville, and two provinces Kampot and Koh Kong Province.

These coastal provinces/municipalities under the effect of tropical weather and mosoon winds with all year around temperature from 24^{o}C to 30^{o}C. The rainy season is from May through October and the cool season is from November to January and the dry season is from February to April. The average rainfalls in Kep vary from 1,200mm to 1,875mms or a higher – 2,500mms. The moisture level is also moderately high.

In Koh Kong Province, the Rainfall ranges between 2,000mm and 5,268mm (according to Koh Kong Water Resource and Meteorological Department). The monthly average temperature is 27^{o}C low and 38^{o}C high. In rainy season, the wind comes from the west or from the sea that can cause storms with duration of 3 to 7 days rendering travel by sea difficult. During strong winds and storms waves can reach 2-3.5m in height.

4. THREATS, PRESENT AND FUTURE

4.1 Human Pressure

4.1.1 Population Pressure

In 1995, the total population of the three coastal provinces was estimated to be 6.5% (675,000 populations) of the total national population. Topulation densities vary from 7.07 people/km^2 in Kampot province to 138 people/km^2 in Sihanoukville with an average density of 37 people/km^2. Average growth rates in 1993 range from 2.7 to 4.6% in Koh Kong and Kampong Som respectively.

4.1.2 Coastal Development

The Royal Government's goals for Coastal provinces and municipality originally planned for economic development in Cambodia through the rebuilding of urban growth tourism port expansion and industry.

Urbanisation
Investment in coastal development will lead to increased urban growth as population from the rural areas move to tourism and associated services for increased economic opportunities The Urban environment infrastructure is current insufficient to meet the requirement of even the current urban population Without appropriate investments the environmental quality of this town will degrade.

Tourism development
Coastal area is a matter of great in importance to the future of Cambodia both in term of economical and environmental considerations. This development is expected to lead the way for Coast to develop as commercial centre which would substantially increase its population. The impact from this development may be affected to coastal inland resources coastal water resources. The number of tourists in the three coastal provinces has been estimated at 10,206. An approximately 9% growth in tourism arrivals in Cambodia is Japanese Taiwan and Chinese. This indicated that the positive growth in the potential tourism Development sector in the country.

Port development
Coastal ports expansions developments can make a contribution to the economy as a main hub for growth of maritime transport which should in turn attract manufacturing entries but may also have an adverse impact on the surrounding environment. These effects of new expansion port can be focused upon location port construction and port operation. These lead to impacts on water quality coastal hydrology bottom contamination marine ecology air noise waste management and visual quality.

Industrial development
The industrial development zone was established in Sihanoukville called "Stung Hav Sihanoukville Industrial Zone". This industrial zone include petrochemical production to exploit recently confirmed oil and gas reserves in the gulf of Thailand food processing based on the local fisheries in the area timber processing and re manufacturing However these industries pose potential damage to the environment.

4.2 Natural Phenomena

Because coastal zones are affected directly and indirectly by the impacts of climate change such as change in precipitation, hydrological pattern, and frequency and intensity of cyclones, storm surges, Cambodia's coastal zone is among the most vulnerable areas to global warming and climate change.

5. SOCIAL USE AND OWNERSHIP

5.1 Ownership

5.1.1 Protected Areas

Most of the mangrove areas have been designated within the protected areas system under the Royal Decree Creation and Designation of Protected Areas' signed on November 1, 1993 by King Sihanouk (Table 2). These protected areas include the Peam Krasaop Wildlife Sanctuary (31,022ha), and Botum Sakor National Park (171,250ha). In addition, Koh Kapik (12,000ha) and associate islets situated within Peam Krasaop Wildlife Sanctuary, have been nominated as a wetland of international importance under the Ramsar Convention (ADB, 1995). All of these areas are under the responsibility of the Ministry of Environment (MOE). Management plans for these areas are yet to be developed.

Table 2 Protected Areas in the Coastal and Marine Zones of Cambodia.

Name	Area (ha)	Province
National Parks		
Phnom Bokor	140,000	Kampot
Kep	5,000	Kampot
Ream (Preah Sihanouk)	15,000	Kompong Som
Botum Sakor	171,250	Koh Kong
Kirirom	35,000	Koh Kong, Kampong Speu
Wildlife Sanctuaries		
Peam Krasaop	23,750	Koh Kong
Phnom Samkos	333,750	Koh Kong
Aural	253,750	Koh Kong, Pursat, Kampong Channang, Kampong Speu
Multiple Use Management Areas		
Dong Peng	27,700	Koh Kong

Source: ADB (1995).

5.1.2 Communities

The communities who live in the villages located inside or directly adjacent to the South-West Cluster Protected Areas come mainly from the Khmer, Cham, Pear, Chong and Sóach ethnic groups. The majority are Khmer, although there is a significant minority of Cham living in and around Ream and Bokor National Parks who are engaged in fisheries-related activities and farming. The park-adjacent and park-dwelling populations include a mix of more recent immigrants (most who came to the area during or after the Khmer Rouge era), and longer-term settlers.

Actually, the communities' development and the communities of conservation and protection have popularly been applied throughout the whole country. This term have been used in term of co-management of Protected Areas and Natural Resources that is adjacent to their communities.

5.2 Present Uses

Given the multiple use potential of mangrove ecosystems, an integrated approach to mangrove management is essential and should cover the full range of products and services which can be obtained from these areas.

The uses and values of the products obtainable from mangroves are many and important. The importance of the resource stems from the many products taken directly from the mangroves, including the non-wood products, as well as amenities provided from within and beyond its boundaries. Wood products range from timber, poles and posts to firewood, charcoal and tannin.

Non-wood products include thatch, honey, wildlife, fish, fodder and medicine. In addition, mangrove lands are often converted to salt ponds or to agriculture or aquaculture purposes. Table 3 illustrtes different kinds of mangrove products and uses along the costline of Cambodia.

Table 3 Different Kinds of Mangrove Products and Uses.

Fuel • Firewood • Charcoal **Construction** • Timber, scaffolds • Heavy construction • Railway sleepers • Mining props • Boat building • Dock pilings • Beams and poles • Flooring, paneling • Thatch or matting • Fence posts, chipboards **Fishing** • Fishing stakes • Fishing boats • Wood for smoking fish • Tannin for net/lines • Fish attracting shelter	**Textile, leather** • Synthetic fibers (rayon) • Dye for cloth • Tannin for leather preservation **Food, drugs and beverages** • Sugar • Alcohol • Cooking oil • Vinegar • Tea substitute • Fermented drinks • Dessert topping • Condiments (bark) • Sweetmeats (prop gules) • Vegetables (fruit/leaves) **Agriculture** • Fodder	**Household items** • Glue • Hairdressing oil • Tool handles • Rice mortar • Toys • Match sticks • Incense **Other forest products** • Packing boxes • Wood for smoking sheet rubber • Medicines **Other natural products** • Fish/Crustaceans • Honey • Wax • Birds • Mammals • Reptiles/other fauna

- **Services**
  a. Coastal protection against wave and wind erosion.
  b. Moderating the effects of coastal storms and cyclones.
  c. Shelter and habitat for diverse wildlife, particularly avifauna.
  d. Nutrient sink-effect and reduction in excessive amounts of pollutants.
  e. Entrapment of upland runoff sediments thus protecting near shore reefs and reducing water turbidity.
  f. Mangroves also provide opportunities for education, scientific research, recreation and ecotourism.

- **Wood products**

Mangrove forests have favorable silvicultural characteristics which lend themselves to intensive forest management for wood products. Some of these characteristics are as follows:

- Rapid growth: mature stands under suitable conditions may yield over 270m^3/ha within 30 years, equivalent to an MAI of 9-10m^3/ha.
- Good regeneration potential: most mangrove species flower and fruit regularly and the prop gules are dispersed by tides. Thus, mangrove stands can recover rapidly from natural or man-made disturbances, including intensive logging.
- Tendency to form homogeneous/even-aged stands: pure stands of *Rhizophora* or *Avicennia* are not uncommon and even in mixed stands; the principal components are restricted to a handful of species.
- Diversity of forest products: a wide range of products are produced and as bioenergy plantations even the smaller thinning may be used as firewood.

- **Timber**

Under favorable conditions, mangrove trees can grow to large sizes. *Rhizophora* over 40 m tall are not uncommon and individuals over 62.5m have been reported. However, large trees are becoming scarce, especially in South East Asia, as most of them are removed before they can attain such sizes.

Rhizophora spp. are, however, not valuable as timber because of their tendency to split and warp when dried. The wood is dense and difficult to work. The sapwood is easy to preserve but not the hardwood. It is resistant to decay but not to marine borers. Its possible uses include agricultural implements, boat construction (knees and ribs), general heavy construction (rafters, beams, joists), marine and bridge construction (underwater, non-teredo infested waters), marine and bridge construction (above water), fence posts and poles.

The wood of *Rhizophora* is exceedingly heavy with a specific gravity varying from 0.8-1.2. *Avicennia*, which has a lower density (about 0.64) and good nail holding qualities, is often used as railway ties.

- **Charcoal**

Rhizophora spp. is preferred for charcoal making. Their moisture content (MC) when felled is about 40 percent (as percent of oven dry weight) compared to *Avicennia* wood which ranges from 70-95 percent. *Rhizophora* wood dries to about 25 percent MC after two months, whereas *Avicennia* requires up to six months drying to 35 percent MC. This partly explains the popularity of *Rhizophora* wood, as predrying stock can be kept to a minimum. Other species (*Bruguiera gymnorhiza* and *Ceriops* sp.) are also used but in smaller quantities.

Charcoal is the main mangrove product in Cambodia. Industries are well developed at the village and cottage industry levels in most Asian countries where mangroves still abound. Charcoal is mainly used for cooking purposes and small-scaled industries.

- **Firewood**

Rhizophora in Cambodia are favored as fuel wood for domestic purposes and are commercially removed, or collected by fishermen and villagers.

- **Fishing stakes/poles**

Actually in Cambodia, there is an established demand for mangrove piling poles used in land reclamation and the construction industry. Used in wet sites which are not infested by shipworms, such mangrove piles can outlast non-treated inland hardwoods.

Along the muddy river banks, small fishing stakes are used to support tidal fish nets. Mangrove poles are also used for scissor nets in housing construction. In countries in South East Asia, fishermen cut mangroves and dump them into the shallow coastal waters as a way of creating shade and thus attract fish (fish attraction devices).

- **Tannin**

Rhizophora bark produces very fine tannin suitable for leather work. Tannin from mangrove species has also been used for curing and dyeing of fishing nets made of natural fibred to make the nets more resistant to biological decay.

The production of tannin has declined greatly in recent years, in particular since local demands have been reduced after the introduction of nylon fishing nets and the use of chrome as the predominant agent for leather curing.

- **Nipa palm**

The uses of this palm are many and diverse. It yields an important thatching material, which is used for the roofs and walls of rural houses. The shingles produced are cheap, light to transport, easy to fix and can last several years, particularly when used in houses with open stoves. Cigarette wrappers are also made from the young shoots of Nipa.

- **Wildlife**

As in other forest types, the wildlife in the mangroves is an important source of protein for the local community. In addition, some species, especially reptiles, are hunted or reared for their hides. Examples of traditional utilization of selected wildlife species found in mangroves are described in the following.

The wild boar (Sus scrofa) is often found marauding in the swamp margin and it is a source of bush meat in Cambodia.

- **Fisheries products**

From an economic point of view, mangroves are often far more important for the aquatic production they support than for the wood production potential. Kapetsky (1985) estimated that the average yield of fish and shellfish in mangrove areas is about 90kg/ha, with maximum yield being up to 225kg/ha. According to this author, the total halieutic production of the world's mangroves would be around 1,000,000 tonnes per year (for an estimated area of 83,000km^2 of open water in mangroves), which is slightly more than 1 percent of estimated total world production in all waters per year.

- **Fish**

In Cambodia, the main commercial fish species caught in or close to mangrove areas include mullets (*Liza subviridis*), sea bass (*Lates calcarifer*), snappers (*Lutjanus* spp.), tilapia (T*ilapia* spp.), groupers (*Epinephelus* spp.), sea catfish (*Arius* spp.), threadfins (*Eleutheronema* spp.) and snake eel (*Ophichthus microcephalus)* (Christensen, 1979).

5.3 Potential Uses

Other animals and plants associated with mangroves. Mangroves help provide for a great diversity of plant and animal life. They provide essential habitats for aquatic inhabitants such as crabs, shrimp, fishes, and various invertebrates, as well as other species such as shorebirds and monkeys.

All these resources as mentioned above are very high potential in term of local use and external demands.

5.4 Current Management Regime

5.4.1 Enforcement of Existing Laws

The environmental protection and natural resources management law is not adequately enforced. This is largely because of lack of human and financial resources. The fisheries law has many good provisions for the protection of marine habitats and fisheries resources. For instance, dynamite fishing trawling in coastal water pushing netting and cutting mangrove occurs daily but are rarely prosecuted.

5.4.2 Decision-making Processes

The decision making process relating the development in the coastal zone is poorly defined vague and ambiguous. It appears that whatever the official mechanisms are high ranking individuals can make decisions without consultation and participation. On the other hand, it appears to be conflict between provincial and national decision makers with plans and policies developed independently by the two levels of government.

5.4.3 Legal Framework

A legal framework does exist for management of the coastal zone. There are laws on protected areas fishing industrial development land use forestry environmental protection and natural resources management, environmental impact assessment, water pollution control and other important coastal zone issues. All governors and departments in all provinces and municipalities identified the lack of a legal and policy framework for coastal zone management and administrative structure to implement it as a major constraint on coastal zone management in Cambodia.

Lack of Coastal Zone Planning

All provinces and municipalities are required to prepare Master Plans. Planning has not occurred in the coastal zone. However, the plan prepared by provincial authorize specifies industrial tourism and residential zones but does not suggest any guidelines for development standards or further plans. Unplanned and uncoordinated development is occurring all along the coast but is not yet viewed as a major problem because the rate of development is slow. However, it is envisaged that this is lack of planning result in haphazard development and will be a source of serious conflicts in the near future.

Lack of Information about Distribution and Status of Natural Resources

Information on marine habitats such as coral reefs, sea-grasses and endangered species are still limited. The distribution of such these information and data both national and provincial levels are limited. Without information about what people are catching, it is not possible to estimate where the fisheries are over-fishing.

Lack of Public Awareness and Participation and Capacity

Many problems related to public and participation could be addresses. And actions to these should strengthen laws raising public awareness and doing research associated with this concern is a serious lack of technical capacity among government staff and minimal resources to prepare and disseminate information.

Participation is still low priority for most government officials that may be reflecting the historical lack of community participation in decision making in Cambodia. The lack of participatory planning and management has meant that some solutions to environmental problems are unsatisfactory.

5.4.4 Cambodian Policy and Administrative Frameworks

The basic emphasis of the Cambodian government at present is to attempt to clarify the lines of responsibility for activities that currently transcend local, regional and national interests the intent is to manage and coordinate government actions to clarify ministry attributions and to ensure administrative effectiveness and propriety. The existing restructuring of administrative tasks is directed reshaping the civil service reforming the organizational framework for effective management and reforming the regulatory mechanisms. The effectiveness and efficiency of organizing and managing planned coastal development and resources use is depending upon this successful restructuring of the state (reformed administration). The Royal Government of Cambodia is being emerged to develop Cambodia to become a state with a functional legal and administrative system.

Many Royal decrees laws, sub decrees and other legal instruments have been issued and are being developed. At the present, a process of making policy and law are done by a combination of national and international experts. These are law on Environmental Protection and Natural Resources Management, land law, Royal decree on the Creation and Designation of Protected Areas. Sub decree on Environmental Impact Assessment and Water control Pollution, Fisheries and Forestry laws and Law on Land Management Urbanization and construction. On the other hand, Cambodia became a member of the Coordinating Body of the Seas of East Asia (COBSEA) Association of South East Asian Nation (1999), MARPOL (1994), Biodiversity convention (1994), CITES convention (1997), Ramsar convention (1999), and Climate Change convention (1995).

5.4.5 Institutional Frameworks

The numerous institutions with statutory power or interests in coastal and marine areas give rise to the problems of overlap gaps in responsibilities and lack of coordination. The government has set up some organizational institutions in order to ensure overall coordination and cooperation of the different policies and measures taken by ministry levels of administration. A part from the existing coastal and marine coordination consists of the Ministry of Environment, Ministry of Agriculture Forestry and Fisheries, Coastal Coordinating Unit and the National Coastal Steering Committee.

The Ministry of Environment (MoE) was established in 1993 to address issues of environmental management in the country hold a number of responsibilities with respect to the coastal zone, the most obvious being the general protection of the environment in the coastal zone. More specific duties include the planning and management of the protected area system in the coastal zone. And its strategy is based on the execution of sole and joint responsibilities in conjunction with other ministries concerned with specific aspects of natural resources and infrastructure management.

The Ministry of Agriculture Forestry and Fisheries (MAFF) is the main ministry responsible for managing Cambodia' s forests including inundated forests mangrove as well as wildlife and fisheries. Two departments of MAFF are directly relevant to biodiversity management and protection in Cambodia. It is clear from the responsibilities of MAFF and MoE that close coordination between the ministries and departments involved in nature conservation is essential to avoid conflicts and promote complementary activities towards implementing the coastal protected area plans.

National Coastal Steering Committee (NCSC) is an attempt to deal with the multi sectoral natural of coastal resource issues. This committee was established in and meet on a quarterly basis Members of this Committee include the Minister of Environment (Chairman), Under Secretaries of State from Ministry of Agricultural Forestry and Fisheries (Vice-chair), Ministry of Tourism, Industry Mines and Energy Public Works and Transport, Rural Development, Women's Affairs Planning, Council of

Development for Cambodia, Governors of coastal provinces and others donors NGOs and related coastal projects are observers. The NCSC is responsible for the overall direction of coastal projects and activities. All members are asked to ensure the cooperation of their line ministries and provincial authorities. The committee assisted by secretariat calls Coastal Coordinating Unit (CCU) was created in the Ministry of Environment and is responsible for coordination of activities by international organizations governmental agencies and the private sectors in the coastal area in Cambodia Provincial working groups have been formed at the provinces and municipalities. These working groups are supported by Danida coastal zone project in its ongoing technical assistance activities in the coastal zone.

6. ECONOMIC VALUATION

6.1 Direct Use Values

Today, 49 Village Fishing Groups and a Village Fisheries Committee work to regulate conserve and manage marine resources in the Park according to the fisheries management guidelines and regulations that they have developed.

Analysis of the value of resource use shows that overall; Ream National Park constitutes an extremely important economic resource for local communities. Up to 84% of households depend on the Park's resources for their basic subsistence and income, to a net value of some US$1.24 million a year or an average of US$233 for every household living in and beside the National Park.

In an area where the median family income is only US$316 a year and a third of families earn less than US$200, and where half of households can barely provide for their own subsistence.

A survey of 90 households was undertaken in three villages within Koh Kapik, the study area and proposed Ramsar site, in order to provide information on the traditional uses of the mangrove by local communities. The research focused on the economic valuation of non-timber forest products collected from the mangrove area by households; these include fuel wood, charcoal, construction materials, and crabs, shrimp, fish and snails. In addition, the important ecological functions of the mangroves, such as storm protection and biodiversity maintenance were identified. Eight shrimp farms were surveyed in order to assess the viability of shrimp farming in the area.

Over 90% of households are dependent on fishing for their livelihood. However, fish productivity has declined dramatically in recent years due to the increased number of fishers, the loss of mangrove areas to shrimp farms and water pollution from these farms. 90% of households involved in fishing claim that it was harder to fish now compared to 5 years ago. Local fishing benefits are estimated to be US$84 per hectare.

The area of mangrove forest required per charcoal kiln per year is estimated by this study to be between 0.20-0.40 hectares. Assuming a 30 year cutting cycle, and that only already disturbed mangrove areas would be allocated for charcoal production, potential returns per hectare per year for sustainably managed charcoal production are estimated at over US$400.

While 50% of farms made a profit in the past year, overall shrimp farms in the area suffered an average loss of over US$1,000 per hectare. Largely due to problems with disease associated with poor water quality management, it is rare for farms to have two successful harvests a year, and in some cases both harvests have failed. Individual farms have reported losses ranging from US$40,000 - 240,000.

The real costs of shrimp farming are in fact much higher since the analysis does not account for the environmental costs associated with shrimp farming. Unsustainable shrimp farming is linked to water pollution and the extensive clearing of mangroves for farm use, preventing accretion and wiping out of nursery areas. There is also a social linkage: over 90% of local people oppose the shrimp farms. This could result in social unrest and security problems in the future if not adequately addressed.

The relocation of families out of sensitive mangrove areas is supported by provincial authorities. Land is available in upland areas in the province where crop cultivation is possible alongside fishing. Some households in Koh Kapik have expressed an interest in relocation. While an in-depth assessment of the suitability of relocation sites is lacking, the possibility of voluntary relocation could be considered as a way of protecting an ecologically valuable resource and improving the living standards of the local people. Relocation support is estimated around US$2,000 per household to cover the cost of house construction and living expenses before the first harvest.

Generally the Intensive shrimp farming covered an area of 850ha in 1994 with production of 450 tonnes a year. But disease outbreaks have since reduced the culture area to 20%, with estimate of national losses amounting to US$28.6 million a year. A moratorium on further licensing of shrimp farms has been enforced.

6.2 Environmental Service Values

The value of mangrove conservation in Ream National Park

In total there are approximately 1,800ha of mangroves in Ream, with a total volume of 111,645m^3. A simple cost-benefit analysis demonstrates the high value of mangrove conservation in terms of local socio-economic and environmental benefits. Under realistic recovery and harvesting conditions, clear-cutting the mangroves would yield a one-time income of less than US$630,000. Although prawn farms can, under the best conditions, realize a net income of almost US$4,500/ha/yr, few actually do. In Koh Kong, a similar mangrove area lying to the west of Ream National Park, half of prawn farms are making a loss at a realistic productivity rate of 3.6 tonnes per harvest, this loss is nearly US$9,950/ha/yr and in aggregate they show a loss of US$1,103 per ha per year. Yet even if only half of the forest, fisheries and agricultural production in surrounding villages depend on mangroves in the Park, their clearance would result in a loss of local income of around US$620,000 a year. It was confimed that US$344/ha/yr is a realistic one data for similar mangrove areas in Thailand estimate local use of mangroves to be worth between US$230 (Christensen 1979) and US$1,200 (Sathirthai 1998) a year, and values in Koh Kong Province exceed US$500/ha, including charcoal. In fact many more economic losses would occur from mangrove clearance, such as the damage to houses, infrastructure, farmland, employment, markets and general local welfare that result from the loss of vital environmental functions and ecological services. In Southern Thailand, the economic benefits of mangroves in terms of coastline protection have been estimated to have a value of between US$76.5/ha/year and 165/ha/year (Christensen 1979), carbon sequestration benefits US$2.2/ha, and mangrove storm protection functions have been valued at US$32/ha in Koh Kong Province. Taking into account these indirect economic benefits increases the annual economic value of conserving Ream's mangroves to US$900,000 a year. This is far more than the one-off gain (and long-term loss) of clear-cutting the mangroves and turning them over to prawn farms. The economic costs of estroying these valuable natural ecosystems, both immediate and long-term, far exceed the benefits or in other words, biodiversity conservation in Ream National Park is a demonstrably economically worthwhile activity to engage in.

Net value (US$/ha/yr)	**Total Value (US$ '000/yr)**
Local use:	344,619,200
Storm protection:	3,257,600
Coastal erosion prevention:	122,219,600
Carbon sequestration:	23,600
Total Value:	500,900,000

7. CONCLUSION AND RECOMMENDATIONS

Refereed to description above, the data and information is still very limited, especially for the specific issues such as mangrove composition and specie distributions. The most of the supports are likely to work just in this stage on a very small areas comparing to all the mangrove areas. In other words, nobody take it care yet for the whole mangrove areas even though the Cambodia is in progress of green development way. Regarding the local data and information, it is mostly focusing on the socio-economic and health issues which are the immediate objectives to help people to survive maintain and develop their own life. The environment issues are the secondary or long term objectives.

In addition, no one institution is responsible for researches neither data and information coordination and management. Due to there are no research supports and its facilities, lack of financial supports; and very limited knowledge and skills. On the other hand there is no linking between the independent researches and project/programme realizations. So the data and information are available unless there is a project or programme in place.

Regarding the project or programme, it is unsustainable manner. It means some projects/programmes just for 1 year, 2 years, 3 years or… but no permanent. So when it is not permanent, its data is not fixed. When the project/programme finished, the data and information are also misplaced and disappeared.

Therefore the national self-management of the data and information is the key actor. Concerning its management, there are lack of knowledge and skill in information and data management and its supported infrastructures. The people are essentially less considered for the data and information for decision making, planning and monitoring as well as evaluation. The principle causes are lack of mechanism for data and information sharing among other peoples and lack of its dissemination, which allows people to understand the important, use effectively and manage it.

In order to maintain and keep records up to date, the key issue is to compile and manage the existing data and information in a national database system that can be used by other people. As Cambodian human resources are very limited, thus the capacity building in data and information use and management is a prerequisite as the immediate objectives.

Gathering and giving data and information are the principle to promote and maximize for its sharing and dissemination. It needs to establish the coordination for data and information management with the enhancement of flow mechanism with its free access.

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Annex 1 List of Mangrove Species in Cambodia.

N.	Khmer Name	Scientific Name	Family
1	Trochjiek cragn slekweng/trochjiekcragn pkapor sar	*Acanthus ebracteatus* (shrub)	Acanthaceae
2	Trochjiek cragn Slekbanla/trochejiekcragn pkapor svay	*Acanthus ilicifolius* (shrub)	Acanthaceae
3	Trochjiek cragn slek-eit banla	*Acanthus vulubilis* (shrub)	Acanthaceae
4	Brong	*Acrostichum aureum* (fern)	Pteridaceae
5	Brong/Khnagn	*Acrostichum speciosum* (fern)	Pteridaceae
6	Smair	*Aegialites rotundifolia* (tree)	Plumbaginaceae
7	???	*Aegiceras corniculatum* (tree)	Myrsinaceae
8	???	*Amoora cucullata* (tree)	Meliaceae
9	???	*Atalantia monophylla* (tree)	Rutaceae
10	Kbagnsor/Sman/Mouroujsrotorb	*Avicennia alba* (tree)	Verbenaceae
11	Kbagn Sporng/ Mouroujsrotorb	*Avicennia marina* (tree)	Avicenniaceae
12	Kbagnkmao/Spong	*Avicennia officinalis* (tree)	Avicenniaceae
13	Dawmtrojiekbres/Pchek tekbray	*Barringtonia racemosa* (tree)	Lecythidaceae
14	???	*Brownlowia tersa* (shrub)	Tiliaceae
15	Basac/Omlann	*Bruguiera cylindrica* (tree)	Rhizophoraceae
16	Basac Kroahom	*Bruguiera gymnorrhiza* (tree)	Rhizophoraceae
17	Basacsor	*Bruguiera sexangula* (tree)	Rhizophoraceae
18	???	*Caesalpinia crista* (shrub or climber)	Leguminosae-Caesalpinoideae
19	???	*Calycopteris floribunda* (climber)	Combretaceae
20	Dawmcheungtia/Pilpicht/Chompourey	*Cerbera odollam* (tree)	Apocynaceae
21	Smairsor	*Ceriops decandra* (tree)	Rhizophoraceae
22	Smerkrohorm	*Ceriops tagal* (tree)	Rhizophoraceae
23	Dawmchheongpurs	*Clerodendrum inerme* (shrub)	Verbenaceae
24	???	*Combretum tetralophum*	Combretaceae
25	Dyerohatt	*Cordia cochinchinesis* (tree)	Boruginaceae
26	???	*Derris trifoliata* (climber)	Leguminosae Papilionoideae
27	Tatom/Chheu chhor	*Excoecaria agallocha* (tree)	Euphorbiaceae
28	???	*Finlaysonia maritima* (vine)	Asclepiadaceae
29	Pdaoondawk/Voirre	*Flagellaria indica* (climber)	Flagellariaceae
30	Kann-kai/Dawmklai/Semornsakmot	*Heritiera littoralis* (tree)	Sterculiaceae
31	Dawm-beus/Kabbaspreyteukbrey	*Hibiscus tiliaceus* (tree)	Malvaceae
32	Krokosteukpray/Krongnungteukbray	*Intsia bijuga* (tree)	Leguminosaecae-salpinoiddeae
33	???	*Kandelia candel* (tree)	Rhizophoraceae
34	Krognyeppka krohom/Krognyep-krohom	*Lumnitzera littorea* (tree)	Combretaceae

Annex 1 *cont.* **List of Mangrove Species in Cambodia.**

N.	Khmer Sound	Scientific Name	Family
35	Krognyep pkasor/Krognyep sor	*Lumnitzera racemosa* (tree)	Combretaceae
36	Chark	*Nypa fruticans* (palm)	Palmae
37	Peng	*Phoenix paludosa* (palm)	Palmae
38	???	*Premna obtusifolia* (tree)	Verbenaceae
39	Kongkangslektoch	*Rhizophora apiculata* (tree)	Rhizophoraceae
40	Kongkang slekthom	*Rhizophora mucronata*	Rhizophoraceae
41	???	*Sapium indicum* (tree)	Euphorbiaceae
42	Ampouthmar/Rompea chheu	*Sonneratia alba* (tree)	Sonneratiaceae
43	Ampoukrohom	*Sonneratia caseolaris* (tree)	Sonneratiaceae
44	Ampea	*Sonneratia griffithii*	Sonneratiaceae
45	Ampea	*Sonneratia ovata* (tree)	Sonneratiaceae
46	Porhteukpray	*Thespesia populnea* (tree)	Malvaceae
47	Tabonsor	*Xylocarpus granatum* (tree)	Meliaceae
48	Tabonkmao	*Xylocarpus moluccensis* (tree)	Meliaceae
49	Tabann	*Xylocarpus rumphii* (tree)	Meliaceae
50	Khontrianket sahmot	(fern/herb ??)	
51	Voartrohkhuntek sahmot	(vine)	
52	Voarsoandeik kmouch	(vine)	
53	Nonoung sahmot	(vine)	
54	Voartadet	(vine)	
55	Rhumjeik sahmot	*Pandanus tectorius* (palm/tree)	Pandanaceae
56	???	*Scaevola taccada* (shrub)	Goodeniaceae
57	Vorprieng	(vine)	
58	Phut-tria sahmot	(tree/shrub)	
59	Thaw-sai (Thai)		
60	Lambit thalay (Thai)		
61	Phosai		
62	Thuk-kai		
63	Phat-yanman (Thai)		
64	Lang-katsaa (Thai)		

Source: IDRC, 1995.

Annex 2 Different Types of Mangrove Values in Cambodia.

Description	Gross value (US$/year)	Net value (US$/year)	Average value per user household (US$/year)
Firewood	125,133	112,062	25
Construction wood	23,659	23,659	18
Medicinal plants	10,788	10,788	11
Food	17,695	17,695	18
Roofing materials	13,397	13,397	84
Sub-total, forest products	**190,672**	**177,601**	
Crops	316,594	316,594	119
Livestock	203,750	227,702	143
Sub-total, farming	**520,344**	**544,296**	
Total forest products and farming	**711,015**	**721,897**	

United Nations Environment Programme

UNEP/GEF South China Sea Project

Global Environment Facility

NATIONAL REPORT

on

Mangroves in South China Sea

CHINA

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Table of Contents

List of Tables, Figures and Annexes

1. GEOGRAPHIC DISTRIBUTION

1.1 Maps

Natural mangroves in China are found along the coastlines of Hainan, Guangxi, Guangdong, Fujian, Taiwan, Hong Kong, and Macao. Fuding city (27°20'N) of Fujian province is considered as the northmost boundary for natural mangroves, but for artificial mangroves, Yueqing (28°25'N) of Zhejiang province is the northmost border, where *Kandelia candel* was transplanted successfully in 1950s. Figure 1 shows Map of Mangrove Distribution in China.

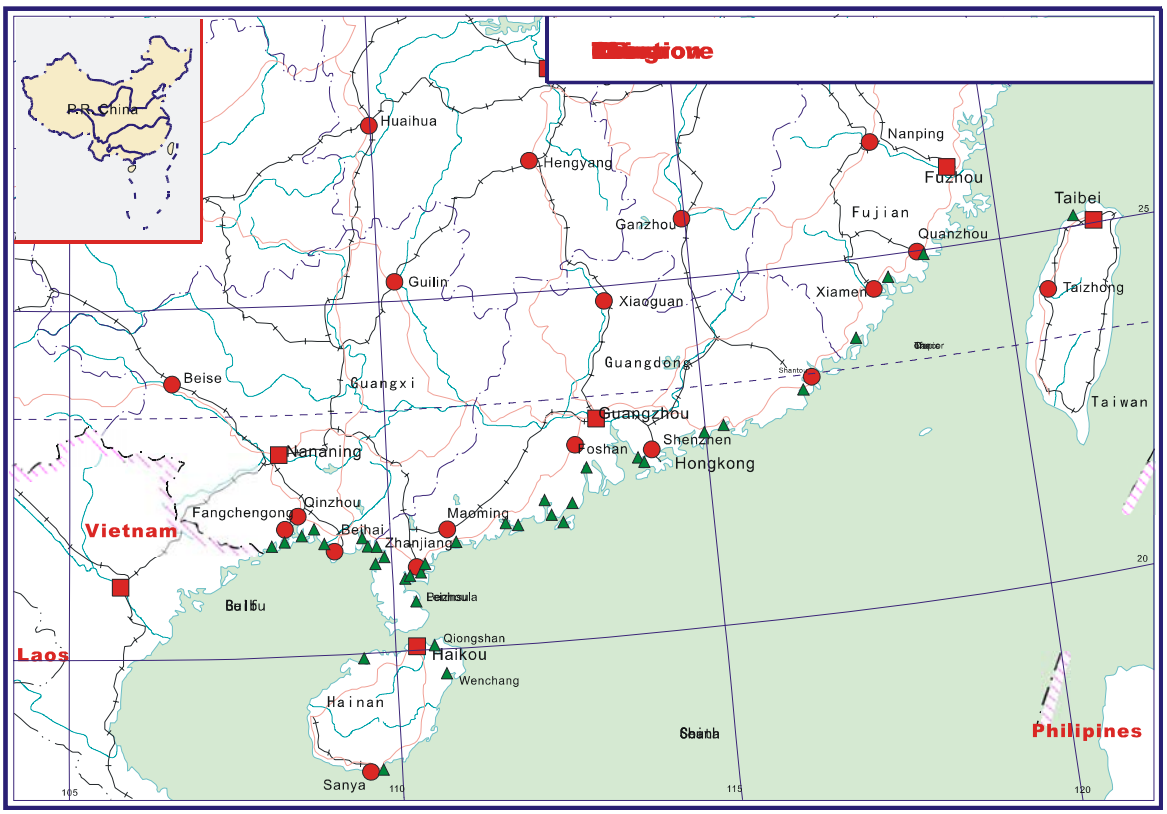

Figure 1 Map of Mangrove Distribution in China.

1.2 Area Distribution

Generally, in terms of administrative region, mangroves in China mainly occur in three provinces, Guangdong (9,891ha), Guangxi (8,375ha), and Hainan (3,930.3ha), constituting an area of 22,196ha, which accounts for 94.67% of the total China mangroves.

Generally, in terms of administrative region, mangroves in China mainly occur in three provinces, Guangdong (9,891ha), Guangxi (8,375ha), and Hainan (3,930.3ha), constituting an area of 22,196ha, which accounts for 94.67% of the total China mangroves.

It is believed that the coverage of mangrove in China was around 40, 000ha in 1950s (He, 1999). Now, the area of existing mangrove, according to some scholars (He, et al. 1995; Fan, 2000; Zhang and Sui, 2001), is estimated to be about 15,000ha. However, the result of an overall survey on mangroves conducted in 2001 showed that mangrove area in China was 23,445.7ha (Table 1).

The latter figure, though it suggests 8,445.7ha more mangrove area than the widely accepted figure, is believed to be more accurate, for it was figured out by using remote sensing technology in combination with field surveys. The difference of the two figures implicates only an underestimate of mangrove area by the scholars, but not an increase of mangrove area in China. China has seen a sharp decrease in mangrove area in the past fifty years. To demonstrate this trend, Fan Hangqing estimated (Fan and Li, 1997), based on an analysis on reclamation land along Guangxi coast, that mangrove forest in Guangxi has been depleted from 24,066ha about 150 years ago to 15,951ha in 1950s and to 5,654ha (scholars' estimate) or 8,375ha (remote sensing data) in 2001.

With respect to geographical distribution, mangroves in China mainly occur in three regions:

1) North-eastern coast of Hainan Island, including Qiongshan City (1,701ha, including1,572.6ha mangrove in Dongzhai Harbor Mangrove Nature Reserve) and Wenchang County (1,519ha, including 1188.8ha mangrove in Qinglan Harbor Mangrove Nature Reserve), where mangrove area is 3,220ha, making up 13.73% of China mangroves.
2) Leizhou Peninsula of Guangdong province (7,306ha), which making up 31.16% of China mangroves.
3) Guangxi coast of Beibu Gulf (8,375ha), making up 35.72 % of China mangroves. Mangrove area in the three regions constitutes 78.66% of total mangrove coverage in China.

Table 1 Mangrove areas in China.

Guangdong		Source	Guangxi		Source	Fujian		Source
Grand Total	9890.8		Grand total	8374.9		Grand total	615.1	
Zhanjiang			**Beihai**			**Zhejiang**		A
Wuchuan City	75.6	A	Hepu County	2595.6	A	Grand total	20.6	
Potou District	210.1	A	Haicheng District	28.9	A	**Taiwan**		D
Xiashan District	50.7	A	Yinhai District	448.0	A	Grand total	287.0	
Mazhang District	1986.8	A	Tieshangang District	50.8	A	**Hong Kong**		D
Donghai Island	1475.3	A	sub-total	3123.3		Grand total	263.0	
Leizhou City	1064.6	A	**Qinzhou**			**Macao**		E
Xuwen County	726.9	A	sub-total	3057.3	A	Grand total	64.0	
Suixi County	354.2	A	Fangchenggang					
Lianjiang City	1361.6	A	Dongxing City	801.8	A			
sub-total	7305.8		Fangcheng District	566.4	A			
Maoming		A	Gangkou District	826.1	A			
Maokang District	53.0	A	sub-total	2194.3				
Dianbai County	159.2	A						
sub-total	212.2		**Hainan**					
Yangjiang		A	Grand total	3930.3	A			
Yangdong County	24.2	A	Qiongzhou	1701	C			
Jiangcheng County	157.0	A	Wencang	1519	C			
Hailing County	48.2	A	Chengmai	305	C			
Yangxi County	420.7	A	Zhanzhou	274	C			
sub-total	650.1		Sanya	77	C			
Jiangmen			Lingao	43	C			
sub-total	500.5	A	Dongfang	4	C			
Enping			Linshui	4	C			
sub-total	134.4	A	Wangning	2	C			
Taishan			Qionghai	1	C			
sub-total	366.1	A						

Zhuhai								
Qi'ao District	74.6	A						
Sanhong District	5.7	A						
Doumen County	0.0	A						
Hengqin District	20.4	A		**Whole China**		**23,445.7**		
sub-total	100.7							
Guangzhou								
sub-total	10.0	A						
Shenzhen								
sub-total	330.0	A						
Huizhou								
sub-total	170.0	B						
Shanwei								
sub-total	31.0	B						
Chaozhou								
sub-total	10.0	B						
Shantou								
sub-total	70.0	B						

Notes:

A: Results from remote sensing and ground surveys in 2001.

B: Cheng Yuansheng, et al., 2001.

C: Data were calculated through the total area of 3930.3ha multiplying the relative proportions given by Mo Yanni et al., 2002. The current status of Hainan mangrove resources and protection strategies. Tropical Forestry; 30 (1).

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2. MANGROVE SPECIES DISTRIBUTION AND FORMATION

2.1 Species Distribution

36 species of mangrove have been recorded in China; of which 26 species in 13 families are true mangrove trees and 10 species in nine families are mangrove associates (Table 2). From south to north, the species of mangrove reduce gradually, with 35 species occurring in Hainan, 19 species in Guangdong, 18 species in Guangxi, 17 species in Taiwan, 9 species in Fujian, 5 species in Macao, and 1 species in Zhejiang. *K. candel* is the species occurring in all seven regions, for this species has developed a cold resistant adaptation. Among all the species, only *Sonneratia hainanensis* is category 1 protected national plant. Now only five trees of this species exist in China.

Table 2 Trees and Shrubs of Mangroves in China and Their Distribution.

Scientific Name	Family	Distribution							
		HN	HK	MC	GD	GX	TW	FJ	ZJ
True mangrove									
1. *Acrostichum aureurm*	Acrostichaceae	+	+	+	+	+	+	+	
2. *A. speciosum*	Acrostichaceae	+			+	+			
3. *Bruguiera cylindrical*	*Rhizophoraceae*	+							
4. *B. gymnorrhiza*	*Rhizophoraceae*	+	+		+	+	+	+	
5. *B. sexangula*	*Rhizophoraceae*	+							
6. *B. s. var. rhynochopetala*	*Rhizophoraceae*	+							
7. *Ceriops tagal*	*Rhizophoraceae*	+	+		+		+		
8. *Kandelia candel*	*Rhizophoraceae*	+	+	+	+	+	+	+	+
9. *Rhizophora apiculata*	*Rhizophoraceae*	+							
10. r. *stylosa*	*Rhizophoraceae*	+	+		+	+	+		

Scientific Name	Family	Distribution							
		HN	HK	MC	GD	GX	TW	FJ	ZJ
11. *Acanthus ebracteatus*	Acanthaceae	+			+				
12. *A. ilicifolius*	Acanthaceae	+	+	+	+	+	+	+	
13. *A. xiamenensis*	Acanthaceae							+	
14. *Lumnitzera littorea*	Combretaceae	+							
15. *L. racemosa*	Combretaceae	+	+		+	+	+		
16. *Excoecaria agallocha*	Euphorbiaceae	+	+		+	+	+	+	
17. *Xylocarpus granatum*	Meliaceae	+							
18. *Aegiceras corniculatum*	Myrsinaceae	+	+	+	+	+	+	+	
19. *Nypa fruticans*	Palmae	+							
20. *Scyphiphora hydrophyllacea*	Rubiaceae	+							
21. *Sonneratia alba*	*Sonneratia*ceae	+							
22. *S. caseolaris*	*Sonneratia*ceae	+							
23. *S. hainanensis*	*Sonneratia*ceae	+							
24. *S. ovata*	*Sonneratia*ceae	+							
25. *Heritiera littoralis*	Sterculiaceae	+			+	+			
26. *Avicennia marina*	Verbenaceae	+	+	+	+	+	+	+	
		25	10	5	13	11	10	8	1
Associated mangrove									
1. *Barringtonia racemosa*	Barringtoniaceae	+							
2. *Cerbera manghas*	Apocynaceae	+				+	+		
3. *Dolich*andr*one spathacea*	Bignoniaceae	+			+				
4. *Pluchea indica*	Compositae	+			+	+	+		
5. *Hern*and*ia sonora*	Hernandiaceae	+				+			
6. *Pongamia pinnata*	Leguminosae	+			+	+	+		
7. *Pemphis acidula*	Lythaceae	+					+		
8. *Hibiscus tiliscus*	Malvaceae	+	+		+	+	+	+	
9. *Thespesia populnea*	Malvaceae	+			+	+	+		
10. *Premna obtusifolia*	Verbenaceae	+			+	+	+		
		10	1	0	6	7	7	1	0

Note: HN-Hainan, HK-Hong Kong, MC-Macao, GD-Guangdong, GX-Guangxi, TW-Taiwan, FJ-Fujian, and ZJ-Zhejiang.

2.2 Formation

Based on species composition, appearance, and community characteristic, mangrove communities are grouped into seven formations (Lin, 1988), which are *Bruguiera* Formation, *Rhizophora* Formation, *Kandelia* Formation, *Aegiceras* Formation, *Avicennia* Formation, *Sonneratia* Formation, and *Nypa* Formation.

2.2.1 *Bruguiera* Formation

Bruguiera Formation refers to as the community dominated by trees of *Bruguiera*, which is mainly composed of two communities, *B. gymnorrhiza* community and *B. sexangula* community.

B. gymnorrhiza community distributes along coastline to the south of Xiamen city in Fujian province, well developed in clay loam land near estuaries where are occasionally inundated by high tide. Soil salinities range from 8% to 20%. Dark green in its community physiognomy, trimness in canopy, coverage degree 70-85%, height of trees 3-7.5 meters, diameter at base 14-25cm, diameter of crown of tree 3.6-4.7 meter. Associate species are *K. candel*, *A. marina*, *A. corniculatum*, *E. agallocha* at coast areas in Mainland China, and *Bruguiera sexangula*, *B.* s. var. *rhynochopetala* and *X. granatum* in Hainan Island.

B. sexangula community is only found in Hainan province, growing in sandy clay loam soil, salinity 3.26-14%, fusccpiceous or ruricans in soil colour, dark green in its community physiognomy, scattered with yellow green patches, 3-8 meter tall, 7-8cm in diameter at breast height, associated species are *K. candel* and *Ceriops taga*.

2.2.2 *Rhizophora* Formation

This formation consists of two communities, *R. apiculata* community and *R. stylosa* community. *R. apiculata* communities occurred only in Hainan, growing in muddy soil (salinity 7.1-9.5‰), inconsistent in height, dark green or yellow green in its community physiognomy, coverage of canopy 80%-90%, 3-6 meters tall, 8-10 cm dbh, associated with *B. sexangula* and *A. corniculatum*. *R. apiculata* communities are mostly located in mid tidal or high tidal muddy flats with dark grey soil (salinity 9.26-19.7‰), consistent in height, dark green in physiognomy, coverage 70-90%, 3.5-4.5 meters tall, associate species are *K. candel*, *A. corniculatum*, *B. gymnorrhiza*, and *C. tagal*.

2.2.3 *Kandelia* Formation

The formation is composed of *K. candel* community, distributing widely on all kinds of flats. Trimness in forest form, grey brown in soil colour, salinity 10-20‰, yellowish green in physiognomy, 0.6-0.9 in degree of closeness, tall 1.5-6 meters, 10-30cm dbh, usually form two layers of community with *A. corniculatum*, associated with few *A. marina* and *A. ilicifolius*.

2.2.4 *Aegiceras* Formation

The formation is constituted by *A. corniculatum* community that widely distributes in China. Sandy or clay loamy soil (salinity 6-27‰), yellow green in community physiognomy, trimness in canopy, coverage 50-90%, 4-5 meters tall in Shenzhen and mostly 1-1.5 meters tall, 15cm in diameter at base and 5-10cm dbh, associated with few *K. candel*, *R. stylosa*, and *A. marina*.

2.2.5 *Avicennia* Formation

The formation consists of *A. marina* community, widely distributing at low tidal flats. Soil salinity is between 5-20% (extremely at 25%), grey green in community physiognomy, 70-95 in degree of coverage, 2-3 meters tall (8 meter the tallest), 8-10cm in diameter at base (23cm the biggest).

2.2.6 *Sonneratia* Formation

The formation only occurs in Hainan, mostly locating at coast of bay or estuary. Aqueous soil of silt (rarely sandy clay), 5-20 in salinity, yellow green in community physiognomy, dominated by *Sonneratia* association, 10-13 meter tall, trimless in forest form, 60-80% in coverage degree, associated with *R. stylosa* and *A. marina*.

2.2.7 *Nypa* Formation

The formation is mostly composed of *N. fruticans* community, mainly distributing at shelter harbor or alluvial fan at estuary. Aqueous soil of silt, salinity low at 5%, dark green in community physiognomy, 80% in coverage degree, 3-4 meters tall (5 meters the tallest), dominated by *N. fruticans*, associated with *A. aureum* and *Acanthus ebrecteatus*.

3. ENVIRONMENTAL STATE

3.1 Physical Characteristic

The distribution of the mangrove in China is strongly influenced by two kinds of physical factors, macroscopic factors and microcosmic factors. Macroscopic factors include the physical factors like climate, salinity and ocean current, and microcosmic factors contain those of geomorphology, tide, sediment, and so on.

3.1.1 Macroscopic Factors

3.1.1.1 Climate

In China, mangrove species and their heights vary with latitude, i.e. mangrove species decrease and mangrove tress become small as latitude increases. Such latitudinal influence on mangroves implicates, deduced from the relation between temperature and latitude, that temperature is one of key factors limiting the occurrence of mangrove. Among the major mangrove areas, Hainan Island is the province with highest average temperature and lowest latitude, in which 35 species of true mangroves and associated mangrove occu*r.* Mangrove trees there are well developed, and most of them are less than 10 meters tall. Mangrove communities are comparatively simple, characterised with trim canopy. The highest tree is the 14-meter tall *B. sexangula* tree. Guangdong and Guangxi are two neighbouring provinces in south China at similar latitude, thus in same climatic zone. In Guangxi 11 species of true mangrove and 7 species of associated mangrove occur and in Guangdong 13 species of true mangrove and 6 species of associated mangrove happen. Research demonstrated that the mangrove forests in Guangxi are better developed than those in Guangdong, but not as good as those in Hainan. A record shows that in Guangxi the tallest *H. littoralis*, *E. agallocha* and P. pinnata are 15 meters, 13 meters and 13.5 meters in height and 80cm, 25cm, and 23cm diameter at breast height respectively, and these figures emphasize that the mangrove in Guangxi is comparatively well-developed. In Taiwan province, where the Kuroshio Current passes nearby and exerts large influence on the climate, 17 species of mangrove are found even if it is at higher latitude. However, in Fujian province, which is opposite to Taiwan across the Taiwan Strait, mangrove communities are less developed, and mangrove species are fewe*r.* Fuding, Fujian province is considered as the northernmost boundary for the naturally mangrove in China. To the north of Fujian province, so far, only the species of *K. candel* has been successfully introduced into Zhejiang province. Table 3 shows temperature conditions in some major mangrove areas of China.

Table 3 Temperature Conditions in Some Major Mangrove Areas of China.

Major mangrove areas in China	Qinglan Harbor, Hainan	Shankou, Guangxi	Beilun Estuary, Guangxi	Futian, Shenzhen, Guangdong	Jiulong Estuary, Fujian	Fuding, Fujian
Latitude (N)	19°34′	21°28′	21°33′	22°32′	24°54′	27°20′
Average Temperature(□)	24.3	22.4	22.5	22.5	21.0	18.5
Lowest Monthly Average Temperature(□)	18.6	15.0	14.1	15.0	12.2	8.4
Minimum Temperature(□)	6.2	0.5	1.0	0.2	0.5	-4.3

Mangrove in China were classified by two Chinese botanists, Zhang and Lin (1984), into three ecotypes based on their adaptability to temperature, namely cold tolerant polytopic species, thermophilic polytopic species, and thermophilic stenotopic species, respectively.

Temperature is the key factor controlling the introduction of mangrove from low latitude areas to high latitude areas. So far, two mangrove transplanting approaches have been successfully conducted in China, one is the transplantation of mangrove in an area with suitable temperature and another is the introduction of mangrove with a cold resistant ability into an area in high latitude. To promote such activities in China, in 1999 Wang at al. (1999) proposed to establish a national mangrove gene bank in Hainan Island and to transplant mangrove trees from domestic and abroad in the island where the most favorable temperature prevail, hoping this pilot trial will benefit the similar approaches in other areas of China.

3.1.1.2 Salinity

The occurrence of mangrove in high salinity intertidal flat can attribute to its physiological adaptation, such as the salt resistance and salt excretion mechanism, but this adaptation does not support normal growth of mangrove in any saline environment. The research of two Chinese scientists (Lin & Wei, 1981) indicated that *K. candel* trees grown in different saline conditions showed huge differences in growth, flowering, and fruiting. In the salinity of 7.5-21.2%, the tree could grow well into 1.6-2.0 meter high with

normal flowering and fruiting. However, in the salinity range of 1.04-5.3% and 25.6-37.5%, the growth of the trees, flowering, and fruiting were hindered. It was concluded (Lin, 1995) that the upper limit of salinity is the main factor to impact the growth of mangrove.

3.1.1.3 Ocean current

Viviparous propagules are an exclusive ecological adaptation of mangrove. When tide out, the torpedo shape propagules that drop from mangrove trees can make a penetration into the soft muddy sediment, and then grow there; when tide in, the propagules that fall from mangrove trees can float in seawater and be carried away by sea current to other places, where the germination of the propagules may happen randomly. It was believed that this reproductive mechanism, the ocean current dependent shift of mangrove seeds, is vital to the gene exchange among mangrove populations. After exploring the gene structure of the population of *K. candel*, the most common mangrove in East Asia, by using mtDNA and cpDNA as genetic labels, a Chinese scientist (Huang, et al. 2001) discovered that the Sarawak population has a close genetic relation with the Ranong population in the Indian Ocean. But the gene structure of the Sarawak population differs from that of the population at northern coast of the South China Sea. He also believed that the tiny differentiation of the gene structure between the *K. candel* population at northern coast of the South China Sea and *K. candel* population in the Ryukyu Archipelago and Taiwan was an implication of gene exchange between two populations in the form of propagules transfer by sea current in summer time.

3.1.2 Microcosmic Factors

3.1.2.1 Geomorphology

Mangrove forest is a typical appearance in tropical and subtropical areas and it occurrence is limited in the areas with suitable geomorphology. Mangrove is commonly found in sheltered coast, usually flourishing along creeks and growing on muddy flats of soft sediment comprised of tiny grains.

The accumulation of sediment derived from coasts and riverbanks and the degradation of organic matters, such as mangrove leaf litter, in mangrove areas creates mangrove soil and alters mangrove landform as mangrove flat level being raised. It is reported that the ascending rate of mangrove flats is 2.3cm/year in Shankou mangrove area of Guangxi (Mo & Fan, 1999), 1.2-3.6cm/year in Fujian, and 5.7cm/year in Guangdong (Wang, et al. 1991). It is also concluded, deriving from an analysis of the sections of four mangrove flats in Guangdong and Hainan (Tan, et al. 1997), that the gradients of mangrove flats are bigger than that of open flats. With regard to mangrove landform, all the four mangrove flats share a common characteristic, more obvious in well-protected mangrove areas, of a special formation of the flat with three rises along with adjacent slightly sunken land, and this formation can be regarded as a result of long lasting process of tide movement, wave action, and deposition in mangrove areas.

However, mangrove landform, whose formation is hydrodynamic dependent, will undergo a reshape in response to hydrodynamic change resulted from human activities, such as coastal levee construction. A typical reshape of mangrove landform was illustrated (Fan, 1996) with the sandy mangroves at Daguansha, Beihai, Guangxi, where the invasion of sand dune caused by hydrodynamic change arising from the building of coastal dike has damaged the habitat of a *A. marina* vegetation belt of 100-300 meter wide, degrading the mangrove and even killing the mangrove trees.

3.1.2.2 Tide

Mangroves are a diverse group of plants that share a common ability to live in waterlogged soil subjected to tidal inundation, but differ in the tolerance to inundation. The zonation of mangrove, a regular series of vegetational bands parallel to the coastline, is the response of the mangrove ecosystem to a number of external factors. In intertidal mangrove flats, the existence of zones is evident in mangrove environments, representing a specific occupation of one species of mangrove in certain area.

The harmful impacts of the fouling organisms on mangroves are also controlled by tidal movement, which can change living conditions of biofouling organisms, such as feed and wetness of the habitat, and hence the number of attached biofouling organisms. It was pointed out (Fan, et al., 1992; Chen, et al., 1992) that the comprehensive influences of tidal movement on mangroves reduce in degree from open coast to estuarial coast to sheltered coast and from seaward forests to middle forests to landward forests.

3.1.2.3 Mechanical composition of sediment

The mechanical composition of sediment of mangrove flats can influence the insertion and germination of viviparous propagules; soft muddy flats allow easy penetration of propagules, but hard sandy flats handicap the insertion of propagules. In addition, the mechanical composition of mangrove soil is related to soil nature and textures. It was suggested (Lan, et al., 1993) that the quantity of tiny glutinous grains (<0.01mm) of mangrove soil are positively correlated to the amount of organic matter, total N, total P, and total K in the soil. The cementation and agglomeration of tiny soil grain with organic matter forms nutritious soil for mangrove forests.

3.2 Chemical Characteristic

The intensive biological reaction in mangrove soil, which is subject to regular tidal influence, produce a unique saline environment characterized with acidification, deoxidation, and heavy load of organic matter.

3.2.1 pH in Mangrove Soil

A lasting absorb of SO42- in soil by mangrove trees results in high sulfur content in the trees, and its concentration usually five times that in terrestrial plants in subtropical region. The degradation of mangrove leaf litter and other organic matter by bacteria, which produce hydrogen sulphide, results in a drop of pH value in the soil. It was found (Lan, et al., 1993) that the pH value of mangrove soil is at a lower level, 3.3-6.9 in surface layer and 3.02-3.8 in the bottom laye*r.*

3.2.2 Electric Potential of Oxidation Reduction

Mangrove soil, influenced by tidal inundation, belongs to deoxidized soil with lower electric potential of oxidation-reduction. Mangrove soil is moisture saturated soil (air content below 1%), and no oxygen can infiltrate past the top few horizons, an oxidized layer that can be recognized by its yellow brown color. In mangrove soil, the content of deoxidized substance, such as active iron, is high, and decreases by the depth of soil layer (Yang, et al., 1987).

3.2.3 Organic Matter in the Soil

The content of organic matter in mangrove soil is comparatively high at an average rate of 4.48% (Liao, 1995). This higher load of organic matter in the soil can partly attributed to the decomposing of large mass of leaf litter and rotten roots in the soil. Contrary to higher content of organic matter in mangrove soil, the content of organic matter in soil of open beach is lower. It is reported (Lan, et al, 1994) that the average load of organic matter in soil of open beach in Guangxi is only 0.92%.

3.2.4 The Salt Content of Mangrove Soil

The higher salt content (generally above 10%) of mangrove soil can be regarded as a result of salification of mangrove trees that inhabit in waterlogged soil subjected to tidal inundation. An analysis of top layer of mangrove soil in Guangxi (Luo, 1986) revealed that the salt content is less than 10% in sandy soil, 10-30% in light clayey soil and above 40% in clayey soil.

In mangrove soil, among the ion of salinity, Cl- is the dominant anion followed by SO42-, and Na+ the dominant cation. In the soil layer where mangrove litters are buried, the content of SO42- is higher than that in other layers (Liao, 1995).

3.2.5 Nutrients in Mangrove Soil

Mangrove soil with tiny glutinous grains and rich organic matter contribute to the maintaining of nutrients in soil. Generally, the soil is higher in content of total K and K2O, average in Total P, and lower in P2O5. The content of total N, total P and total K in mangrove soil is much higher than that in the soil of open beach, implicating that intensive bioaccumulation is happening in mangrove area. It was indicated that in well-developed mangrove area, the nutrient level in mangrove soil is higher (Liao, 1995).

3.3 Biological Characteristic

3.3.1 Phytoplankton

Phytoplankton is the primary producers in mangrove ecosystem, most of them can be directly fed by larvae and juveniles of marine animals, and some of them can be used as indicators of marine pollution.

231 species of phytoplankton (see Annex 1) in 62 genera were recorded from mangroves in China, 195 species in 46 genera belonging to Bacillariophyta (account for 84.3% of the total species number), 17 species in 4 genera belonging to Euglenophyta, 3 species in 2 genera belonging to Chlorophyta, 3 species in 1 genera belonging to Cyanophyta, 7 species in 3 genera belonging to Pyrrophyta, 4 species in 4 genera belonging to Cryptophyta, and 2 species in 2 genera belonging to Chrysophyta. Diatoms are the dominant category in waters of mangrove areas in China, whether their species composition or biomass are concerned. The genera with more species are Nitzschia, 32 species, Chaetoceros, 25 species, Rhizosolenia, 25 species, Coscinodiscus, 15 species and Navicula, 14 species, respectively.

3.3.2 Mangrove Trees and Shrubs

36 species of mangrove trees have been recorded from the mangrove trees in China, of which 26 species in 15 genera of 13 families are true mangroves, and 10 species in 10 genera of 9 families are associated mangrove. The mangrove communities in China were classified as seven groups in terms of their species composition and the characteristic of community appearance (Lin, 1988), which are *Bruguiera* formation, *Rhizophora* formation, *Kandelia* formation, *Aegiceras* formation, *Avicennia* formation, *Sonneratia* formation, and *Nypa* formation.

3.3.3 Zooplankton

110 species of zooplanktons (see Annex 2) in 68 genera have been reported occurring in mangroves area in China, including 1 species in Protozoa, 49 species of Coelenterate in 34 genera (mostly jelly fish); 48 species of Arthropod in 29 genera (2 species in 2 genera belonging to Cladocerans, 2 species in 2 genera belonging to Ostracoda, 35 species in 20 genera belonging to Copepoda, 2 species in 2 genera belonging to Amphipoda, 2 species of Euphausiid in 1 genera, and 5 species in 2 genera belonging to Decapod), 9 species of Chaetognath in 1 genera, and 3 species of Urochordata in 3 genera, and as well as many unidentified larvae, fish eggs, and juvenile fishes.

3.3.4 Macrobenthos

Intensive surveys have been conducted in most mangrove areas in the four provinces of Guangxi, Hainan, Guangdong, and Fujian in China. A total of 650 species of Macrobenthos (see Annex 3) belonging to 12 phyla have been identified as inhabiting in these areas (351 species more than the statistics record of Lin peng (year?)), of which 8 species in 8 genera belong to Coelenterate, 1 species in 1 genera belong to Platyhelminthes, 1 species in 1 genera belong to Nemathelminthes, 2 species in 2 genera belong to Nemertea, 120 species in 72 genera belong to Annelida, 10 species in 5 genera belong to Sipunculoidea, 3 species in 3 genera belong to Echiura, 231 species in 131 genera belong to Mollusk, 208 species in 88 genera belong to Arthropod, 1 species in 1 genera belong to Brachiopod, 27 species in 18 genera belong to Echinoderm, 3 species in 3 genera belong to Urochordata, and 30 species in 27 genera belong to Chordate.

Lingula anatina, mainly inhabiting in the mangrove flats in Qinglan Harbor and Beilun estuary, is under protection by the state as an animal at the top list of protected animals. In addition, horseshoe crabs (*Tachypleus tridentatus, Carcinoscorpins routnolicauda, Tachypleus sp*) are also national protected animals.

3.3.5 Fish

Fan Hangqing et al. (1998) recorded 42 species of fishes occurring in the waters 30 meters outside the fringe of mangrove forests in Yingluo Harbor, of which *Stolephorus chinensis*, *Harengula ovalis*, *Stolephorus tri*, *Ambassis gymnocephalus*, *Hemirhamphus limbatus*, *Leiognathus daura*, *Tylosurus strongylurus* and *Atherina bleekeri* were abundant. Of the total 42 species, 26 species are mangrove-associated fishes (7 species highly associated). Most of the fishes are small in size (<10cm), implicating

that small fishes and fish fries are common near mangrove fringe. In this mangrove area, the fish density was 75, 466/net, and the fish biomass was 39.38kg/net.

In Yingluo Harbor, 54 species in 29 families were observed in tidal creeks (He, et al., 2000), most of them appearing occasionally or seasonally and only 14.5% of the species occurring in four seasons which are *Ambassis gymnocephalus*, *Stolephorus chinensis*, *Leiognathus* ruconius, Clupanodon punctatus, Osteomugil ophuyseni, Zenarchopterus buffoni, Liza carinatus, and Butis butis. With respect to fish community in this mangrove area, dominant species and the number of species varied seasonally, with occurring of 30, 30, 26, and 22 species in spring, summer, autumn and winter respectively. The results of surveys on fishes in the two mangrove sites showed that fish community in tidal creeks was more diverse than that in waters outside mangrove fringe.

In summer of 1999, 27 species of fishes in 19 families were observed in the tidal waters 10 meters outside mangrove fringe in Zhenzhu Bay (He, et al., 1995), the fish community in the area can be categorized as two groups in terms of thermophily, dominated by the species which only occur in warm waters (92.6%). In this mangrove area, most of the fishes are benthic fishes, with *Leiognathus brevirostri* and *Harengula ovalis* being the dominant species.

With respect to fish standing stock in the waters near mangrove areas, Lin (2001) recorded 141 species in 96 genera from the waters between Zhangjiang Estuary and Dongshan Bay in Fujian province; the third Institute of Oceanography, SOA conducted a visual census of 115 species belonging to 59 families from Quanzhou Bay in Fujian; Jiang Jinxiang et al (1997) recorded 300 species in 90 families in Qinglan Harbor and 212 species in Dongzhai Harbor in Hainan province. All the species of fishes were observed in the waters far from mangrove forests; hence their association with mangroves has not been confirmed.

80 species of fishes in 40 genera have been recorded in mangrove areas in Guangxi, all of them belong to Oteichthyes (Annex 4). 59 species in 59 genera of 36 families were recorded in SMNR (He, et al., 2001) and 27 species in 23 genera of 19 families were recorded in BEMNR.

3.3.6 Reptiles and Amphibians

Few surveys have been conducted in China on the reptiles and amphibians inhabiting in mangrove forests. So far, only one paper (Wang, et al., 1998) addressing such issue has been published.

3.3.6.1 Reptiles in mangroves forests in China

A total of 38 species of reptiles observed in mangrove forests were identified, of which 8 species in 3 families belong to Testudinata, 5 species in 3 families belong to Sauria, and 25 species in 5 families belong to Serpentiformes. All these animals were rated as endangered species, for they are targeted as food and medicine and have reduced to a small number due to over exploitation.

3.3.6.2 Amphibians found in mangroves of China

Few survey focused on amphibians in mangroves of China has been conducted. Only 13 species of amphibians in 5 families were found inhabiting in mangroves, and all of them are the species belonging to Salientia. *Rana rugulosa* is the only one category 2 national protected animals among the animals of Batrachia.

Mangrove usually occurs at transitional zone from sea to land, where habitats are diverse and complex. From seaward to landward side, the habitats in this junction zone of water and land can be categorized as five habitats: seawater zone, tidal flat zone, mangrove forest zone, shrubbery zone, and terrestrial zone. And practically, the terrestrial zone can then be classified as several kinds of habitats such as paddy field, shrubbery, sparse shrubbery, forest, and so on. To be high in heterogeneity and perimetery efficiency, the habitats in the junction zone are endowed with unusual biodiversity and richness in birds.

Most of birds present in mangrove areas are found in not only mangrove but also other habitats near mangrove. Nidified in mangrove, some birds in the family of Ardeidae are commonly seen foraging in tidal flats and paddy fields nearby. Some birds have never been found foraging in mangrove forest even if they nidify in mangrove, such as *Streptopelia chinensis*, this herbivore bird only forages its food in paddy fields. Centropus toulou and Centropus sinensis are examples of those birds that nidify outside mangrove but hunt for food inside mangrove forest when tide is out. Birds in the family of Anatidae are often found

dropping in mangrove forest by tidal creeks when tide is in and foraging on tidal flats beyond mangrove when tide is out. The frequent in and out of birds among differents habitats in mangrove areas will benefit the flow of substance and energy inside and among systems.

286 species of birds (see Annex 5) associated with mangroves in Mainland China (including Guangxi, Guangdong, Hainan, and Fujian) were identified, which belong to 50 families in 19 orders, with 47% (139 species) being water birds. Of these birds, 4 species were rated as category 1 protected bird, and 36 species category 2 protected birds.

3.3.7 Mammals

Mangrove associated mammals are not restricted to the mangrove ecosystem. In China, few survey focused on mammals in Mangrove forests has been conducted. The species of mammals listed below, in scientific sense, are not restricted to mangrove.

So far, only 28 species in 24 genera of 15 families of mammals have recorded occurring in mangrove areas (18 species more than the statistic record of Lin Peng in 1995). Of which, *Viverricula indica* and Lutra lutra are category 2 national protected animals. Further understanding of mammals in mangrove areas in China still relies on more in-depth research on these animals. Mangrove forests, which are comparatively small and easy to open access duo to their locations in relatively developed coastal areas in China, are subject to human disturbance that will inevitably disorders the life of mammals in mangroves. In consequence, mammals are much less abundant in mangroves than in other forests, and most of the mammals are adaptable animals such as rats and bats. Though these mammals are on top trophic level of food chains, they are less significant than birds.

4. AFFORESTATION

4.1 Afforestation Activities

Mangrove afforestation was initiated in the late 1950s in China, interrupted from 1966 to 1979 and resumed in 1980. At its early stage, only small-scale mangrove afforestation was performed in China. The only exception was mangrove planting in small area under the classification of “fodder and protection forest forestation”, e.g. the planting of 7ha fodder forest of *A. marina* at Qinzhou of Guangxi and 100ha protection forest of *R. stylosa* at Haikang of Guangdong. Since 1966, land reclamation along the coastline in Mainland China has not only stopped mangrove afforestation, but also destructed mass mangrove habitats. During this period, a large number of mangrove forests were logged for salt industry and paddy fields. Mangrove afforestation was restored in early 1980, and meanwhile several national level mangrove reserves were created, to prevent existing mangrove resources from being damaged and restore mangroves. Perceiving the significance of mangroves by scientists, government, and communities of China has changed the status of mangroves and attracted more attention on it. Afforestation attempts have gained some momentum in China. Based on the scheme of protection forest project, 60,000ha of mangroves will be planted at coastal region in South China to establish a mangrove forest system that will function along the coastline.

With regard to mangrove protection and restoration, the mangrove reserves in China have played a vital role and achieved recognition for their significant work.

Mangrove afforestation in mangrove reserves has been practiced mainly in small area for scientific research purpose.

4.1.1.1 Shenzhen Futian Mangrove Reserve

In 1986 the afforestation of mangrove, *K. candel*, *A. corniculatum*, was initiated in the reserve, which is found in 1984. In 1990, a trial of planting two ha mangrove trees with propagules succeeded. Subsequently, in 1991 about four million mangrove saplings were planted in the reserve, forming 50 ha mangrove plantation. In 1992, workers in the reserve, assisted by the Tropical Forestry Institute of Chinese Academy of Forestry, successfully raised over 6 ha demonstration forests of *K. candel*, *B. gymnorrhiza*, which are thriving now (Liu, 1995).

4.1.1.2 Guangdong Zhanjiang Mangrove Nature Reserve

Mangrove forestation was started during the late l990s in this reserve after it was created in 1990. So far 100 ha mangrove trees of *B. gymnorrhiza*, *R. stylosa*, *K. candel*, *A. marina* and *A. corniculatum* have been planted and 50ha second growth of mangrove rehabilitated (Lin, et al., 1990).

4.1.1.3 Guangxi Shankou Mangrove Nature Reserve

The reserve was set up in 1990 under the approval of the State Council of China as a national level reserve. Mangrove afforestation has been practiced in the reserve since 1992. Mangrove afforestation attempts started with the foundation of two sapling nursery gardens, where 62,100 propagules of *R. stylosa*, *R. apiculata*, *C. tagal*, *B. gymnorrhiza*, *K. candel*, *R. stylosa*, *C. tagal* and *B. sexangula* have been raised to saplings at an average survival rate of 63% from 1992 to 1994. From 1994 to 1995, planting trial of the introduced mangrove species of *R. apiculata*, *C. tagal*, *B. sexangula* and *Sonneratia apetala* was carried out in the reserve for the first time, and only the seedlings of *S. apetala* were successfully raised. In addition, planting trial of mangrove to their natural regeneration, comparative afforestation experiment, and mangrove second growth rehabilitation were also successfully conducted in the reserve.

With the assistance of local government, communities and youth volunteers, SMNR has worked hard on planting mangrove, increasing mangrove coverage in the reserve from 730ha to present 806.2ha (He, et al., 1995).

4.1.1.4 Guangxi Beilun Estuary Marine Nature Reserve

The reserve, founded in 1990, is situated at the delta near Beilun estuary, where planting practice of mangrove has been carried out over a period time. Mangrove afforestation, initiated in 1987 by Qinzhou Forestry Institute, started with the planting of propagules of *K. candel*, *A. marina*, *A. corniculatum*, *B. gymnorrhiza* and *R. stylosa* at 1.5×1.5m spacing. 90 ha mangrove plantation has been developed in this way. According to a survey conducted in 2002, the mangrove trees, though comparatively smaller, still in healthy condition. In 1991 wildlings of *A. corniculatum*, *A. marina* were planted at 1×1m matrix on 10ha flats, and now the trees have grown to an average height of 50cm. Since 1998, Guangxi Mangrove Research Centre has also conducted trials of planting mangrove trees in the reserve, such as rehabilitating *R. stylosa* population, reconstructing second growth of *K. candel* community, planting *B. gymnorrhiza* with seedlings and planting *R. stylosa* with propagules. The planted *B. gymnorrhiza* and *R. stylosa* survived at a rate 61% and 76% one year later and grew to a height of 37.3cm and 35.8cm respectively. Four year later, the *B. gymnorrhiza* and *R. stylosa* grew to a height of 50cm and 70cm at survival rate of 56% and 71%. Besides, local communities also have been involved in planting mangrove. From 1991, the students of local elementary schools started to plant mangrove seedlings at the fringe of mangrove forests. To date, they have developed four ha new mangrove plantation.

4.1.1.5 Hainan Dongzhai Harbor Mangrove Reserve

The reserve was established in 1980 under the approval of the State Council of China. Mangrove coverage is 1733ha. In the reserve, the species of *K. candel*, *B. gymnorrhiza*, *B. sexangula*, *R. apiculata*, *R. stylosa*, and *X. granatum* have been planted on denuded flat at seaward edge, open flat in the forest, and within second growth shrubs. Low survival and even 100% mortality were observed of the mangrove saplings planted on unsuitable spots (high salinity, hard soil). In 1999, Liao et al (1999) reported a low survival (30%) of *B. gymnorrhiza*, *B. sexangula* trees planted at Tashi. Since 1981, mangrove planting, mangrove introduction, and second growth rehabilitation have been performed in the reserve (Zhen, 1999). So far, 285ha mangrove have been planted and 251ha mangrove have survived. In the reserve, planting techniques have been developed through mangrove afforestation experiment and practices, and the pioneer species, such as *S. apetala*, *S. cylindrica*, *S. abla*, *K. candel*, and *A. marina*, suitable for planting in lower intertidal flats have also been screened out.

A five year plan (from 2000 to 2004) of mangrove ecosystem restoration was initiated in 2000, with the intention of planting 135ha mangrove of *B. sexangula*, *B. gymnorrhiza*, *B.* s. var. *rhynochopetala*, *K. candel*, *S. apetala* and *A. marina* in the area. Planted trees will be monitored regularly and replanting will be conducted if survival is lower than 90%.

To meet the increasing demand on mangrove saplings, a nursery garden (2ha) with an annual capacity of producing 300,000 seedlings is going to be set up. The nursery will be managed by qualified technicians.

Additionally, a mangrove forestation scheme of planting fast growing mangroves trees, *S. apetala* and *A. marina*, in the areas subject to erosion will be implemented in the reserve. Rare species such as *S. hainanensis*, *S. alba*, *S. ovata*, *Sonneratia paracaseolaris*, *N. fruticans*, L. littorea, *X. granatum* will be planted in larger area.

4.2 Evaluation of Mangrove Afforestation

Forestry administration is the government organ in charge of management of mangrove resource, including mangrove afforestation and appraisement of afforestation practice and outcome (Chen, 1993). As the afforestation techniques have not yet been standardized, to substantially appraise the results of mangrove planting require an overall consideration of all aspects of mangrove planting practice. In spite of this, the outcome of mangrove afforestation can be evaluated simply by measuring the area of successfully raised mangrove forests.

5. SOCIAL USE AND OWNERSHIP

5.1 Ownership

According to Chinese law, land is owned by the state, including mangrove land. Even if ownership of land is unalterable, mangrove forests can be private property. In China, most of mangrove forests belong to the state; some are in the possession of communities; and few are private forests.

According to the survey data of 2001, 97.5% of China mangrove land is state-owned, 2.5% are community-owned; 82.7% of China mangrove forests are state-owned, 17.3% are community-owned. As for the mangroves forests in Guangxi, relevant statistics showed that 66% of mangrove forests belong to the state, 33% are owned by communities, and 1% are private property.

To encourage private investment in forestry, Chinese government has adopted some policies to allow private management of state owned forests in the form of contract (lease term 50-70 years), hoping that the investment in forestry will be increased and the management of forests will be improved. For this reason, private mangrove forests can be expected to expand in the future.

5.2 Utilisation

5.2.1 Wise Utilization

Mangrove forest is considered as a component of wind protected forests at the front along coastline in southeast China. Consequently, Chinese government ranked all mangrove forests in China as non-profit ecological forests in 2002 for their effective protection and management. So far, 30.6% of mangrove forests in China have been protected under the form of mangrove reserves. 66.5% of mangrove forests are designated as wind shelter forests. The remaining 2.9% of the mangroves are used for special purpose.

5.2.2 Destructive Utilization

5.2.2.1 Use of mangrove land for construction of shrimp ponds

Illegal encroachment of mangrove land for alternative uses of the land, especially for the production of shrimp and fish, has converted vast mangrove area to shrimp ponds. Mangroves in Zhuhai, which used to occur in 25 habitats, have decreased from 93ha to 6.8ha during previous ten years, and the habitats reduced to six at the same time. In Leizhou Peninsula of Guangdong, mangrove habitats are also destroyed for construction of shrimp ponds. From 1999 to 2001, in Hepu of Guangxi province, 353ha of mangroves in intertidal flats were depleted to build shrimp ponds. The so-called “coastal development” such as shrimp industry has destroyed mangroves in many places in China.

5.2.2.2 Digging eatable invertebrates

Traditionally, mangrove habitats are important seafood providers along the coastline in south China. The major commercial invertebrates are sea worms of Phascolosoma esculenta within mangroves and *Sipunculus nudus* outside mangroves. Shellfish of Anomalocordia flexuosa and Meretrix meretrix are found both inside and outside mangrove forests.

Eatable benthos digging is the major income-generating practice of the people who live in and around mangroves or within a reasonable proximity of the mangroves (about 3km). Along the coast of Leizhou Peninsula, nearly 30% of mangrove habitats suffer from such a situation all year round. In some mangrove areas, digging happens so often to more than 20 times per year, which not only severely damages mangrove roots but also destroys the habitats of invertebrates. Fan Hangqing (2000) demonstrated that digging had degraded the urban mangroves in Beihai (Table 4).

Table 4 Degradation of an *A. marina* Community caused by Digging at Beihai Urban Area.

Year	Mean Density (ind./m^2)	Mean Height (m)	Mean area of canopy (m^2/ind)	Coverage (%)	Associate species	Occasional species
1992	0.68	2.05	2.92	96	*K. candel, A. corniculatum*	*B. gymnorrhiza*, *R. stylosa*
2001	0.49	0.88	0.35	35	*A. corniculatum*	*None*
Decline	27.94%	57.07%	88.01%	63.54%	Lost one species	Lost two species

5.2.2.3 Other destructive utilizations

Fruits of *A. marina* are traditional foods of the people at Guangdong and Guangxi coast. Mangrove fruits have become more popular as people adore natural food or green food. Fruits are usually colleted from June to October, and this will inevitably hinder the growth and reproduction of *A. marina*. Raising ducks in mangroves is becoming another problem now. The eggs laid by ducks growing in mangroves are believed to be more nutritious because of the red colour of egg yolk, and the high price of such eggs has stimulated raising duck in mangrove forests. This practice will pose some threats to biodiversity in mangroves. Mangrove forests are also used as anchorage ground for small fishing boats. Besides, city expansion and industry development will use mangrove land for purposes such as construction of ports, roads, and urbanization, etc.

5.3 Potential Utilisation

Fast growing economy and public awareness of the importance of sustainable development may inspire the utilization of mangrove in following pursuits.

- Ecotourism in mangrove areas.
- Mangrove afforestation to make greenbelts and birds sanctuary to cope with city expansion.
- Wise mariculture in mangrove areas.
- Mangrove education and technical training.
- Construction of demonstration zone of mangrove restoration.
- Material supply for producing foods and medicines.

5.4 Current Management Regime

5.4.1 Current Status

With respect to the conservation of mangrove resources, government regulations and management are too complicated. The government agencies involved in mangrove management include the administrations of forestry, ocean, environmental protection, fishery, water resource, and planning, and this often lead to inefficient management and obscure regulations.

The Forestry Ministry is the government organ in charge of the management of forests in China, including mangrove forests, which, in terms of wetland, are also managed by the Forestry Ministry, the executive agency of International Wetland Convention in China. All mangrove resources in China, except SMNR and BEMNR, are under jurisdiction of the Forestry Ministry of China.

According to the Law of Maritime Space Administration, All the intertidal flats and maritime space below high tide line are under the jurisdiction of State Oceanic Administration (SOA). As a result, all mangrove land is placed under SOA for management, and now two mangrove reserves in Guangxi, SMNR and BEMNR, are under SO*A.*

Environment Protection Bureau is the organ in charge of the management of environmental resources, responsible for the assessment of resources and approval of creation of nature reserves, including mangrove reserves. Fishery department is also involved in mangrove management, for mangroves are closely linked with fishery resources. Being valuable natural resources capable of functioning as "coast guard", mangroves are also considered the natural resources managed by water resource department. Besides, in making city expansion plan, city planning commissions of local governments also take mangrove into consideration. Figure 2 illustrates Current Management Regime of Mangrove Ecosystem of China.

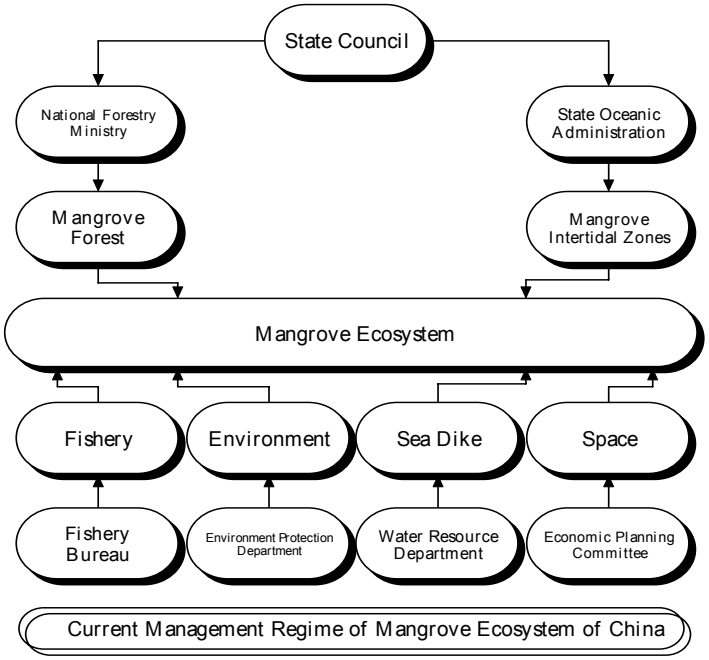

Figure 2 Current Management Regime of Mangrove Ecosystem of China.

Fundamentally, with respect to mangrove management, mangrove land is placed under oceanic administration, while mangrove forests are under the jurisdiction of forestry administration. Other government organs are involved by their links with mangrove.

5.4.2 Ambiguous Status of Mangrove in China

In terms of management, the status of mangrove in China is quite ambiguous. This ambiguity, which arises from the complexity of mangroves, has confused the management of this unique ecosystem. The following aspects concerned with mangrove management can explain such ambiguity of mangrove status.

Naturally, mangrove is the unique natural forests occurred in transition zone from land to sea, where the life of the sea and the life of the land merge in a biological blur. The dynamic properties of mangrove ecosystem with large biodiversity require a multiple involvement of government agencies for proper management.

Legislatively, laws and regulations of China are drafted by administrative organs and then passed by the People Congress before they come valid. Such a law making procedure usually causes dissension among different government organs that determine their function on their own account. For this reason, mangrove has become a cross sector management resource.

6. ECONOMIC VALUATION

6.1 Direct Use Values

Young leaf of certain mangrove plants, *A. aureum*, *H. tiliscus*, are edible. The ripe fruits of *S. cylindrica* can be directly eaten or used as ingredient of soft drinks. *Nypa* fruit can be consumed immediately or used to make chowchow, sugar, vinegar, and alcohol. The fruits of *A. marina*, termed as "Lanqian" by local people, are consumed widely at coast areas of Guangxi; the famous dish "Clam and Lanqian Soup" is so tasty and refreshing that make it one of the top choices of consumers who believe in its function of purging fire and relieving summer-heat. It was estimated that the annual output of the fruits of one-hectare *A. marina* forests could reach 1.2 t and have a worth of 3,600 Yuan (calculated at the market price of 3.00 Yuan/kg).

6.2 Indirect Use Values

It is believed that both inshore and offshore fishery depends on inshore nursery areas, some of which are associated with mangrove. On the other hand, being the unique coastal forests at subtropical and tropical areas, mangrove can be regarded as a tourist attraction for developing ecotourism and recreation industry.

6.2.1 Benefits to Inshore Fisheries

The average rate of leaf litter production of *Bruguiera sexangula* forests in Hainan, *R. stylosa* forests in Guangxi, and *K. candel* forests in Fujian are estimated to be 1,255g m-2 year-1, 631.3 g m-2 year-1, and 920.8 g m-2 year-1 respectively, with leaf constituting large parts of leaf litter at a rate of 64%, 89%, and 70%. Table 5 illustrates the quanity of leaf liter in different parts of three mangrove species.

Table 5 Quantity of Leaf Litter of Different parts of three Mangrove Species.

Formation	Latitude (N)	Quantity of leaf litter of different parts g/m^2					Sources
		Leaf	Branch	Flower	Fruit	Total	
B. sexangula	19°	807.2	46.2	133.4	267.8	1255.0	Lin, et al., 1990
R. stylosa	21°	561.5	23.2	19.4	27.1	631.3	Yin, et al., 1992
K. candel	24°	644.6	140.9	37.5	96.6	920.8	Lu, et al. 1988

The leaf litter production varies seasonally, which is usually high in summer-autumn and low in winter. In general, leaf litters are decomposed before they are consumed by other consumers; only few of them are consumed directly. Decomposition rate of leaf litter is an index of the conversion speed of energy and matter. Research showed that the half decomposition of leaf litter of the species of *B. sexangula*, *R. stylosa*, and *K. candel* are 20-45d (Lu, et al., 1990), 9-13d (Lu, et al. 1994), and 18-56d (Lu, et al., 1988) or 20-71d (Fan, et al., 1992).

Inferred from relevant research results, the average leaf litter production rate of mangrove in China is estimated to be 6,310-12,550kg dry weight ha-1year-1. Being decomposed by microorganisms, leaf litter will become the important food source of primary level consumers such as mollusks, crabs and worms, which in turn will be consumed by secondary consumers, including small fish and juvenile predators.

6.2.2 Mangrove Values in Tourism

Measuring mangrove values in tourism is not easy. So far, no assessment on the ecotourism value of mangrove reserves has been conducted in China. To figure out the value of mangrove reserves in ecotourism, we can use the income from ecotourism in SMNR as an example. Statistics showed that the annual revenue of the reserve is 2.72 million Yuan (40,000 visitors at an average spending of 68 Yuan). In consequence, the total income from ecotourism in seven mangrove reserves of China can be expected to be 19.04 million Yuan, and this number can be modified to 42.00 million Yuan with exclusion of the income leakage (usually 55% in developing country in respect of tourism).

6.3 Value of Mangrove's Contribution to Environment

From a scientific perspective, the values of mangroves can be divided into ecological, community and economic values. Values of mangrove on its contribution to environment include the ecological values and community values.

So far, four research projects have been conducted with regard to the values of mangrove on its contribution to environment; they are "Environmental Ecology and Economic Utilization of Mangroves in China", "Mangroves in Beihai City and Public Participation", "Interactions between Mangrove and People in Beihai City and Environmentally Friendly Economy", and "Ecotourism in Shankou Mangrove Reserve and Public Participation".

The approach on mangrove service to environment was started in 1980s (Zhou, et al., 1980). Since then, some researchers such as Zhang (1993) and Yie & Pang (1987) had also attempted to value mangrove service to environment qualitatively.

Because of the difficulties of determining the ecological and community values of mangroves, no quantification assessment of mangrove values on its contribution to environment has been tried until Dr. Fan Hangqing (1995) attempted to identify the ecological and community values of mangroves in Guangxi (see Table 6). In Guangxi, if a 100-meter wide green belt of mangrove trees were planted along the coast, mangrove area in Guangxi would expand from 5,654ha to 9,599.8ha, of which 592.4ha were rehabilitated from second growth along 59.24km coastline and 3,945.8ha were replanted along 394.6km coastline, meanwhile, 226.92ha farming ponds would be created within. The environmental contribution of the green belt of mangrove trees would be 61,900 Yuan/ha year or 1.3102 million Yuan/km/year (Fan, 2000).

Table 6 Ecological and Community Values of Mangroves in Guangxi.

Items	Assessment coefficient	Scope of project	Annual Benefits (million Yuan)
Reduce loss caused by cyclone 60%	/	9,599.8ha	13.8084
Lower coastal levee maintenance70%	/	9,599.8ha	16.7862
Paddy fields protection	14,927.9km/km·year	453.84km	6.7749
Fruits of *A. marina*	3,600.0 Yuan/ha·year	3,359.9ha	12.0956
Lumber	1,050.0 Yuan/ha·year	9,599.8ha	10.0798
Erosion control	465.0 Yuan/ha·year	9,599.8ha	4.4639
Soil fertility Maintain	200.0 Yuan/ha·year	9,599.8ha	1.9200
Oxygen release	70.0 Yuan/ha·year	9,599.8ha	0.672
Sustain fauna	15,000.0 Yuan/ha·year	9,599.8ha	143.9970
Purify air and water	25,000.0 Yuan/ha·year	9,599.8ha	239.9950
Benefit inshore fishery	15,000.0 Yuan/ha·year	9,599.8ha	14399.70
Total	/		594.5898

Han et al. (2000), by using some valuation approaches such as market value approach, shadow project approach, opportunity cost approach, and substitution cost approach, also tried to identify the service of 13, 646 ha mangrove in the three South China's provinces of Hainan, Guangxi, and Guangdong. He indicated that the service of the mangrove to environment was worth 2,365.31 million Yuan, of which biomass value is worth 81.63 million Yuan, coast protection 992.06 million Yuan, soil conservation 1,156.92 million Yuan, CO2 fixation and O2 release 67.06 million Yuan, animal habitat 54.70 million Yuan, Nutrient accumulation 10.12 million Yuan, pollutant degradation, disease and insect damage prevention 2.82 million Yuan.

Disease and insect damage prevention value was calculated with substitution cost approach. The average cost for controlling plant diseases and insect pests in China in 1995 was 3.57 Yuan/ha, so it is reasonable to calculate the value in controlling plant diseases and insect pests by multiply mangrove area with estimated prevention cost (5 Yuan/ha, slightly higher than actual cost in 1995). Then the value of mangrove in controlling plant diseases and insect pests is 70,000 Yuan (5×13,646). It is estimated that cost in controlling plant diseases and insect pests only accounts for 10% of the cost for comprehensive prevention of disease and insect damage, so the disease and insect damage prevention value of mangrove can be quantified to be the sum of both, i.e. 0.77 million Yuan (70,000 +70,000/10%).

7. THREATS, PRESENT AND FUTURE

7.1 Human Pressure

Human activities in mangrove area inevitably cause stresses on mangrove ecosystems. To manage mangrove effectively and protect the unique ecosystem in the world, we are obliged to know these human activities first (Fan, 2000).

7.1.1 Reclamation for Paddy Field and Salt Industry

From 1949 to 1980, two third mangrove areas in China were depleted due to the land reclamation in coastal area. Land reclamation used to be the major reason for the destruction of mangroves, but now such reclamation hardly happens again because of the strict control of government and low price of salt and rice.

7.1.2 Conversion of Mangrove Land for Shrimp Farming

Rapid expansion of shrimp farming in 1990s has converted vast tracts of mangroves into shrimp ponds. Illegal encroachment of mangrove land for shrimp farming was encouraged by the high monetary return of shrimp culture within a short period. In late 1980s, 200 ha mangrove forests in Dongzhai Mangrove Nature Reserve were destroyed illegally for shrimp farming, and 157 ha mangrove stands in Chengmai County of Hainan were depleted as well. In early 1990s, 2557 ha shrimp ponds were also constructed in mangrove area at Guangxi coast. In Qinzhou of Guangxi, many small shrimp ponds have been built in mangrove area, destructing the mangrove forests near Qinzhou port.

7.1.3 Building Materials

Mangrove trees, mostly *B. gymnorrhiza*, *A. corniculatum*, used to being used as building materials to build sea wall and dike of shrimp ponds. In 1960s, mangrove trees, exp. *B. gymnorrhiza*, *A. corniculatum* were cut in Fangcheng to build coastal levee. In Qinzhou and Fangcheng, *A. corniculatum* trees were also cut for building shrimp pond dikes. It is estimated that every 100 meter long dike will cost 0.38-0.60 ha *A. corniculatum* forests. All trees were cut illegally by shrimp farmers.

7.1.4 Coastal Levee Construction

The construction of coastal levee in mangrove area may destroy mangrove habitats, resulting in thinning and second growth of mangroves and shortening of mangrove trees, and hence weakening the role of mangroves in coastal protection. Southeast coast of China is regularly hit by typhoon every year, mostly between July and September. Though mangrove has been recognized to be wind protection trees, effective in combating waves and accelerating deposition, more money is still spent in building coastal levee instead of planting mangrove. Levee construction, unfortunately, may disturb or even destroy mangrove trees and habitats, resulting in second growth and sparse and dwarf mangrove trees beyond coastal levee.

7.1.5 Construction of Ports and City Expansion

As economy is growing fast in China, the use of mangrove land for various purposes such as construction of ports, industries, urbanization, etc. has become a serious threat to mangroves. Such destruction of mangrove forests happens consistently. For example, in 1998, 60 ha of mangroves was cleared for the construction of Qinzhou port; in Fangcheng, the most flourishing *A. corniculatum* forests were cut to build a port; In Beihai, Sanya, Shenzhen, Xiamen, large area of mangroves was destroyed or degraded for the purpose of urbanization, industry and construction of roads and ports.

7.1.6 Grazing

Grazing animals in mangroves is routine practices of villagers in proximity to mangroves. They usually graze cattle and goats in *A. marina* and *K. candel* forests, where buffalos and goats graze young leave and twigs of mangrove trees. Trampling and herbivory of animals can damages mangroves, killing saplings mortality, producing sparse communities and dwarf trees, and subsequently hindering mangrove restoration.

7.1.7 Fruit Collecting

Fruits of *A. marina*, which is commonly found along coastline of Beibu Gulf, are consumed widely by the people in coast area of Guangxi. Fruit collecting is regular practice of local people. However, fruit collecting causes no damage to mangrove trees unless it is handled improperly.

7.1.8 Firewood

In remote coastal area, mangrove trees (mainly *A. corniculatum*, *A. marina*, *K. candel*) used to be used as firewood by mangrove dwellers. Such pressure on mangrove is becoming less, as people can find an alternative in cheaper cost (liquid gas or electricity).

7.1.9 Medicine and Green Manure

Medicine is traditional utilization of mangrove by local people. No serious stresses on mangrove have been produced by such utilization, except for *A. ilicifolius*. Use of mangrove trees (*A. marina*), as green manure was traditional practice, but seldom conducted now.

7.1.10 Digging

Digging for invertebrates such as bivalve shells and mangrove worms are regular in mangrove forests, and such practice will inevitably damage mangrove habitats and harm mangrove roots. Mangrove roots injured frequently by digging cannot function normally to provide mangrove trees enough nutrients, so that slow growth, sparse forests and dwarf trees occur in disturbed mangrove forests. Digging and trampling can also kill mangrove saplings, thus will hinder natural regeneration of mangrove forests. Expanding market demand on mangrove worms and bivalve shells has further intensified such digging. More and more mangrove habitats have been damaged and the output of marine animals from mangroves has reduced sharply.

7.1.11 Overfishing

Fishing in mangrove area with small mesh (<2.5mm) net will inevitably reduce fish resource, for mangroves provide a home for a variety of organisms, including many juvenile species of fish and prawns. Besides, illegal fishing, such as dynamite fishing, poison fishing, and electric shock fishing, also happen occasionally in mangrove area. Research showed that from 1990 to 1994 the output of benthos and fish in mangrove areas of Guangxi had reduced by 60% and 80% respectively.

7.1.12 Feed Collecting

Collecting of barnacles, clams, oysters, and other small snails in mangrove forests for feeding crab and shrimp also produces some stresses to mangroves. The reduction of these primary level consumers will result in the decline of secondary level consumers such as small fish, crabs, etc. In consequence, the productivity of mangrove ecosystem will decrease.

7.1.13 Poultry Raising and Apiculture

Raising poultry, mainly duck and goose, in mangrove forests are at large in coastal villages, where ducks and geese prey on mollusks, crustaceans, and small fishes. Such practices will reduce the biodiversity of mangrove and disturb the insertion and sprout of propagules. However, apiculture in mangrove forests can benefit mangrove through entomophilous pollination by bees.

7.1.14 Tourism

Ecotourism in mangrove initiated in 1992 and developed quickly. However, inadequate manpower and logistics for the implementation of effective management has caused some damages of mangrove resource and decline of environmental quality. Tourists' improper behavior, such flower and fruit picking, has also damaged mangrove trees and reduced the aesthetic value of mangrove; noises generated by boats have disturbed the birds in mangrove forests; and spill from boat and waste water released from the restaurants nearby also have polluted the mangrove environment.

7.1.15 Pollution

Heavy pollutants such as spill, industry effluent, etc. may damage mangrove ecosystem, including mangrove flora and fauna. Even though mangrove ecosystem can resist doses of organic pollution, heavy organic pollution entering mangroves can be harmful to mangrove trees, for instance, in 1995 in Futian, Shenzhen, some *K. candel* trees were burned by waste released from a pig farm nearby. Oil may be another threat to mangroves. There are four major sources of oil pollution, leakage from vessels, nearshore bilge, accidental spills and refinery effluent. Oils entering mangroves will damage and even kill mangrove trees, for oil covers the pneumatophores and leaves, thereby preventing access of oxygen to the roots and retarding photosynthesis. Compared with mangrove, marine animals are more sensitive to pollution and vulnerable. Even though the different types of pollutants (sewage, pesticide, spills, heavy metals, etc) may not be affecting the mangrove growth, they are certainly toxic to animals living in mangroves and may eventually destroy it. As economy at coastal areas of China is growing fast, pollution has become a potential threat to mangroves.

7.1.16 Engineering Impacts

The construction of ports and coastal levee may change hydrodynamic conditions, which may be harmful to mangroves. Hydrology variation may result in sand invasion into mangrove land or slow the flow of fresh water from mangrove forests after heavy rain, and these disturbances will destroy mangrove and even kill mangrove trees. For example, between June and July of 1994, heavy rain caused flood at coast of Guangxi, *A. corniculatum* forest (5 ha) at Shankou was killed after being submerged for three times at duration of 5 to 8 days each time. In 1958, several hundred-hectare natural mangrove areas at Daguansha of Beihai were reclaimed for salt industry, and hydrodynamic conditions were changed. Subsequently, mangrove trees nearby became sparse and sand invaded duo to such variation.

7.2 Natural Phenomena

7.2.1 Typhoon

Typhoon's impact on large and sparse mangrove trees is more serious than on small and dense mangrove trees. In 1996, a strong typhoon broke many large *B. gymnorrhiza* trees in SMNR of Guangxi. A study on the effects of typhoon on the mangroves were conducted in Shenzhen Mangrove Nature Reserve, concluding that only grade 11-12 wind can damage mangrove trees (Chen, et al., 2000). The damage rate of typhoon to mangrove like *Sonneratia* species can be high up to 80%. The destruction of typhoon to mangroves was correlated to the origin, density and age of the mangrove stands: the *Sonneratia* plantation was destroyed severely by typhoon, while the natural forests were little influenced; the sparse *Sonneratia* plantations were destroyed more seriously than the younger.

7.2.2 Pest Insects

It was observed that mangrove diseases were increasing in most of China mangrove habitats during the past decade. Jia Fenglong et al reported in 2001 that there were several pest insects damaging Shenzheng's mangroves: Oligochroa cantoneella Carad ja and Pseudocatharyll Hampson harm to *A. marina*, and Amatissa sp and Zeuzera coffeae harm to *K. candel*. It was reported that six species of mangrove trees in Guangxi were infected by Colletotrichum (Huang & Zhou, 1997). It was found that *A. corniculatum* in Guangxi estuarine area was infected by pathogenic fungi of sooty mold. The occurrence of these diseases can be attributed to degradation of coastal environment in China.

7.2.3 Erosion

Erosion is another threat to mangroves. In some places, mangrove forests were eliminated by erosion resulted from natural coastal changes accelerated by human activities. For instance, there was a small mangrove islet about 15×5m2 at SMNR before 1995, and it disappeared by the end of 1998. The possible reason may be the rise of mean sea level and erosion caused by local people's digging for eatable benthos.

7.3 Causal Chain Analysis

Direct threats to mangrove include:

- Conversion of mangroves for shrimp ponds, coastal highway, harbour, industry, urbanization, etc. Shrimp farming, which is believed to be the major threat, is widespread at coast areas in South China and hard to control.
- Mangrove worm digging. Mangrove worm is popular seafood at coast areas in South China. Since mangrove worm mainly occurs in mangroves, digging for this commercial organism will hurt mangrove roots, creating extensive second growth and hindering mangrove regeneration.
- Exotic species introduction. *S. apetala* has been transplanted extensively at coast areas in Mainland China since 1995. Now *S. apetala* is found even thriving in the core zones of some mangrove reserves. Introducing *S. apetala* may change original mangrove community and generate ecological risks.
- Pollution. As economy is growing fast in China, in particular along the coastline of South China, more and more pollutants, such as shrimp farm effluents, industry effluents, and domestic sewage, will find their way into mangroves. Even though organic matter seems to encourage the growth of mangroves, the transfer of pollutants through food chain cannot be ignored.

The causes for mangrove degradation and destruction in China are diverse. At social economic aspects, low public awareness on mangroves and pursuit for short-term benefit are two main causes; in addiction, it is clear that natural resources are shared by all communities, but obscure that who is responsible for mangrove conservation; economic benefit weights more than ecological benefit when local government is evaluated; long-term benefit is usually despised and short-term benefit is overweighted; cross sector management on mangroves hampers coordination; non-profit approach in natural resource conservation conflicts with profit making economy; etc.

The 11 main causes are listed below:

- Aquafarming can generate quick money for mangrove residents.
- No alternative wise use technique and mechanism has been developed to generate more tangible benefits than shrimp farming.
- Short of funds for mangrove conservation, management, and research
- No national criteria and technical norms for planting, monitoring, and evaluating mangroves have been established.
- Sometime, marine environment and maritime space use are evaluated without mangrove experts being involved duo to short of money, which will weaken the conclusion.
- No special national law has been made for mangrove management. Cross-sector management often brings about sectorial conflicts.
- Most of mangroves are state-owned forests, but investment on mangrove development by government is insufficient. A mechanism to compensate for private investment on mangrove should be developed to encourage multi-channel investing in ecological maintenance at coastal areas.
- Decisions regarding mangroves are usually made by government with few public involvements.
- Few opportunities have been offered to mangrove staff in mangrove reserves for exchange of experience.
- Materials and means for mangrove education are not available.
- Poor information share among different institutions limits the utilization of mangrove data for effective management of mangroves. Cooperation is also not common.
- Improve mangrove education and strengthen exchange and cooperation, so as to promote mangrove management and research in China.

Figure 3 shows the Causal Chain Analysis for China Mangrove Ecosystem.

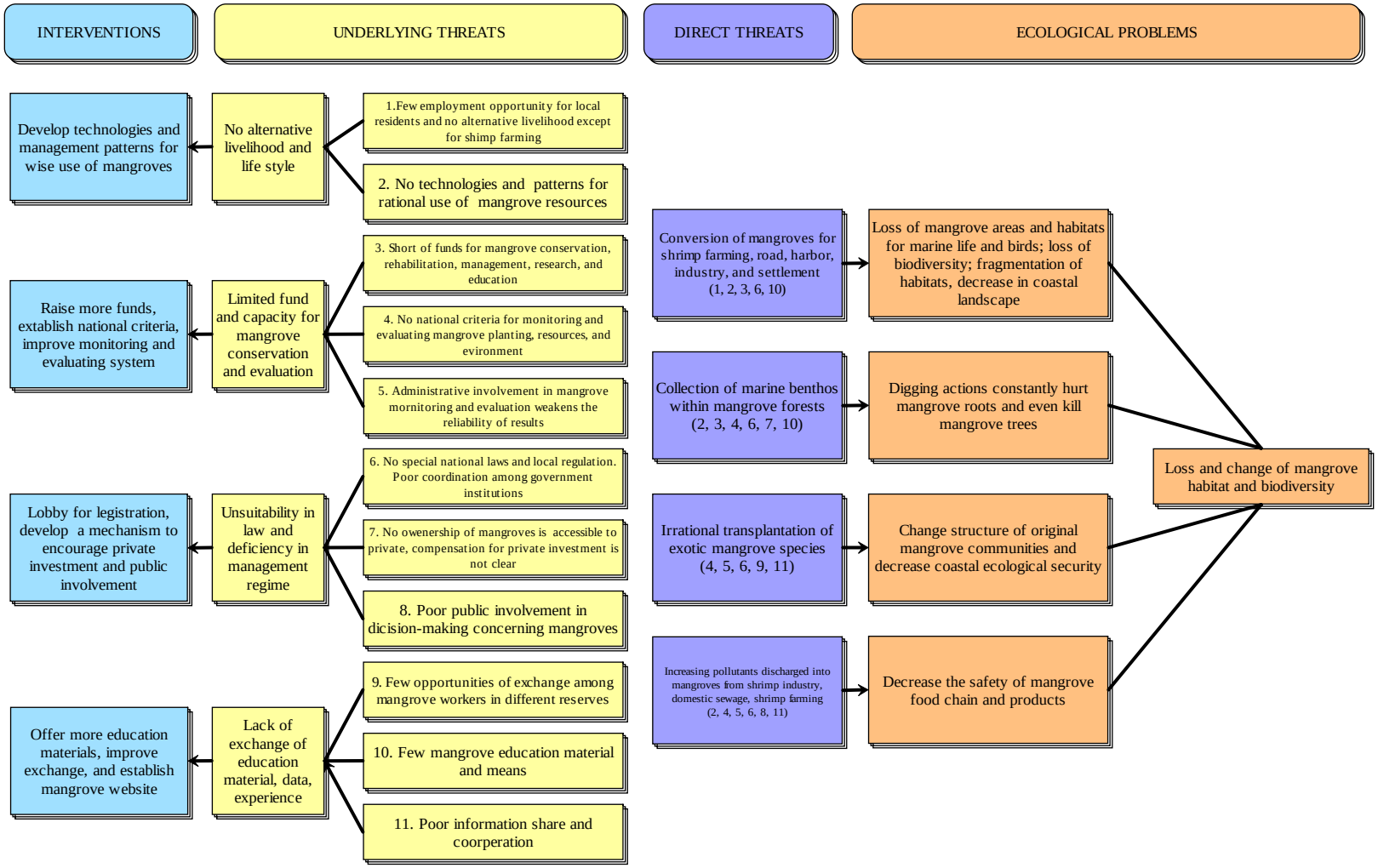

Figure 3 The Causal Chain Analysis for China Mangrove Ecosystem.

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Annex 1 List of Phytoplankton recorded in Mangroves of China.

No.	Scientific name	No.	Scientific name	No.	Scientific name
	Bacillariophyta	79	*Diatoma hylina*	158	*Pleurosigma intermedium*
1	*Actinocyclus crassus* V. Heurck	80	*Diatoma vulgare* var. *capitualta*	159	*Pleurosigma naviculaceum*
2	*Amphiprore alata*	81	*Diploneis bombus* Ehr.	160	*Pleurosigma normani*
3	*Amphora coffeaeformis* (Ag.) Kutzing	82	*Diploneis fusca* var.*pelagica*	161	*Pleurosigma rectum*
4	*Amphora coffeaeformis* v. *acutiuscula* (Kutz.) Hustedt	83	*Diploneis papula*	162	*Pleurosigma salinatum*
5	*Amphora exigua*	84	*Diploneis rutilans*	163	*Pleurosigma* sp.
6	*Amphora laevis*	85	*Diploneis splendica*	164	*Pseudo - Eunotia doliolus*
7	*Amphora lineolata*	86	*Ditylum brightwelli* (West) Grun.	165	*Pseudo - Nitzschia sicula*
8	*Amphora lineolata* var. *chinensis*	87	*Dylindrotheca gracilis*	166	*Pseudo - Nitzschia sicula* var. *bicuneata*
9	*Amphora proteus* Gregory	88	*Eucampia cornuta* (Cl.) Grun.	167	*Rhizosolenia acuminata*
10	*Amphora* sp.	89	*Eucampia zoodiacus* Ehr.	168	*Rhizosolenia alata* f. *genuine*
11	*Astereionella japonica*	90	*Guinardia flaccida* (Castr.) Per.	169	*Rhizosolenia alata* f. *gracillima* (Cl.) Grun.
12	*Axhnanthes brevipes*	91	*Gyrosigma apenerii*	170	*Rhizosolenia bergonii*
13	*Axhnanthes brevipes* var. *angustata*	92	*Gyrosigma balticum* (Ehr.) Rabh.	171	*Rhizosolenia calcar-avis* Schultz
14	*Axhnanthes clevei*	93	*Gyrosigma fasciola* v. *arcuata* (Donk.) Cl.	172	*Rhizosolenia clevei* Ostf.
15	*Bacillaria paradoxa* Gmelin	94	*Gyrosigma fasciola* v. *tenuirostris* (Grun.) Cl.	173	*Rhizosolenia crassispina* Schrod.
16	*Bacteriastrum comosum* v. *hispida* (Castracane) Ikari	95	*Gyrosigma macrum* (W. Sm.) Gr. et Hen.	174	*Rhizosolenia fragilissima* Berg.
17	*Bacteriastrum cosmosum* Pav.	96	*Gyrosigma obliquum* (Grun) Boyer	175	*Rhizosolenia hebetata* v. *semispina* (Hens) Gran.
18	*Bacteriastrum hyalinum* Laud.	97	*Gyrosigma qasciola*	176	*Rhizosolenia imbricata* Brightw.
19	*Bacteriastrum* sp.	98	*Gyrosigma* sp.	177	*Rhizosolenia robusta* Norm.
20	*Bacteriastrum varians* Laud.	99	*Hemiaulus hauckii* Grun.	178	*Rhizosolenia* sp.
21	*Bellerochea malleus*	100	*Hemiaulus membranaceus* Cl.	179	*Rhizosolenia stolterfothii* Per.
22	*Biddulphia aurita*	101	*Hemiaulus sinensis*	180	*Rhizosolenia styliformis* Brightw.
23	*Biddulphia heteroceros* Grun.	102	*Lauderia borealis* Gran	181	*Rhizosolenia styliformis v. latissima*
24	*Biddulphia mobiliensis* (Bail.) Grun.	103	*Leptocylindrus danicus* Cl.	182	*Schroederella delicatula*
25	*Biddulphia obtusa* Kutzing	104	*Mastogloia inaequalis*	183	*Skeletonema costatum*
26	*Biddulphia regia* (Schultze) Ostf.	105	*Mastogloia pusilla* var.*subcapitata*	184	*Stephanopyxis palmeriana* (Grev.) Grun.
27	*Biddulphia sinensis* Grev.	106	*Melosira sulcata* (Ehr.) Kutz.	185	*Streptotheca thamesis*
28	*Campylodiscus biangulatus* Grev.	107	*Navicula dicephala*	186	*Surirella gemma* Ehr.
29	*Cerataulina bergonii* Per.	108	*Navicula directa*	187	*Surirella qluminensis*
30	*Cerataulina campacta* Ostenfeld	109	*Navicula directa* var.*javanica*	188	*Thalassionema nitzschioides* Grun.
31	*Chaetoceros affinis*	110	*Navicula distans*	189	*Thalassiosira rotula* Meunier
32	*Chaetoceros affinis* v. *willei* (Gran) Hust.	111	*Navicula gracilis*	190	*Thalassiothrix frauenfeldii* Grun.
33	*Chaetoceros brevis* Schutt	112	*Navicula lyra* v. *insignis A.* Schmidt	191	*Thalassiothrix longissima*
34	*Chaetoceros compressus* Land.	113	*Navicula membranacea* Cl.	192	*Triceralium formosum*
35	*Chaetoceros constrictus* Gran	114	*Navicula minima*	193	*Triceratium favus* Ehr.
36	*Chaetoceros convolutes*	115	*Navicula pinna*	194	*Triceratium gibbosum*
37	*Chaetoceros costatus* Pav.	116	*Navicula placentula fo.lanceolata*	195	*Chaetoceros lauderi* Ralfts

Annex 1 c*ont.* **List of Phytoplankton recorded in Mangroves of China.**

No.	Scientific name	No.	Scientific name	No.	Scientific name
38	*Chaetoceros curvisetus*	117	*Navicula salinarum*		**Euglenophyta**
39	*Chaetoceros debilis*	118	*Navicula* sp.	196	*Colacium cyclopicola*
40	*Chaetoceros decipiens* Cl.	119	*Navicula viridula* var. *slesvicensis*	197	*Egulenopsis vorax*
41	*Chaetoceros decipiens* f. *singulari* Gran	120	*Nitzschia acuminate*	198	*Euglena bracilis*
42	*Chaetoceros densus* Cl.	121	*Nitzschia amphbia*	199	*Euglena caudate*
43	*Chaetoceros denticulatus* Land.	122	*Nitzschia closterium* Ehr.	200	*Euglena deses*
44	*Chaetoceros didymus* Ehr.	123	*Nitzschia cocconeiformis*	201	*Euglena ehrenbergii*
45	*Chaetoceros distans* Cl.	124	*Nitzschia delicatissima*	202	*Euglena geniculata*
46	*Chaetoceros diversus* Cl.	125	*Nitzschia dissipata*	203	*Euglena mutabilis*
47	*Chaetoceros indicum*	126	*Nitzschia filiformis*	204	*Euglena pisciqormis*
48	*Chaetoceros lorenzianus* Grun.	127	*Nitzschia frustulum*	205	*Euglena polymorpha*
49	*Chaetoceros peruvianus* Brightw.	128	*Nitzschia granulate*	206	*Euglena tritella*
50	*Chaetoceros pseudocurvisetus* Mang.	129	*Nitzschia hungarica*	207	*Euglena variabilis*
51	*Chaetoceros radians*	130	*Nitzschia hydrida* Grun.	208	*Euglena viridis*
52	*Chaetoceros socialis*	131	*Nitzschia lanceolata*	209	*Phacus acuminatus*
53	*Chaetoceros subsecundus* (Grunow) Hust.	132	*Nitzschia logissimia* f. *reversa* W. Smith	210	*Phacus caudatus*
54	*Chaetoceros* sp.	133	*Nitzschia longissima* (Breb) Ralf	211	*Phacus longicauda*
55	*Cocconeis scutellum* Ehr.	134	*Nitzschia longissima var.re-versa*	212	*Phacus spp*.
56	*Cocconeis scutellum* var. *varians*	135	*Nitzschia lorenziana* Grun.		**Chlorophyta**
57	*Corethron hystrix* Hens.	136	*Nitzschia lorenziana* v. *densestriata* (Per.) *A.* Sch.	213	*Ulothrix aequalis*
58	*Coscinodiscus argus*	137	*Nitzschia marina*	214	*Ulothrix tenerrima*
59	*Coscinodiscus astromphalus* Ehr.	138	*Nitzschia navicularis*	215	*Scenedesmus sp*.
60	*Coscinodiscus bipartitus*	139	*Nitzschia obtuse*		**Cyanophyta**
61	*Coscinodiscus centralis* Ehr.	140	*Nitzschia obtusa* v. *scalpelliformis* Grun.	216	*Oscillatoria lacustris*
62	*Coscinodiscus curvatulus v. Minor*	141	*Nitzschia panduriformis*	217	*Oscillatoria tenuis*
63	*Coscinodiscus divisus*	142	*Nitzschia punctata*	218	*Oscillatoria* sp.
64	*Coscinodiscus exceutricus* Ehr.	143	*Nitzschia pungens* Grun.		**PYRROPHYTA**
65	*Coscinodiscus gigas* v. *praetexta* (Janisch) Hust.	144	*Nitzschia sigma*	219	*Ceralium fusus*
66	*Coscinodiscus oculus-iridis* Ehr.	145	*Nitzschia sigma* v. *Intercedens*	220	*Ceralium macroceros*
67	*Coscinodiscus radiatus* Ehr.	146	*Nitzschia sigmoidea*	221	*Ceralium tripos*
68	*Coscinodiscus reniformis*	147	*Nitzschia sp*.	222	*Ceratium fusus* (Ehr.) Dujardin
69	*Coscinodiscus* sp.	148	*Nitzschia spectabies*	223	*Ceratium fusus trichoceros* (Ehr.) Kofoid
70	*Coscinodiscus spinosus* Chin.	149	*Nitzschia subtilis*	224	*Dinophysis caudata* Sarille-Kent
71	*Coscinodiscus wailesii*	150	*Nitzschia vitrea*	225	*Peridinium depressum*
72	*Cyclotella comta* var. *oligactis*	151	*Pinnularia molaris*		**Chryptophyta**
73	*Cyclotella stelligera*	152	*Plagiogramma vanheurckii*	226	*Cyptomonas salinax*.
74	*Cyclotella striata*	153	*Planktoniella sol*	227	*Hemiselmis cycolpea*
75	*Cyclotella stylorum* Brightw.	154	*Pleurosigma pelagicum* Per.	228	*Nephroselmis olivacea*
76	*Cymbella gravilis*	155	*Pleurosigma affine* Grun.	229	*Protochrysis phaeophycearum*
77	*Cymbella sp*.	156	*Pleurosigma angulatum*		**Chrysophyta**
78	*Dactyliosolen mediteraneus*	157	*Pleurosigma formosum*	230	*Chrysococcus rufescens*
				231	*Mallomonas longiseta*

Annex 2 List of Zooplankton recorded in Mangroves of China.

No.	Scientific name	No.	Scientific name
	I PROTOZOA	38	*Acrocalanus gibber* Giesbrecht
1	*Noctiluca miliaris* Suriray	39	*Acrocalanus gracilis* Giesbrecht
	II **COELENTERATA**	40	*Calanopia thompsonis A.* Scott
2	*Aeginura rgimaldii*	41	*Calanus sinicus* Brodsky
3	*Aequorea macrodactyla*	42	Candac*ia bradyi A.* Scott
4	*Aequorea* sp.	43	*Canthocalanus pauper* (Giesbrecht)
5	*Aglaura hemistoma* Peron et Lesueur	44	*Centropuges tenuiremis* Thompson
6	*Beroe cucumis* Fabricius	45	*Eucalanus subcrassus* Giesbrecht
7	*Bougainvillia britannica*	46	*Euchaeta concinna*
8	*Densia subtiloides*	47	*Euchaeta plana*
9	*Diphyes chamisonis*	48	*Labidocera bipinnata*
10	*Ectopleura dumortieri* (Van Beneden)	49	*Labidocera euchaeta* Giesbrecht
11	*Eirene ceylonensis* Browne	50	*Oithona brevicornis*
12	*Eirene hexanemalis* (Goette)	51	*Pontellopsis tenuicauda*
13	*Eirene menoni*	52	*Pontellopsis yamadae*
14	*Eirene* sp.	53	*Schmackeria poplesia*
15	*Euphysora bigelowi*	54	*Sinocalanus tenellus*
16	*Eutima japonica*	55	*Temora turbinata* (Dana)
17	*Eutima modesta*	56	*Tortanus derjugini*
18	*Helgicirraha malayensis* (Stiasny)	57	*Tortanus forcipatus*
19	*Lensia subtiloides* (Lens et van Riensdijk)	58	*Tortanus gracilis*
20	*Liriope tetraphylla*		**AMPHIPODA**
21	*Malagazzia carolinae* (Mayer)	59	*Lestrigonus larva*
22	*Moerisia inkermanica* Paltschikowa- Ostroumova	60	Gammaridea
23	*Muggiaea atlantica*		**EUPHAUSIACEA**
24	*Obelia spp*.	61	*Psedeuphausia sinica*
25	*Phialidium folleatum*	62	*Pseudeuphausia* sp.
26	*Physophora hydrostatica*		**DECAPODA**
27	*Pleurobrachia globosa* Moser	63	*Acetes japonicus*
28	*Podocoryne apicata*	64	*Lucifer faxonii*
29	*Turritopsis lata*	65	*Lucifer hanseni* Nobili
30	*Zanclea costata* Gegenbaur	66	*Lucifer intermedius* Hansen
	III **ARTHROPODA**		IV **CHAETOGNATHA**
	Cladocera	67	*Sagitta bedoti* Beraneck
31	*Evadne tergestina* Claus	68	*Sagitta delicata*
32	*Penilia avirostris* Dana	69	*Sagitta enflata* Grassi
	OSTRACODA	70	*Sagitta larva*
33	*Cypridina dentata*	71	*Sagitta nagae*
34	*Euconchoecia aculeata*	72	*Sagitta neglecta*
	COPEPODA	73	*Sagitta pulchra*
35	*Acartia erythraea* Giesbrecht		V **UROCHORDATA**
36	*Acartia pacifica* Steuer	74	*Oikopleura dioica* Fol
37	*Acartia spinicauda* Giesbrecht		

Annex 3 List of Macrobenthos recorded in Mangroves of China.

No	Scientific name	No	Scientific name	No	Scientific name	No	Scientific name
	COELENTERATA	158	*Brachidontes variabilis* (Krauss)	323	*Natica vitellus* (Linnaeus)	486	*Charybdis hellerii* (A Milne-Edwards)
1	*Eudendrium racemosum* Pallas	159	*Hormomya mutabilis* (Gould)	324	*Natica tigrina* Lamarck	487	*Charybdis japonica*(*A.*Milne-Edwards)
2	*Haliplanella luciae* (Verrill)	160	*Septifer bilocuakis* (Linnaeus)	325	*Natica didyma* (Ruding)	488	*Charybdis variegata* (Fabricius)
3	*Metridium sp*.	161	*Modiolus* (*Modiolus*) *comptus* Sowerby	326	*Natica zebra* Lamarck	489	*Charybdis vadorum* Alcock
4	*Cancrisocia sp*.	162	*Modiolus* (*Modiolus*) *metcalfei* (Hanley)	327	*Phalium strigatum strigatum* (Gmelin)	490	*Charybdis bimaculata* (Miers)
5	*Cerianthus* sp.	164	*Perna viridis* (Linnaeus)	328	*Apollon olivator* (Fulton)	491	*Thalamita danae* Stimpson
6	*Cavernularia habereri* Moroff	165	*Musculista senhausia* (Benson)	329	*Drupa margariticola* (Broderip)	492	*Thalamita* sp.
7	*Virgularia gustaviana* (Herclots)	166	*Musculista japonica* (Dunker)	330	*Rapana venosa* (Valenciennes)	493	*Euxanthus exsculptus* (Herbst)
8	*Pteroeides chinensis* Harclots	167	*Xenostrobus atrata* (Lischke)	331	*Thais gradata* Jonas	494	*Leptodius exaratus* (H. Millne-Edwards)
	PLATYHELMINTHES	168	*Lioderus vagina* (Larmarck)	332	*Thais clavigera* Kuster	495	*Parapanope euagora* de Haan
9	*Planocera sp*.	169	*Atrina* (*Servatrina*) *pectinata* (Linnaeus)	334	*Thais carinifera*	496	*Heteropilumnus subinteger* (Lanchester)
	NEMATODA	170	*Chlamys nobilis* (Reeve)	335	*Thais sp*.	497	*Heteropilumnus* sp.
10	*Mesacanthion* sp.	171	*Enigmonia aenigmatica* (Holten)	336	*Mitrella bella* (Reeve)	498	*Pilumnopeus makiana* (Rathbun)
	NEMERTEA	172	*Placuna placenta* (Linnaeus)	337	*Nassarius variciferus* (*A.* Adams)	499	*Heteropanope glabra* Stimpson
11	*Cerebratulina natans* Punnet	173	*Parahyotissa imbricata* (Lamarck)	338	*Nassarius festivus* (Powys)	500	*Xantho distinguendus* (de Haan)
12	*Procephalathrix* sp.	174	*Saccostrea cucullata* (Born)	339	*Nassarius* (*Zeuxis*) *succinctus* (*A.* Adams)	501	*Xantho* sp.
	ANNELIDA	175	*Saccostrea echinata* (Quoy et Gaimard)	340	*Nassarius siquijorensis* (*A.* Adams)	502	*Ser fukiensis* Rathbun
13	*Phyllodocidaes* spp.	176	*Dendostrea crenulifera* Sowerby	341	*Nassarius hepaticus* (Pulteney)	503	*Typhlocarcinus* sp.
14	*Lepidonotus* sp.	177	*Ostrea nigromarginata* Sowerby	342	*Nassarius thersites* (Bruguiere)	504	*Typhlocarcinus nudus* Stimpson
15	*Lepidosthemia* sp.	178	*Ostrea glomerata* Gould	343	*Nassarius dealbatus* (*A.* Adams)	505	*Typhlocarcinus villosus* Stimpson
16	*Sigalion* sp.	179	*Otrea denselamellosa* Lischke	344	*Nassarius sp*.	506	*Hexapus anfractus* Rathbun
17	*Sthenolepis japonica* (McIntosh)	180	*Alectryonella plicatula* Gmelin	345	*Semiretusa bomeensis*	507	*Tritodynamia hainaensis* Dai
18	*Synelmis albini* (Langerhans)	181	*Talonostrea pestigris* Hanley	346	*Conus sp*.	508	*Neoxenophthalmus obscurus* (Henderson)
19	*Ancistrosyllis* sp.	182	*Anodontes philippinana* (Reeve)	347	*Inquistor flavidula* (Lamarck)	509	*Xenophthlmus pinnotheroides* (White)
20	*Sigambra hanaokai* (Kitamori)	183	*Anodontia Stearnsiana* Oyama	348	*Gemmula deshayesii* (Doumel)	510	*Mortensenella forcepe* Rathbun
21	*Sigambra* sp.	184	*Pseudopythina ochetostomae* Morton et Scatt	349	*Turricula javana* (Linnaeus)	511	*Mictyris longicarpus* Latreille
22	*Ceratonereis burmensis* (Monro)	185	*Mactra veneriformis* Reeve	350	*Turricula nelliae spurius* (Hedley)	512	*Ocypode ceratophthalmus* (Pallas)
23	*Ceratonereis erythraeensis* Fauvel	186	*Lutraria* (*psommophila*) *maxima* Jonas	351	*Brachystomia vexillum* Habe et Kosuge	513	*Ocypode cordimana* Desmarest
24	*Dendronereis Pinnaticirris* (Grube)	187	*Meropesta nicobarica* (Gmelin)	352	*Cinguloterebra torquiata*	514	*Ocypode stimpsoni* Ortmann
25	*Nereis* sp.	188	*Atactodea striata* (Gmelin)	353	*Terebra* (*Noditerebra*) *dussumieri* Kiener	515	*Uca arcuata* (de Haan)
26	*Namalycastis aibiuma* (Muller)	189	*Atactodea* sp.	354	*Tiberia* sp.	516	*Uca dussumieri* H. Milne-Edwards
27	*Neanthes gl*andicincta (Southern)	190	*Coecella turgida* Deshayes	355	*Punctacteon yamamurae* Habe	517	*Uca marionis* Desmarest
28	*Neanthes japonica* (Izuka)	191	*Chion semigranosus* (Dunker)	356	*Radix auricularia* (Linnaeus)	518	*Uca nitidus* Desmarest
29	*Neanthes succinea* (Frey et Leuckart)	192	*Chion* sp.	357	*Bullacta exarata* (Philippi)	519	*Uca uroillei* H. Milne-Edwards
30	*Nectoneanthes oxypoda* (Marenzeller)	193	*Donax faba* (Gmelin)	358	*Melanoides tuberculata* (Muller)	520	*Uca lacteus* de Haan

Annex 3 *cont.* **List of Macrobenthos recorded in Mangroves of China.**

No	Scientific name	No	Scientific name	No	Scientific name	No	Scientific name
31	*Nectoneanthes* sp.	194	*Angulus vestalis* (Hanley)	359	*Melanoides* sp.	521	*Uca vocans*(Linnaeus)
32	*Ceratonereis sp*.	195	*Angulus* sp.	360	*Retusa borneensis* (*A.* Adams)	522	*Uca* (*celuca*) *annlipes* (H.Milne-Edwards)
33	*Perinereis aibuhitensis* Grube	196	*Merisca diaphana* (Deshayes)	361	*Pupa* sp.	523	*Macrophthalmus dilatum* (de Haan)
34	*Perinereis camiguinoides* Augener	197	*Arcopaginula* sp.	362	*Ellobium chinensis* (Pfeiffer)	524	*Macrophthalmus convexus* Stimpson
35	*Perinereis nuntia* (Savigny)	198	*Moerella culter* (Hanley)	363	*Ellobium aurismidae* (Linnaeus)	525	*Macrophthalmus crassipes* (H.Milne-Edwards)
36	*Tylonereis bogoyawleskyi* Fauvel	199	*Moerella iridescens* (Benson)	364	*Ellobium* sp.	526	*Macrophthalmus botel* Tobagoe
37	*Tylorrhynchus heterochaetus* (Quatrefages)	200	*Moerella jedoensis* (Lischke)	365	*Melampus triticeus* (küster)	527	*Macrophthalmus japonicus* de Haan
38	*Lennates erythraeenis* Fauvel	201	*Moerella philippinurum* (Hanley)	366	*Melampus castaneus*	528	*Macrophthalmus pacificus* Dana
39	*Leonnates* sp.	202	*Moerella rutila* (Dunker)	367	*Auriculastra elongata*	529	*Macrophthalmus definitus* Adams et White
40	*Nicon sinica* Wu et Sun	203	*Nitidotellina iridella* (Martens)	368	*Laemodonta punotigera* (H.et *A.* Adams)	530	*Macrophthalmus erato* de Man
41	*Pareleonnates uschkovi* Chlebovitsch et Wu	204	*Nitidotellina minuta* (Lischke)	369	*Laemodonta* sp.	531	*Macrophthalmus catreillei* (Desmarest)
42	*Glycera chirori* Izuka	205	*Nitidotellina nitidula* (Dunker)	370	*Cassidula plecotrematoides* (Möllendorff)	532	*Macrophthalmus simdentatus* Shen
43	*Glycera rouxi* Audouin et M.-Edwards	206	*Fabulina tsichungyeni* Scarlato	371	*Pythia* sp.	533	*Macrophthalmus* sp.
44	*Glycera convolute* Keferstein	207	*Macoma* (*Psammacoma*) *lucerna* (Hanley)	372	*Onchididum verruculatus* Cuvier	534	*Campt*and*rium elongatum* Rathbun
45	*Glycera subaenea* Grube	208	*Macome nobillis* (Hanley)		**CEPHALOPODA**	535	*Campt*and*rium aromaoum* Shen
46	*Glycera* sp.	209	*Macome* cand*ida* (Lamarck)	373	*Sepiola birostrat* Sasaki	536	*Campt*and*rium sexdentatum* Stimpson
47	*Glycinde* sp.	210	*Macome nipponica*	374	*Octopus variabilis* (Sasaki)	537	*Cleistostoma dilatatum* de Haan
48	*Goniada emerita* Audouin et M.-Edwards	211	*Apolymetis* sp.	375	*Octopus fusiformis* Brock	538	*Paracleistostoma cristatum* de Haan
49	*Goniada japonica* Izuka	212	*Pulvinus micans* (Hanley)	376	*Octopus sp.*	539	*Paracleistostoma depressum* de Man
50	*Goniada maculata* Oersted	213	*Theora lata* (Hinds)		**ARTHROPODA**	540	*Ilyoplax dentimerosa* Shen
51	*Aglaophamus sinensis* (Fauvel)	214	*Gari reevei* Habe		**Merostomata**	541	*Ilyoplax formosensis* Rathbun
52	*Aglaophamus dibranchis* Grube	215	*Gari* sp.	377	*Carcinoscorpins routnolicauda* (Latrelle)	542	*Ilyoplax tansuiensis* Sakai
53	*Inermonephtys inermis* (Ehlers)	216	*Hiatula diphos* (Linnaeus)	378	*Tachypleus tridentatus* Leach	543	*Ilyoplax serrata* Shen
54	*Nephtys californiensis* Haitman	217	*Soletellina atrata* Reeve	379	*Tachypleus* sp.	544	*Ilyoplax ningpoensis* Shen
55	*Nephtys ciliata* (Muller)	218	*Hiatula togata* (Deshayes)		**CRUSTACEA**	545	*Ilyoplax* sp.
56	*Nephtys oligobranchia* Southern	219	*Soletellina acula* (Cai et Zhuang)	380	*Euraphia withersi* Pilsbry	546	*Tmethypocoelis ceratophora* (Koelbel)
57	*Nephtys capensis* Day	220	*Psammotaena elongata* (Lamarck)	381	*Chirona amaryllis* (Darwin)	547	*Scapimera tuberculata* Stimpson
58	*Nephtys* sp.	221	*Psammotaena* sp.	382	*Chelonibia patula* (Ranzani)	548	*Scopimera bitympana* Shen
59	*Haploscoloplos elongatus* (Johnson)	222	*Solen grandis* Dunker	383	*Balanus albicostatus* Pilsbry	549	*Scopimera globosa* de Haan
60	*Haploscoloplos cf. fragillis* Webster	223	*Solen strictus* Gould	384	*Balanus amphitrrite* Pilsbry	550	*Dotilla wichmanni* de Man
61	*Scoloplos rubra orientalis* Gallardo	224	*Solen dunkerianus* Clessin	385	*Balanus littoralis* Ren et Lin	551	*Metopograpsus frontalis* Miers
62	*Scoloplos gracillis* Pillai	225	*Cultellus attenuatus* Dunker	386	*Balanus reticulatus* Utinomi	552	*Metopograpsus quadridentatus* Stimpson
63	*Scoloplos dubia* Tebble	226	*Cultellus scalprum* (Gould)	387	*Balanus cirratus* Darwin	553	*Metopograpsus messor* (Forskal)

Annex 3 c*ont.* **List of Macrobenthos recorded in Mangroves of China.**

No	Scientific name	No	Scientific name	No	Scientific name	No	Scientific name
64	*Scoloplos* sp.	227	*Siligua minima* (Gmelin)	388	*Balanus uliginosus* Utinomi	554	*Metopograpsus* sp.
65	*Aricidea* sp.	228	*Sinonovacula constricta* (Lamarck)	389	*Paranthura japonica* Richardson	555	*Pachygrapsus crassipes* Randall
66	*Cossura dimorpha* Hartman	229	*Pharella acutidens* (Broderip et Sowerby)	390	*Cirolana japonensis* (Richardson)	556	*Hemigrapsus longitarsis* (Miers)
67	*Laonice cirrata* (Sars)	230	*Trapezium liratum* (Reeve)	391	*Sphaeroma* sp.	557	*Hemigrapsus peniciillatus* (de Haan)
68	*Paraprionospio pinnata* (Miers)	231	*Libitna japonica* (Pilsbry)	392	*Ligia exotica* (Roux)	558	*Varuna litterata* (Fabricius)
69	*Prionspil booki*	232	*Corbicula fluminea* (Muller)	393	*Porcellio* sp.	559	*Gaetice depressus* (de Haan)
70	*Prionspil malmgreni* Claparede	233	*Corbicula nitens* (Philippi)	394	*Corophium* sp.	560	*Nanosesarma* (*N.*) *pontianacensis* (de Man)
71	*Magelona cincta* Ehlers	234	*Gelolna coaxans* (Gmelin)	395	*Gammarus gregoryi* Tattersall	561	*Nanosesarma* (*N.*) *minutum* (de Man)
72	*Chaetopterus* sp.	235	*Callista chinensis* (Holten)	396	*Gammarus* sp.	562	*Sesarma* (*Holometopus*) *haematocheir* (de Haan)
73	*Poecilochaetus serpens* All	236	*Callista erycina* (Linnaeus)	397	*Amipithoe* sp.	563	*Sesarma dehaani* H. Milne-Edwards
74	*Poecilochaetus tropicus* Okuda	237	*Dosinia japonica* (Reeve)	398	*Caprella scaura* Templeton	564	*Sesarma* (*Parasesarma*) *pictum* (de Haan)
75	*Poecilochaetus Paratropicus* Gallardo	238	*Dosinia troscheli* Lisckke	399	*Atypopenaeus stenodactylus* (Stimpson)	565	*Sesarma plicata* (*Latreille*)
76	*Cirriformia tentaculata* (Montaau)	239	*Dosinia gibba A.*Adams	400	*Metapenaeopsis barbata* (de Haan)	566	*Sesarma bidens* (de Haan)
77	*Cirratulus* sp.	240	*Dosinia corrugata* (Reeve)	401	*Metapenaeus ensis* de Haan	567	*Sesarma* (*Sesarmops*) *sinensis* H.Milne-Edwards
78	*Barantolla sculpta*	241	*Meretrix meretrix* (Linnaeus)	402	*Metapenaeus joyneri* (Miers)	568	*Sesarma intermedia* (de Haan)
79	*Barantolla* sp.1	242	*Meretrix lusoria* (Rumphius)	403	*Metapenaeus* sp.	569	*Sesarma picta* (de Haan)
80	*Herteromastus filiforms* (Claparede)	243	*Anomalocordia flexuosa* (Linnaeus)	404	*Miyadiella podophthalmus* (Stimpson)	570	*Sesrama* sp.
81	*Herteromastus simillis* Southern	244	*Anomalodiscus squamosus* (Linnaeus)	405	*Parapenaeopsis cultrirostris* (Alcock)	571	*Eriocheir sinensis* H. Milne-Edwards
82	*Herteromastus* sp.	245	*Clausinella calophylla* (Philippi)	406	*Parapenaeopsis hardwickii* (Miers)	572	*Helice tridens tientsinensis* Rathbun
83	*Notomastus latericeus* Sars	246	*Clausinella isabellina* (Philippi)	407	*Parapenaeopsis hungerfordi* Alcock	573	*Helice tridens* Wuana
84	*Notomastus aberans* Day	247	*Clausinella* sp.	408	*Parapenaeopsis cornuta* (Kishinouye)	574	*Metaplax longipes* Stimpson
85	*Parheteromatus tenuis* Monro	248	*Gomphina aequilatera* (Sowerby)	409	*Parapenaeopsis tenella* (Bate)	575	*Metaplax elegans* de Man
86	*Euclymene annandalei* Southern	249	*Gomphina melanaegis* (Sowerby)	410	*Penaeus orientalis* Kishinouye	576	*Metaplax sheni* Gordon
87	*Euclymene* sp.	250	*Cyclina sinensis* (Gmelin)	411	*Penaeus merguionsis* De Man	577	*Metaplax* sp.
88	*Praxillella praetermissa* (Malmgren)	251	*Gafrarium divaricatum* (Gmelin)	412	*Penaeus* (*Fenneropenaeus*) *penicillatus* Alcock	578	*Clorida latreillei* (Eydoux et Souleyet)
89	*Armandia lanceolata* Willey	252	*Marcia rimularis* (Lamarck)	413	*Penaeus* (*Marsupenaeus*) *japonicus* Bate	579	*Cloridopsis scorpio* (Latreille)
90	*Armandia leptocirrus* Grube	253	*Marcia hiantina* (Lamarck)	414	*Penaeus* (*M.*) *latisulcatus* Kishinouye	580	*Lophosquilla costata* (de Haan)
91	*Armandia* sp.	254	*Marcia marmorata* (Lamarck)	415	*Penaeus monodon* Fabricius	581	*Oratosquilla interrupta* (Kemp)
92	*Ophelia acuminata* Oersted	255	*Tapes literata* (Linnaeus)	416	*Penaeus semisulcatus* De Haan	582	*Oratosquilla oratoria* (de Haan)
93	*Ophelia grandis* Pillai	256	*Paphia* (*Paratapes*) *undulata* (Born)	417	*Penaeus stylyorostris*	583	*Oratosquilla kempi* (Schmitt)
94	*Traoisia* sp.	257	*Ruditapes philippinarum* (Adams et Reeve)	418	*Trachypenaeus cornuta*	584	*Oratosquilla nepa* (Latreille)
95	*Eurythoë parvecarunculata* Horst	258	*Ruditapes variegata* (Sowerby)	419	*Trachypenaeus sedili* Hall		**BRACHIOPODA**
96	*Eurythoë* sp.	259	*Glauconme chinensis* (Gray)	420	*Acetes chinensis* Hansen	585	*Lingula anatina* Lamarck
97	*Chloeia parva* Baird	260	*Mya* sp.	421	*Acetes japonicus* Kishinouye		**ECHINODERMATA**

Annex 3 *cont.* **List of Macrobenthos recorded in Mangroves of China.**

No	Scientific name	No	Scientific name	No	Scientific name	No	Scientific name
98	*Euphrosine* sp.	261	*Potamocorbula fasciata* (Reeve)	422	*Leptochela gracilis* Stimpson	586	*Leptopentacta imbricata* (Semper)
99	*Diopatra neapolitana* Della Chiaje	262	*Potamocorbula laevis* (Hinds)	423	*Leptochela pugnax* de Man	587	*Mensamaria intercedens* (Lampert)
100	*Diopatra sugokai* Izuka	263	*Bankia carinata* (Gray)	424	*Exopalaemon annandalei* (Kemp)	588	*Acaudina molpadioides* (Semper)
101	*Diopatra amboinesis* Audouin et Milne Edwards	264	*Bankia saullii* (Wright)	425	*Exopalaemon carinicauda* (Holthuis)	589	*Protankyra bidentata* (Woodward et Barrett)
102	*Diopatra* sp.	265	*Teredo manni* (Wright)	426	*Palaemon gravieri* (Yu)	590	*Protankyra* sp.
103	*Onuphis eremita* Audouinet M.-Edwards	266	*Teredo navalis* Linnaeus	427	*Palaemon macrodacttylus* Rathbun	591	*Craspidaster hesperus* (Muller et Troschel)
104	*Marphysa sanguinea* (Montagu)	267	*Laternula* (*Exolaternula*) *marilina* (Reeve)	428	*Palaemon serrife* (Stimpson)	592	*Astropecten monacanthus* Sladen
105	*Marphysa* sp.	268	*Laternula* (*E.*) *truncata* (Lamarck)	429	*Macrobrachium rosenbergii* (de Haan)	593	*Luidia quinaria* von Martens
106	*Euniphysa aculeata* Wesenberg Lund	269	*Laternula nanhaiensis* Zhuang et Cai	430	*Alpheus bisincisus* de Haan	594	*Asterina limboonkengi* G. *A.* Smith
107	*Lumbrineris heteropoda* (Marenzeller)	270	*Laternula anatina* Linnaeus	431	*Alpheus brevicristatus* de Haan	595	*Temnopleurus toreumaticus* (Leske)
108	*Lumbrineris inflata* (Moore)	271	*Laternula* sp.	432	*Alpheus distinguenus* de Haan	596	*Temnopleurus reevesii* (Gray)
109	*Lumbrineris latreilli* Audouinet M.-Edwards	272	*Trigonothracia jinxingae* Xu	433	*Alpheus hoplochels* Coutiere	597	*Arachnoides placenta* (Linnaeus)
110	*L. brevicirra* (Schmarda)		**GASTROPODA**	434	*Alpheus japonious* Miers	598	*Trichaster acanthifer* Doderlein
111	*L. nagae* Gallardo	273	*Patelloida* sp.	435	*Alpheus lobidens* de Haan	599	*Amphioplus depressus* (Ljungman)
112	*Lumbrineris* sp.	274	*Trochus* sp.	436	*Alpheus stanleyl dearmarus* de Man	600	*Amphioplus impressus* (Ljungman)
113	*Driloneris filum* (Claparede)	275	*Umbonium vestiarium* (Linne)	437	*Alpheus* sp.	601	*Amphioplus laevis* Lyman.
114	*Sternaspis sculata* (Renier)	276	*Turbo brunneum* Roding	438	*Ogyrides orientalis* (Stimpson)	602	*Amphioplus ancistrotus* (H. L. Clark)
115	*Owenia fusformis* Delle Chiaje	277	*Lunella coronata granulata* (Gmelin)	439	*Ogyrides striaticauda* Kemp	603	*Amphioplus lucidus*
116	*Lygdamis indicus* Kinberg	278	*Nerita polita* Linnaeus	440	*Lysmata vittata* (Stimpson)	604	*Amphioplus duplicata*
117	*Pectinaria conchilega* Grube	279	*Nerita albicilla* Linnaeus	441	*Laomedia astacina* de Haan	605	*Amphioplus praestans*
118	*Pectinaria papillosa* Caullery	280	*Nerita striata* (Burrow)	442	*Upogebia wuhsienweni* YU	606	*Astrodendrum sagaminum* (Doderlein)
119	*Pectinaria aegyptia sensu*	281	*Nerita yoldi* Recluz	443	*Upogebia* sp.	607	*Amphiurap achybactra* Murakami
120	*Isolda pulcholla* Muller	282	*Nerita achatina* (Reeve)	444	*Clibanarius clibanarius* (Herbst)	608	*Amphiura* sp.
121	*Melinna aberrans*	283	*Nerita japonica* (Dunker)	445	*Clibanarius infrasipinatus* Hilgendorf	609	*Ophiactis affinis* Duncan
122	*Melinna cristata* (Sars)	284	*Nerita* sp.	446	*Clibanarius* sp.	610	*Ophiothrix exigua* Lyman
123	*Paramphicteis* sp.	285	*Dostia violacea* (Gmelin)	447	*Diogenes avarus* Heller	611	*Placophiothrix plana* (Lyman)
124	*Terebellides stroemii* Sars	286	*Clithon oualaniensis* (Lesson)	448	*Diogenes edwardsii* (de Haan)	612	*Ophiocnemis marmorata* (Lamarck)
125	*Loimia medusa*	287	*Littoraria articulata* (Philippi)	449	*Diogenes paracristimanus* Wang et Dong		**UROCHORDATA**
126	*Pista cristata* (Muller)	288	*Littoraria melanostoma* Gray	450	*Diogenes rectimanus* Miers	613	*Oikopleura dioica* Fol
127	*Pista* sp.	289	*Nodilittorina* (*N.*) *radiata* (Eydoux et Souleyet)	451	*Diogenes tomentosus* Wang et Dong	614	*Styela plicata* (Lesueur)
128	*Streblosoma* sp.	290	*Littorina* (*Littoraria*) *coccinea* (Gmelin)	452	*Diogenes* sp.	615	*Microcosmus exasperatus* Heller
129	*Potamilla* sp.	291	*Stenothyra glabrata A.*Adams	453	*Pagurus dubius* (Ortmann)		**CHORDATA**
130	*Pomatoleios* sp.	292	*Valvata* sp.	454	*Pagurus geminus* Melaughlin	616	*Chanos chanos* (Forskal)
131	*Sabellastarte zebuensis* Mcintosh	293	*Assiminea latericera* H.et *A.*Adams	455	*Pagurus* sp.	617	*Clupanodon punctatus* (Temminck et Schlegel)
132	*Tubifex* sp.	294	*Assiminea scalaris* Heude	456	*Pisidia serratifrons* (Stimpson)	618	*Anguilla japonica* Temminck et Schlegel

Annex 3 *cont.* **List of Macrobenthos recorded in Mangroves of China.**

No	Scientific name	No	Scientific name	No	Scientific name	No	Scientific name
	SIPUNCULA	295	*Assiminea violacea* Heude	457	*Raphidopus ciliatus* Stimpson	619	*Muraenichthys malabonensis* Harre
133	*Antillesoma antillarum* (Crube et Oersted)	296	*Assiminea brevicula* Pfeiffer	458	*Hippa adactyla* Fabricius	620	*Pisoodonophis boro* (Ham Buch)
134	*Phascolosoma esculenta* (Chen et Yeh)	297	*Assiminea lutea japonica* (*A.*Adams)	459	*Dorippe* (*Neodorippe*) *japonica* von Siebold	621	*Syngnathus cyanospilus* Bleeker
135	*Phascolosoma perlucens* Baird	298	*Assiminea nitida*	460	*Dorippe* (*Neodorippe*) *callida* (Fabricius)	622	*Mugil cephalus* Linnaeus
136	*Phascolosoma scolops* (Selenka, De Man et Bulow)	299	*Assiminea sculpta*	461	*Dorippe polita* Alcock et Anderson	623	*Epinephelus amblycephalus* (Blecker)
137	*Phascolosoma similes* (Grube et Oersted)	300	*Turritella terebra* (Linne)	462	*Nursia rhomboidalis* (Miers)	624	*Epinephelus laurina*
138	*Themiste spinulum* (Chen et Yeh)	301	*Turritella bacillum* Kiener	463	*Nursia sinica* Shen	625	*Lates calarifer* (Bloch)
139	*Siphonosoma australe* (Keferstein)	302	*Architectonica maxima* (Philippi)	464	*Philyra platycheira* de Haan	626	*Rhabdosargus sarba* (Forskal)
140	*Sipunculus mudus* Linneaus	303	*Architectonica perdix* (Hinds)	465	*Philyra biprotubera* Dai et Guan	627	*Sparus latus* Houttuyn
141	*Sipunculus angasoides* Chen et Yeh	304	*Cerithidea cingulata* (Gmelin)	466	*Philyra carinata* Bell	628	*Petroscirtes kallosoma* Bleeker
142	*Sipunculus* sp.1	305	*Cerithidea microptera* (Kiener)	467	*Philyra pisum* de Haan	629	*Bostrichthys chinensis* (Lac)
	ECHIURA	306	*Cerithidea sinensis* (Philippi)	468	*Philyra olivaca* Rathbun	630	*Perecottus glehni* Dyboweki
143	*Para-arhynchite nexoronale* Chen	307	*Cerithidea Rhizophorarum A.* Adams	469	*Philyra minuta* Chen et Türkay	631	*Aboma lactipes* (Hilgendort)
144	*Listriolobus* sp.	308	*Cerithidea ornata* (*A.*Adams)	470	*Philyra scabra* (Dai)	632	*Amblyeleotris caninus* (Cuvier et Valenciennes)
145	*Ochetostoma erythrogrammon* Leuckart et Ruppell	309	*Cerithidea djadjarniensis* (K. Martin)	471	*Matuta planipes* Fabricius	633	*Amblyeleotris chlorostigmatoides* (Bleeker)
	MOLLUSCA	310	*Cerithidea largillierti* (Philippi)	472	*Matuta lunaris* Farskal	634	*Apocryptodon bleekeri* (Day)
	BIVALVIA	311	*Cerithidea* sp.	473	*Matuta banksii* Leach	635	*Chaeturichthys hexanema* Bleeker
146	*Nucula tenuis* (Montagu)	312	*Terebralia sulcata* (Born)	474	*Orithyia siinica* Linnaeus	636	*Ctenogobius brevirostris* (Gunther)
147	*Nucula* sp.	313	*Batillaria zonalis* (Bruguiere)	475	*Elamenopsis* sp.	637	*Ctenogobius gymnauehen* (Bleeker)
148	*Arca binakayanensis* Faustino	314	*Batillaria cumingi* (Crosse)	476	*Phalangipus longipes* (Linnaeus)	638	*Gobius poecilichthy* Jord. & Snyd
149	*Barbatia decussata* Sowerby	315	*Cerithium citrinus* Sowerby	477	*Scylla serrata* (Forskal)	639	*Bathygobius fuscus* (Ruppell)
150	*Barbatia* sp.	316	*Cerithium pfefferi*	478	*Portunus trituberculatus* (Miers)	640	*Amoya brevirostris* (Gthr.)
151	*Scapharca cornea* (Reeve)	317	*Rhinoclavis sinensis* (Gmelin)	479	*Portunus pubescens* (Dana)	641	*Periophthalmus cantonensis* (Osbeck)
152	*Scapharca gubernaculum* (Reeve)	318	*Bittium* sp.	480	*Portunus hastatoides* (Fabricius)	642	*Boleuphthalmus pectinirostris* (Linnaeus)
153	*Scapharca anomala* (Reeve)	319	*Lunatica gilva* (Philippi)	481	*Portunus argentatus* (White)	643	*Scartelaos viridis* (Ham & Buch)
154	*Tegillaria granosa* (Linnaeus)	320	*Polinices mammata* (Roding)	482	*Portunus gracilimanus* (Stimpson)	644	*Odontamblyopus rubicundus* (Hanilton)
155	*Tegillaria nodifera* (Martens)	321	*Polinices macrostoma* (Philippi)	483	*Charybdis acuta A.* Milne-Edwards	645	*Trypauchen vegina* (Bloth et Schneider)
156	*Didimacar tenebrica* (Reeve)	322	*Sinum incisum* (Reeve)	484	*Charybdis affinis* Dana		
157	*Brachidontes striatulus* (Hanley)			485	*Charybdis feriatus* (Linnaeus)		

Annex 4 List of Fishes recorded in Mangrove of China.

Elopidae	**Lutjanidae**
1. *Elops saurus* Linnaeus	42. *Lutjanus johni* (Bloch)
Clupeidae	**Sparidae**
2. *Kowala coval* (Cuvier)	43. *Pagrosomus major* (Temminck et Schlegel)
3. *Harengula bulan* (Bleeker)	44. *Sparus berda* Forskal
4. *H. ovalis* (Bennett)	45. *S. latus* Houttuyn
5. *Sardinella richardsoni* Wongratana (Richardson)	**Pomadasyidae**
6. *Clupanodon punctatus* (Temminck et Schlegel)	46. *Pomadasys hasta* (Bloch)
7. *Ilisha elongata* (Bennett)	**Theraponidae**
Engraulidae	47. *Helotes sexlineatus* (Quoy et Gaimard)
8. *Stolephorus chinensis* (Gunther)	48. *Therapon jarbua* (Forskal)
9. *S. tri* (Bleeker)	**Mullidae**
10. *Thrissa hamiltonii* (Gray)	49. *Mulloidichthys suriflamma* (Forskal)
Chirocentridae	**Drepanidae**
11. *Chirocentrus dorab* (Forskal)	50. *Drepane longimana* (Bloch et Schneider)
Congridae	**Scatophagidae**
12. *Anago anago* (Temminck et Schlegel)	51. *Scatophagus argus* (Linnaeus)
Ophichthyidae	**Siganidae**
13. *Pisoodonophis boro* (Hamilton-Buchanan)	52. *Siganus oramin* (Bloch et Valenciennes)
Atherinidae	53. *S. fuscescens* (Houttuyn)
14. *Atherina bleekeri* (Gunther)	**Trichiuridae**
Belonidae	54. *Trichiurus haumela* (Forskal)
15. *Tylosurus strongylurus* (Van Hasselt)	**Eleotridae**
Hemiramphidae	55. *Bostrichthys sinensis* (Lacepede)
16. *Hemirhamphus intermedius* Cantor	56. *Butis butis* (Hamilton)
17. *Hemirhamphus limbatus* (Cuvier et Valenciennes)	57. *Brionobutis koilomatodon* (Bleeker)
18.*Zenarchopterus buffoni* (Cuvier et Valenciennes)	**Gobiidae**
Mugilidae	58. *Bathygobius fuscus* (Ruppell)
19. *Osteomugil ophuyseni* (Bleeker)	59. *Glossogobius giuris* (Hamilton)
20. *O. strongylocephalus* (Richardson)	60. *Acentrogobius viridipunctatus* (Cuvier et Valenciennes)
21. *Valamugil seheli* (Forskal)	61. *A. chlorostigmatoides* (Bleeker)
22. *Liza carinatus* (Cuvier et Valenciennes)	62. *Ctenogobius brevirostris* (Gunther)
23. *L. haematocheila* (Temminck et Schlegel)	63. *C. gymnauehen* (Bleeker)
Ambassidae	64. *Synechogobius ommaturus* (Richardson)
24. *Ambassis gymnocephalus* (Lacepede)	65. *Apocryptodon malcolmi* Smith
Latidae	**Periophthalmidae**
25. *Lates calcarifer* (Bloch)	66. *Periophthalmus cantonensis* (Osbeck)
Serranidae	67. *Boleophthalmus pectinirostris* (Linnaeus)
26. *Lateolabrax japonicus* (Cuvier et Valenciennes)	68. *Scartelaos viridis* (Hamilton- Buchanan)
Sillaginidae	**Taenioididae**
27. *Sillago sihama* (Forskal)	69. *Odontamblyopus rubicundus* (Hamilton-Buchanan)
Carangidae	70. *Taenioides aguillaris* (Linnaeus)
28. *Caranx* (*Carangoides*) *praeustus* Bennett	71. *Trypauchen vagina* (Bloch et Schneider)
29. *C.* (*Atule*) *kalla* Cuvier et Valenciennes	**Synanceiidae**
30. *C.*(*A.*) *mate* Cuvier et Valenciennes	72. *Inimicus sinensis* (Valenciennes)
31. *C.* (*A.*) *malam* (Bleeker)	**Platycephalidae**
32. *Chorinemus hainanensis* Chu et Cheng	73. *Platycephalus indicus* (Linnaeus)
Sciaenidae	**Soleidae**
33. *Umbrina russelli* Cuvier et Valenciennes	74. *Solea ovata* Richardson
Leiognathidae	**Cynoglossidae**
34. *Leiognathus ruconius* (Hamilton-Buchanan)	75. *Cynoglossus puncticeps* (Richardson)
35. *L. elongatus* (Gunther)	76. *C. sinicus* Wu
36. *L. dussumieri* (Cuvier et Valenciennes)	**Triacanthidae**
37. *L. rivulatus* (Temminck et Valenciennes)	77. *Triacanthus brevirostris* Temminck et Schlegel
38. *L. brevirostris* (Cuvier et Valenciennes)	**Tetraodotidae**
39. *L. daura* (Cuvier)	78.*Gastrophysus lunaris* (Bloch et Scheider)
Gerridae	79. *Gastrophysus spadiceus* (Richardson)
40. *Pentarion longimanus* (Cantor)	80. *Fugu alboplumbeus* (Richardson)
41. *Gerreomorpha japonica* (Bleeker)	

Annex 5 List of Mangrove Associated Birds in China.

GAVIIFORMES	**(12) Turnicidae**	145. *Larus argentatus*	**(42)Oriolidae**
(1) Gaviidae	72. *Turnix sylvatica*	146. *Larus schistisagus*	209. *Oriolus chinensis*
1. *Gavia stellata*	73. *Turnix tanki*	147. *Larus ridibundus*	**(43) Sturnidae**
PODICIPEDIFORMES	74. *Turnix suscitator*	148. *Larus saundersi*	210. *Sturnus sericeus*
(2) Podicipedidae	**(13) Gruidae**	149. *Chlidonias hybrida*	211. *Sturnus nigricollis*
2. *Tachybaptus ruficollis*	75. *Grus grus*	150. *Chlidonias leucoptera*	212. *Sturnus sinensis*
3. *Podiceps cristatus*	**(14) Rallidae**	151. *Hydroprogne caspia*	213. *Acridotheres tristis*
PELECANIFORMES	76. *Rallus aquaticus*	152. *Sterna dougallii*	214. *Acridotheres cristatellus*
(3) Pelecanidae	77. *Rallus striatus*	153. *Sterna hirundo*	215. *Sturnus cineraceus*
4. *Pelecanus philippensis*	78. *Rallina eurizonoides*	154. *Thalasseus bergii*	**(44) Corvidae**
5. *Pelecanus crispns*	79. *Porzana pusilla*	**(24) Columbidae**	216. *Pica pica*
(4) Phalacrocoracidae	80. *Porzana fusca*	155. *Streptopelia orientalis*	217. *Dendrocitta formosae*
6. *Phalacrocorax pelagicus*	81. *Amaurornis akool*	156. *Streptopelia chinensis*	218. *Corvus torquatus*
7. *Phalacrocorax carbo*	82. *Amaurornis phoenicurus*	157. *Oenopopelia tranquebarica*	219. *Corvus macrorhynchos*
CICONIIFORMES	83. *Porzana paykullii*	158. *Treron bicincta*	**(45)Muscicapidae**
(5) Ardeidae	84. *Porzana bicolor*	**PSITTACIFORMES**	220. *Luscinia calliope*
8. *Ardea cinerea*	85. *Gallicrex cinerea*	**(25) Psittacidae**	221. *Luscinia svecica*
9. *Ardea purpurea*	86. *Gallinula chloropus*	159. *Psittacula krameri*	222. *Luscinia cyane*
10. *Butorides striatus*	87. *Porphyrio porphyrio*	**CUCULIFORMES**	223. *Copsychus saularis*
11. *Ardeola bacchus*	88. *Fulica atra*	**(26) Cuculidae**	224. *Tarsiger cyanurus*
12. *Bubulcus ibis*	**CHARADRIIFORMES**	160. *Clamator coromandus*	225. *Phoenicurus auroreus*
13. *Egretta alba*	**(15) Jacanidae**	161. *Cuculus sparverioides*	226. *Saxicola torquata*
14. *Egretta garzetta*	89. *Metopidius indicus*	162. *Cuculus micropterus*	227. *Saxicola ferrea*
15. *Egretta eulophotes*	90. *Hydrophasianus chirurgus*	163. *Cuculus merulinus*	228. *Monticloa cinclorhynchus*
16. *Egretta sacra*	**(16) Rostratulidae**	164. *Cuculus poliocephalus*	229. *Monticola solitarius*
17. *Egretta intermedia*	91. *Rostratula benghalensis*	165. *Cuculus saturatus*	230. *Myiophoneus caeruleus*
18. *Nycticorax nycticorax*	**(17) Haematopodidae**	166. *Eudynamys scolopacea*	231. *Zoothera citrina*
19. *Gorsachius goisagi*	92. *Haematopus ostralegus*	167. *Centropus sinensis*	232. *Zoothera sibirica*
20. *Gorsachius melanolophus*	**(18) Charadriidae**	168. *Centropus toulou*	233. *Zoothera dauma*
21. *Ixobrychus sinensis*	93. *Vanellus vanellus*	**STRIGIFORMES**	234. *Turdus cardis*
22. *Ixobrychus eurhythmus*	94. *Vanellus cinereus*	**(27) Strigidae**	235. *Turdus merula*
23. *Ixobrychus cinnamomeus*	95. *Vanellus duvaucelii*	169. *Otus scops*	236. *Turdus hortulorum*
24. *Ixobrychus flavicollis*	96. *Pluvialis squatarola*	170. *Otus bakkamoena*	237. *Turdus pallidus*
25. *Botaurus stellaris*	97. *Pluvialis fulva*	171. *Ninox scutulata*	238. *Turdus naumanni*
(6) Ciconiidae	98. *Pluvialis dominica*	**CAPRIMULGIFORMES**	239. *Pomatorhinus ruficollis*
26. *Ciconia nigra*	99. *Charadrius hiaticula*	**(28) Caprimulgidae**	240. *Garrulax perspicillatus*
27. *Ciconia boyciana*	100. *Charadrius placidus*	172. *Caprimulgus indicus*	241. *Garrulax chinensis*
(7) Threskiornithidae	101. *Charadrius dubius*	173. *Caprimulgus affinis*	242. *Garrulax canorus*
28. *Threskiornis aethiopicus*	102. *C.alexandrinus*	**APODIFORMES**	243. *Cettia diphone*
29. *Platalea leucorodia*	103. *Charadrius mongolus*	**(29) Apodidae**	244. *Cettia robustipes*
30. *Platalea minor*	104. *Charadrius leschenaultii*	174. *Apus pacificus*	245. *Acrocephalus arundinaceus*
ANSERIFORMES	105. *Charadrius asiaticus*	175. *Apus affinis*	246. *Acrocephalus bistrigiceps*
(8) Anatidae	106. *Charadrius veredus*	**CORACIIFORMES**	247. *Acrocephalus agricola*
31. *Anser cygnoides*	**(19) Scolopacidae**	**(30) Alcedinidae**	248. *Acrocephalus aedon*
32. *Anser fabalis*	107. *Numenius phaeopus*	176. *Ceryle rudis*	249. *Phylloscopus fuscatus*
33. *Anser anser*	108. *Numenius arquata*	177. *Ceryle lugubris*	250. *Phylloscopus proregulus*
34. *Anser erythropus*	109. *Numenius madagascariensis*	178. *Alcedo atthis*	251. *Phylloscopus borealis*
35. *Dendrocygna javanica*	110. *Numenius minutus*	179. *Halcyon smyrnensis*	252. *Phylloscopus inornatus*
36. *Tadorna ferruginea*	111. *Limosa limosa*	180. *Halcyon pileata*	253. *Phylloscopus trochiloides*
37. *Tadorna tadorna*	112. *Limosa lapponica*	**(31) Meropidae**	254. *Cisticola juncidis*
38. *Anas acuta*	113. *Tringa erythropus*	181. *Merops leschenaulti*	255. *Orthotomus sutorius*
39. *Anas crecca*	114. *Tringa totanus*	182. *Merops philippinus*	256. *Prinia subflava*
40. *Anas formosa*	115. *Tringa stagnatilis*	**(32) Coraciidae**	257. *Prinia flaviventris*
41. *Anas falcata*	116. *Tringa nebularia*	183. *Eurystomus orientalis*	258. *Ficedula narcissina*
42. *Anas platyrhynchos*	117. *Tringa glareola*	**(33) Upupidae**	259. *Ficedula mugimaki*
43. *Anas poecilorhyncha*	118. *Tringa ochropus*	184. *Upupa epops*	260. *Ficedula parva*
44. *Anas strepera*	119. *Tringa hypoleucos*	**PICIFORMES**	261. *Ficedula strophiata*
45. *Anas penelope*	120. *Xenus cinereus*	**(34)Picidae**	262. *Ficedula cyanomelana*
46. *Anas querquedula*	121. *Arenaria interpres*	185. *Jynx torquilla*	263. *Muscicapa sibirica*
47. *Anas clypeata*	122. *Heteroscelus brevipes*	**PASSERIFORMES**	264. *Muscicapa ferruginea*
48. *Aythya ferina*	123. *Limnodromus semipalmatus*	**(35)Pittidae**	265. *Muscicapa muttui*
49. *Aythya baeri*	124. *Calidris acuminata*	186. *Pitta nympha*	266. *Muscicapa latirostris*
50. *Aythya fuligula*	125. *Philomachus pugnax*	**(36)Hirundinidae**	267. *Muscicapa thalassina*
51. *Nettapus coromandelianus*	126. *Tringa guttifer*	187. *Hirundo daurica*	268. *Niltava hainana*
52. *Mergus squamatus*	127. *Gallinago stenura*	188. *Delichon urbica*	269. *Terpsiphone paradisi*
53. *Mergus serrator*	128. *Gallinago megala*	189. *Hirundo rustica*	270. *Terpsiphone atrocaudata*
54. *Mergus albellus*	129. *Gallinago gallinago*	**(37) Motacillidae**	**(46)Paridae**
55. *Cygnus columbianus*	130. *Scolopax rusticola*	190. *Dendronanthus indicus*	271. *Parus major*
FALCONIFORMES	131. *Calidris ruficollis*	191. *Motacilla flava*	**(47) Nectariniidae**
(9) Accipitridae	132. *Calidris subminuta*	192. *Motacilla cinerea*	272. *Nectarinia jugularis*
56. *Milvus migrans*	133. *Calidris temminckii*	193. *Motacilla alba*	273. *Aethopyga christinae*
57. *Elanus caeruleus*	134. *Calidris alpina*	194. *Anthus hodgsoni*	**(48) Zosteropidae**
58. *Accipiter soloensis*	135. *Calidris tenuirostris*	195. *Anthus novaeseelandiae*	274. *Zosterops japonica*
59. *Accipiter trivirgatus*	136. *Calidris ferruginea*	196. *Anthus cervinus*	**(49) Ploceidae**

Annex 5 *cont.* List of Mangrove Associated Birds in China.

GAVIIFORMES	**(12) Turnicidae**	145. *Larus argentatus*	**(42)Oriolidae**
60. *Accipiter nisus*	137. *Crocethia alba*	**(38)Campephagidae**	275. *Passer montanus*
61. *Accipiter virgatus*	138. *Limicola falcinellus*	197. *Coracina melaschistos*	276. *Lonchura striata*
62. *Buteo buteo*	**(20)Recurvirostridae**	198. *Pericrocotus roseus*	277. *Lonchura punctulata*
63. *Butastur indicus*	139. *Himantopus himantopus*	199. *Pericrocotus divaricatus*	**(50)Fringillidae**
64. *Pandion haliaetus*	140. *Recurvirostra avosetta*	**(39)Pycnonotidae**	278. *Carduelis sinica*
65. *Aquila heliaca*	**(21) Phalaropodidae**	200. *Pycnonotus jocosus*	279. *Eophona migratoria*
66. *Circus aeruginosus*	141. *Phalaropus lobatus*	201. *Pycnonotus sinensis*	280. *Emberiza rutila*
67. *Circus spilonotus*	**(22) Glareolidae**	202. *Pycnonotus aurigaster*	281. *Emberiza aureola*
(10) FaLconidae	142. *Glareola maldivarum*	**(40)Laniidae**	282. *Emberiza elegans*
68. *Falco peregrinus*	**LARIFORMES**	203. *Lanius cristatus*	283. *Emberiza spodocephala*
69. *Falco subbuteo*	**(23) Laridae**	204. *Lanius collurioides*	284. *Emberiza pusilla*
70. *Falco tinnunculus*	143. *Larus crassirostris*	205. *Lanius schach*	285. *Emberiza fucata*
GALLIFORMES	144. *Larus canus*	**(41)Dicruridae**	286. *Melophus lathami*
(11) Phasianidae		206. *Dicrurus macrocercus*	
71. *Coturnix coturnix*		207. *Dicrurus leucophaeus*	
GRUIFORMES		208. *Dicrurus hottentottus*	

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Global Environment Facility

NATIONAL REPORT

on

Mangroves in South China Sea

INDONESIA

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Table of Contents

List of Tables, Figures and Annexes

1. INTRODUCTION

In Indonesia, 13 provinces has been identified bordering directly with the SCS viz. Riau, Jambi, South Sumatra, Bangka Belitung, Lampung, Banten, DKI Jakarta, West Java, Central Java, East Java, West Kalimantan, Central Kalimantan, and South Kalimantan. Data collected from all 13 provinces consists of secondary and primary data. The secondary data will includes distribution areas of mangroves, geographical information (position, topography, total area of region and mangrove forest, and land-uses), biological information (flora, fauna, and aquatic biota), utilization, and socio-economic and socio-cultural aspects. Based on the evaluation of secondary data, primary data will be collected from selected provinces at the priority sites, e.g., West Kalimantan, DKI Jakarta and Bengkalis. Primary data will consist of biological, physical and socio-cultural information's, and utilization.

Sources of secondary data will be collected from Faculty of Forestry, Faculty of Fisheries of the Bogor Agricultural University (BAU) Bogor, the Centre for Marine and Coastal Resources Studies, BAU Bogor, LPPM Bogor, Birdlife International, Wetland International-Indonesia program, LIPI, Department of Forestry, Department of Home Affairs, Department of Marine and Fisheries and State Ministry of Environment.

2. MANGROVE ECOSYSTEM IN 13 PROVINCES SURROUNDING THE SOUTH CHINA SEA

2.1 Extend of Mangrove Forest

Data on total area of mangrove forest in Indonesia are very varies from 3,177,700 ha (Bina Program Kehutanan 1973), 3,707,100ha (UNESCO 1979), 4,251,011 ha (Bina program Kehutanan 1982) to 4,355,553ha (Intag Departemen Kehutanan 1993). This is due to the facts that estimated value of mangrove forest are differentiated from one to another along with their different definition of the border zone they used.In 1989 to 1996, the Department of Forestry (1999) by using Landsat Imagery estimated that the total area of mangroves in Indonesia amounted to be 3,533,660 ha, consisting of protected forests (424,800ha), Nature Reserve and Recreation Forest (674,600ha), Natural Forest Production (583,600ha), Production Forest (372,400ha), Production Forest for Conversion (928,900ha) and Other Forest Land-use (449,300ha).

Inventory of degraded mangrove forest conducted by the Department of Forestry (1999) shows that the mangrove forests in Indonesia covers an area of about 9,248,039 ha, consisting of state forest land (3,720,187ha) and non-state forest land (5,527,852ha). From the above figure, about 5,579,116.53ha (60.32% of the total mangrove forest in Indonesia, and 1,877,605.51ha and 3,701,511.02ha belong to state and non-state forest areas, respectively) is found in the provinces at surrounding the South China Sea (SCS).

2.2 Mangrove Forests for Forestry Exploitation

The area of mangrove forest managed by Indonesian forest concessions (HPH, and HPHTI) at the surrounding SCS in 1982 amounted to be 226,000ha, and in 2000 it will be 172,143ha and managed by 9 companies. The mangrove forests managed by HPH used to be exploited for their wood as a raw material for chip industry. In some locations of West Kalimantan, the holders of HPH concession having less performance and their permission are terminated by the recent government policy (No log export regulation).

2.3 Mangrove Forest to be rehabilitated

Rehabilitation activity for mangrove forests commencing since the early of 1960 in Java and conducted by Perum Perhuani (The State Forestry Corporation). In connection with conserving of the mangrove forest and referring to needs of the people for agricultural lands, Perum Perhutani has developed a tambak tumpang sari system or tambak empang parit, call as silvo-fisheries. It was reported that about 20,000ha of degraded mangrove forests in the northern coast of Java have been rehabilitated successfully with *Rhizophora* spp. and *Avicennia* spp. For Segara Anakan, 105ha of degraded mangrove forests have been rehabilitated too, with *Rhizophora* sp. and *Bruguiera gymnorrhiza*. DitJen RLPS of the Department of Forestry have been rehabilitating the degraded mangrove forests in 12 provinces with a total area of 15,830ha.

Table 1 shows Extent, Distribution and Number of Changed Mangrove Forest Area in the South China Sea (at 13 provinces in Indonesia) during 1982–1999. Also, Figure 1 illustrates the Map of Mangrove Distribution in Indonesia.

Table 1 Extent, Distribution and Number of Changed Mangrove Forest Area in the South China Sea (at 13 provinces in Indonesia) in 1982–1999.

No.	PROVINCE	EXTENT (Ha)							MUMBER OF CHANGED 1982 – 1999 (%)		
		STATE FOREST (SF)						NON STATE FOREST (NSF)			
		BIPRAN (1982)	PHPA-AWB (1987)	INTAG (1993)	RePPPRoT 1985-1989	GIESEN (1993)	RLPS (1999)	RLPS (1999)	(3) – (5)	(5) – (8)	(3) – (8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1.	Riau	276,000	470,000	221,050	239,900	184,400	551,747.79	603,373.68	-19.91	+149.6	+99.91
2.	Jambi	65,000	50,000	13,450	18,00	4,050	36,703.50	226,645.51	-79.31	+172.9	-43.53
3.	South Sumatera	195,000*	110,000*	363,430*	240,700*	231,025*	458,562.29	429,811.55	+86.37	+61.8	+201.48
4.	Bangka Belitung	0	0	0	0	0	129,317.42	29,205.23	tak hingga	tak hingga	Tak hingga
5.	Lampung	17,000	3,000	49,440	31,800	11,000	10,762.07	7,607.91	+190.82	-78.2	-36.69
6.	West Java & DKI Jakarta	28,608**	5,700**	8,200**	8,200**	55,000**	32,314.40	66,844.41	-71.34	+308.0	+16.94
7.	Banten	0	0	0	0	0	1,139.31	27,999.14	tak hingga	tak hingga	Tak hingga
8.	Central Java	13,576	1,000	18,700	18,700	13,570	18,931.67	76,406.35	+37.74	+1.2	+39.45
9.	East Java	7,750	500	6,900	6,900	500	42.22	97,669.98	-10.97	-99.4	-99.46
10.	West Kalimantan	40,000	60,000	194,300	205,400	40,000	86,918.03	252,907.00	+385.75	-55.3	+117.30
11.	Central Kalimantan	10,000	20,000	48,740	28,700	20,000	474,999.90	1,750,586.90	+387.40	+874.6	+4650.00
12.	South Kalimantan	66,650	90,000	120,780	112,300	66,650	76,166.91	132,453.36	+81.22	-36.9	+14.28
Total		719,584	810,200	1,044,990	892,618	626,195	1,877,605.51	3,701,511.02			

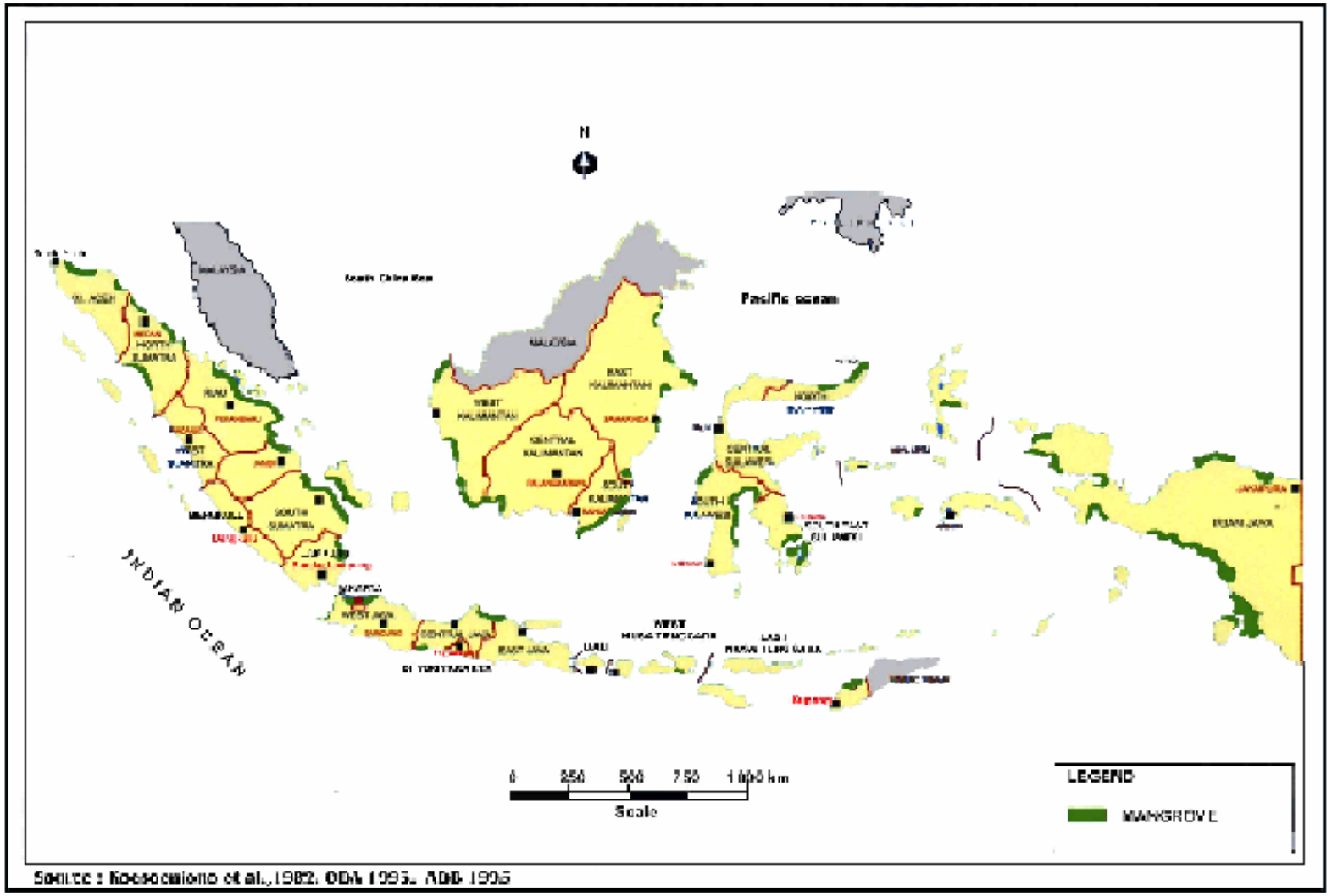

Figure 1 Map of Mangrove Distribution in Indonesia.

3. MANGROVE ECOSYSTEM CONDITION SURROUNDING THE SCS

3.1 Characteristics

3.1.1 Mangrove Zonation

In Indonesia the mangrove forests can be divided into two geographical zone, viz. Asia zone and Oceania zone. Both zones have highest plant, animal and micro-organism diversity than the other zones in the world. This is primarily due to the nature of the region that the islands have different characters with each other, even site by site in the same island. The harmonized system between mangrove forest resource and their specific substrate produce the life characters of heir species.

According to their substrates, mangrove species grow characteristically as zone by zone. And can be identified as follows: in the seaward edge as *Sonneratia* and *Avicennia* zone and followed by *Rhizophora, Bruguiera, Ceriops* and *Nypa* association zones at the inland-ward edge. All zones will be inundated by tides and at sea edge zone will receive strong wind and wave energies, and different salinity regimes than the other zones. At the areas in the sea edge zone with high salinity and soft mud substrate, *Sonneratia* spp. plays as pioneer species followed by *Avicennia* spp. as the substrate more compact. As the distance from the sea edge increased and the soil will be more compacted in the land ward areas, transition zone will be formed and the species of terrestrial forest occurs as a marginal species. The species configuration and changes at the sites examined are the response to the environmental gradients and usually call as succession. Species zonation in the mangrove forests therefore, is determined by change and period of inundation, soil salinity, sun shine intensity, tides and freshwater flows. It means that different location will have different zonation. For instance in Rambut island, 3 zones from sea edge to inland are identified as: *Rhizophora mucronata, R. stylosa*, and *Scyphyphora hydrophyllacea*, and *Lumnitzera racemosa*.

In Riau province, the mangrove forests usually zoned by *R. apiculata* and *R. mucronata* at the sea edge zone, and than mixed of *R. apiculata* and *Sonneratia alba* at the sand sediment substrates, and with *Avicennia marina* and *A. officinalis* at the muddy sediment.

At the upper rivers, *Nypa fruticans* will be abundance and sometimes associated with single of *S. caseolaris* trees. In the inland part of the zone, *Bruguiera cylindrica* and *Xylocarpus granatum* are found and will be followed by *B. gymnoorhiza, B. parviflora, X. moluccensis, Ceriops tagal, Heritiera littoralis, Lumnitzera littorea* and *Excoecaria agallocha* as the common species in the inland zone running to terrestrial zone, as the species of palm, *Oncosperma tigillaria* occurs if the area become freshwater swampy.

In Lampung province, the mangrove forests in the accretion area mostly dominated by both *Avicennia alba* and *A. marina*, and at the estuaries area will be by *E. agallocha*. Than at upper river by *Nypa fruticans, S. caseolaris*, and *X. granatum* as freshwater effect will more prominent. At the sandy habitat of the mangroves associated with coral reef, *R. stylosa* dominates. This is a common feature in the islands of Lampung Bay and along their coastline.

3.1.2 Habitats

As the transition zone between sea and terrestrial land, the mangrove ecosystems have shape environmental gradient. Tidal currents in the sites is one factor controlling the changes of water salinity and temperature, and as a result only the specific plant species and their animals who have tolerant to that regime will exist and growth and develop in the mangrove forest. Consequently, the biota's of mangrove have low diversity but have high in number of individual.

Although the mangrove habitat is specific, every marine biota will have an environmental range for their occurrences and niche. This will caused the form of mangrove community at different sites along with their species composition. Factors that are play essentially as ecological preference will consist of: (1). Soil type: hard or soft, sand and clay contents in different ratio, (2). Salinity: daily variation and average annual value roughly equal to the frequency, depth and period of flooding, (3). Ability of species cope with current and wave, and (4). Combination of germination and growth of seedling in related to ecological amplitudes of species in responding the above three factors.

In the following zones, *Bruguiera cylindrical* present mixed with *B. parviflora, Rhizophora apiculata* and *R. mucronata* and finally in landward side with *Xylocarpus granatum* (the canopy will reach up to 35-40m tall).

At the deep mud with soft characters, *Rhizophora* species distributed locally and *R. mucronata* is the typical species at the soft mud substrate and *R. stylosa* at the sandy and coral single substrate while

R. apiculata is the species at the transition between both substrates. Mangrove forests at the landward side, far from sea edge, usually form as pure stands.

There are close relationship with the tide factor, especially in the estuarine and lagoon areas. At the inland part of both estuarine and lagoon areas, *Rhizophora* will be replaced by *Lumnitzera*, a species of more less salty.

The effect of current velocity can be learned daily along the river, and at the side of river during the strong current, e.g., in the tributary, usually mangrove found typically mixed with a palm species, *Nypa fruticans*.

3.1.3 Physical Charatristics

a. Soil. In Indonesia, soil types in the mangrove forest can be classified into several land systems as follows:

a.1-PRT Land System (Rotan island). The land system have a landform of coral islands and reefs with slope < 2% and relief of < 2m. The soils type is tropopsaments with their parent materials from young marine sediments, sand and gravel. Tropopsament soils at this land system have a sandy clay texture with consistency of clay at each layer. Drainage of the soil in this land system generally slightly buds with brown in color of chroma 4, pH in H_2O ranges from 6.0-7.0 and no pyrite at the <100cm depth can be found (Dephutbun and PT, 1998).

a.2-KHY Land System (Kahayan). The land system have a landform of lower river dikes and alluvial slope of combination between estuarine and terrestrial areas. KHY system have a slope < 2% and relief of 2-10m. The soil type is tropohemist with their parent material from peat of medium ripening (Dephutbun and PT, 1998). In the area free of mangrove forests, tropohemist soils have silty clay up to clay in texture with high consistency, bud drainage and blackly in color at the chroma 2 and pH of 7-8. Pyrite potential in the amount of 0.19% and 0.85% can be found at a depth of 70-100cm and 100-120cm, respectively. And the decreasing of pH (in H_2O) up to 3 degree (with the oxidation of H_2O_2) is the form of their identity. The content of pyrite at the different depth layer was 0.23%, 0.75% and 0.41%, respectively (Dephutbun and PT, 1998).

a.3-PTG Land System. The soil type in this land system belong to tropoquents, with clay texture and have moderate consistency, bud drainage and grey in color, pH (in H_2O) ranges from 5.0-8.0. Pyrite potential can be found in a depth of 30-50cm and 50-90cm, which indicated by their decreasing of pH (in H_2O) up to 3-4 degree with the oxidation by H_2O_2. The content of pyrite at the different depth layer was 1.395 and 1.90%, respectively (Dephutbun and PT, 1998).

a.4-KJP Land System. The soil type in this land system belongs to hydraquents, and found in the less density of mangrove stands. At that condition, the texture of the soil will be sandy clay up to clay with moderate consistency, bud drainage, grey in color, pH 9 in H_2O) ranges from 6.0-7.0 and no pyrite can be found at a depth of less than 100 cm (Dephutbun and PT, 1998). Hydraquent soils which found in the dense mangrove forests have a sandy clay up to silty clay in texture with high consistency, very bud drainage, grey in color, pH (in H_2O) range from 6.0-6.5 and no pyrite can be found less than 100cm.

a.5-MKS Land System. The soil type in this land system belongs to fluvaquents with their parent materials from young marine alluvium sediments. The soil type have a silty clay in texture and moderate to high consistency, bud drainage, grey in color, pH (in H_2O) ranges from 7.0-8.0. Pyrite potential can be found at a depth of 30-50cm, 50-70cm and 70-100cm with 0.03%, 0.06% and 0.05%, respectively (Dephutbun and PT, 1998).

a.6-UPG Land System. The soil type in this land system belongs to dystropepts with their parent materials from young marine alluvium sediment and coastal sand. The soil type have a silty clay and clay in texture, and moderate to high in consistency, bud drainage, grey-brown in color, pH (in H_2O) ranges from 5.5-6.0 and no pyrite can be found at a depth of less than 100cm (Dephutbun and PT, 1998).

b. Water. The water quality of mangrove forests at the SCS region very varies, event up to their limiting layer for some parameter, e.g., in the Jakarta Bay DKI. The water quality at Muara Angke mangroves have been polluted by industrial waste and domestic waste. At the bottom sediment of tambak and their water canal, oil and heavy metals pollutant have been found, e.g. 6.176-10.882 ppm/g for Cu, 6.666-8.000ppm/g for Pb and 0.4000-0.450ppm/g for Hg.

Generally, the water quality in the Riau waters in October 2000 shown highest than the standard for marine biota both for mariculture and marine park, e.g., for Cu, Cd and Pb are less than the value of quality standard, but the degree Hg (minimum: <1 mg/l) and Cr (minimum: <0.001mg/l) are higher than the quality standard. In the Riau islands, generally the waters are in good condition, especially for Batan island groups, Rempang and Batam islands, Senayang, Lingga and Singkep island groups, and surrounding Bintan Island. Temperature, salinity, pH and DO values indicated of their normal condition for tropical waters, even thus for upper and lower layers at different sites. At the western side of Riau islands, e.g., in the south and west parts of Karimun Island and Kundur Island, the waters condition are more turbid.

Based on the standard criteria of water quality for fishery culture (SK. Menteri Negara KLH No. 02/MENKLH, 19Januari 1988), the water parameter in West Kalimantan waters such as temperature, turbidity, salinity, DLH, DO, CO_2 are in good condition to support the marine biota normally. But pH, DMA, COD and BOD are poorly in quality for that marine biota.

c. Hidro-Oceanography. In the SCS region, there are some rivers which affected the growth of mangrove, viz. Siak, Siak Kecil, Mandau rivers in the Riau province, Berbak and Batanghari rivers in the Jambi province, Mesuji, Lala, Banyuasin and Musi rivers in the South Sumatra province, Mesuji, Way Seputih, Way Sekampung and Tulang Bawang rivers in the Lampung province, Cisadane, Cidurian, Cibanten, Cidanau and Cipasuruan in the Banten province,Citarum and Cimanuk rivers in the West Java province, Brantas, Konto and Kali Madiun rivers in the East Java province, Kapuas river in West Kalimatan province, Mentaya, Katingan, Sebangau, Kahayan, Kapuas and Barito rivers in South Kalimantan province. It is therefore, the influence of tides for mangrove species distribution in Indonesia need to be studies in detail.

3.1.4 Environmental Classes of Mangrove Forest

Based on the environmental setting, the type of mangrove forests can be grouped into 4, viz. (a). Delta type: Formed in the estuaries of big river, and their sediment load in the river flow are deposited vastly formed as delta and generally their morphology are as tributary. Such a delta system can be found in Sumatra (e.g., Musi river delta, Tembilahan delta, Siak river delta). (b). Mudflat. Mudflats are found in the sea shores, generally typified by vast river flow, high tidal current and distributed sediments which become terrestrial lands. Widest sedimentation along with the tidal current and river erosion will threat the mangrove forests. (c). Terrestrial islands. The small island and their substrates consist of terrestrial sediment and marine carbonate sediment, and usually occupied by water during high tides. At low tides, the island represent of unique habitat for mangroves, e.g., Seribu islands. (g). Terrestrial shores. The habitat formed as a narrow strip in the shores, and mostly consists of sand, coral single and sandy mud. Here, the mangrove growth as a fringing mangrove community, e.g., in east shore of Lampung and South Sumatra and northern coast of West Java.

3.2 Biodiversity

3.2.1 Flora

70 species of mangrove plants are identified in the world, and 40 species of which are found in SE. Asia, 15 species in Africa and 10 species in America. It was reported that 15 families along with 18 genera and 41 species, and 116 associated species are to be found in the mangrove ecosystem in Indonesia. At present, many reports claim that at least 101 species of mangrove plants can be identified and belonging to several families and life-forms such as, trees (47 species), scrubs (5 species), herbs and grasses (9 species), liana (9 species), epiphytes (29 species) and parasites (2 species). While at the 13 provinces of the SCS region, there will be 36 species of true mangroves, 11 species of associated and 38 species of marginal plants.

Based on the dominant tree species, the mangrove communities found in the SCS region can be formed as stand associations. Five associations can be identified as *Avicennia, Rhizophora, Sonneratia, Bruguiera* and *Nypa consocies*. Generally, the *Bruguiera – Rhizophora* associations are commonly found in Indonesia. From biodiversity point of view, at the transition zone between mangroves and fresh water swamps, there will be more species to be found.

3.2.2 Fauna

In the 13 provinces of the SCS region, there will be 48 species of mammals, 27 species of reptiles, and 333 species of birds. Marine fauna reported to be 522 species of fish, 116 species of crustaceans, 275 species of gastropods, and 162 species of bivalves.

3.3 Socio-economic of Societies

The total area of 13 provinces to be 1,011,148km^2 (or 53.48% of the total area of Indonesia) and only 48 districts can be included with a total area of 312,703.25km^2 (or 16.54% of the total area of Indonesia). The population of 13 provinces was 152,244,395 peoples (or 73.81% of the Indonesian population), and for the 48 district amounted to be 88,475,396 peoples (or 42.89% of the Indonesian population). The number of district closed to the SCS region amounted only 16.54% with a total population of 42.89%. This means that most population living in the coastal zone, and represent as threats for the mangrove forests.

3.4 Utilization of Mangrove Forests

a. Charcoal

In both provinces of Riau and West Kalimantan, mangrove charcoal produced based on the HPHH permission. This traditional production called as panglong system with Chinese technology, popularized of about hundreds years ago. The mangrove plants used as the best species for charcoal materials were *Rhizophoraceae* (*Rhizophora apiculata, R. mucronata* and *Bruguiera gymnorrhiza*). The production of mangrove charcoal in 1998 was 330,000 tonnes, and mostly exported to Japan and Taiwan through Malaysia and Singapore. The FOB export price of charcoal was US$1,000.00/10 tonnes, and at the local markets will be varies from Rp350 to Rp950/kg (Batu ampar, West Kalimantan). The total amount of exported charcoal in 1993 was 83,000,000kg worth at about US$13,000,000 (Rp105,214,000).

b. Firewood

The mangrove species having a good quality for firewood and produced high heating and permanent, except for *Avicennia* spp. and *Sonneratia* spp. the market price of firewood in the villages in East Java reach up to Rp 13,000/m^3. Every cubic meter of firewood of mangrove plants can be used for cooking for one month/family (with 3 children's). One peace of firewood pole with 8cm diameter and 50cm length are enough for cooking rice for 5 persons of one family.

c. Construction materials.

The mangrove species suitable for construction materials are *Rhizophora apiculata, R. mucronata* and *Bruguiera gymnorrhiza*, usually for kaso, pole, and wood plane. The price for kaso with 4-5cm diameter and 3-4m length is Rp Rp 1,500/pole.

d. Chip

Generally, the mangrove forest allocated for producing chip will be managed under the HPH concession. Silviculture system adopted for exploiting the mangrove forests for chip was KS. DirJen Kehutanan No. 60/Kpts/DJ/I/1978: selecting cutting system, 30 years rotation, tree cutting with diameter >10cm, and 40 trees/ha for mother trees (diameter >20cm), planting system in the abandoned logging areas, green belt protection along the riverbank/coastlines.

In 1998, the total amount of chip production in Indonesia was 250,000 tonnes, and mostly exported to Japan and Korea. The production area of chip distributed in the provinces of Riau, West Kalimantan, East Kalimantan and Irian Jaya. The price of chip in international markets was US$40/tonnes. The mangrove chips are very comparable to the other chip (*Acassia mangium*) in the level of price and quality including the transportation fee (using water transportation facility). For producing chip sustain, the sizeable of mangrove forests with their good potential of wood are needed.

e. Tannin

Tanning can be produced from the bark of the mangrove species, such as *Rhizophora Apiculata, R. mucronata* and *Xylocarpus granatum.* The liquid concentration of extract called as catch are exported in the high amount and used for coloring the skin products (bags, shoes etc.). This material are no longer exported and replaced by chemical synthetic products. In the fishermen community in Indonesia, mangrove tannin is still useful for coloring the fishing nets.

f. Nipa

Nipa palm (*Nypa fruticans*) are one of mangrove plants commonly used by local peoples for traditional materials such as leaf for thatching materials (5 years life), cigarette wrappers, and the young fruits are for foods (es, manisan, table fruit, wajid), and their nira are source for sugar production. The atap (shingle) of nipa in Riau markets are Rp200/peace, and the sugar in Cilacap reach up to Rp2,000/kg (in November 1999).

g. Medicinal plants

The mangrove plants are source of medicinal materials at the traditional level. The decoction of *R. apiculata* is used as astringent, and bark of *R. mucronata* are useful for blood purification. The decoction of *Ceriops tagal* is useful as antiseptic treatments, and *Acanthus ilicifolius* for diabetes, and *Xylocarpus granatum* fruits mixed with rice powder are for skin repellence and against skin diseases.

h. Fishery

One of the important utilization of mangrove ecosystem in term of fishery is their habitat for supporting the life of marine biota through producing biomass (litterfall: leaf, branch and twig). The decomposition of their litter by microorganisms will finally produced detritus suitable for many planktonic organisms, and will be a source of food for fishes, crabs and shrimp.

Roots systems of the mangrove forest represent a shelter for protecting the marine biota. Those conditions determine the mangrove forests as a habitat for catching shrimp, fish and crab.

Milkfish culture in the brackish water has been practiced in Indonesia for more than 300 years. President Decree No.39/1980 issued by the government is concern with the bund of pukat harimau. Since the time of that effective, tambak develop vastly in the coastal zone along with their high international demand and increasing price in the market. In 1975, the total area of tambak in Indonesia was 180,000ha with their production amounted to be 9,600 tonnes, and in 1991 increased to 290,000ha with production of 140,000 tonnes. The tambak distributed in Java (45%), Sulawesi (35%), Sumatra (17%) and the rest are found in scattered areas in Kalimantan, Maluku and Irian Jaya.

The productivity of tambak with extensive technology will be up to 3-5 year, and with traditional technology or extensive can be up to 300 years. The extensive tambak consists of silvofisheries (leads by Perum Perhutani) and tambak traditional. Tambak traditional have been managed by people with mangrove tree cultured at the dikes, e.g., in Curah Sawo Probolinggo.

There are some of tambak development friendly environment developed in Indonesia, namely: **(a). Empang Parit.** This model used by government for rehabilitation program. This is moderate system of silvofishery or wanamina with their tidal creeks surrounding the *Rhizophora* stands. At the 8-10 year old, the thinning production can be harvested as a pole, and the final product will be at 20-30 year as wood product. The additional product can be found such as shrimp, fish and crabs from the keramba culture. The area development of mangrove hopefully will be produced shrimp as feeding grounds. At the design of this model, water canals will be narrow and consequently the tannin content will be increased and the water volume will be lower for fish and the water will shade by the canopy. The model recommended as much as 10ha in size per unit with 2ha of tambak in centre and surrounded by 8ha of *Rhizophora* plantation. **(b). Silvofishery**. The model will be used for industrial fishery with small scale productivity for supporting the mangrove conservation. The goal of the model was to produce fish, shrimp and to protect the mangrove plantation as vegetation, and no cutting will be allowed. The ration between tambak and mangrove land will be 20%: 80% up to 50%: 50%. Along the line of 5-10m wide in the riverbank and/or creeks and in the coastline will be protected as silvofishery areas. Due to their wide is more than empang parit system, the water supply will much better for the growth of mangrove plants and so the negative impact of tannin content will be reduced. The model has been implemented in Subang district by the Perum Perhutani (The State Forestry Corporation). **(c). Wanamina wood model.** The model has attractive capacity as the above model, and practiced for producing wood for firewood, and managed as the surrounding area for tambak. The smaller unit of land for the model will be 25ha, and zone with 5-10m wide along the coastline, river bank and small river will left as protection area. The 0.5ha tambak for fish will separated 100m away from the mangrove stands. The ration of tambak and mangrove land will 20-80% and the minimum unit for tambak will be 5ha and 20ha for mangrove plants. The mangrove plantation will managed for wood at the 20 year rotation. **(d). Integrated mangrove culture.** The model implemented for supporting the daily life of people with the diversity product of fish along with their agricultural crops. At the model, mangrove plays an important role as protected agent, firewood source, foliages for animals and shading plant for crops. **(e). Tambak extensive model with mangrove plants.** The management of tambak extensive has been practiced since a memorial, and technically as a mangrove-friendly aquaculture. The owner of tambak will planting the mangrove along their dikes, And usually they used *Rhiozophora* spp. and *Avicennia* spp. with 5-10m distance. The mangrove with high canopy and dense of stands will reduced the sun shine for tambak and finally will affect the growth of shrimps. Based on those facts, the recommended will be cutting and replanting rotation of 20 year period.

i. Agriculture.

The fruits of Nipa (*N. fruticans*) and pedada (*S. caseolaris*) are source of edible mangrove plants, and very often consumed by people for traditional cake. The fruits of tumu (*B. gymnorrhiza*), api-api (*Avicennia* spp.) and bakau (*Rhizophora* spp.) can be eaten too, but must be processed and cooking for safely food. The foods recipes of mangrove plants are available at the LPP Mangrove Bogor (26 recipes), and need for further socialization. Honey beetle are common in mangrove forests, and Pidada flowers (*Sonneratia caseolaris*) are the plants suitable for producing honey. This is another minor product from mangrove forests and potentially need to be improved. The mangrove forests play an important role for wind breaking, protection from erosion and abrasion, and finally very important barrier for protecting the agricultural land and their settlements. It is therefore, the conversion of mangrove forest into another land use types such as coconut and oil palm plantations, sawah (rice field) will adversely affected the coastal zone itself due to salinity and sulfates contexts.

3.5 Problems

Mangroves growth and developed under the optimal condition of inundation and continued water circulation in the upper layer. The fixed circulation of the tides will increase the input of nutrient and oxygen for the respiration and production activity of plants. The waters with low salinity will reduce salt and alkaline materials. It is remembered that salty waters can neutralized the soil acidity. Generally, mangrove ecosystem has a resistance to the kinds of threats and environmental stress. Unfortunately, the mangroves are vulnerable to the sedimentation and sediments character, and finally can alter the oxygen content for respiration, and can cause the mangrove mortality. The change of thus factors controlled to the salinity pattern in the substrate can cause the species composition, and salinity over than 90ppt can damaging the mortality of biota in number of amount. The salinity change can be happen due to the change of hydrological cycle, fresh water flow and leaching by the damp, and others activity of water treatment. The main problems of digging or stress to the mangrove ecosystem originally come from the human needs for conversing the mangrove forest into the other areal for housing, commercial purposes (industrial area, harbors, tambaks) and agricultural lands. On the otherhand, the increasing demands for wood products cause the over exploitation of mangrove forests.

Since 1992, Spatial Land-use Planning for provincial and district levels implemented for appropriate mangrove management status at the some sites. Based on the Spatial Land Use, the mangrove forests included in both the Protected Area and Culture Area (Forestry culture, Fishery and Agricultural cultures). At the some sites, the mangrove forest areas included in the protected areas, so that the position will be debating controversially against the previous policy.

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Annex 1 List Species of Mangrove of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Family	Province													Remarks
				1	2	3	4	5	6	7	8	9	10	11	12	13	
1	Jeruju putih	*Acanthus ebracteatus*	Acanthaceae			+											
2	Jeruju hitam	*Acanthus ilicifolius*	Acanthaceae	+		+	+								+	+	
3	Piai raya	*Acrostichum aureum*	Pteridaceae	+		+	+							+	+	+	
4	Piai lasa	*Acrostichum speciosum*	Pteridaceae				+										
5	Teruntun	*Aegiceras corniculatum*	Myrsinaceae	+	+	+	+							+			
6	Teruntun	*Aegiceras marina*	Myrsinaceae													+	
7	Api-api	*Avicennia aecalyptifolia*	*Avicenni*aceae							+	+						
8	Api-api	*Avicennia alba*	*Avicenni*aceae		+	+	+		+	+		+	+	+			
9	Api-api	*Avicennia lanata*	*Avicenni*aceae											+			
10	Api-api	*Avicennia marina*	*Avicenni*aceae	+	+	+	+	+	+	+	+		+	+	+		
11	Api-api daun lebar	*Avicennia officinalis*	*Avicenni*aceae			+			+	+	+	+	+	+			
12	Lenggadai	*Bruguiera cylindrica*	*Rhizophora*ceae		+	+	+		+			+	+	+		+	
13	Tancang merah	*Bruguiera gymnorrhiza*	*Rhizophora*ceae	+	+		+	+	+	+		+	+	+	+	+	
14	Langgade	*Bruguiera parviflora*	*Rhizophora*ceae		+	+						+	+	+			
15	Tancang sukun	*Bruguiera sexangula*	*Rhizophora*ceae			+				+	+	+	+	+			
16	Tengal	*Ceriops decandra*	*Rhizophora*ceae	+	+	+		+					+				
17	Wanggo	*Ceriops tagal*	*Rhizophora*ceae		+	+		+					+			+	
18	Buta-buta	*Excoecaria agallocha*	Euphorbiaceae	+	+	+	+	+	+	+	+	+	+	+	+	+	
19	Bayur laut	*Heritiera littoralis*	Sterculiaceae			+		+					+	+			
20	Teruntum	*Lumnitzera llittorea*	Combretaceae	+	+	+		+					+	+			
21	Api- api balah	*Lumnitzera racomosa*	Combretaceae			+	+						+				
22	Nipah	*Nypa fruticans*	Arecaceae	+		+	+	+	+	+	+	+	+	+	+	+	
23	Cantigi	*Pemphis acidula*	Lythraceae					+							+		
24	Bakau minyak	*Rhizophora apiculata*	*Rhizophora*ceae	+	+	+	+	+	+	+	+	+	+	+	+	+	
25	Bakau merah	*Rhizophora mucronata*	*Rhizophora*ceae	+	+	+	+	+	+	+	+	+	+	+			
26	Bakau	*Rhizophora stylosa*	*Rhizophora*ceae	+	+	+	+	+	+	+			+	+			
27	Cingam	*Scyphiphora hydrophyllacea*	Rubiaceae				+	+					+				
28	Pedada	*Sonneratia acida*	Sonneratiaceae			+											
29	Pedada	*Sonneratia alba*	Sonneratiaceae	+	+	+		+		+		+	+	+		+	
30	Pedada	*Sonneratia caseolaris*	Sonneratiaceae	+	+	+	+	+	+	+	+	+	+	+	+		
31	Pedada	*Sonneratia griffithi*	Sonneratiaceae											+			
32	Kedabu	*Sonneratia ovata*	Sonneratiaceae									+	+				
33	Nyirih	*Xylocarpus granatum*	Meliaceae	+	+			+	+	+	+	+	+	+	+		
34	Nyirih batu	*Xylocarpus maluccensis*	Meliaceae	+	+	+		+				+	+	+	+		
35	Nyirih	*Xylocarpus rumphii*	Meliaceae							+	+						

Annex 1 c*ont.* List Species of Mangrove of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Family	Province													Remarks
				1	2	3	4	5	6	7	8	9	10	11	12	13	
Associate Mangrove Species																	
1	Bogem	*Barringtonia asiatica*	Lecythidaceae										+				
2	Nyamplung	*Callophyllum inophyllum*	Guttiferae		+			+	+	+		+	+	+			
3	Biduri	*Calotropis gigantea*	Aselepiadaceae										+				
4		*Camptostemon philippensis*	Bombaceae							+		+					
5	Cemara laut	*Casuarina equisetifolia*	Casuarinaceae										+				
6	Bintan	*Cerbera manghas*	Apocynaceae		+	+			+	+	+	+	+	+			
7	Bintan	*Cerbera adollan*	Apocynaceae		+				+				+			+	
8	Dadap laut	*Clerodendrum inerme*	Verbenaceae										+				
9		*Combretocarpus fagifer*											+				
10		*Cyperus malaccensis*	Cypuaceae				+									+	
11		*Cyperus javanicus*	Cypuaceae				+										
12	Teki Laut	*Cyperus maritima*	Cypuaceae			+	+										
13		*Cyperus portulacastrum*	Cypuaceae			+											
14		*Cyperus sp*	Cypuaceae			+											
15	Ambungan	*Derris heptophylla*	Leguminosae			+	+		+	+		+					
16	Ambungan	*Derris trifoliata*	Leguminosae				+		+	+		+	+		+		
17		*Dolichondrone spathacea*	Bignoniaceae										+	+			
18		*Flacourtia rukam*											+				
19	Waru laut	*Hibiscus tiliaceus*	Malvaceae	+	+		+	+		+		+	+	+		+	
20	Batata pantai	*Ipomomea pes-capre*	Convolvulaceae										+				
21		*Oncosperma tigillarium*							+				+				
22	Pandan	*Pandanus odoratissima*	Pandanaceae										+				
23	Pandan	*Pandanus tectorius*	Pandanaceae										+				
24	Bangkong	*Pongamia pinnata*	Leguminosae										+				
25		*Saccharum spontaneum*						+	+	+		+					
26		*Sapium indicum*													+		
27		*Scyrpus grossus*		+													
28		*Sesuvium portulacastrum*	Aizoaceae										+				
29	Ketapang	*Terminalia catappa*	Combretaceae	+	+			+	+	+		+	+	+			
30	Waru lot	*Thepesia populnea*	Malvaceae										+				

Annex 1 c*ont.* List Species of Mangrove of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Family	Province													Remarks
				1	2	3	4	5	6	7	8	9	10	11	12	13	
Other Species																	
1	Akasia laut	*Acacia auriculiformis*	Leguminosae	+				+						+			
2	Saga pohon	*Adenanthera microsperma*						+						+			
3		*Andropogon nardus*						+						+			
4		*Cryptocoryne ciliata*	Araceae				+										
5		*Cynodon dactylon*	Poaceae				+										
6	Kayu hitam	*Dyospiros maritime*						+						+			
7	Kedoya	*Dysoxylum amooroides*						+						+			
8		*Eichornia crassipes*						+						+			
9	Beringin	*Ficus sp.*	Moraceae					+									
10		*Fimbristylis ferruginea*	Cyperaceae	+													
11		*Fimbristylis scathacea*	Cyperaceae			+											
12		*Fimbristylus globulosa*	Cyperaceae			+											
13		*Imperata cylindrica*						+						+			
14	Jambu-jambu	*Ixora javanica*						+						+			
15	Rumput rawa	*Laersia hexandra Swartz*		+													
16	Lebar daun	*Macaranga sp.*						+						+			
17	Mangga	*Mangifera indica*		+													
18	Gelam	*Melaleuca sp.*	Myrtaceae								+						
19	Mengkudu	*Morinda citrifolia*						+						+			
20	Pisang	*Musa sp.*		+													
21	Sengon	*Paraserianthes falcataria*	Malvaceae					+						+			
22		*Plucea indica*	Comporitae			+											
23	Kesambi	*Schleichera oleosa*						+						+			
24		*Sesuvium portulacastrum*	Portulaceae			+											
25	Kepuh	*Sterculia feotida*						+						+			
26		*Thespesia populnea*	Malvaceae			+		+						+			
27	Seruni	*Widelia biflora*				+											

Annex 2 List Species of Mammals in Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Common Name	Family	Province													Status				Remark
					1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
1	Sero Ambrang	*Aonyx cinnerea*	Oriental Small-clawed Otter	Mustelidae					+						+			A, F	-	-	II	
2	Banteng	*Bos javanicus*														+		-	-	-	-	
3	Bajing Kinabalu	*Callosciurus baluensis*	Kinabalu Squirrel	Sciuridae											+			-	-	-	-	
4	Bajing Kelapa	*Callosciurus notatus*	Plantain Squirrel	Sciuridae											+		+	-	-	-	-	
5	Rusa Timor	*Cervus timorensis*	Javan Rusa	Cervidae										+				A, F	-	-	-	
6	Rusa Sambar	*Cervus unicolor*	Sambar Deer	Cervidae				+		+		+	+		+			A, F	-	-	-	
7		*Conilurus sp.*						+										-	-	-	-	
8	Curucut Gigi Putih	*Crocidura fuliginosa*	Southeast Asian White-toothed Shrew	Soricidae											+			-	-	-	-	
9	Cerucut Kecil	*Crocidura monticula*	Sunda Shrew	Soricidae											+			-	-	-	-	
10	Musang Air	*Cynogale bennetti*	Otter-Civet	Viverridae										+	+			C, F	-	E	II	
11	Kelelawar Ekor Trubus Kecil	*Embalonura monticula*	Lesser Sheath-tailled Bat	Emballonuridae											+			-	-	-	-	
12	Kucing Hutan	*Felis bengalensis*	Leopard Cat	Felidae			+								+			F, G	-	-	I, II	
13	Kucing Bakau	*Felis viverrinus*	Fishing Cat	Felidae			+	+							+			D, F	-	IK	II	
14		*Gernus* sp.															+	-	-	-	-	
15	Beruang Madu	*Helarctos malayanus*	Sun Bear	Ursidae						+			+		+	+	+	A, F	-	V	I	
16	Garangan Jawa	*Herpectes javanicus*						+										-	-	-	-	
17	Barong Dayak	*Hipposideros dyacorum*	Dayak Roundleaf Bat	Hipposideridae											+			-	-	-	-	
18		*Hydromys chrysogaster*						+										-	-	-	-	
19		*Isodon sp.*						+										-	-	-	-	
20	Berang-berang Pantai	*Lutra-lutra*	Eurasian Otter	Mustelidae			+	+		+	+				+			-	V	-	I	
21	Monyet Ekor Panjang	*Macaca fascicularis*	Long-tailed Macaque	Cercopithecidae														-	-	-	II	
22	Monyet Ekor Panjang	*Macaca fascicularis*	Long-tailed Macaque	Cercopithecidae	+			+	+	+	+		+	+	+		+	-	-	-	-	
23	Kera Abu-abu	*Macaca irrus*		Cercopithecidae											+		+	-	-	-	-	
24	Beruk	*Macaca nemestrina*	Piq-tailed Macaque	Cercopithecidae				+		+	+	+		+	+		+	-	-	-	II	
25		*Macroglossus lagochilus*						+										-	-	-	-	
26	Codot madu kecil	*Macroglossus minisus*						+										-	-	-	-	
27	Trenggiling Peusing	*Manis javanica*	Pangolin	Manidae								+		+			+	A, F	-	-	II	
28		*Melomys sp.*						+										-	-	-	-	
29		*Mesembriomys sp.*						+										-	-	-	-	
30	Kijang	*Muntiacus muntjak*	Red muntjak	Cervidae						+				+			+	A, F	-	-	-	
31		*Mus musculus*						+										-	-	-	-	
32	Musang Kepala Putih	*Mustela Nudipes*	Malay Weasel	Mustelidae											+			-	-	-	-	

Annex 2 *cont.* List Species of Mammals in Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Common Name	Family	Province													Status				Remark
					1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
33	Bekantan	*Nasalis larvatus*	Proboscis Monkey	Cercopithecidae											+	+	+	A, F	-	V	I	
34	Macan dahan	*Neofelis nebulosa*	Clouded Leopard	Felidae										+		+		D, F	V	V	I	
35	Harimau Sumatera	*Panthera tigris sumatrana*	Sumatran Tiger	Felidae							+			+				C, F	E	E	I	
36	Musang Luwak	*Paradoxurus hermaphroditus*	Common Palm Civet	Viverridae				+				+			+		+	-	-	-	III IN	
37		*Perameles sp.*						+										-	-	-	-	
38	Lutung Kelabu	*Presbiytis cristata*	Silvered Langur	Cercopithecidae			+	+		+			+	+				-	-	-	-	
39	Lutung Simpai	*Presbytis femoralis*	Banded Langur	Cercopithecidae											+			-	-	-	II	
40	Lutung Merah	*Presbytis rubicunda*	Red Leaf Monkey	Cercopithecidae											+			-	-	-	-	
41		*Pteropus alecto*		Pteropidae				+										-	-	-	-	
42		*Pteropus conspicillatus*		Pteropidae				+										-	-	-	-	
43	Kalong Kecil	*Pteropus hypomelanus*	Island flying Fox	Pteropidae				+							+			-	-	-	-	
44		*Pteropus policephalus*		Pteropidae				+										-	-	-	-	
45	Kalong Besar	*Pteropus vampyrus*	Large flying Fox	Pteropidae				+	+			+		+	+			-	-	-	II	
46	Tikus Sawah	*Rattus argentiventer*	Ricefield Rat	Muridae			+								+			-	-	-	-	
47		*Rattus rattus diardii*		Muridae			+								+			-	-	-	-	
48		*Rattus sordidus*		Muridae				+										-	-	-	-	
49	Tikus Belukar	*Rattus tiomanicus*	Malaysian Wood Rat	Muridae	+		+	+	+						+			-	-	-	-	
50	Tikus Riul	*Ratus norvegicus*	Norway Rat	Muridae											+			-	-	-	-	
51	Tikus	*Ratus ratus*		Muridae													+	-	-	-	-	
52	Kelelawar Ladam Lapet Kecil	*Rhinolopus sedulus*	Lesser Woolly Horseshoe Bat	Rhinolophidae											+			-	-	-	-	
53	Kelelawar Rumah Kuning Kecil	*Scatophilus teminckii*						+										-	-	-	-	
54	Lumba-lumba	*Stenella sp.*		Stonidae											+			F	-	-	-	
55	Munggis Rumah	*Suncus murinus*	House Shrew	Soricidae			+								+			-	-	-	-	
56	Tikus Besar Lembah	*Sundamys muelleri*	Muller's Rat	Muridae											+			-	-	-	-	
57	Babi hutan	*Sus barbatus*	Bearded Pig	Suidae						+			+	+	+			-	V	-	-	
58	Babi hutan	*Sus scrofa*	Domestic Pig	Suidae								+			+		+	-	-	-	-	
59		*Tidarida planiceps*						+										-	-	-	-	
60	Pelanduk Kancil	*Tragulus javanicus*	Lesser Mouse Deer	Tragulidae						+					+		+	-	-	-	-	
61	Napu	*Tragulus* sp.		Tragulidae						+								-	-	-	-	
62		*Trichosurus arnhemensis*						+										-	-	-	-	
63	Tupai Bergaris	*Tupaia dorsalis*	Striped Treeshrew	Tupaiidae											+			-	-	-	II	
64	Tupai Akar	*Tupaia glis*	Common Treeshrew	Tupaiidae											+			-	-	-	-	
65	Tupai Tana	*Tupaia tana*	Large Treeshrew	Tupaiidae											+			-	-	-	II	
66		*Ursus malayanus*		Ursidae											+			-	-	-	-	
67		*Wallabia bicolor*						+										-	-	-	-	

Annex 3 List Species of Reptile of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Common Name	Family	Province													Status				Remark
					1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
1	Ular Kadut	*Acrochordus granulatus*	File Snake	Acrochordidae			+	+	+									-	-	-	-	
2		*Aipysurus eydouxii*						+										-	-	-	-	
3	Kura-kura	*Batagur baska*	Mangrove Terrapin	Bataguridae											+			-	-	-	-	
4	Ular Cincin Mas	*Boiga dendrophilia*	Mangrove Sanke	Colubridae				+	+		+							-	-	-	-	
5	Ular Cincin Mas	*Boiga dendrophilia*	Mangrove Sanke	Colubridae										+			+	-	-	-	-	
6	Kodok	*Bufo bipurcatus*		Bufonidae													+	-	-	-	-	
7	Ular Welang	*Bungarus fasciatus*	Banded Krait	Elapidae					+		+							-	-	-	-	
8	Penyu Muara	*Callagur borneoensis*	Red-headed Terrapin	Bataguridae											+			-	E	-	-	
9	Ular Tambak	*Cerberus rynchops*	Dog-faced Water Snake	Colubridae			+				+			+				-	-	-	III IN	
10	Penyu hijau	*Chelonia mydas*	Green Turtle	Chelonidae											+	+		F	E	E	III IN	
11	Buaya Muara	*Crocodilus porosus*	Saltwater	Crocodylidae						+	+	+	+	+	+	+	+	F	V	V	I, II	
12		*Crocodylus siainensis*		Crocodylidae													+	-	-	-	-	
13	Penyu Belimbing	*Dermochelys coriacea*	Leatherback Turtle	Dermochelyidae								+			+			F	E	E	I	
14	Bunglon	*Draco volans*	Blanford's Gliding Lizard	Agamidae	+												+	-	-	-	-	
15	Ular Daun	*Dryophiops rubescens*	Keel-bellied	Colubridae					+		+						+	-	-	-	-	
16	Ular Sapi	*Elaphe radiata*	Radiated Rat Snake	Colubridae			+											-	-	-	-	
17		*Enhydris punctata*						+										-	-	-	-	
18		*Ephalophis greyi*						+										-	-	-	-	
19		*Ephalophis mertoni*						+										-	-	-	-	
20	Penyu sisik	*Eretmochelys imbricata*	Hawwksbill Turtle	Chelonidae								+			+	+		F	E	E	I	
21	Ular Bakau	*Fardonia leucobalia*	Whitebelly Mangrove Snake	Colubridae				+			+		+		+			-	-	-	-	
22		*Hydrophis elegans*						+										-	-	-	-	
23	Penyu lekang	*Lepidochelys olivacea*	Olive Ridley Turtle	Chelonidae											+			F	E	E	I	
24	Ular pyton	*Liasis fuscus*						+										-	-	-	-	
25	Ular pyton	*Liasis olivaceus*						+										-	-	-	-	
26		*Lophognathus temporalis*						+										-	-	-	-	
27	Kadal	*Mabouya multifasciata*	Many-lined Sun Skink	Scincidae	+		+	+	+		+	+		+	+		+	-	-	-	-	
28		*Morelia spilotes*						+										-	-	-	-	
29		*Myron richardsonii*						+										-	-	-	-	
30	Ular Kobra	*Naja sputatrix*		Elapidae				+	+			+						-	-	-	II	
31	Ular Tedung	*Ophiophagus hannah*	King Cobra	Elapidae							+						+	-	-	-	II	
32		*Phyton malans*		Boidae													+	-	-	-	-	
33	Ular Sawah	*Phyton reticulatus*	Reticulated python	Boidae			+		+		+	+	+	+			+	-	-	-	II	
34	Katak Sawah	*Rana cancrivora*						+										-	-	-	-	
35	Buaya ikan	*Tomistoma schelegii*	Sunda Gharial	Crocodylidae						+				+		+		F	E	E	I	
36	Labi-labi	*Trionhyx cartilagineus*	Southeast Asian Soft-shelled Turtle	Trionychidae							+				+			-	-	-	-	
37	Biawak	*Varanus salvator*	Water Monitor	Varanidae			+	+	+	+	+	+	+	+	+		+	-	-	-	II	
38	Buaya Rawa			Crocodylidae									+					-	-	-	-	
39	Buaya Sungai			Crocodylidae									+					-	-	-	-	
40	Katak Rawa				+		+											-	-	-	-	
41	Ular Laut				+													-	-	-	-	
42	ular sanca											+										

Annex 4 List Species of Birds of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Common Name	Family	Province													Status				Remark
					1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
1	Julang Emas	*Aceros undulatus*	Whreathed Hornbill	Bucerotidae										+	+			-	-	-	II	Migrant
2	Jalak Ungu	*Acridotheres javanicus*	Javan Myna	Sturnidae				+										-	-	-	-	Migrant
3	Kerakbasi	*Acrocephalus stentoreus*	Clamarous Reed-warbler	Silviidae			+	+	+									-	-	-	-	Resident
4	Trinil Pantai	*Actitis hypoleucos*	Common Sandpiper	Scolopocidae			+	+	+		+			+	+		+	-	-	-	-	Migrant
5	Cipoh Kacat	*Aegithina tiphia*	Common Iora	Chloropseidae			+	+	+						+			-	-	-	-	Resident
6	Cipoh Jantung	*Aegithina viridissima*	Green Iora	Chloropseidae											+			-	-	-	-	Resident
7	Burung Madu Sepah Raja	*Aethopyga siparaja*	Crimson Sunbird	Nectariniidae											+		+	A, F	-	-	-	Migrant
8	Burung Madu Ekor Merah	*Aethopyga temminckii*	Temmick's Sunbirds	Nectariniidae											+			A, F	-	-	-	Migrant
9	Raja Udang Erasia	*Alcedo atthis*	Common Kingfisher	Acledinidae										+				A, F	-	-	-	Migrant
10	Raja Udang	*Alcedo caerulescens*	Blue Kingfisher	Acledinidae			+	+	+						+			A, F	-	-	-	Resident
11	Raja Udang Meninting	*Alcedo meninting*	Blue-eared Kingfisher	Acledinidae			+		+					+	+			A, F	-	-	-	Migrant
12	Burung Wergan Coklat	*Alcippe brunneicauda*	Brown Fulvetta	Timalidae											+			-	-	-	-	Migrant
13	Kareo	*Amauromis phoeenicurus*	White breaste waterhen	Rallidae			+	+	+						+			-	-	-	-	Migrant
14	Itik Benjut	*Anas gibberifrons*	Sunda Teal	Anatidae			+	+										-	-	-	-	Resident
15		*Anhinga glareola*		Phalacrocoracidae				+										-	-	-	-	n. i
16	Pecuk Ular Asia	*Anhinga melanogaster*	Oriental Darter	Anhingidae			+	+	+	+	+				+	+		D, F	-	-	-	Resident
17		*Anhinga nebularia*		Phalacrocoracidae				+										-	-	-	-	n. i.
18		*Anhinga stagnatilis*		Phalacrocoracidae				+										-	-	-	-	n. i.
19		*Anhinga totanus*		Phalacrocoracidae				+										-	-	-	-	n. i.
20		*Annideeheres javanicus*					+											-	-	-	-	n. i.
21	Burung Enggan Klihingan	*Anorrhinus galeritus*	Bushy-crested Hornbill	Bucerotidae											+			-	-	-	II	Migrant
22	Kangkareng Perut Putih	*Anthracoceros albirostris*	Oriental Pied Hornbill	Bucerotidae											+			-	-	-	II	Migrant
23	Kangkareng Hitan	*Anthracoceros malayanus*	Asian Black Hornbill	Bucerotidae											+			-	-	-	II	Migrant
24	Burung Madu Kelapa	*Anthreptes malacensis*	Plain-throated Sunbieds	Nectariniidae				+	+						+			A, F	-	-	-	Resident
25	Burung Madu Polos	*Anthreptes simplex*	Plain Sunbirds	Nectariniidae											+			A, F	-	-	-	Migrant
26	Burung Madu Belukar	*Anthreptes singalensis*	Ruby-Cheeked Sunbirds	Nectariniidae											+			A, F	-	-	-	Migrant
27	Perling Kumbang	*Aplonis panayensis*	Asian Glossy Starling	Sturnidae											+			-	-	-	-	Migrant
28	Kapinis rumah	*Apus affinis*	Little Swift	Apodidae			+								+			-	-	-	-	Resdinet
29	Pijantung Gunung	*Arachnothera affinis*	Grey Breasted Spiderhunter	Nectariniidae					+						+			-	-	-	-	Migrant
30	Pijantung Telinga Kuning	*Arachnothera chrysogenys*	Yellow-eared Spiderhunter	Nectariniidae											+			-	-	-	-	Migrant
31	Pijantung Tesmak	*Arachnothera flavigaster*	Spectacled Spiderhunter	Nectariniidae											+			-	-	-	-	Migrant
32	Pijantung Kecil	*Arachnothera longirostra*	Liitle Spiderhunter	Nectariniidae				+							+			-	-	-	-	Migrant
33	Pijangtung Besar	*Arachnothera robusta*	Long-billed Spiderhunter	Nectariniidae											+			-	-	-	-	Migrant
34	Cangak Abu	*Ardea cinerea*	Grey Heron	Ardeidae			+	+	+		+		+	+	+			A, F	-	-	-	Migrant

Annex 4 *cont.* List Species of Birds of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Common Name	Family	Province													Status				Remark
					1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
35	Cangak merah	*Ardea purpurea*	Purple Heron	Ardeidae			+	+	+						+	+		A, F	-	-	-	Migrant
36	Cangak Laut	*Ardea sumatrana*	Giant Heron	Ardeidae			+	+			+				+			A, F	-	-	-	Resident
37	Blekok Sawah	*Ardeola speciosa*	Javan Pond Heron	Ardeidae			+	+	+	+					+		+	A, F	-	-	-	n. i.
38	Trinil Pembalik Batu	*Arenaria interpres*	Ruddy Turnstone	Scolopocidae			+											-	-	-	-	Migrant
39	Kuau Raja	*Argusianus argus*	Great Argus	Phasianidae						+					+			B, F	-	-	II	Migrant
40		*Artamus contra*		Artamidae				+										-	-	-	-	n. i.
41	Kekep Babi	*Artamus leucorhynchus*	White-breasted Wood-swallow	Artamidae			+	+	+						+			-	-	-	-	Migrant
42		*Artamus melanopterus*		Artamidae				+										-	-	-	-	n. i.
43		*Artamus sturminus*		Artamidae				+										-	-	-	-	n. i.
44	Burung Baza Jerdon	*Aviceda jerdoni*	Jerdon's Baza	Accipitridae											+			B, F	-	-	II	Migrant
45	Pelatuk Pangkas	*Blythipicus rubiginosus*	Maroon Woodpecker	Picidae											+			-	-	-	-	Migrant
46	Beluk Jempuk	*Bubo sumatranus*	Barred Eagle-owl	Strigidae											+			-	-	-	II	Migrant
47	Kuntul Kerbau	*Bubulcus ibis*	Cattle Egret	Ardeidae			+	+	+						+			-	-	-	III GH	Migrant
48	Rangkong Papan	*Buceros bicornis*	Great Hornbill	Bucerotidae						+				+				A	-	-	I	Migrant
49	Rangkong Badak	*Buceros rhinoceros*	Rhinoceros Hornbill	Bucerotidae											+			A, F	-	-	II	Migrant
50	Kokokan Laut	*Butorides striatus*	Striated Heron	Ardeidae			+	+	+	+	+			+	+			-	-	-	-	Resident
51	Kakatua Jambul	*Cacatua galerita*	Sulphur-creasted Cocktoo	Psittacidae													+	B, E, F	-	-	II	Migrant
52	Wiwik Lurik	*Cacomantis sonneratii*	Banded Bay Cuckoo	Cuculidae											+			-	-	-	-	Migrant
53	Kedidi Golgol	*Calindris feruginea*	Curlew Sandpiper	Sclolopacidae				+										-	-	-	-	Migrant
54	Kedidi Leher Merah	*Calindris ruficollis*	Rufous-necked Stint	Sclolopacidae			+	+										-	-	-	-	Migrant
55	Kedidi Kedidi Panjang	*Calindris subminuta*	Long-toed Stint	Sclolopacidae			+											-	-	-	-	Migrant
56	Burung Takur Ampis	*Calorhamphus fuliginosus*	Brown Barbet	Capitonidae											+			-	-	-	-	Migrant
57	Burung Madi Hijau Kecil	*Calyptomena viridis*	Green Boradbill	Eurylaimidae											+			-	-	-	-	Migrant
58	Burung Cabak Kota	*Caprimulgus affinis*	Savannah Nightjar	Caprimulgidae			+	+	+						+		+	-	-	-	-	Migrant
59		*Casmerodius albus*						+														
60	Bubut alang-alang	*Centropus bengalensis*	Lesser Coucal	Cuculidae			+		+		+				+		+	-	-	-	-	Migrant
61	Bubut Jawa	*Centropus nigrorofus*	Sunda Coucal	Cuculidae			+		+								+	-	V	-	-	Resident
62	Bubut	*Centropus rectunguis*		Cuculidae												+						
63	Bubut Besar	*Centropus sinensis*	Greater Coucal	Cuculidae							+				+		+	-	-	-	-	Migrant
64	Delimukan Zamrud	*Chalcophaps indica*	Zebra-Dove	Columbidae											+		+	-	-	-	-	Migrant
65	Cerek Tilil	*Charadrius alexandrinus*	Kentish Plover	Charadriidae			+								+			-	-	-	-	Migrant
66	Cerek Kalung Kecil	*Charadrius dubius*	Little Ringed Plover	Charadriidae			+	+										-	-	-	-	Migrant
67	Cerek Pasir Besar	*Charadrius leschenaultii*	Greater Sand-plover	Charadriidae				+							+			-	-	-	-	Migrant
68	Cerek Pasir Mongolia	*Charadrius mongolus*	Mongolian Plover	Charadriidae				+						+				-	-	-	-	Migrant
69	Cerek Melayu	*Charadrius peronii*	Malaysian Plover	Charadriidae											+			-	-	-	-	Resident
70	Cerek Asia	*Charadrius veredus*	Oriental Plover	Charadriidae				+										-	-	-	-	Migrant
71	Cerek Besar	*Charadus mongolus*		Charadriidae			+							+								
72	Dara Laut Kumis	*Chlidonias hybridus*	Whiskered Tern	Sternidae				+						+				A, F	-	-	-	Migrant

Annex 4 *cont.* **List Species of Birds of Indonesia Mangrove Ecosystem in the South China Sea.**

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					1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
73	Dara Laut Sayap Putih	*Chlidonias leucopterus*	White-winged Tern	Sternidae			+	+										-	-	-	-	Migrant
74	Burung Cica Daun Kecil	*Chloropsis cyanopogon*	Lesser Green Leafbird	Chloropseidae											+			-	-	-	-	Resident
75	Burung Cica Daun Besar	*Chloropsis sonnerati*	Greater Green Leafbird	Chloropseidae											+			-	-	-	-	Resident
76	Burung Kedasi Ungu	*Chrysococcyx xanthorhynchus*	Violet Cuckoo	Cuculidae											+			-	-	-	-	Resident
77	Pelatuk Tunggir Emas	*Chrysocolaptes lucidus*	Greater Goldenback	Picidae										+				-	-	-	-	Migrant
78	Bangau Sandang Lawe	*Ciconia episcopus*	Woolly-necked Stork	Ciconiidae						+								A, F	-	-	-	Migrant
79	Bangau Storm	*Ciconia stormi*	Storm's Stork	Ciconiidae						+					+	+		A, F	R	-	-	Migrant
80	Burung Cici Padi	*Cisticola juncidis*	Zitting Cisticola	Silviidae			+											-	-	-	-	Migrant
81	Saeran Gila	*Ciypsirina temia*		Silviidae			+															
82	Bubut Pacar Jambul	*Clamator coromandus*	Chesnut-winged Cuckoo	Cuculidae					+									-	-	-	-	Resident
83	Walet Sapi	*Collocalia esculenta*	Glossy Swiftlet	Apodidae	+		+	+	+						+			-	-	-	-	n. i.
84	Walet sarang putih	*Collocalia fuchipaga*	Edible-nest Swiftlet	Apodidae					+									-	-	-	-	Resident
85	Kucica Hutan	*Copsychus malabaricus*	White-rumped Shama	Turdidae					+						+			-	-	-	-	Migrant
86		*Copsychus pyrropygus*		Turdidae											+			-	-	-	-	n. i.
87	Kucica Kampung	*Copsychus saularis*	Magpie Robin	Turdidae				+	+						+			-	-	-	-	Migrant
88	Gagak Hutan	*Corvus enca*	Slender-billed Crow	Corvidae					+						+			-	-	-	-	Migrant
89	Gagak Kampung	*Corvus macrorhynchos*	Large-billed Crow	Corvidae			+	+									+	-	-	-	-	Migrant
90	Burung Madi Kelam	*Corydon sumatranus*	Dusky Broadbill	Eurylaimidae											+			-	-	-	-	Migrant
91	Puyuh Batu	*Coturnix chinensis*	Blue-breasted Quail	Phasianidae											+			-	-	-	-	Migrant
92	Burung Janggut	*Criniger bres*	Grey-cheeked Bulbul	Pycnonotidae											+			-	-	-	-	Migrant
93	Empuloh Leher-Kuning	*Criniger finschii*	Finsch's Bulbul	Pycnonotidae											+			-	-	-	-	Migrant
94		*Criniger phaeocephalus*		Pycnonotidae											+			-	-	-	-	n. i.
95	Tangkar Centrong	*Crypsirina temia*	Racket-tailed Treepie	Corvidae					+									-	-	-	-	Migrant
96	Kangkok Melayu	*Cuculus fugax*	Hodgson's Hawk-Cuckoo	Cuculidae											+			-	-	-	-	Migrant
97	Kangkok India	*Cuculus microptelus*	Indian Cuckoo	Cuculidae											+			-	-	-	-	Migrant
98	Burung Unciung	*Cuculus saepulchralis*		Cuculidae			+											-	-	-	-	Migrant
99	Sikatan Kelapa-Abu	*Culicicapa ceylonensis*	Grey-headed Flycatcher	Muscicapidae				+										-	-	-	-	Migrant
100	Sempur-Hujan Sungai	*Cymbirhynchus macrorhynchos*	Black-and-red Broadbill	Eurylaimidae											+			-	-	-	-	Migrant
101	Sikatan bakau	*Cyornis rufigastra*	Mangrove Blue-flycatcher	Muscicapidae					+									-	-	-	-	Resident
102	Layang-layang Rumah	*Delichon dasypus*	Asian House-martin	Hirundinidae				+										-	-	-	-	Migrant
103	Belibis Kembang	*Dendrocygna arcuata*	Wandering Whisthing-Duck	Anatidae					+	+								-	-	-	-	Resident
104	Belibis Batu	*Dendrocygna javanica*	Lesser Whisthing-Duck	Anatidae			+								+		+	-	-	-	-	Migrant
105	Burung Cabai Rimba	*Dicaeum chrysorrheum*	Yellow-vented Flowerpecker	Dicaeidae											+			-	-	-	-	Migrant
106	Burung Cabai Polos	*Dicaeum concolor*	Plain Flowerpecker	Dicaeidae											+			-	-	-	-	Migrant

Annex 4 *cont.* **List Species of Birds of Indonesia Mangrove Ecosystem in the South China Sea.**

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					1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
107	Burung Cabai Bunga-Api	*Dicaeum trigonostigma*	Orange-billied Flowerpecker	Dicaeidae											+			-	-	-	-	Resident
108	Cabai jawa	*Dicaeum trochileum*	Scarlet-headed Flowerpecker	Dicaeidae				+	+						+			-	-	-	-	Resident
109	Srigunting Gagak	*Dicrucus annectans*	Crow-billed Drongo	Dicruridae														-	-	-	-	Migrant
110	Srigunting Hitam	*Dicrucus macroceros*	Black Drongo	Dicruridae	+		+		+						+		+	-	-	-	-	Resident
111	Srigunting Batu	*Dicrurus paradiseus*	Greater Racket-tailed Drongo	Dicruridae											+			-	-	-	-	Resident
112	Pelatuk Raffles	*Dinopium rafflesii*	Olive-becked Woodpecker	Picidae											+			-	-	-	-	Migrant
113	Pelatuk Ayam	*Dryocopus javensis*	White-bellied Woodpecker	Picidae											+		+	-	-	-	I	Migrant
114	Pergam Hijau	*Ducula aenea*	Green Imperial-Pigeon	Culumbidae											+			-	-	-	-	Resident
115	Pergam Laut	*Ducula bicolor*	Pied Imperial-Pigeon	Culumbidae					+						+			-	-	-	-	Resident
116	Kuntul Besar	*Egretta alba*	Great Egret	Ardeidae	+		+	+	+	+				+	+	+	+	A, F	-	-	III GH	Migrant
117	Kuntul Kecil	*Egretta garzetta*	Little Egret	Ardeidae			+	+	+					+	+	+		A, F	-	-	III GH	Migrant
118	Kuntul Perak	*Egretta intermedia*	Intermediate Egret	Ardeidae				+	+									A, F	-	-	-	Resident
119	Kuntul Karang	*Egretta sacra*	Pacific Reef-egret	Ardeidae			+	+	+					+	+			A, F	-	-	-	Resident
120	Elang Tikus	*Elanus caeruleus*	Black-winged Kite	Accipitridae			+								+		+	A, B	-	-	II	Resident
121	Emberiza Pundak Putih	*Emberiza aureola*	Yellow-breasted Bunting	Emberitidae			+								+			-	-	-	-	Migrant
122	Burung Meninting Besar	*Enicurus leschenaulti*	White-crowned Forktail	Turdidae											+			-	-	-	-	Migrant
123	Burung Meninting Cegar	*Enicurus ruficapillus*	Chesnut-naped Forktail	Turdidae											+			-	-	-	-	Migrant
124	Tuwur Asia	*Eudynamys scolopacea*	Asian Koel	Coculidae					+		+							-	-	-	-	Migrant
125	Sipinjur Melayu	*Eupetes macroceros*	Malaysian Rail-babbler	Timalidae											+			-	-	-	-	Migrant
126	Taktarau Melayu	*Eurostopodus temminckii*	Malaysian Eared-nightjar	Caprimulgidae											+			-	-	-	-	Migrant
127	Sempur-Hujan Rimba	*Eurylaimus javanicus*	Banded Broadbill	Eurylaimidae											+			-	-	-	-	Migrant
128	Sempur-Hujan darat	*Eurylaimus ochromalus*	Balck-and-Yellow Broadbill	Eurylaimidae											+			-	-	-	-	Migrant
129	Tiong Lampu Biasa	*Eurystomus orientalis*	Dollarbird	Meropidae										+	+			-	-	-	-	Migrant
130	Alap-alap Kawah	*Falco peregrinus*	Peregrine falcon	Falconidae				+										-	-	-	I	Migrant
131	Sikatan Emas	*Ficedula zanthopygia*	Yellow-Rumped Flycatcher	Muslicapidae			+											-	-	-	-	Migrant
132	Cikalang Christmas	*Fregata andrewsi*	Christmas Frigatebird	Fregatidae				+										-	-	V	I	Migrant
133	Cikalang Kecil	*Fregata ariel*	Lesser Frigatebird	Fregatidae			+		+									-	E	-	-	Migrant
134	Mandar Bontod	*Gallicrex cinerea*	Watercock	Rallidae				+										-	-	-	-	Migrant
135	Mandar Batu	*Gallinula chloropus*	Common Moorhen	Rallidae				+										-	-	-	-	Migrant
136	Mandar Padi Sintar	*Gallirallus striatus*	Slaty-breasted	Rallidae			+											-	-	-	-	Migrant
137	Perkutut Jawa	*Geopelia striata*	Zebra-Dove	Columbidae				+									+	-	-	-	-	Migrant

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138	Remetuk Laut	*Gerygone sulphurea*	Golden-bellied Gerygone	Muscicapidae			+	+	+						+			-	-	-	-	Migrant
139	Terik Asia	*Glareola maldivarum*	Oriental Pratincole	Glareolidae			+	+										-	-	-	-	Migrant
140	Tiong Emas	*Gracula religiosa*	Hill Myna	Sturnidae											+			B, F	-	-	III TH	Migrant
141	Jenjang	*Grus antigone*		Grusdae													+	F, H	-	-	II	n. i.
142	Raja Udang	*Halcyon capensis*	Stork-billed Kingfisher	Alcedinidae										+								
143	Cekakak	*Halcyon chloris*	White-collared Kingfisher	Alcedinidae			+	+	+					+	+		+	A, F	-	-	-	Resident
144	Cekakak Merah	*Halcyon coromanda*	Ruddy Kingfisher	Alcedinidae											+			A, F	-	-	-	Resident
145	Raja Udang	*Halcyon funebris*		Alcedinidae						+								A, F	-	-	-	Migrant
146	Cekakak Cina	*Halcyon pileata*	Black-capped Kingfisher	Alcedinidae											+		+	A, F	-	-	-	Migrant
147	Cekakak Suci	*Halcyon sancta*	Scared Kingfisher	Alcedinidae			+	+	+	+					+			A, F	-	-	-	Migrant
148	Elang Laut Perut Putih	*Haliacetus leucogaster*	White-billied Fish Eagle	Accipitridae				+	+		+		+	+	+		+	B, F	-	-	II	Resident
149	Elang Bondol	*Haliastur indus*	Brahminy Kite	Accipitridae				+	+	+	+			+	+		+	B, F	-	-	II	Resident
150	Burung Luntur Diard	*Harpactes diardii*	Driad's Trogon	Trogonidae											+			A, F	-	-	-	Migrant
151	Burung Luntur Putri	*Harpactes duvaucelii*	Scarlet-rumphed Trogon	Trogonidae											+			A, F	-	-	-	Migrant
152	Burung Luntur Kasumba	*Harpactes kasumba*	Red-naped Trogon	Trogonidae											+			A, F	-	-	-	Migrant
153	Caladi Tikotok	*Hemicircus concretus*	Grey-and-buffWoodpecker	Pecidae											+			-	-	-	-	Migrant
154	Tepekong Jambul	*Hemiprocne longipennis*	Grey-rumped Treeswift	Hemipracnidae			+								+			-	-	-	-	Migrant
155	Jinjing batu	*Hemipus hirundinaceus*	Black-winged Flycatcher-shrike	Campephagidae					+									-	-	-	-	Migrant
156	Kapinis Jarum Gendang	*Hirundapus giganteus*	Brown-backed Needletail	Apodidae											+			-	-	-	-	Resident
157	Layang-layang Api	*Hirundo rustica*	Barn Swallow	Hirundinidae			+	+	+						+			-	-	-	-	Migrant
158	Layang-layang Batu	*Hirundo tahitica*	Pacific Swallow	Hirundinidae			+	+	+						+		+	-	-	-	-	Migrant
159	Burung Madu Rimba	*Hypogramma hypogrammicum*	Purpl-naped Sunbird	Nectariniidae											+			-	-	-	-	Migrant
160	Burung Kehicap Ranting	*Hypothymis azurea*	Black-naped Monarch	Muscicapidae											+			-	-	-	-	Resident
161		*Hypsipetes criniger*		Pygnonotidae											+			-	-	-	-	n. i.
162		*Hypsipetes malaccensis*		Pygnonotidae											+			-	-	-	-	n. i.
163	Elang Ikan Kecil	*Ichthyophaga humilis*	Lesser Fish-eagle	Accipitridae											+			B, F	-	-	II	Resident
164	Elang ikan kepala kelabu	*Ichtyophaga icthyaetus*		Accipitridae						+												
165	Elang Hitam	*Ictinaetus malayensis*	Black Eagle	Accipitridae										+	+			B, F	-	-	II	Resident
166	Burung Kacembang Gadung	*Irena puella*	Asian Fairy-Bluebird	Oriolidae											+			-	-	-	-	Migrant
167	Bambangan Merah	*Ixobrychus cinnamomeus*	Cinnamon Bittern	Ardeidae			+	+	+						+			-	-	-	-	Resident
168	Kokokan Sungai	*Ixobrychus flavicollis*	Black Bittern	Ardeidae			+								+			-	-	-	-	Resdient
169	Bambangan Kuning	*Ixobrychus sinensis*	Yellow Bittern	Ardeidae			+	+										-	-	-	-	Resident
170	Bambangan Coklat	*Ixobrychus uerhythmus*	Schrenk's Bittern	Ardeidae			+								+			-	-	-	-	Migrant

Annex 4 *cont.* List Species of Birds of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Common Name	Family	Province													Status				Remark
					1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
171	Berencet Loreng	*Kenopia striata*	Striped wWren-babler	Timaliidae											+			-	-	-	-	Migrant
172	Beluk Ketupa	*Ketupa-ketupu*	Buffy Fish-owl	Tytonidae				+									+	-	-	-	II	Migrant
173	Kapasan Kemiri	*Lalage nigra*	Pied Triller	Campephagidae					+						+			-	-	-	-	Resident
174	Bentet Coklat	*Lanius cristatus*	Brown Shrike	Laniidae											+			-	-	-	-	Migrant
175	Bentet Kelabu	*Lanius schach*	Long-tailed Shrike	Laniidae			+		+						+		+	-	-	-	-	Migrant
176	Bangau Tongtong	*Leptoptilos javanicus*	Lesser Adjutant	Ciconiidae	+					+	+		+	+		+		A, F	V	-	III GH	Migrant
177	Kedidi Paruh Lebar	*Limicola falcinellus*	Broad-billed sandpiper	Scolopacidae			+											-	-	-	-	Migrant
178	Trinil Lumpur Asia	*Limnodromus semipalmatus*	Asian Dowitcher	Scolopacidae			+				+		+	+				E, F	R	-	-	Migrant
179	Biru Laut Ekor Blorok	*Limosa lapponica*	Bar-tailed Godwit	Scolopacidae										+				-	-	-	-	Migrant
180	Biru Laut Ekor Hitam	*Limosa limosa*	Blac-tailed Godwit	Scolopacidae			+				+				+			-	-	-	-	Migrant
181	Bondol Kalimantan	*Lonchura fuscans*	Dusky Munia	Ploceidae											+			-	-	-	-	Migrant
182	Bondol jawa	*Lonchura leucogastroides*	Javan Munia	Ploceidae			+	+	+						+			-	-	-	-	Migrant
183	Bondol Haji	*Lonchura maja*	White-headed Munia	Ploceidae				+									+	-	-	-	-	Migrant
184	Bondol Rawa	*Lonchura malacca*	Black-headed Munia	Ploceidae				+							+			-	-	-	-	Migrant
185	Bondol Peking	*Lonchura punctulata*	Scaly breasted Munia	Ploceidae			+	+	+									-	-	-	-	Migrant
186		*Lophura bulweri*		Phasianidae												+						
187	Ambang	*Lophura erythrophthalma*	Crestless fireback	Phasianidae												+						
188	Sempidan Biru	*Lophura ignita*	Crested Fireback	Phasianidae						+					+			-	V	V	III MY	Migrant
189	Serindit	*Loriculus exillis*		Psitracidae													+					
190	Serindit Melayu	*Loriculus galgulus*	Blue-crowned Hanging-Parrot	Psitracidae											+		+	-	-	-	II	Migrant
191	Serindit Jawa	*Loriculus pusillus*	Yellow-throated Hanging-Parrot	Psitracidae											+			-	-	-	II	Migrant
192	Ciung Air Pongpong	*Macronous ptilosus*	Fluffy-backed Tit Babbler	Timaliidae											+			-	-	-	-	Migrant
193	Burung Uncal Buau	*Macropygia emiliana*	Ruddy Cuckoo	Columbidae			+								+			-	-	-	-	Resident
194	Burung Asi Topi Jelaga	*Malacopteron affine*	Sooty-capped Babbler	Timaliidae											+			-	-	-	-	Migrant
195	Burung Asi Dada Kelabu	*Malacopteron albogulare*	Grey-breasted Babbler	Timaliidae											+			-	-	-	-	Migrant
196	Burung Asi Topi Sisik	*Malacopteron cinereum*	Scaly-crowned Babbler	Timaliidae											+			-	-	-	-	Migrant
197	Burung Asi Besar	*Malacopteron magnum*	Rufous-crowned Babbler	Timaliidae											+			-	-	-	-	Migrant
198	Burung Takur Tenggeret	*Megalaima australis*	Blue-eared Barbet	Capitonidae											+			-	-	-	-	Migrant
199	Takur Warna Warni	*Megalaima mystacophanos*	Red-throated Barbet	Capitonidae											+			-	-	-	-	Migrant
200	Burung Takur Tutut	*Megalaima rafflesii*	Red-crowned Barbet	Capitonidae											+			-	-	-	-	Migrant
201	Burung Takur Topi Emas	*Megalaime henricii*	Yellow-crowned Barbet	Capitonidae											+			-	-	-	-	Migrant
202	Caladi Batu	*Meiglytes tristis*	Buff-rumped Woodpecker	Picidae											+			-	-	-	-	Migrant
203	Caladi Badok	*Meiglytes tukki*	Buff-necked Woodpecker	Picidae											+			-	-	-	-	Migrant
204	Puyuh Hitam	*Melanoperdix nigra*	Black partridge	Phasianidae											+	+		-	-	-	III MY	Migrant
205	Kirik-kirik Laut	*Merops philippinus*	Blue-tailed Bee-eater	Meropidae			+	+	+					+				-	-	-	-	Migrant

Annex 4 *cont.* **List Species of Birds of Indonesia Mangrove Ecosystem in the South China Sea.**

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					1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
206	Kirik-kirik Biru	*Merops viridis*	Blue-throated Bee-eater	Meropidae											+			-	-	-	-	Resident
207	Alap-alap Capung	*Microhierax fringillarius*	Black-thighed Falconet	Falconidae											+			B, F	-	-	II	Migrant
208	Branjangan Jawa	*Mirafra javanica*	Australian Lark	Alaudidae			+											-	-	-	-	Migrant
209	Pelatuk Kelabu Besar	*Mulleripicus pulverulentus*	Great Slaty Woodpecker	Picidae											+			-	-	-	-	Migrant
210	Bluwok	*Mycteria cinerea*	Milk Strok	Ciconiidae			+	+	+	+	+		+	+				A, F	V	V	I	Migrant
211	Burung Madu Bakau	*Nectarinia calcostetha*	Copper-throated Sunbird	Nectariniidae					+						+			A, F	-	-	-	Resident
212	Burung Madu Sriganti	*Nectarinia jugularis*	Olive-backed Sunbird	Nectariniidae			+	+	+						+			A, F	-	-	-	Migrant
213	Burung Madu Pengantin	*Nectarinia sperata*	Purple-throated Sunbird	Nectariniidae											+			A, F	-	-	-	Resident
214	Angsa Kerdil Kapas	*Nettapus coromandelianus*	Cotton pygmy-Goose	Anatidae				+		+								A, F	-	-	-	Migrant
215	Punggok Coklat	*Ninox scutulata*	Brown Hawk-owl	Strigidae											+			-	-	-	II	Migrant
216	Gajahan Besar	*Numenius arquata*	Eurasian Curlew	Scolopacidae			+	+						+	+			F, H	-	-	-	Migrant
217	Gajahan Pengala	*Numenius phaeophus*	Whimbrel	Scolopacidae				+	+					+	+			F, H	-	-	-	Migrant
218	Kowak Malam Kelabu	*Nycticorax nycticorax*	Black-crowned Night-heron	Ardeidae			+	+	+	+					+	+		-	-	-	-	Migrant
219	Cirik-cirik Kumbang	*Nyctyornis amictus*	Red-bearded Bee-eater	Meropidae											+			-	-	-	-	Migrant
220	Kepudang Hutan	*Oriolus xanthonotus*	Dark-throated Oriole	Oriolidae											+			-	-	-	-	Migrant
221	Kepudang Kuduk Hitam	*Orioulus chinensis*	Black-naped Oriole	Oriolidae			+	+	+									-	-	-	-	Resident
222	Cinenen Kelabu	*Orthotomus ruficeps*	Ashy Tailorbird	Silviidae			+		+					+	+			-	-	-	-	Migrant
223	Cinenen Jawa	*Orthotomus sepium*	Olive-backed Tailorbird	Silviidae			+		+									-	-	-	-	Migrant
224	Cinenen Pisang	*Orthotomus sutorius*	Common Tailorbird	Silviidae			+											-	-	-	-	Migrant
225	Kancilan Bakau	*Pachycephala grisola*	Mangrove Whistler	Pachycephalidae											+			-	-	-	-	Resident
226	Elang Tiram	*Pandion haliaetus*	Osprey	Pandionidae				+			+				+			B, F	-	-	II	Migrant
227	Gelatik Batu Kelabu	*Parus major*	Great Tit	Paridae	+		+		+									-	-	-	-	Resident
228	Burung gereja erasia	*Passer montanus*	Eurasian Tree Sparrow	Ploceidae			+		+									-	-	-	-	Resident
229	Raja Udang	*Pelargopsis capensis*	Strok-billed Kingfisher	Alcedinidae										+	+		+	A, F	-	-	-	n.i
230	Undan Paruh Totol	*Pelecanus philippensis*	Spot-brilled Pelicen	Pelecanidae							+							A, F	I	-	-	Resident
231	Pelanduk Topi Hitam	*Pellorneum capistratum*	Black-capped Babbler	Timaliidae											+			-	-	-	-	Migrant
232	Sepah Tulin	*Pericrocotus igneus*	Fiery Minivet	Cumpephagidae											+			-	-	-	-	Migrant
233	Sikep Madu Asia	*Pernis ptilorhynchus*	Oriental Honey-buzzard	Accipitridae							+							B, F	-	-	II	Resident
234	Kadalan Birah	*Phaenicophaeus curvirostris*	Chesnut-breasted Malkoha	Cuculidae							+							-	-	-	-	Migrant
235	Pecuk Padi Belang	*Phalacrocorax melanoleucus*	Little Pied Cormorant	Phalacrocoracidae					+									-	-	-	-	Resident
236	Pecuk Padi Kecil	*Phalacrocorax niger*	Little Cormorant	Phalacrocoracidae			+	+	+									-	-	-	-	Resident
237	Pecuk Padi	*Phalacrocorax pymaeus*		Phalacrocoracidae					+									-	IK	-	-	Resident
238	Pecuk Padi Hitam	*Phalacrocorax sulcirostris*	Little Back Cormorant	Phalacrocoracidae				+	+									-	-	-	-	Resident
239	Philentoma sayap-Merah	*Philentoma pyrhopterum*	Rufous-winged Philentoma	Muscicapidae											+			-	-	-	-	Migrant

Annex 4 *cont.* **List Species of Birds of Indonesia Mangrove Ecosystem in the South China Sea.**

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					1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
240	Philentoma Kerudung	*Philentoma velatum*	Moroon-breasted Philentoma	Muscicapidae											+			-	-	-	-	Migrant
241	Serak Bukit	*Phodilus badius*	Oriental Bay Owl	Strigiformes											+			-	-	-	II	Migrant
242	Cikrak Kutub	*Phylloscopus borealis*	Arctic Warbler	Silviidae				+										-	-	-	-	Migrant
243	Caladi Ulam	*Picoides macei*	Fulvous-breasted macei	Picidae					+						+			-	-	-	-	Migrant
244	Caladi tilik	*Picoides moluccensis*	Sunda Woodpecker	Picidae					+									-	-	-	-	Migrant
245	Pelatuk Kumis Kelabu	*Picus mentalis*	Checker-throated Woodpecker	Picidae											+			-	-	-	-	Migrant
246	Pelatuk Sayap Merah	*Picus puniceus*	Crimson-winged Woodpecker	Picidae											+			-	-	-	-	Migrant
247	Paok Delima	*Pitta granatina*	Garnet Pitta	Pittidae											+			A, F	-	-	-	Migrant
248	Paok Hujan	*Pitta moluccensis*	Blue-winged Pitta	Pittidae											+			A, F	-	-	-	Migrant
249	Tiong Batu Kalimantan	*Pityriasis gymnocephala*	Bornean Bristlehead	Corvidae											+			-	-	-	-	Migrant
250	Tangkar Kambing	*Platysmurus leucopterus*	Black Magpie	Corvidae											+			-	-	-	-	Migrant
251	Ibis Rokoroko	*Plegadis falcinellus*	Glossy Ibis	Threskiornithidae				+	+									A, F	-	-	-	Migrant
252	Manyar Jambul	*Ploceus manyar*	Streaked Weaver	Ploceidae	+			+										-	-	-	-	Migrant
253	Trulek Kli-it	*Pluvialis dominica*	Lesser Golden Plover	Charadriidae			+	+										-	-	-	-	Migrant
254	Cerek Besar	*Pluvialis squatarola*	Grey Plover	Charadriidae				+							+			-	-	-	-	Migrant
255	Cica-Kopi Melayu	*Pomatorhinus montanus*	Chesnut-backed Scimitar-babbler	Timaliidae											+			-	-	-	-	Migrant
256	Mandar Besar	*Porphyrio porphyrio*	Purple Swamphen	Rallidae			+		+									-	-	-	-	Migrant
257	Tikusan Alis Putih	*Porzana cinerea*	White-browed Crake	Rallidae			+											-	-	-	-	Migrant
258	Tikusan Merah	*Porzana fusca*	Ruddy-breasted Crake	Rallidae			+											-	-	-	-	Migrant
259	Prenjak Jawa	*Prinia familiaris*	Bar-winged Prinia	Silviidae			+	+	+									-	-	-	-	Resident
260	Prenjak Rawa	*Prinia flaviventris*	Yellow-bellied Prinia	Silviidae			+								+			-	-	-	-	Migrant
261	Prenjak Coklat	*Prinia polychroa*	Brown Prinia	Silviidae					+									-	-	-	-	Migrant
262	Prenjak Sisi Merah	*Prinia subflova*	Tawny-flanked Prinia	Silviidae			+										+	-	-	-	-	Migrant
263	Prenjak	*Prinia veaviventris*		Silviidae													+					
264	Pentis Jawa	*Prionochilus maculatus*	Yellow-brested Flowerpecker	Dicaeidae											+			-	-	-	-	Migrant
265	Pentis Pelangi	*Prionochilus percussus*	Crimson-breasted Flowerpecker	Dicaeidae											+			-	-	-	-	Migrant
266	Pentis Kumbang	*Prionochilus thoracicus*	Scarlet-breasted Flowerpecker	Dicaeidae											+			-	-	-	-	Migrant
267	Pentis Kalimantan	*Prionochilus xanthopygius*	Yellow-rumped Flowerpecker	Dicaeidae											+			-	-	-	-	Migrant
268		*Pseudibis davisoni*														+						
269	Betet Biasa	*Psittacula alexandri*	Red-breasted Parakeet	Psittacidae					+						+			-	-	-	II	Migrant
270	Betet Ekor Panjang	*Psittacula longicauda*	Long-tailed Parakeet	Psittacidae										+	+			-	-	-	II	Migrant
271	Nuri Tanau	*Psittinus cyanurus*	Blue-rumped Parrot	Psittacidae											+			-	-	-	II	Resident

Annex 4 *cont.* **List Species of Birds of Indonesia Mangrove Ecosystem in the South China Sea.**

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					1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
272	Cucak Kurincang	*Pycnonotus atriceps*	Black-headed Bulbul	Pycnonotidae											+			-	-	-	-	Migrant
273	Cucak Kutilang	*Pycnonotus aurigaster*	Sooty-headed Bulbul	Pycnonotidae			+		+						+			-	-	-	-	Migrant
274	Cucak Kelabu	*Pycnonotus cyaniventris*	Grey-Bellied Bulbul	Pycnonotidae											+			-	-	-	-	Migrant
275	Merbah Kacamata	*Pycnonotus erythropthalmos*	Spectacled Bulbul	Pycnonotidae											+			-	-	-	-	Migrant
276	Cucak Rumbai Tungging	*Pycnonotus eutilotus*	Puff-backed Bulbul	Pycnonotidae											+			-	-	-	-	Migrant
277	Merbah Cerucuk	*Pycnonotus goiavier*	Yellow-vented Bulbul	Pycnonotidae			+	+	+						+		+	-	-	-	-	Migrant
278	Cucak Sakit Tubuh	*Pycnonotus melanoleucos*	Black and White Bulbul	Pycnonotidae											+			-	-	-	-	Migrant
279	Merbah Corok-corok	*Pycnonotus simplex*	Cream-vented Bulbul	Pycnonotidae											+			-	-	-	-	Migrant
280	Cucak Besisik	*Pycnonotus squamatus*	Scaly-breasted Bulbul	Pycnonotidae											+			-	-	-	-	Migrant
281	Cucak Rawa	*Pycnonotus zeylanicus*	Straw-headed Bulbul	Pycnonotidae											+			-	-	-	-	Migrant
282	Merbah Mata Merah	*Pygnonotus brunneus*	Red-eye Bulbul	Pycnonotidae											+			-	-	-	-	Migrant
283	Pelatuk Kundang	*Reinwardtipicus validus*	Orange-backed Woodpecker	Picidae											+			-	-	-	-	Migrant
284	Kapinis Jarum Kecil	*Rhaphidura leucopygialis*	Silver-rumped Swift	Apodidae											+			-	-	-	-	n. i.
285		*Rhapodytes diardi*		Cuculidae											+			-	-	-	-	n. i.
286	Sikatan Rimba Dada Kelabu	*Rhinomyias umbratilis*	Brown-chested Jungle flycatcher	Muscicapidae											+			-	-	-	-	Resident
287		*Rhinortha chlorophaea*													+			-	-	-	-	n. i.
288	Kipasan Belang	*Rhipidura javanica*	Pied Fantail	Muscicapidae			+	+	+						+			D, F	-	-	-	Resident
289	Kipasan Mutiara	*Rhipidura perlata*	Spotted Fantail	Muscicapidae											+			-	-	-	-	Resident
290		*Rhopodytes diardi*													+							
291		*Rhyticeros corrugatus*		Bucerotidae											+			-	V	V	II	Migrant
292	Rangkong	*Rhyticeros undulatus*												+								
293	Puyuh Sengayan	*Rollulus rouloul*	Crested Partridge	Phasiariidae											+			-	-	-	III MY	Migrant
294	Caladi Tikus	*Sasia abnormis*	Rufous Piculet	Picidae											+			-	-	-	-	Migrant
295	Kucica Batu	*Saxicola caprata*	Pied Bushchat	Turdidae			+											-	-	-	-	Migrant
296	Empuloh Paruh Kait	*Setornis criniger*	Hook-billed Bulbul	Pycnonotidae											+	+		-	-	-	-	Migrant
297	Gelatik Munguk	*Sitta frontalis*	Velvet-fronted Nuthatch	Sittadae											+			-	-	-	-	Migrant
298	Elang Ular Bido	*Spilornis cheela*	Crested Serpent Eagle	Accipitridae										+	+			B, F	-	-	II	Resident
299	Elang brontok	*Spizaetus cirrhatus*		Accipitridae						+												
300	Elang Wallace	*Spizaetus nanus*	Crested Serpent Eagle	Accipitridae											+			-	R	-	II	Resident
301	Tepus Merbah Sampah	*Stachyris erythroptera*	Chesnut-winged Babbler	Timalidae											+			-	-	-	-	Migrant
302	Tepus Tugir Merah	*Stachyris maculata*	Chesnut-rumpet Babbler	Timalidae											+		+	-	-	-	-	Migrant
303	Tepus Kaban	*Stachyris nigricollis*	Black-throated Babbler	Timalidae											+			-	-	-	-	Migrant
304	Camar Kejar Pomarin	*Stercorarius pomarinus*	Pomarine jaeger	Stercorariidae										+				-	-	-	-	Migrant
305	Dara Laut Kecil	*Sterna albifrons*	Little Tern	Sternidae											+			-	-	-	-	Resident
306	Dara Laut Batu	*Sterna anaethetus*	Bridled Tern	Sternidae											+			-	-	-	-	Migrant
307	Dara Laut Benggala	*Sterna bengalensis*	Lesser Crested-Tern	Sternidae			+											A, F	-	-	-	Migrant

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308	Dara Laut Jambul	*Sterna bergii*	Great Crested	Sternidae											+			-	-	-	-	Migrant
309	Dara Laut Biasa	*Sterna hirundo*	Common Tern	Sternidae					+						+			A, F	-	-	-	Migrant
310	Dara Laut Tengkuk Hitam	*Sterna sumatrana*	Black-naped Tern	Sternidae													+	-	-	-	-	Migrant
311	Dederuk Jawa	*Streptopelia bitorquata*	Island Collares-Dove	Columbidae			+	+										-	-	-	-	Migrant
312	Tekukur Biasa	*Streptopelia chinensis*	Spotted Dove	Columbidae			+	+	+						+		+	-	-	-	-	Migrant
313	Kukuk Beluk	*Strix leptogrammica*	Brown Wood-owl	Strigiformes											+			F, H	-	-	II	Migrant
314	Jalak Putih	*Sturnus melanopterus*	Black-winged Starling	Strigiformes					+									-	-	-	-	Migrant
315	Kedasi Hitam	*Surniculus lugubris*	Drongo-Cuckoo	Cuculidae											+			-	-	-	-	Migrant
316	Titihan Telaga	*Tachybaptus rucifollis*	Little Grebe	Podicipedidae			+											-	-	-	-	Migrant
317	Jingjing Petulak	*Tephrodornis gularis*	Large Woodshrike	Campephagidae											+			-	-	-	-	Migrant
318	Seriwang Asia	*Terpsiphone paradisi*	Japanese Paradise	Muscicapidae											+			-	-	-	-	Migrant
319	Ibis Cucuk Besi	*Threskiornis melanocephalus*	Black-headed Ibis	Threskiornithidae					+		+			+				A, F	-	-	-	Migrant
320	Cekakak Sungai	*Todirhampus chloris*	Collared Kingfisher	Alcedinidae					+									-	-	-	-	Resident
321	Cekakak suci	*Todirhampus sanctus*	Cekakak Suci	Alcedinidae			+											-	-	-	-	Migrant
322	Punai Siam	*Treron bicincta*	Orange-breasted Green	Columbidae			+											-	-	-	-	Migrant
323	Punai	*Treron capellei*		Columbidae												+						
324	Punai Lengkuak	*Treron curvirostra*	Thick-billed Green-Pigeon	Columbidae														-	-	-	-	Migrant
325	Punai Lengkuak	*Treron curvirostra*	Thick-billed Green-Pigeon	Columbidae							+				+							
326	Punai Bakau	*Treron fulvicollis*	Cinnamon-Headed Green- Pigeon	Columbidae							+							-	-	-	-	Resident
327	Punai Kecil	*Treron olax*	Little Green-Pigeon	Columbidae					+						+			-	-	-	-	Migrant
328	Punai Gading	*Treron vernans*	Pink-necked Green-Pigeon	Columbidae				+	+		+				+			-	-	-	-	Resident
329	Pelanduk Merah	*Trichastoma bicolor*	Ferruginous Babbler	Timaliidae											+			-	-	-	-	Migrant
330	Kancilan	*Trichastoma malaccense*		Timaliidae											+			-	-	-	-	Migrant
331	Kancilan Sunda	*Trichastoma sepiarium*	Horsfield's Babbler	Timaliidae											+			-	-	-	-	Migrant
332	Trinil Semak	*Tringa glareola*	Wood Sandpiper	Scolopacidae			+								+			-	-	-	-	Migrant
333	Trinil Nordmann	*Tringa guttifer*	Nordmann's Greenshank	Scolopacidae							+		+					E, F	I	I	I	Migrant
334	Trinil Pantai	*Tringa hypoleucos*	Common Sandpiper	Scolopacidae			+							+				-	-	-	-	Migrant
335	Trinil Kaki Hijau	*Tringa nebularia*	Common Greenshank	Scolopacidae			+								+			-	-	-	-	Migrant
336	Trinil Rawa	*Tringa stagnatilis*	Marsh Sandpiper	Scolopacidae			+								+			-	-	-	-	Migrant
337	Trinil Kaki Merah	*Tringa totanus*	Common Redshank	Scolopacidae			+				+							-	-	-	-	Migrant
338		*Turnix sylvatica*																				
339	Serak Rawa	*Tyto alba*	BarnOwl	Strigiformes			+	+										-	-	-	II	Migrant
340	Trinil Terik	*Xenus cinereus*	Terek Sandpiper	Scolopacidae			+	+			+				+			-	-	-	-	Migrant
341	Burung Anis Merah	*Zoothera citrina*	Orange-headed Thrush	Turdidae			+											-	-	-	-	Migrant
342	Burung Kacamata Laut	*Zosterops chloris*	Lemon-bellied White-eye	Zosteropidae			+		+									-	-	-	-	Migrant
343	Burung Kacamata Jawa	*Zosterops flavus*	Javan White-eye	Zosteropidae			+								+			-	R	-	-	Resident
344	Burung Kacamata Biasa	*Zosterops palpebrosus*	Oriental White-eye	Zosteropidae			+		+									-	-	-	-	Migrant

Annex 5 List Species of Fish of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Family	Province													Status				Remark
				1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
1	Ikan Betok	*Abudefduf coeletinus*	Pomacentridae										+								
2	Ikan Julung-julung	*Acantognathus sp.*	Hemiramphidae							+							-	-	-	-	
3	Ikan Butana	*Achanthurus mata*	Thenthidae										+				-	-	-	-	
4	Ikan Boso	*Actinogobius ommaturus*	Bobiidae			+											-	-	-	-	
5	Ikan Piso	*Aeoliscus strigatus*	Centricidae									+					-	-	-	-	
6	Ikan pari	*Aetobatus narinari*	Bobiidae			+		+									-	-	-	-	
7	Ikan Kuweh	*Alectis indica*	Carangidae			+											-	-	-	-	
8		*Alepes jedaba*				+											-	-	-	-	
9	Ikan Trubuk	*Alosa toli*	Clupidae			+											-	-	-	-	
10		*Altherina temmincki*	Centraopomidae			+											-	-	-	-	
11	Ikan Serinding	*Ambassis gymnocephalus*	Centraopomidae	+		+											-	-	-	-	Migrant
12	Ikan Serinding	*Ambassis interupta*	Centraopomidae			+											-	-	-	-	Migrant
13	Ikan Srinding	*Ambassis kopsi*	Ambassidae			+											-	-	-	-	Migrant
14	Ikan Serinding	*Ambassis nalua*	Centraopomidae			+											-	-	-	-	Migrant
15	Ikan Serinding	*Ambassis sp.*	Centraopomidae											+		+	-	-	-	-	Migrant
16		*Amblyglyphidodon aureus*	Pomacentridae											+			-	-	-	-	
17		*Amblyglyphidodon curacao*	Pomacentridae										+	+			-	-	-	-	
18	Ikan Kelabau	*Amblyrhynchichthys truncatus*	Cyprinidae											+	+	+	-	-	-	-	Migrant
19	Ikan Giru	*Amphiprion ocellaris*	Pomacentridae										+				-	-	-	-	
20	Ikan Garu	*Amphiprion percula*	Pomacentridae					+									-	-	-	-	
21		*Amphiprion sandaracinos*											+				-	-	-	-	
22	Ikan Betok	*Anabas testudineus*	Anabantidae			+		+	+	+				+	+		-	-	-	-	Migrant
23	Ikan Sidat Laut	*Anguilla australis*	Anguillidae	+		+											-	-	-	-	
24		*Anodontostoma chacunda*				+											-	-	-	-	
25		*Anthias monotoni*	Serranidae			+											-	-	-	-	
26	Ikan Belanak	*Aplocheilus panchax*	Mugilidae			+											-	-	-	-	
27	Ikan Glagah	*Apogon poecilopterus*	Apongidae			+											-	-	-	-	
28		*Apogon quinquqlineata*	Apogonidae														-	-	-	-	
29	Ikan Glagah	*Apogon sealei*	Apongidae										+				-	-	-	-	
30	Ikan Glagah	*Apogon sp.*	Apongidae										+				-	-	-	-	
31	Ikan Manyung Duri	*Arius argyropleuron*	Ariidae							+							-	-	-	-	Migrant
32	Ikan Manyung Duri	*Arius caelatus*	Ariidae							+				+	+		-	-	-	-	Migrant
33	Ikan Manyung	*Arius macolatus*	Ariidae			+						+		+	+		-	-	-	-	Migrant
34	Ikan Manyung Duri	*Arius macronotacanthus*	Ariidae			+				+							-	-	-	-	Migrant
35	Ikan manyung duri	*Arius maculatus*	Ariidae							+							-	-	-	-	
36	Ikan Manyung Duri	*Arius sagor*	Ariidae			+				+							-	-	-	-	Migrant
37	Ikan Manyung	*Arius sp.*	Ariidae		+					+			+				-	-	-	-	Migrant
38	Ikan Manyung Duri	*Arius stormi*	Ariidae							+							-	-	-	-	Migrant
39	Ikan manyung	*Arius thalassinus*	Ariidae	+				+			+			+	+		-	-	-	-	Migrant
40	Ikan duri kuning	*Arius truncatus*	Ariidae											+	+		-	-	-	-	
41	Ikan Manyung Duri	*Arius utik*	Ariidae							+							-	-	-	-	Migrant

Annex 5 *cont.* List Species of Fish of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Family	Province													Status				Remark
				1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
42	Ikan duri manyung	*Arius venosus*	Ariidae											+	+		-	-	-	-	
43		*Atherina temmineki*	Atherinidae			+											-	-	-	-	
44	Ikan Gronggong	*Atherina valenciennesi*	Atherinidae			+											-	-	-	-	
45	Ikan Tongkol	*Auxis sp.*	Thunnidae			+							+				-	-	-	-	Migrant
46	Ikan Tongkol	*Auxis thazard*	Thunnidae	+													-	-	-	-	Migrant
47	Ikan Baung Tikus	*Bagrichthys macracanthus*	Bagridae											+	+	+	-	-	-	-	Resident
48	Ikan Gulamah	*Bahaba polykladiskos*	Sciaenidae							+							-	-	-	-	
49	Ikan Gulamah	*Bahaba sp.*	Sciaenidae							+							-	-	-	-	
50	Ikan Gulamah	*Bahaba taipingensis*	Sciaenidae			+											-	-	-	-	
51	Ikan Gulamah	*Bahaba taipingensis*	Sciaenidae														-	-	-	-	
52	Ikan Paku	*Barbichthys laevis*	Cyprinidae											+	+		-	-	-	-	
53	Ikan Bonun	*Barbucca Diabolica*	Balitoridae											+	+		-	-	-	-	
54	Ikan Lundu	*Batrachocephalus mino*	Ariidae											+	+		-	-	-	-	Migrant
55	Ikas Sepat	*Belontia hasselti*	Belontidae											+	+	+	-	-	-	-	
56	Ikan Tangkit	*Betta anabantoides*	Belontidae											+	+	+	-	-	-	-	
57	Ikan Tangkit	*Betta foerschi*	Belontidae											+			-	-	-	-	
58	Ikan Cupang	*Betta pugnans*	Belontidae							+							-	-	-	-	
59	Ikan Glodok	*Boleophthalmus boddarti*	Apocrypteidae	+		+		+		+							-	-	-	-	
60	Ikan Gelang Gendis	*Brachygobius doriae*	Gobidae											+	+		-	-	-	-	Resident
61		*Breitensteinia insignis*	Akysidae											+	+		-	-	-	-	
62	Ikan Beloso	*Butis butis*	Eleotridae	+						+							-	-	-	-	
63	Ikan Beloso	*Butis gymnopomus*	Eleotridae							+							-	-	-	-	
64	Ikan Beloso	*Butis melanostigma*	Eleotridae	+	+					+							-	-	-	-	
65	Ikan Ekor Kuning	*Caesio erythrogaster*	Lutjanidae								+		+				-	-	-	-	
66		*Callionymus sagitta*	Callionymidae			+											-	-	-	-	
67		*Callionymus schaapi*	Callionymidae			+											-	-	-	-	
68	Ikan Kuwe	*Carangoides chrysophrys*	Carangidae					+									-	-	-	-	
69	Ikan Kuweh Lilin	*Carangoides sp.*	Carangidae								+						-	-	-	-	
70	Ikan Selar	*Caranx boops*	Carangidae	+		+											-	-	-	-	
71	Ikan Selar Bentong	*Caranx crumenophthalmus*	Carangidae					+									-	-	-	-	
72	Ikan Selar Batang	*Caranx kalla*	Carangidae	+						+							-	-	-	-	
73	Ikan Selar Kuning	*Caranx leptolepis*	Carangidae				+										-	-	-	-	
74	Ikan Kele Panjang	*Caranx nieuhofi*	Carangidae							+							-	-	-	-	
75	Ikan Selar Kuning	*Caranx sexfasciatus*	Carangidae							+							-	-	-	-	
76	Ikan Selar	*Caranx sp.*	Carangidae	+	+					+	+		+				-	-	-	-	
77	Ikan Cucut	*Carcharias sp.*	Carcharhinidae	+	+					+	+		+				-	-	-	-	
78	Ikan Buntal	*Carinotetraodon lorteti*	Tetraodontidae											+	+		-	-	-	-	Migrant
79		*Ceilinus fasciatus*											+				-	-	-	-	
80	Ikan Baung	*Cephalocassis melanochir*	Ariidae											+	+		-	-	-	-	
81	Ikan kerapu karang	*Cephalopholis cyanostigma*	Serranidae											+	+		-	-	-	-	
82		*Cephalopholis pachycentron*	Serranidae											+	+		-	-	-	-	

Annex 5 c*ont.* List Species of Fish of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Family	Province													Status				Remark
				1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
83	Ikan kerapu	*Cephalopholis sp.*	Serranidae										+				-	-	-	-	
84	Ikan Bandera	*Chaetodon auriga*	Chaetodontidae										+				-	-	-	-	
85	Ikan Kepe-kepe	*Chaetodon melanotus*	Chaetodontidae										+				-	-	-	-	
86	Ikan kupu-kupu	*Chaetodon octofasciatus*	Chatodontidae										+				-	-	-	-	
87		*Chaetodon oxyxephalus*	Chaetodontidae										+				-	-	-	-	
88		*Chaetodon plebesus*	Chaetodontidae										+				-	-	-	-	
89		*Chaetodon semenion*	Chaetodontidae										+				-	-	-	-	
90		*Chaetodon trifascialis*	Chaetodontidae										+				-	-	-	-	
91	Ikan kepe-kepe	*Chaetodon vagabundus*	Chaetodontidae										+				-	-	-	-	
92	Ikan Runtuk	*Channa bankanensis*	Channidae											+	+		-	-	-	-	Migrant
93	Ikan Judung	*Channa lucius*	Channidae								+			+	+	+	-	-	-	-	Migrant
94	Ikan Tomang	*Channa micropeltes*	Channidae							+				+	+		-	-	-	-	Migrant
95	Ikan Serandang	*Channa pleuropthalmus*	Channidae							+				+	+		-	-	-	-	Migrant
96	Ikan Bandang	*Channa sp.*	Channidae										+				-	-	-	-	Migrant
97	Ikan Arwana	*Channa striata*	Channidae			+							+	+	+	+	-	-	-	-	Migrant
98	Ikan Banden	*Chanos chanos*	Channidae	+		+	+	+									-	-	-	-	
99	Ikan nuri	*Cheilinus fasciatus*	Labridae											+	+		-	-	-	-	
100	Ikan Seluang	*Chela laubuca*	Cyprinidae											+	+		-	-	-	-	
101		*Chelmon rostratus*	Chatodontidae											+	+		-	-	-	-	
102		*Chelonodon patoca*	Tetraodontidae			+				+							-	-	-	-	
103	Ikan Parang-parang	*Chirocentrus dorab*	Clopeidae							+			+				-	-	-	-	
104	Ikan Gigi Anjing	*Choerodon anchorago*	Labridae														-	-	-	-	
105		*Choerodon schoewenleini*	Labridae														-	-	-	-	
106		*Chonerchines maritus*	Carangidae							+							-	-	-	-	
107		*Chonerhinos modestus*	Tetraodontidae							+							-	-	-	-	
108	Ikan Talang-talang	*Chorinemus tala*	Carangidae			+		+			+						-	-	-	-	
109		*Chorinemus toloparah*	Carangidae	+													-	-	-	-	
110		*Chromileptes altivelis*											+				-	-	-	-	
111		*Chromis analis*	Pomacentridae										+				-	-	-	-	
112		*Chrysiptera springeri*											+				-	-	-	-	
113		*Chrysiptera tricincta*											+				-	-	-	-	
114	Ikan Napoleon	*Cillianus undulatus*									+		+				-	-	-	-	
115	Ikan Keli Panjang	*Clarias batrachus*	Cloriidae					+		+			+				-	-	-	-	
116	Ikan Duri	*Clarias melanoderma*	Cloriidae							+							-	-	-	-	
117	Ikan keli panjang	*Clarias nieuhofi*								+							-	-	-	-	
118	Ikan Kelik	*Clarias teijsmanni*	Cloriidae											+	+		-	-	-	-	Resident
119	Ikan Bulu Ayam	*Clupea brachysoma*	Clupeidae							+							-	-	-	-	
120	Ikan Tembang	*Clupea dispolinotus*	Clupeidae			+											-	-	-	-	
121	Ikan Tembang	*Clupea fimbricata*	Clupeidae	+	+	+					+						-	-	-	-	
122	Ikan Bulu Ayam	*Clupea hypselosoma*	Clupeidae							+							-	-	-	-	
123	Ikan Lenguru	*Clupea leiogaster*	Clupidae														-	-	-	-	

Annex 5 *cont.* List Species of Fish of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Family	Province													Status				Remark
				1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
124	Ikan Bulu Ayam	*Clupea lile*	Clupeidae			+				+							-	-	-	-	
125	Ikan Tembang	*Clupea platygaster*	Clupeidae	+									+				-	-	-	-	
126	Ikan Tembang	*Clupea spp.*	Clupeidae														-	-	-	-	
127	Ikan Tembang	*Clupea toli*	Clupeidae			+											-	-	-	-	
128	Ikan Bulu Ayam	*Coillia dussumieri*	Clupeidae							+							-	-	-	-	
129	Ikan Ringau	*Coius quadrifasciatus*	Datnioididae											+			-	-	-	-	
130	Ikan Malung	*Congresox talabon*	Muraenesocidae										+				-	-	-	-	
131	Ikan Temperas	*Cyclocheilichthys apogon*	Caprinidae											+	+		-	-	-	-	
132	Ikan Kekulai	*Cyclocheilichthys armatus*	Caprinidae											+			-	-	-	-	
133	Ikan Kungkum	*Cyclocheilichthys janthochir*	Caprinidae											+	+		-	-	-	-	
134	Ikan Ilat-ilat	*Cynoglossus bilineatus*	Soleidae	+		+											-	-	-	-	
135	Ikan Ilat-ilat	*Cynoglossus bomeensis*	Soleidae			+											-	-	-	-	
136	Ikan Ilat-ilat	*Cynoglossus brachicephalus*	Soleidae			+											-	-	-	-	
137	Ikan ilat-ilat	*Cynoglossus cynoglossus*	Soleidae							+							-	-	-	-	
138	Ikan Lidah	*Cynoglossus feldmanni*	Soleidae											+	+		-	-	-	-	Resident
139	Ikan Ilat-ilat	*Cynoglossus kaupi*	Soleidae			+											-	-	-	-	
140	Ikan Lidah	*Cynoglossus lida*	Soleidae			+											-	-	-	-	
141	Ikan Ilat-ilat	*Cynoglossus lingua*	Soleidae							+							-	-	-	-	
142	Ikan Ilat-ilat	*Cynoglossus macrolepidotus*	Soleidae							+							-	-	-	-	
143	Ikan Lidah	*Cynoglossus puncticeps*	Soleidae			+				+							-	-	-	-	
144	Ikan Lidah	*Cynoglossus spp.*	Soleidae										+				-	-	-	-	Resident
145	Ikan jelame	*Dangila ocellata*	Lutjanidae											+	+		-	-	-	-	
146	Ikan Kiu-kiu	*Dascyllus carneus*	Pomacentridae										+				-	-	-	-	
147	Ikan Pari	*Dasyatis sp.*	Dastatidae	+	+						+		+	+			-	-	-	-	Migrant
148	Ikan Layang	*Decapterus kuroides*	Carangidae	+													-	-	-	-	
149	Ikan Layang Dedes	*Decapterus macrosoma*	Carangidae	+													-	-	-	-	
150	Ikan Layang	*Decapterus russelli*	Carangidae	+	+												-	-	-	-	
151	Ikan Layang	*Decapterus spp.*	Carangidae										+				-	-	-	-	
152	Ikan Gulamah	*Dendrophyssa russelli*								+							-	-	-	-	
153		*Dorosoma chacunda*	Clupeidae			+				+							-	-	-	-	
154	Ikan Kili-kili Buaya	*Doryichthys martensii*	Syngnathidae											+			-	-	-	-	
155	Ikan Ketang-ketang	*Drepane puncata*	Chaetodontidae							+							-	-	-	-	
156	Ikan Japuh	*Dussumieria acuta*	Clupeidae		+					+							-	-	-	-	
157	Ikan Japuh	*Dussumieria hasselti*	Clupeidae							+	+						-	-	-	-	
158		*Ecutir insidiator*				+											-	-	-	-	
159	Ikan Baju	*Eirmotus octozona*	Cyprinidae											+	+		-	-	-	-	Resident
160	Ikan Kurau	*Eleutheronema tetradactylum*	Polynemidae	+		+				+		+	+				-	-	-	-	Resident
161	Ikan Payus	*Elops hawaensis*	Elorsidae			+							+				-	-	-	-	
162	Ikan Bilis	*Engraulis grayi*	Engraulidae			+				+							-	-	-	-	
163		*Engraulis kammalensis*	Engraulidae			+											-	-	-	-	
164	Ikan Bilis	*Engraulis malabaricus*	Engraulidae			+											-	-	-	-	

Annex 5 c*ont.* List Species of Fish of Indonesia Mangrove Ecosystem in the South China Sea.

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				1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
165	Ikan Bilis	*Engraulis mystax*	Engraulidae			+				+							-	-	-	-	
166	Ikan Kerapu	*Ephinephelus boenack*	Serranidae														-	-	-	-	Resident
167	Ikan Kerapu	*Ephinephelus coioides*	Serranidae											+			-	-	-	-	Resident
168	Ikan Kerapu	*Ephinephelus nebulosus*	Serranidae	+													-	-	-	-	Resident
169	Ikan Kerapu	*Ephinephelus sp.*	Serranidae	+					+				+				-	-	-	-	Resident
170	Ikan Kerapu	*Ephinephelus tauvina*	Serranidae	+		+											-	-	-	-	Resident
171	Ikan Kerapu	*Ephiniphelus boenack*				+											-	-	-	-	
172		*Epinephelus coioides*	Serranidae												+		-	-	-	-	
173	Ikan Tongkol	*Euthynnus affinis*	Katanwonidae	+					+								-	-	-	-	Resident
174	Ikan Tongkol	*Euthynnus spp.*	Katanwonidae		+						+						-	-	-	-	Resident
175	Bawal hitam	*Formio sp.*											+				-	-	-	-	
176		*Gastrophysus lunaris*								+							-	-	-	-	
177	Ikan Keras Kaki	*Gazza minuta*	Leioganthidae	+		+											-	-	-	-	
178	Ikan Kapas	*Gerres filamentosa*	Leioganthidae			+											-	-	-	-	
179	Ikan Kapas	*Gerres macrosoma*	Leioganthidae			+											-	-	-	-	
180	Ikan Kapas	*Gerres punctatus*	Leioganthidae	+													-	-	-	-	
181	Ikan Kapas	*Gerres sp.*	Leioganthidae							+							-	-	-	-	
182	Ikan Bobosok Hitam	*Glossogobius biocellatus*	Gobiidae			+											-	-	-	-	
183	Ikan Beloso	*Glossogobius giuris*	Gobiidae	+		+											-	-	-	-	
184		*Glyptothorax major*	Sisoridae											+			-	-	-	-	
185	Ikan Tungguliang	*Gobiopterus brachypterus*	Gobiidae			+											-	-	-	-	
186		*Gymnothorax lile*	Muraenidae							+							-	-	-	-	
187	Ikan Langkung	*Hampala macrolepidota*	Cyprinidae											+			-	-	-	-	
188	Ikan Nomae	*Harpadon neherues*	Scopelidae							+			+				-	-	-	-	
189	Ikan Tembakang	*Helostoma temmincki*	Anabantidae						+					+	+		-	-	-	-	
190	Ikan Mayang	*Hemiarius stormii*	Ariidae	+										+	+		-	-	-	-	Migrant
191	Ikan Duri	*Hemipimelodus borneensis*	Ariidae											+	+		-	-	-	-	Migrant
192	Ikan Manyung Duri	*Hemipimelodus microcephalus*	Ariidae							+							-	-	-	-	
193	Ikan Kenyulung	*Hemirhamphodon kapuasensis*	Hemirhamphidae					+						+	+		-	-	-	-	Migrant
194	Ikan Julung-julung	*Hemirhamphodon pogonognatus*	Hemirhamphidae											+			-	-	-	-	
195	Ikan Julung-julung	*Hemirhamphus sp.*	Hemirhamphidae						+	+			+								
196	Ikan Julung-julung	*Hemirhamphus unifasciatus*	Hemirhamphidae			+											-	-	-	-	Resident
197	Ikan Tratjas	*Hemirhampus dussumieri*	Hemirhamphidae			+											-	-	-	-	Resident
198	Ikan Julung-julung	*Hemirhampus georgii*	Hemirhamphidae	+													-	-	-	-	Resident
199	Ikan Terubuk	*Hilsa sp.*											+				-	-	-	-	
200		*Illisha kampeni*	Pristigasteridae											+			-	-	-	-	
201	Ikan Gulamah	*Johnius belangeri*	Scaeniidae			+				+				+	+		-	-	-	-	Resident
202	Ikan Gulamah	*Johnius dussumieri*	Scaeniidae							+							-	-	-	-	
203	Ikan tiang layar	*Johnius sp.*	Sciaenidae							+							-	-	-	-	
204	Ikan tirus	*Johnius trachycephalus*	Sciaenidae											+	+		-	-	-	-	

Annex 5 *cont.* List Species of Fish of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Family	Province													Status				Remark
				1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
205	Cakalang	*Katsuwonus pelamis*	Katanwonidae						+								-	-	-	-	
206	Ikan Keting	*Ketengus sp.*	Ariidae					+									-	-	-	-	
207	Ikan Lais	*Kryptopterus apogon*	Ariidae											+	+	+	-	-	-	-	
208	Ikan Lais Juaro	*Kryptopterus cryptopterus*	Ariidae							+							-	-	-	-	
209	Ikan Aur-aur	*Kryptopterus macrocephalus*	Ariidae											+	+	+	-	-	-	-	Resident
210	Ikan Lais Muncung	*Kryptopterus micronema*	Ariidae							+							-	-	-	-	
211	Ikan Kebali	*Labiobarbus fasciatus*	Cyprinidae											+	+	+	-	-	-	-	
212	Ikan Ketulai	*Labiobarbus festivus*	Cyprinidae											+			-	-	-	-	
213	Ikan Lelemah	*Lactarius lactarius*	Lactaridae			+											-	-	-	-	
214	Ikan Buntal	*Lagocephalus lunaris*	Tetraodontidae											+	+		-	-	-	-	
215	Ikan Kakap	*Lates calcacifer*	Centropomidae	+		+			+	+			+	+	+		-	-	-	-	Migrant
216	Ikan Gapi	*Lebistes reticulatus*	Poecillidae					+									-	-	-	-	
217	Ikan Tikus	*Leiocassis fuscus*	Bagridae											+	+	+	-	-	-	-	Migrant
218	Ikan Baung Tikus	*Leiocassis micropogon*	Bagridae											+	+	+	-	-	-	-	Migrant
219	Ikan Baung Tikus	*Leiocassis myersi*	Bagridae											+	+	+	-	-	-	-	Migrant
220	Ikan Baung Tikus	*Leiocassis stenomus*	Bagridae											+	+	+	-	-	-	-	Migrant
221	Ikan Kalangkitu	*Leiognathus eguulus*	Leiognathidae			+				+							-	-	-	-	
222	Ikan Kalangkitu	*Leiognathus fasciatus*	Leiognathidae			+											-	-	-	-	
223	Ikan Petek	*Leiognathus sp.*	Leiognathidae	+				+		+							-	-	-	-	
224	Ikan Peperek Cina	*Leiognathus spledens*	Leiognathidae			+											-	-	-	-	
225		*Lepidocephalichthys pristes*	Cobitidae											+	+		-	-	-	-	
226	Ikan Jelawat	*Leptobarbus hoeveni*	Cyprinsdae						+	+		+					-	-	-	-	
227		*Leptosynanceia asteroblepa*	Synanceidae							+							-	-	-	-	
228	Ikan Belanak	*Liza carinata acrinata*	Mugilidae							+							-	-	-	-	
229	Ikan Belanak	*Liza macrolepis*	Mugilidae							+							-	-	-	-	
230	Ikan Belanak	*Liza sp.*	Mugilidae											+			-	-	-	-	
231	Ikan Kakap Batu	*Lobotes surinamensis*	Lobotidae	+													-	-	-	-	
232	Ikan Tamparosok	*Luciocephalus pulcher*	Luciociphalidae											+	+		-	-	-	-	
233	Ikan kerapu	*Lutjanus bohar*	Lutjanidae								+						-	-	-	-	
234	Ikan semerah	*Lutjanus fulvus*	Lutjanidae											+	+		-	-	-	-	
235	Ikan Kakap merah	*Lutjanus sanguineus*	Lutjanidae			+					+						-	-	-	-	
236	Ikan Kakap	*Lutjanus sp.*	Lutjanidae	+	+							+		+			-	-	-	-	Migrant
237	Ikan kakap Putih	*Lutjanus sp.*	Lutjanidae			+															
238		*Lycothrissa crocodillus*	Clupeidae											+	+		-	-	-	-	Migrant
239	Ikan Parang	*Macrochirichthys macrochirus*	Cyprinidae	+							+	+		+	+		-	-	-	-	
240	Ikan Betutu	*Macrognathus aculeatus*	Mastocempelidae							+				+	+		-	-	-	-	
241	Ikan Tilan	*Macrognathus sp.*	Mastocempelidae											+			-	-	-	-	
242	Ikan Tilan	*Macrognatus maculatus*	Mastocempelidae											+	+		-	-	-	-	
243	Ikan Lundu	*Macrones gulio*	Bagridae	+		+				+							-	-	-	-	Resident
244	Ikan Duri	*Macrones wolfi*	Bagridae							+							-	-	-	-	Resident
245	Ikan Lonjing	*Mastacembelus erythrotaenia*	Mastacembelidae											+	+		-	-	-	-	

Annex 5 *cont.* List Species of Fish of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Family	Province													Status				Remark
				1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
246	Ikan tilan	*Mastacembelus maculatus*	Mastocembelidae											+	+		-	-	-	-	
247	Ikan Botua	*Megalaspis cordyla*	Carangidae							+			+				-	-	-	-	
248	Ikan Gulamah	*Megalonibea fusca*								+							-	-	-	-	
249	Ikan Cengkurengan	*Melagopsis cordyla*	Carangidae			+		+			+						-	-	-	-	
250	Ikan Muna	*Monodactylus argenteus*	Monodactylidae			+											-	-	-	-	
251	Belut	*Monopterus albus*	Synbranchidae											+	+		-	-	-	-	
252	Ikan Belanak	*Mugil cephalus*	Mugilidae			+			+	+							-	-	-	-	
253	Ikan Belanak	*Mugil dussumieri*	Mugilidae	+	+	+		+			+	+					-	-	-	-	Resident
254	Ikan Belanak	*Mugil sp.*	Mugilidae			+	+		+								-	-	-	-	
255	Ikan Belanak	*Mugil troscheli*	Mugilidae							+							-	-	-	-	
256	Ikan Belanak	*Mugil viogiensis*	Mugilidae							+							-	-	-	-	
257	Ikan Remang	*Muraena pardalis*	Muraena			+											-	-	-	-	
258	Ikan Pucuk Kanipa	*Muraenesox talaban*	Congridae	+													-	-	-	-	
259	Ikan Baung	*Mystus micracanthus*	Notopteridae											+	+	+	-	-	-	-	Migrant
260	Ikan Baung	*Mystus nemurus*	Notopteridae							+				+	+	+	-	-	-	-	Resident
261	Ikan Baung	*Mystus nigriceps*	Notopteridae						+			+		+		+	-	-	-	-	Resident
262	Ikan Baung	*Mystus olyuroides*	Notopteridae											+	+	+	-	-	-	-	Resident
263	Ikan Baung	*Mystus wyckii*	Notopteridae											+	+	+	-	-	-	-	Migrant
264	Ikan Selipi Garam	*Nandus nebulosus*	Nandidae											+	+		-	-	-	-	
265		*Nedystoma dayii*	Ariidae	+													-	-	-	-	
266	Ikan Kurisi	*Nemipterus sp.*	Notopteridae								+		+				-	-	-	-	
267		*Neopomacentrus cyanomos*	Pomacentridae														-	-	-	-	
268	Ikan Gulamah	*Nibea soldado*	Sciaenidae							+							-	-	-	-	
269	Ikan Belido	*Notopterus bornensis Bleeker*	Notopteridae						+					+	+		J, K	-	-	-	
270	Ikan Belido	*Notopterus chilata*	Notopteridae							+							J, K	-	-	-	
271	Ikan Petek	*Notopterus notopterus*	Notopteridae		+					+							J, K	-	-	-	
272		*Odontamblyopus rubigundus*	Gobioididae							+							-	-	-	-	
273	Ikan Belanak	*Oedalechilus labiosus*								+							-	-	-	-	
274	Ikan Lais Putih	*Ompok leiacanthus*	Cyprinidae											+	+		-	-	-	-	
275	Ikan Bangko	*Ophichthys sp.*	Ophichthidae							+							-	-	-	-	
276	Ikan Gabus	*Ophiocephalus striatus*	Ophiocephalidae					+				+					-	-	-	-	
277	Ikan Bulu Ayam	*Ophistopterus macrognathus*	Pristigasteridae			+				+							-	-	-	-	
278		*Oplopomus oplopomus*		+													-	-	-	-	
279	Ikan Mujair	*Oreochromis mosambicus*	Cichlidae				+	+									-	-	-	-	
280	Ikan Nila	*Oreochromis nilotica*	Cichlidae					+													
281	Ikan Kaloi	*Osphronemus goramy*	Osphronemidae											+	+		-	-	-	-	
282	Ikan Kebali	*Osteochilus hasselti*	Cyprinidae											+	+	+	-	-	-	-	Migrant
283		*Osteochilus kappenii*	Cyprinidae											+	+						
284	Ikan Kelabau	*Osteochilus melanopleura*	Cyprinidae											+	+		-	-	-	-	Migrant
285	Ikab Seluang	*Osteochilus spilurus*	Cyprinidae											+	+		-	-	-	-	Migrant
286	Ikan Kelabau	*Osteochilus waandersii*	Cyprinidae											+			-	-	-	-	Migrant

Annex 5 *cont.* List Species of Fish of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Family	Province													Status				Remark
				1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
287	Ikan Manyung Duri	*Osteogeneiosus militaris*	Ariidae							+							-	-	-	-	
288	Ikan Buntel	*Ostracion nasus*	Ostraciidae			+											-	-	-	-	
289	Ikan Gilingan	*Otolithes argenteus*	Sciaenidae			+											-	-	-	-	
290	Ikan Jarang	*Otolithes cuvieri*	Sciaenidae			+				+							-	-	-	-	
291	Ikan Gigi Karang	*Otolithes lateoides*	Sciaenidae			+											-	-	-	-	
292	Ikan Tiga Wajah	*Otolithes micradon*	Sciaenidae			+											-	-	-	-	
293	Ikan Gulamah	*Otolithes pama*	Sciaenidae							+							-	-	-	-	
294	Ikan Gulamah	*Otolithes ruber*	Sciaenidae							+							-	-	-	-	
295	Ikan Blama	*Otolithoides brunneuss*	Sciaenidae			+											-	-	-	-	
296	Ikan Betutu	*Oxyeleotris marmorata*	Eleotridae						+					+			-	-	-	-	Migrant
297	Ikan Bakut	*Oxyeleotris urophthalmoides*	Eleotridae											+	+		-	-	-	-	Migrant
298	Ikan Bedul	*Oxyrichthys micropelis*	Gobidae			+											-	-	-	-	
299	Ikan Bawal Putih	*Pampus argenteus*		+		+				+							-	-	-	-	Migrant
300	Ikan Bawal	*Pampus chinensis*								+							-	-	-	-	Migrant
301	Bawal putih	*Pampus* sp.											+				-	-	-	-	
302	Ikan Kepala Timah	*Panchax panchax*	Cyprinodontidae					+									-	-	-	-	
303	Ikan Lawang	*Pangasius lithosoma*	Pangasidae											+			-	-	-	-	
304	Ikan Juaro	*Pangasius polyuranodon*	Pangasidae							+							-	-	-	-	
305	Ikan Bandeng	*Pangasius sp.*	Pangasidae					+									-	-	-	-	
306	Ikan Seluang	*Parachela oxygastroides*	Cyprinidae											+	+		-	-	-	-	
307		*Paraglyphidodon nigroris*	Pomacentridae														-	-	-	-	
308		*Parakysis anomalopteryx*	Parakysidae											+	+		-	-	-	-	
309	Ikan Serinding	*Parambassis macrolepis*	Centraopomidae	+										+	+	+	-	-	-	-	
310	Ikan Bawal Hitam	*Parastromateus niger*			+	+											-	-	-	-	
311	Ikan Tangkit	*Parosphonemus sp.*	Belontidae											+			-	-	-	-	
312	Ikan Dero	*Pellona ditchoa*	Clumpeidae			+				+							-	-	-	-	
313	Ikan Peperang	*Pellona kampeni*	Clupeidae											+	+		-	-	-	-	
314	Ikan Bulu Ayam	*Pellona sp.*	Clumpeidae							+							-	-	-	-	
315	Ikan Bulu Ayam	*Pellona xanthoptera*	Clumpeidae							+							-	-	-	-	
316	Ikan Tembakul	*Periophthalmus chrysospilos*	Periophthalmidae											+	+		-	-	-	-	
317	Ikan Blodok	*Periophthalmus variabilis*	Periophthalmidae			+	+										-	-	-	-	
318	Ikan Belodok	*Periophthamodon schlosseri*					+					+					-	-	-	-	
319	Ikan sebelah	*Pespodes spp.*											+				-	-	-	-	
320	Ikan Baji-baji	*Platycephalus crocodilus*	Platicephalidae			+											-	-	-	-	Resident
321	Ikan Baji-baji	*Platycephalus scaber*	Platicephalidae			+											-	-	-	-	Resident
322	Ikan Sembilang	*Plotosus canius*	Platosidae	+		+				+				+	+		-	-	-	-	
323	Ikan Selangan	*Plotosus sp.*	Platosidae									+					-	-	-	-	
324	Ikan kedepar	*Polyacanthus haselti*								+							-	-	-	-	
325	Ikan Senangin	*Polynemus dubius*	Polynemidae							+							-	-	-	-	
326	Ikan Kuro	*Polynemus multifilis*	Polynemidae							+							-	-	-	-	
327		*Polynemus sextarius*	Polynemidae			+											-	-	-	-	

Annex 5 c*ont.* List Species of Fish of Indonesia Mangrove Ecosystem in the South China Sea.

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				1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
328	Ikan Kepe-kepe	*Pomacanthus semicirculatus*	Pomacanthidae	+													-	-	-	-	
329	Ikan Gerot-gerot	*Pomadasys hasta*	Lutjanidae	+		+		+		+	+	+	+				-	-	-	-	Resident
330	Ikan Ampling	*Pomatomus saltator*	Pomatomidae			+											-	-	-	-	
331		*Porochilus obbesi*	Plotosidae	+													-	-	-	-	
332		*Porosoma chacunda*		+													-	-	-	-	
333	Ikan Patong	*Pristolepis fasciata*	Pristoleptidae	+										+	+		-	-	-	-	
334	Ikan Gulamah	*Protonibea diacanthus*								+							-	-	-	-	
335		*Psamoperca waigiensis*	Ceutropomidae	+													-	-	-	-	
336	Ikan Jaingan	*Pseudapocryptes lanceolatus*	Gobiidae	+		+											-	-	-	-	
337		*Pseudomia polystigma*		+													-	-	-	-	
338		*Pseudomugil gertrudae*		+													-	-	-	-	
339	Ikan Tigawojo	*Pseudosciaena aneus*	Sciaenidae		+												-	-	-	-	
340	Ikan Terusan	*Pseudosciaena microlepis*	Sciaenidae							+							-	-	-	-	
341	Ikan Otot	*Pseudosciaena saldado*	Sciaenidae	+													-	-	-	-	
342	Ikan Lepu	*Pterois ruslii*	Scorpaenidae					+									-	-	-	-	
343	Ikan Paku	*Puntioplites bulu*	Cyprinidae											+	+		-	-	-	-	
344	Ikan Bemba	*Puntioplites waandersi*	Cyprinidae											+	+		-	-	-	-	
345	Ikan Bungkarit	*Puntius eugrammus*	Cyprinidae											+	+	+	-	-	-	-	
346	Ikan Sari Gantang	*Puntius Rhomboocellatus*	Cyprinidae											+	+		-	-	-	-	
347	Ikan Seluang Batang	*Rasbora argyrotaenia*	Cyprinidae							+							-	-	-	-	
348	Ikan Seluang	*Rasbora bankanensis*	Cyprinidae									+		+	+		-	-	-	-	
349	Ikan Seluang	*Rasbora cephalotaenia*	Cyprinidae											+	+		-	-	-	-	
350	Ikan Seluang	*Rasbora dorsiocellata*	Cyprinidae											+	+		-	-	-	-	
351	Ikan Seluang	*Rasbora dusonensis*	Cyprinidae											+	+		-	-	-	-	
352	Ikan Seluang	*Rasbora gracilis*	Cyprinidae											+		+	-	-	-	-	
353	Ikan Seluang	*Rasbora kalbarensis*	Cyprinidae											+	+		-	-	-	-	
354	Ika Seluang Padi	*Rasbora kalochroma*	Cyprinidae											+	+		-	-	-	-	
355	Ikan Bahuk	*Rasbora pauciperforata*	Cyprinidae											+	+		-	-	-	-	
356	Ikan Seluang Bilis	*Rasbora sp.*	Cyprinidae						+	+							-	-	-	-	
357	Ikan Seluang Maram	*Rasbora tornieri*	Cyprinidae											+	+		-	-	-	-	
358	Ikan Seluang	*Rasbora vaillanti*	Cyprinidae							+							-	-	-	-	
359	Ikan Kembung	*Rastrelliger brachysoma*	Scombridae					+													
360	Ikan Kembung	*Rastrelliger kanagurta*	Scombridae					+													
361	Ikan Kembung	*Rastrelliger neglectus*	Scombridae	+		+	+				+	+	+				-	-	-	-	Migrant
362	Ikan Kembung	*Rastrellinger brachysoma*	Scombridae	+		+											-	-	-	-	
363	Ikan Kembung	*Rastrellinger kanagurta*	Scombridae	+		+											-	-	-	-	
364	Ikan Kembung	*Ratrelliger spp.*	Scombridae		+				+								-	-	-	-	
365		*Sarda orientalis*	Myctopheidae	+													-	-	-	-	
366	Ikan Tembang	*Sardinella fimbriata*	Clupeidae	+		+		+	+	+							-	-	-	-	
367	Ikan Lemuru	*Sardinella lemuru*	Clupeidae	+	+						+						-	-	-	-	
368	Ikan Siro	*Sardinella siro*	Clupeidae	+													-	-	-	-	

Annex 5 *cont.* List Species of Fish of Indonesia Mangrove Ecosystem in the South China Sea.

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				1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
369	Ikan Lemuru	*Sardinella sp.*	Clupeidae										+				-	-	-	-	
370	Ikan Bloso	*Saurida gracilis*				+											-	-	-	-	
371		*Scartelaos viridis*	Gobiidae	+													-	-	-	-	
372	Ikan Kakatua	*Scarus microrhinus*	Scaridae								+						-	-	-	-	
373		*Scatophagus argus*	Chaetodontidae	+		+		+		+				+	+		-	-	-	-	
374	Ikan Kerakot	*Sciaena macropterus*	Scianidae			+											-	-	-	-	
375	Ikan Arwana	*Scleropages formosus*	Osteoglabsidae							+				+	+		-	-	-	-	
376	Ikan Tengiri	*Scomberomerus commerson*	Scomberomoridae	+		+						+					-	-	-	-	
377	Ikan Tengiri	*Scomberomerus guttatus*	Scomberomoridae	+		+				+							-	-	-	-	
378	Ikan Tengiri	*Scomberomorus sp.*	Scomberomoridae		+	+				+	+		+				-	-	-	-	
379		*Secutor ruconius*	Leiognathidae							+							-	-	-	-	Resident
380	Ikan Peperek	*Secutor sp.*	Leiognathidae		+									+			-	-	-	-	Resident
381	Ikan Selar Betong	*Selar crumenophthalmus*	Carangidae	+													-	-	-	-	
382		*Selaroides leptolepsis*	Carangidae	+									+				-	-	-	-	
383		*Senentodon conciloidee*		+													-	-	-	-	
384		*Seriolla dumerilli*	Carangidae			+											-	-	-	-	
385		*Seriolla nigrofasciata*	Carangidae			+											-	-	-	-	
386	Ikan Bulu Ayam	*Setipinna breviceps*	Clupeidae							+							-	-	-	-	Resident
387	Ikan Bilis	*Setipinna melanochir*	Clupeidae			+				+							-	-	-	-	Resident
388	Ikan Bulu Ayam	*Setipinna sp.*	Clupeidae	+													-	-	-	-	Resident
389		*Setipinna taty*	Clupeidae							+							-	-	-	-	
390	Ikan Tungguliang	*Sicyopus zosterophorum*	Gobiidae			+											-	-	-	-	Resident
391	Ikan Lingkis	*Siganus canaliculatus*	Siganidae							+							-	-	-	-	
392	Baronang	*Siganus corallinus*	Siganidae	+													-	-	-	-	
393	Ikan Baranong	*Siganus javus*	Siganidae	+		+					+						-	-	-	-	
394	Ikan Samandar	*Siganus sp.*	Siganidae					+									-	-	-	-	
395	Ikan Gelih	*Silago sihama*	Sillaginidae	+		+				+							-	-	-	-	
396	Ikan Boyor	*Sillago sp.*	Sillaginidae						+								-	-	-	-	
397	Ikan Lais hutan	*Silurichthys hasseltii*	Siluridae											+	+	+	-	-	-	-	Resident
398	Ikan Anak Tapa Hutan	*Silurichthys phaiosoma*	Siluridae											+	+	+	-	-	-	-	Resident
399	Ikan Lidah	*Solea humilis*	Pleuronectidae			+											-	-	-	-	
400	Ikan Sumpit	*Sphaerichthys osphromenoides*	Belontidae							+							-	-	-	-	Migrant
401	Ikan Anak Sepat	*Sphaerichthys vaillanti*	Belontidae											+	+	+	-	-	-	-	Migrant
402	Ikan alu-alu	*Sphyraena forsteri*	Sphyraenidae		+						+			+	+		-	-	-	-	
403	Ikan Alu-alu	*Sphyraena jello*	Sphyraenidae	+		+				+							-	-	-	-	
404		*Sporoides oblongus*								+							-	-	-	-	
405	Ikan Teri	*Stelophorus commersoni*	Clupeidae	+						+							-	-	-	-	
406		*Stenogobius genivitatus*	Gobiidae	+						+							-	-	-	-	
407	Ikan Teri	*Stolepharus sp.*	Clupeidae							+							-	-	-	-	
408	Ikan Teri	*Stolephorus baganensis*	Clupeidae							+							-	-	-	-	

Annex 5 c*ont.* List Species of Fish of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Family	Province													Status				Remark
				1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
409	Ikan Teri	*Stolephorus commersonii*	Clupeidae	+		+											-	-	-	-	
410	Ikan Teri	*Stolephorus heterolobus*	Clupeidae			+											-	-	-	-	
411	Ikan Teri	*Stolephorus insularis*	Clupeidae							+							-	-	-	-	
412	Ikan Teri Nasi	*Stolephorus sp.*	Clupeidae	+					+				+				-	-	-	-	
413	Ikan Teri	*Stolephorus tri*	Clupeidae		+	+				+	+						-	-	-	-	
414	Ikan Teri	*Stolephorus zollingeri*	Clupeidae	+		+											-	-	-	-	
415	Ikan Bawal Hitam	*Stromatens niger*	Formlidae							+							-	-	-	-	
416	Ikan Bawal	*Stromateus cinereus*	Formlidae	+	+						+	+					-	-	-	-	
417		*Synapobranchus brevidorsalis*		+													-	-	-	-	
418	Ikan Lidah	*Synaptura aspilos*	Soleidae							+							-	-	-	-	
419	Ikan Ilat-ilat	*Synaputra zebra*	Soleidae			+											-	-	-	-	
420	Belut Tambak	*Synbranchus bengalensis*	Soleidae			+											-	-	-	-	
421	Ikan Manyung	*Tachysurus* sp.								+											
422	Ikan Buntal	*Takifugu oblongus*	Tetraodontidae											+	+		-	-	-	-	
423		*Taniodes cirratus*	Gobiidae							+							-	-	-	-	
424	Ikan Kekerong	*Terapon jabua*	Therapenidae											+	+		-	-	-	-	
425	Ikan Buntel	*Tetraodon fluviatilis*	Tetraodontidae	+													-	-	-	-	Migrant
426	Ikan Buntal	*Tetraodon immaculatus*	Tetraodontidae			+											-	-	-	-	
427	Ikan Buntal	*Tetraodon nigroviridis*	Tetraodontidae											+	+		-	-	-	-	Migrant
428	Ikan Buntal	*Tetraodon palembangensis*	Tetraodontidae	+										+	+		-	-	-	-	Migrant
429	Ikan Manyung	*Thachyrus spp.*	Ariidae						+								-	-	-	-	
430	Ikan bayeman cagal	*Thalassoma lunare*	Labridae					+									-	-	-	-	
431	Ikan Kerong-kerong	*Theraphon teraps*	Therapenidae			+											-	-	-	-	
432	Ikan Erong-erong	*Therapon jarbua*	Therapenidae							+							-	-	-	-	
433	Ikan Kerong-kerong	*Therapon habbemai*	Therapenidae	+													-	-	-	-	
434	Ikan Kerong-kerong	*Therapon jarbua*	Therapenidae			+											-	-	-	-	
435	Ikan Kerong-kerong	*Therapon puta*	Therapenidae			+											-	-	-	-	
436	Ikan Kerot-kerot	*Therapon sp.*	Theraponidae											+			-	-	-	-	
437	Ikan Kerong-kerong	*Therapon theraps*	Therapenidae	+													-	-	-	-	
438	Ikan Layur	*Thrichiurus haumela*	Trichiuridae			+											-	-	-	-	
439	Ikan Layur	*Thrichiurus savala*	Trichiuridae			+											-	-	-	-	
440	Ikan Bulu Ayam	*Thrissa hamiltonii*	Clupeidae			+											-	-	-	-	
441	Ikan Madidihang	*Thunnus albacares*	Scrombridae			+			+								-	-	-	-	
442	Belut Tambak	*Thyrsoidea macrunus*								+							-	-	-	-	
443	Ikan Sumpit	*Toxotes chatareus*	Toxotidae											+	+		-	-	-	-	
444	Ikan Sumpit	*Toxotes jaculator*	Toxotidae	+						+							-	-	-	-	Resident
445	Ikan Senyumpit	*Toxotes microlepis*	Toxotidae											+	+		-	-	-	-	
446	Ikan Susur Wedi	*Trachiphalus sp.*							+								-	-	-	-	
447	Ikan Sokang	*Triacanthus biaculeatus*	Carangidae			+											-	-	-	-	
448	Ikan Lowang	*Triacanthus blochi*	Carangidae							+							-	-	-	-	
449	Ikan Kajang	*Trichiurus glossodon*	Trichiuridae							+							-	-	-	-	

Annex 5 c*ont.* List Species of Fish of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Family	Province													Status				Remark
				1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
450	Ikan Kajang	*Trichiurus muticus*	Trichiuridae							+							-	-	-	-	
451	Ikan Laur	*Trichiurus savala*	Trichiuridae	+													-	-	-	-	
452	Ikan Layur	*Trichiurus sp.*	Trichiuridae	+	+	+				+			+				-	-	-	-	Migrant
453	Ikan Sesepat	*Trichogaster leeri*	Anabantidae											+	+	+	-	-	-	-	Migrant
454	Ikan Sepat Rawa	*Trichogaster pectoralis*	Anabantidae					+									-	-	-	-	Migrant
455	Ikan Sepat Jawa	*Trichogaster trichopteris*	Anabantidae			+		+						+	+		-	-	-	-	Migrant
456	Ikan Layur	*Trichuirus haumela*	Trichiuridae					+									-	-	-	-	
457	Ikan Kacang-kacang	*Tylosurus crocodiles leseveur*	Belonidae			+											-	-	-	-	
458	Ikan Julung-julung	*Tylosurus leiurus*	Belonidae			+											-	-	-	-	
459	Ikan Julung-julung	*Tylosurus sp.*	Belonidae		+	+								+			-	-	-	-	
460	Ikan Cendro	*Tylosurus strongilunus*	Belonidae	+		+				+							-	-	-	-	
461	Ikan Gulamah	*Umbrina sp.*	Sciaenidae	+						+							-	-	-	-	
462	Ikan Biji Nangka	*Upeneus berberinus*	Multidae			+											-	-	-	-	
463	Ikan Kunira	*Upeneus sulphureus*	Multidae	+		+							+				-	-	-	-	
464	Ikan Kada	*Valamugil buchanani*	Mugitlidae	+													-	-	-	-	
465	Ikan Kada	*Valamugil seheli*	Mugitlidae			+											-	-	-	-	
466	Ikan Kada	*Valamugil speigleri*	Mugitlidae			+							+				-	-	-	-	Resident
467	Ikan Tapah	*Wallago leerii*	Siluridae											+	+	+	-	-	-	-	Resident
468	Ikan Tapah	*Wallago miostoma*	Siluridae							+							-	-	-	-	
469		*Weberogobius amodi*		+													-	-	-	-	
470	Ikan Bandera	*Zanlus cornitus*	Chaetodontidae					+									-	-	-	-	
471	Ikan Jelung-julung	*Zenarchopterus ectuntio*	Hemirhamphidae					+		+							-	-	-	-	
472	Ikan Bambangan				+						+						-	-	-	-	
473	Ikan Bulat										+						-	-	-	-	
474	Ikan Cakalan				+												-	-	-	-	
475	Ikan Kewe										+						-	-	-	-	
476	Ikan Lele	*Clarias batracus*	Clariidae									+					-	-	-	-	
477	Ikan Patin								+			+					-	-	-	-	
478	Ikan Rajungan			+													-	-	-	-	
479	Ikan Temang			+													-	-	-	-	
480	Ikan Tuna				+												-	-	-	-	
481	Ikan kecil					+											-	-	-	-	
482	Ikan Sotong					+											-	-	-	-	

Annex 6 List Species of Crustacean of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Family	Province													Status				Remark
				1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
1		*Acartia clausi*			+								+				-	-	-	-	
2		*Acartia* sp.							+								-	-	-	-	
3	Udang rebon	*Acetes* sp											+				-	-	-	-	
4		*Acrocalanus* sp.			+				+								-	-	-	-	
5		*Allochester* sp.				+	+										-	-	-	-	
6	Udang duri	*Alpheus* sp	Alphedidae			+	+						+				-	-	-	-	
7		*Amphithoe* sp.											+				-	-	-	-	
8		*Apseudes*											+				-	-	-	-	
9		*Balamus* sp.	Balanidae			+	+										-	-	-	-	
10		*Calana* sp.				+											-	-	-	-	
11		*Calanus minor*	Cypridídae			+											-	-	-	-	
12		*Calanus* sp.	Cypridídae		+		+					+					-	-	-	-	
13		*Calathura* sp.											+				-	-	-	-	
14		*Caprella* sp.	Caprellidae										+				-	-	-	-	
15		*Caridea* sp.											+				-	-	-	-	
16		*Centropages* sp.			+				+								-	-	-	-	
17		*Clistocaeloma omuguiansis*	Grapsidae					+									-	-	-	-	
18		*Coenobita* sp.	Coenobitidae			+											-	-	-	-	
19	Kepiting bakau	*Cordiosoma* sp.								+							-	-	-	-	
20		*Corycaeus* sp.							+								-	-	-	-	
21		*Crasyonix* sp.											+				-	-	-	-	
22		*Crycaeus* sp.										+					-	-	-	-	
23		*Cyclop* sp.	Cyclopidae	+		+						+					-	-	-	-	
24		*Cypridina* sp.											+				-	-	-	-	
25		*Daphnia* sp.	Daphniidae	+													-	-	-	-	
26		*Dentalium eboreum*											+				-	-	-	-	
27		*Diastylis* sp.											+				-	-	-	-	
28		*Disarina batavianum*	Grapsidae					+									-	-	-	-	
29		*Doclea* sp.											+				-	-	-	-	
30		*Ellakatothrix sp.*		+													-	-	-	-	
31		*Erichthonius difformis*		+													-	-	-	-	
32		*Eucalanus* sp.			+							+					-	-	-	-	
33		*Euchaeta* sp.				+											-	-	-	-	
34		*Eucypris* sp.											+				-	-	-	-	
35		*Eugammarus* sp.				+											-	-	-	-	
36		*Eurytemora* sp.			+												-	-	-	-	
37		*Euterpina* sp.							+			+					-	-	-	-	
38		*Evadne* sp.			+	+			+								-	-	-	-	
39		*Gammorus* sp.											+				-	-	-	-	
40		*Gamnarellus* sp.											+				-	-	-	-	

Annex 6 *cont.* List Species of Crustacean of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Family	Province													Status				Remark
				1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
41		*Gnathia* sp.	Paratanaidae										+				-	-	-	-	
42		*Grapsus tenuirristatus*	Grapsidae											+	+	+	-	-	-	-	
43		*Helice* sp.		+													-	-	-	-	
44		*Heterotanais* sp.											+				-	-	-	-	
45		*Hipplyte varians*											+				-	-	-	-	
46		*Ilyoplax delsinamii*	Ocypodidae			+		+									-	-	-	-	
47		*Ilyoplax Orientalis*	Ocypodidae					+									-	-	-	-	
48		*Lepas* sp.			+												-	-	-	-	
49		*Leptognatha* sp.				+	+										-	-	-	-	
50		*Limulus* sp.					+										-	-	-	-	
51		*Lucaea* sp.		+													-	-	-	-	
52		*Lucifer* sp										+					-	-	-	-	
53		*Lysiosqailla* sp.				+	+										-	-	-	-	
54		*Macrosetella* sp.										+					-	-	-	-	
55		*Maerophthalimus conucxus*	Ocypodidae					+									-	-	-	-	
56		*Maerophthalimus definitas*	Ocypodidae					+									-	-	-	-	
57		*Maerophthalimus teleseopium*	Ocypodidae					+									-	-	-	-	
58		*Mesopodopsis* sp.				+											-	-	-	-	
59	Udang kuning	*Metapenaeus bervicornis*	Penaeidae	+		+											-	-	-	-	
60	Udang krosok	*Metapenaeus burkenroadi*	Penaeidae						+								-	-	-	-	
61	Udang dogol	*Metapenaeus elegans*	Penaeidae						+								-	-	-	-	
62	Udang dogol	*Metapenaeus ensis*	Penaeidae	+		+			+								-	-	-	-	
63	Udang dogol	*Metapenaeus lysianssa*	Penaeidae						+								-	-	-	-	
64	Udang api	*Metapenaeus monoceros*	Penaeidae			+			+								-	-	-	-	
65	Udang mentil	*Metapenaeus* sp.	Penaeidae	+		+											-	-	-	-	
66		*Metaplax elegans*	Grapsidae					+									-	-	-	-	
67		*Metis* sp.				+											-	-	-	-	
68		*Microsetella* sp.			+				+								-	-	-	-	
69	Udang satang	*Mocrobrachium roserbergii*								+							-	-	-	-	
70		*Naupilus* sp.		+		+	+		+			+					-	-	-	-	
71		*Ocypoda anenaria*	Ocypodidae					+									-	-	-	-	
72	Kepiting pasir	*Ocypoda* sp.	Ocypodidae	+							+						-	-	-	-	
73		*Ocypoda uratophthalima*	Ocypodidae					+									-	-	-	-	
74		*Oithona* sp.							+			+					-	-	-	-	
75		*Oncaea* sp.							+								-	-	-	-	
76		*Oxyurostylis* sp.											+				-	-	-	-	
77	Udang putih	*Palaemonetes* spp							+	+							-	-	-	-	
78		*Paracalanus* sp.				+											-	-	-	-	
79	Udang merah	*Parapenaeus* sp											+				-	-	-	-	
80		*Parvocalanus* sp.							+								-	-	-	-	

Annex 6 *cont.* List Species of Crustacean of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Family	Province													Status				Remark
				1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
81	Udang dogol	*Penaeus indicus*	Penaeidae						+	+	+			+			-	-	-	-	
82	Udang putih	*Penaeus marquensis*	Penaeidae	+		+			+	+			+	+	+	+	-	-	-	-	
83	Udang windu	*Penaeus monodon*	Penaeidae			+				+				+	+	+	-	-	-	-	
84	udang jerbung	*Penaeus orientalis*	Penaeidae			+			+		+			+	+	+	-	-	-	-	
85	Udang tiger	*Penaeus semiculatus*	Penaeidae	+						+							-	-	-	-	
86	udang rebon	*Penaeus* sp.	Penaeidae	+		+	+		+		+						-	-	-	-	
87		*Penaieidae* sp											+				-	-	-	-	
88		*Phtisica* sp.	Caprellidae										+				-	-	-	-	
89		*Pinnixa* sp.											+				-	-	-	-	
90		*Pinnotheres* sp.	Pinnoteridae										+				-	-	-	-	
91	Rajungan	*Portunus pelagicus*	Portunidae			+							+				-	-	-	-	
92	Rajungan	*Portunus* spp.	Portunidae							+							-	-	-	-	
93		*Pseudocalanus* sp.			+												-	-	-	-	
94		*Saphirella gamma*											+				-	-	-	-	
95		*Sapparina* sp.	Sapphirinaidae		+												-	-	-	-	
96		*Scoleeithricella abyssalis*											+				-	-	-	-	
97		*Scoleeithricella ctenopus*											+				-	-	-	-	
98	Kepiting	*Scylla serrata*	Potunidae	+		+				+			+	+	+	+	-	-	-	-	
99	kepiting bakau	*Scylla* sp.	Potunidae	+													-	-	-	-	
100		*Scylla sudata*	Portumidae					+									-	-	-	-	
101		*Scylla transquebarita*	Potunidae											+	+	+	-	-	-	-	
102		*Sesarma bidens*	Grapsidae					+									-	-	-	-	
103		*Sesarma bocaurti*	Grapsidae					+									-	-	-	-	
104		*Sesarma cumolps*	Grapsidae					+									-	-	-	-	
105		*Sesarma erythmodactylum*	Grapsidae					+									-	-	-	-	
106		*Sesarma fasciatum*	Grapsidae					+									-	-	-	-	
107		*Sesarma longipes*	Grapsidae					+									-	-	-	-	
108		*Sesarma meinerti*	Grapsidae					+									-	-	-	-	
109		*Sesarma onychophora*	Grapsidae					+									-	-	-	-	
110		*Sesarma rousseauni*	Grapsidae					+									-	-	-	-	
111		*Sesarma smithi*	Grapsidae					+									-	-	-	-	
112	Kepiting	*Sesarma sp*		+		+											-	-	-	-	
113		*Sesarma taeniolata*	Grapsidae					+									-	-	-	-	
114	Udang ronggeng	*Squilla harpax*					+										-	-	-	-	
115	Lobster	*Thalassina anomala*	Upogebidae							+			+				-	-	-	-	
116		*Tigriopus* sp.			+												-	-	-	-	
117		*Uca annulipes*	Ocypodidae					+									-	-	-	-	
118		*Uca bellator bellator*	Ocypodidae			+											-	-	-	-	
119		*Uca cvocans-vocans*	Ocypodidae					+									-	-	-	-	
120	Kepiting	*Uca dussumieri*	Ocypodidae					+		+							-	-	-	-	

Annex 6 c*ont.* List Species of Crustacean of Indonesia Mangrove Ecosystem in the South China Sea.

No	Vernacular Name	Scientific Name	Family	Province													Status				Remark
				1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
121		*Uca lactea*	Ocypodidae					+					+				-	-	-	-	
122		*Uca siguatus*	Ocypodidae					+									-	-	-	-	
123		*Uca* sp.	Ocypodidae	+													-	-	-	-	
124		*Uca tetragonon*	Ocypodidae			+											-	-	-	-	
125		*Uca triangularis*	Ocypodidae					+									-	-	-	-	
126		*Ucaconsobrinus*	Ocypodidae					+									-	-	-	-	
127	Udang karang																-	-	-	-	
128	Udang PS					+											-	-	-	-	
129	Udang sandul					+											-	-	-	-	
130	Udang serengkeh									+							-	-	-	-	

Annex 7 List Species of Gastropods of Indonesia Mangrove Ecosystem in the South China Sea.

No	Scientific Name	Family	Province													Status			Remarks
			1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1994	CITES 1995	
1	*Aclis* sp.					+										-	-	-	
2	*Actaeo pyramis*					+										-	-	-	
3	*Acteon tornatilis*					+										-	-	-	
4	*Adiata gracilion*					+										-	-	-	
5	*Afer comungii*				+											-	-	-	
6	*Agatha* sp.					+	+									-	-	-	
7	*Aliculastrum cylindricum*					+										-	-	-	
8	*Allia* sp.					+										-	-	-	
9	*Allopeas* sp.					+	+									-	-	-	
10	*Amaea* sp.					+										-	-	-	
11	*Antemetulla* sp.					+										-	-	-	
12	*Architectonia maxima*	Architectonicidae			+	+										-	-	-	
13	*Architectonica sp.*	Architectonicidae										+				-	-	-	
14	*Architectonica trochlearis*	Architectonicidae			+											-	-	-	
15	*Argobuicinum argus*				+											-	-	-	
16	*Assiminea brevicula*		+		+											-	-	-	
17	*Assiminea woodmansoniana*		+													-	-	-	
18	*Astele pulcherrimus*					+							+	+	+	-	-	-	
19	*Ataetodea alabrata*	Mesodosmatidae					+									-	-	-	
20	*Ataxocerithium abnormale*	Mesodosmatidae				+										-	-	-	
21	*Australaka* sp.					+										-	-	-	
22	*Babella*						+									-	-	-	
23	*Batillaria* sp.									+						-	-	-	
24	*Bekkochlamys*					+										-	-	-	
25	*Bittium affenuatum*					+										-	-	-	
26	*Bittium* sp.					+										-	-	-	
27	*Blanfordia* sp.					+	+									-	-	-	
28	*Brotia* sp.							+								-	-	-	
29	*Buccirium plectrum*					+										-	-	-	
30	*Bulbus* sp.					+										-	-	-	
31	*Bullia rhodostoma*	Nassaridae					+									-	-	-	
32	*Bullia* sp.	Nassaridae	+			+				+						-	-	-	
33	*Camitia* sp.					+										-	-	-	
34	*Cantarus Coromandelius*	Buceinidae					+									-	-	-	
35	*Cassidula aurisfelis*				+							+				-	-	-	
36	*Cassidula mustelina*		+										+	+	+	-	-	-	
37	*Cassis cornuta*	Buceinidae								+						-	-	-	
38	*Celeophysis*						+									-	-	-	
39	*Ceratoxanthus*					+	+									-	-	-	
40	*Cerithidae cingulata*								+							-	-	-	

Annex 7 *cont.* List Species of Gastropods of Indonesia Mangrove Ecosystem in the South China Sea.

No	Scientific Name	Family	Province												Status			Remarks
			1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1994	CITES 1995	
41	*Cerithidea obtuse*	Potamididae			+											-	-	-	
42	*Cerithideopsilla djadjarensis*				+											-	-	-	
43	*Cerithidia quadrata*											+				-	-	-	
44	*Cerithidie obtusa*											+				-	-	-	
45	*Cerithiidae cingulata*	Cerithiidae					+									-	-	-	
46	*Cerithiidaei obtusa*	Cerithiidae					+									-	-	-	
47	*Cerithiopsis spongicola*					+										-	-	-	
48	*Cerithium alveolum*	Cerithidae				+	+									-	-	-	
49	*Cerithium articulatum*	Cerithidae			+		+									-	-	-	
50	*Cerithium asper*	Cerithiidae					+									-	-	-	
51	*Cerithium fasciatum*	Cerithiidae					+									-	-	-	
52	*Cerithium kobelti*	Cerithidae			+											-	-	-	
53	*Cerithium lutosum*	Cerithidae								+						-	-	-	
54	*Cerithium nodulosum*	Cerithidae								+						-	-	-	
55	*Cerithium ruppelii*	Cerithiidae					+									-	-	-	
56	*Cerithium serratum*	Cerithidae			+											-	-	-	
57	*Cheritdea sp.*											+				-	-	-	
58	*Cherithidae alata*	Potamididae	+													-	-	-	
59	*Chicoreus adustus*											+				-	-	-	
60	*Cipangopaludina longispira*												+	+	+	-	-	-	
61	*Clathrofenella reticulata*					+										-	-	-	
62	*Clathrofenilla* sp.					+										-	-	-	
63	*Clypeomorus moniliferus*	Cerithidae								+						-	-	-	
64	*Clypeomorus* sp.	Cerithidae				+										-	-	-	
65	*Coleophysis sp.*					+										-	-	-	
66	*Coleophysis minimus*					+										-	-	-	
67	*Coleophysis villicus*					+										-	-	-	
68	*Columbella mecrateria*	Comumbellidae					+									-	-	-	
69	*Conus sp.*						+									-	-	-	
70	*Conus litteratus*									+						-	-	-	
71	*Conus textile*									+						-	-	-	
72	*Conus flavidus*									+						-	-	-	
73	*Corbicula* sp.							+								-	-	-	
74	*Cylichnatys angusta*					+										-	-	-	
75	*Cylichnella culcitella*					+										-	-	-	
76	*Cypeonorus moniliferus*	Cerithiidae					+									-	-	-	
77	*Diniatys* sp.					+	+									-	-	-	
78	*Discus* sp.					+										-	-	-	
79	*Dolicholatirus*					+										-	-	-	
80	*Drupa margaritica*				+											-	-	-	
81	*Drupella cornus*									+						-	-	-	

Annex 7 *cont.* List Species of Gastropods of Indonesia Mangrove Ecosystem in the South China Sea.

No	Scientific Name	Family	Province												Status			Remarks
			1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1994	CITES 1995	
82	*Eichinella cumingi*					+										-	-	-	
83	*Ellobium chinense*												+	+	+	-	-	-	
84	*Engina zonalis*				+											-	-	-	
85	*Eoccylichna* sp.					+										-	-	-	
86	*Epitonium lamellosa*					+						+				-	-	-	
87	*Euchelus quadricarinatus*				+											-	-	-	
88	*Eufenella* sp.					+	+									-	-	-	
89	*Eugina alveolata*									+						-	-	-	
90	*Evalea*						+									-	-	-	
91	*Fossarus elegans*											+				-	-	-	
92	*Gassidula plecotremaides*														+	-	-	-	
93	*Gassidula plecotremaides japonica*												+	+		-	-	-	
94	*Gemmula kinieri*				+											-	-	-	
95	*Gemmula* sp.					+	+									-	-	-	
96	*Granulena margaritula*					+										-	-	-	
97	*Heliacus* sp.					+										-	-	-	
98	*Himia paupua*		+													-	-	-	
99	*Hinia stolata*				+											-	-	-	
100	*Homalopoma* sp.					+										-	-	-	
101	*Ischinocerithium* sp.					+										-	-	-	
102	*Isognomum isognomum*	Velsellidae					+									-	-	-	
103	*Kleinella* sp.	Velsellidae				+	+									-	-	-	
104	*Leptoporna* sp.	Stombidae				+				+						-	-	-	
105	*Leucotina*						+									-	-	-	
106	*Limulatys muscarius*					+										-	-	-	
107	*Limulatys ooformis*					+										-	-	-	
108	*Lineata pintado*				+											-	-	-	
109	*Linella* sp.					+										-	-	-	
110	*Lirularia succincta*					+										-	-	-	
111	*Littorina sp.*						+									-	-	-	
112	*Littorina carinifera*	Littorinidae	+													-	-	-	
113	*Littorina cocinea*	Littorinidae					+									-	-	-	
114	*Littorina kraussi*	Littorinidae	+													-	-	-	
115	*Littorina lineata*	Littorinidae			+											-	-	-	
116	*Littorina littoralis*	Littorinidae					+									-	-	-	
117	*Littorina melanostoma*	Littorinidae	+		+				+							-	-	-	
118	*Littorina pinctata*	Littorinidae				+										-	-	-	
119	*Littorina pintado*	Littorinidae				+										-	-	-	
120	*Littorina scraba*	Littorinidae	+				+		+	+						-	-	-	
121	*Littorina sp.*	Littorinidae				+						+				-	-	-	
122	*Littorina striata*	Littorinidae					+									-	-	-	

Annex 7*cont.* List Species of Gastropods of Indonesia Mangrove Ecosystem in the South China Sea.

No	Scientific Name	Family	Province												Status			Remarks
			1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1994	CITES 1995	
123	*Littorina undulata*	Littorinidae	+							+						-	-	-	
124	*Lymnaea sp.*						+									-	-	-	
125	*Mammilla* sp.	Naticidae				+										-	-	-	
126	*Margates pupullus*					+										-	-	-	
127	*Marginilla sp.*											+				-	-	-	
128	*Melampus bidentatus*						+									-	-	-	
129	*Melampus fasciatus*												+	+	+	-	-	-	
130	*Melampus plecotrematoides*														+	-	-	-	
131	*Melampus plecotrematoides japonica*												+	+		-	-	-	
132	*Melanella major*					+										-	-	-	
133	*Melanoides arctecara*							+								-	-	-	
134	*Melanoides granifera*							+								-	-	-	
135	*Melanoides rustica*							+								-	-	-	
136	*Melanoides sp.*		+			+	+									-	-	-	
137	*Melanoides tuberculata*							+	+							-	-	-	
138	*Melanpus pulchellas*		+													-	-	-	
139	*Melo melo*	Volutidae								+						-	-	-	
140	*Melongena galeodes*	Naticidae					+									-	-	-	
141	*Microglyphis*					+	+									-	-	-	
142	*Mitra cerata*	Mitridae					+									-	-	-	
143	*Mitra mitra*								+							-	-	-	
144	*Modulus modulus*				+											-	-	-	
145	*Monodonta labio*	Trochidae								+						-	-	-	
146	*Mormula*						+									-	-	-	
147	*Morula uva*	Thaidinae								+						-	-	-	
148	*Morula granulata*	Thaidinae								+						-	-	-	
149	*Morula musiva*								+							-	-	-	
150	*Murex* sp.	Muricidae				+										-	-	-	
151	*Murex tibulus*	Muricidae			+											-	-	-	
152	*Murex troscheli*	Muricidae								+						-	-	-	
153	*Musculista senhausia*		+													-	-	-	
154	*Nakamigawaea*					+										-	-	-	
155	*Nasarius*						+									-	-	-	
156	*Nassaria pusilla*	Naasariidae			+											-	-	-	
157	*Nassarius camptus*	Buceinidae					+									-	-	-	
158	*Nassarius sp.*	Naasariidae				+						+				-	-	-	
159	*Natica bicolor*	Naticidae			+											-	-	-	
160	*Natica canrena*	Naticidae					+									-	-	-	
161	*Natica catena*	Naticidae					+									-	-	-	
162	*Natica gaulteriana*	Naticidae					+									-	-	-	
163	*Natica maculosa*	Naticidae			+											-	-	-	

Annex 7 *cont.* List Species of Gastropods of Indonesia Mangrove Ecosystem in the South China Sea.

No	Scientific Name	Family	Province												Status			Remarks
			1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1994	CITES 1995	
164	*Natica* sp.	Naticidae				+										-	-	-	
165	*Natica tigrina*	Naticidae			+											-	-	-	
166	*Natica vittelus*								+							-	-	-	
167	*Nerita abicilla*	Neritidae					+			+						-	-	-	
168	*Nerita chamaeleon*	Neritidae								+						-	-	-	
169	*Nerita costata*	Neritidae							+	+						-	-	-	
170	*Nerita lineata*	Neritidae										+				-	-	-	
171	*Nerita planospira*								+							-	-	-	
172	*Nerita plicata*	Neritidae					+			+						-	-	-	
173	*Nerita undata*	Neritidae								+						-	-	-	
174	*Nerita versicolor*	Neritidae					+									-	-	-	
175	*Neritina violacea*		+													-	-	-	
176	*Neritopsis radula*					+							+	+	+	-	-	-	
177	*Notocochlis* sp.	Naticidae				+										-	-	-	
178	*Nucella canaliculata*					+										-	-	-	
179	*Nucella lamellosa*					+										-	-	-	
180	*Ocenebra javonica*												+	+	+	-	-	-	
181	*Ocenetora orpheus*					+										-	-	-	
182	*Odostomea*					+										-	-	-	
183	*Odostomia*						+									-	-	-	
184	*Oliva marmorea*	Olividae					+									-	-	-	
185	*Oliva oliva*	Olividae			+							+				-	-	-	
186	*Ovatella myosotis*						+									-	-	-	
187	*Palidinella*						+									-	-	-	
188	*Papyriscala* sp.					+										-	-	-	
189	*Paradrillia* sp.					+										-	-	-	
190	*Phoshirasei*					+	+									-	-	-	
191	*Phytia plitaca*				+											-	-	-	
192	*Pila ampullacea*								+							-	-	-	
193	*Pisania tritonoides*	Buceinidae					+									-	-	-	
194	*Planaxis sulcatus*									+						-	-	-	
195	*Pleuroplaca filamentosa*	Fasciolandae			+											-	-	-	
196	*Pleuroploca trapezium*	Fasciolandae								+						-	-	-	
197	*Polinices tumidus*	Naticidae								+						-	-	-	
198	*Proclava pfefferi*					+										-	-	-	
199	*Prunum roscidum*						+									-	-	-	
200	*Pselligyra* sp.					+	+									-	-	-	
201	*Pugilena cochlidium*									+						-	-	-	
202	*Punctacteon* sp.					+										-	-	-	
203	*Pussionela hifar*	Turridae					+									-	-	-	
204	*Pygmaeorata* sp.					+										-	-	-	

Annex 7 *cont.* List Species of Gastropods of Indonesia Mangrove Ecosystem in the South China Sea.

No	Scientific Name	Family	Province												Status			Remarks
			1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1994	CITES 1995	
205	*Pyramidella acus*												+	+	+	-	-	-	
206	*Pyramidella sp.*											+				-	-	-	
207	*Pyramidella sulcata*				+								+	+	+	-	-	-	
208	*Pyrene mayor*	Comumbellidae			+											-	-	-	
209	*Pyrene ocellata*	Comumbellidae								+						-	-	-	
210	*Pyrene sripta*	Comumbellidae					+									-	-	-	
211	*Pyrene testudinaria*	Comumbellidae					+									-	-	-	
212	*Pyrunculus phiala*					+										-	-	-	
213	*Pythia pantherina*												+	+	+	-	-	-	
214	*Rhenoclavis aspera*	Cerithidae								+						-	-	-	
215	*Rhenoclavis fasciata*	Cerithidae								+						-	-	-	
216	*Rhenoclavis vertagus*	Cerithidae							+	+						-	-	-	
217	*Rhinoclavis aspera*	Potamididae					+									-	-	-	
218	*Rhinoclavis vertagus*	Potamididae					+									-	-	-	
219	*Rhodopetoma* sp.					+										-	-	-	
220	*Ringicula*						+									-	-	-	
221	*Ringicula doliaris*					+										-	-	-	
222	*Rissoa* sp.					+										-	-	-	
223	*Ritena squamulata*												+	+	+	-	-	-	
224	*Royella* sp.					+										-	-	-	
225	*Salinator fragilis*		+													-	-	-	
226	*Salinator* sp.							+								-	-	-	
227	*Sinum perspectivum*					+										-	-	-	
228	*Siphonofusus* sp.					+										-	-	-	
229	*Smaragolia* sp.					+										-	-	-	
230	*Stenothyra sp.*						+									-	-	-	
231	*Strombus canarium*	Strombidae								+						-	-	-	
232	*Strombus epidermis*	Strombidae								+						-	-	-	
233	*Strombus fasciatus*	Strombidae					+									-	-	-	
234	*Strombus gibberulus*	Strombidae							+							-	-	-	
235	*Strombus plicatus*	Strombidae					+									-	-	-	
236	*Strombus terebelatus*	Strombidae					+									-	-	-	
237	*Strombus urceus*	Strombidae					+			+						-	-	-	
238	*Strombus variabilis*	Strombidae					+									-	-	-	
239	*Sukosa* sp.					+										-	-	-	
240	*Syncera* sp.				+											-	-	-	
241	*Synchera phillipinica*						+									-	-	-	
242	*Taincatella* sp.					+										-	-	-	
243	*Tectonatica* sp.					+										-	-	-	
244	*Telescopium telescopium*	Potamididae			+		+		+			+				-	-	-	
245	*Tellina crasa*	Tellinidae					+									-	-	-	

Annex 7 c*ont.* List Species of Gastropods of Indonesia Mangrove Ecosystem in the South China Sea.

No	Scientific Name	Family	Province												Status			Remarks
			1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1994	CITES 1995	
246	*Terebra bifrons.*	Terebridae			+											-	-	-	
247	*Terebra* sp.	Terebridae			+											-	-	-	
248	*Terebralia palustris*						+		+							-	-	-	
249	*Terebralia sulcata*	Potamididae					+		+							-	-	-	
250	*Thais echinata*	Thaidinae								+						-	-	-	
251	*Thais hippocostarum*	Thaidinae								+						-	-	-	
252	*Thais mancinella*	Thaidinae								+						-	-	-	
253	*Thateheria mirabilis*												+	+	+	-	-	-	
254	*Thliostyra albacilla*												+	+	+	-	-	-	
255	*Throcus*						+									-	-	-	
256	*Tiara yagurai*					+										-	-	-	
257	*Tiberia pusilla*					+										-	-	-	
258	*Tonna* sp.	Tonnidae				+	+									-	-	-	
259	*Trivia oryza*				+											-	-	-	
260	*Trochus lineatus*	Trochidae								+						-	-	-	
261	*Trochus niloticus*	Trochidae								+						-	-	-	
262	*Trochus pyramis*	Trochidae								+						-	-	-	
263	*Trochus radiatus*	Trochidae								+						-	-	-	
264	*Trochus sandwichensis*	Trochidae											+	+	+	-	-	-	
265	*Truncatella sp.*		+													-	-	-	
266	*Truncatella valida*		+													-	-	-	
267	*Turbo imperialis*	Turbinidae				+	+									-	-	-	
268	*Turbo marmoratus*	Turbinidae								+						-	-	-	
269	*Turbo petholatus revii*	Turbinidae											+	+	+	-	-	-	
270	*Turbo sparverius*	Turbinidae								+						-	-	-	
271	*Turbonella pesa*	Turbinidae				+										-	-	-	
272	*Turbonella sp.*	Turbinidae										+				-	-	-	
273	*Turitella* sp.	Turritellidae			+	+	+					+				-	-	-	
274	*Turitella terebra*	Turritellidae			+											-	-	-	
275	*Turricula gemmulaeformis*	Turridae				+										-	-	-	
276	*Turricula granobalteus*	Turridae			+											-	-	-	
277	*Turricula promensis*	Turridae				+										-	-	-	
278	*Turricula waringinensis*	Turridae				+										-	-	-	
279	*Turritela kowinensis*	Turritilidae					+									-	-	-	

Annex 7 c*ont.* List Species of Gastropods of Indonesia Mangrove Ecosystem in the South China Sea.

No	Scientific Name	Family	Province												Status			Remarks
			1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1994	CITES 1995	
280	*Turritella terebracerea*					+										-	-	-	
281	*Umbarium vestiarium*				+	+										-	-	-	
282	*Urosalpix anereus*					+										-	-	-	
283	*Vexillum plicarium*	Costellaridae								+						-	-	-	
284	*Vexillum sp.*	Costellaridae				+						+				-	-	-	
285	*Volema myristica*									+						-	-	-	
286	*Volvara* sp.					+										-	-	-	
287	*Volvarinella*					+										-	-	-	
288	*Zebina*						+									-	-	-	

Annex 8 List Species of Bivalve of Indonesia Mangrove Ecosystem in the South China Sea.

No	Scientific Name	Family	Province													Status				Remarks
			1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
1	*Acanthocerdia tuberculata*				+											-	-	-	-	
2	*Acila diverticata*					+										-	-	-	-	
3	*Acrosterigma elongatum*	Cardiidae					+									-	-	-	-	
4	*Acrosterigma rogusa*	Cardiidae					+									-	-	-	-	
5	*Acteon vertagus*	Acteonidae					+									-	-	-	-	
6	*Amonia sp.*											+				-	-	-	-	
7	*Anadara antiquata*	Arcidae				+				+			+	+	+	-	-	-	-	
8	*Anadara cornea*	Arcidae			+											-	-	-	-	
9	*Anadara granosa*	Arcidae			+				+				+	+	+	-	-	-	-	
10	*Anadara inflata*	Arcidae			+	+			+							-	-	-	-	
11	*Anadara maculosa*	Arcidae			+											-	-	-	-	
12	*Anadara multicostata*					+										-	-	-	-	
13	*Anadara* sp.	Arcidae	+		+											-	-	-	-	
14	*Anadara transversa*	Arcidae					+									-	-	-	-	
15	*Anisocorbula*					+										-	-	-	-	
16	*Anisodonta*					+										-	-	-	-	
17	*Anomia peruviana*					+										-	-	-	-	
18	*Arca petunculoides*	Arcidae										+				-	-	-	-	
19	*Arca* sp.	Arcidae					+			+						-	-	-	-	
20	*Archectectonia* sp.								+							-	-	-	-	
21	*Asaphis violascens*									+						-	-	-	-	
22	*Astarte sp.*					+	+									-	-	-	-	
23	*Astropecten*						+									-	-	-	-	
24	*Atactodea striata*				+	+				+						-	-	-	-	
25	*Atrina vexillum*									+						-	-	-	-	
26	*Barbatia*					+	+									-	-	-	-	
27	*Barbatia reveana*	Acridae								+						-	-	-	-	
28	*Bittium reticulatum*											+				-	-	-	-	
29	*Cardium limedo*	Cardiidae					+									-	-	-	-	
30	*Cardium robustum*	Cardiidae					+									-	-	-	-	
31	*Cassis cornula*								+							-	-	-	-	
32	*Cherithidae cingulata*		+													-	-	-	-	
33	*Chicoreus capucinus*								+							-	-	-	-	
34	*Clinicardium sp.*						+									-	-	-	-	
35	*Cokadia*					+										-	-	-	-	
36	*Corbicula* sp.												+	+	+	-	-	-	-	
37	*Crassatina*					+										-	-	-	-	
38	*Crassostrea* sp.	Ostreidae				+	+			+						-	-	-	-	
39	*Cyathodonta tumbezensis*					+										-	-	-	-	
40	*Cyclinella ulloana*					+										-	-	-	-	

Annex 8 *cont.* List Species of Bivalve of Indonesia Mangrove Ecosystem in the South China Sea.

No	Scientific Name	Family	Province												Status				Remarks
			1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
41	*Donax corneatus*	Donacidae								+						-	-	-	-	
42	*Donax culter*					+										-	-	-	-	
43	*Donax sp.*						+									-	-	-	-	
44	*Donax variabilis*						+									-	-	-	-	
45	*Dosinia biscocta*					+										-	-	-	-	
46	*Dosinia ponderosa*	Veneriidae					+									-	-	-	-	
47	*Elliptotellina*					+										-	-	-	-	
48	*Fimbria fimbriata*					+										-	-	-	-	
49	*Fulvia hungerfordi*					+										-	-	-	-	
50	*Gafrarium divaricatum*	Veneriidae					+									-	-	-	-	
51	*Gafrarium pectinatum*	Veneriidae					+			+						-	-	-	-	
52	*Gafrarium sp.*	Veneriidae					+									-	-	-	-	
53	*Gafrarium tumidum*	Veneriidae					+									-	-	-	-	
54	*Gari helenae*					+										-	-	-	-	
55	*Glycimeris violascens*	Glycimerididae					+									-	-	-	-	
56	*Haliotis asinine*								+							-	-	-	-	
57	*Halodekra subtrigosa*					+										-	-	-	-	
58	*Isognomon bicolor*									+						-	-	-	-	
59	*Isognomon epipium*									+						-	-	-	-	
60	*Isognomon isognomum*												+	+	+	-	-	-	-	
61	*Libitina rostrata*						+									-	-	-	-	
62	*Linulicordia hemicardia*									+						-	-	-	-	
63	*Lopha cristagolli*	Ostreidae								+						-	-	-	-	
64	*Lopha* sp.	Ostreidae								+						-	-	-	-	
65	*Lucina liana*					+										-	-	-	-	
66	*Lutraria incurva*				+											-	-	-	-	
67	*Macoma*					+										-	-	-	-	
68	*Macoma balthica*											+				-	-	-	-	
69	*Mactra antiquata*				+											-	-	-	-	
70	*Malleus albus*	Mellidae					+									-	-	-	-	
71	*Malleus malleus*	Mellidae					+									-	-	-	-	
72	*Mediolus*						+									-	-	-	-	
73	*Meritrix* sp.				+											-	-	-	-	
74	*Mictra chinenasis*						+									-	-	-	-	
75	*Mocoma*						+									-	-	-	-	
76	*Modiolus nipponicus*									+						-	-	-	-	
77	*Modiulus auriculata*						+									-	-	-	-	
78	*Modiulus demissus*						+									-	-	-	-	
79	*Modiulus elongatus*						+									-	-	-	-	
80	*Modiulus modiulus*						+									-	-	-	-	

Annex 8 c*ont.* List Species of Bivalve of Indonesia Mangrove Ecosystem in the South China Sea.

No	Scientific Name	Family	Province													Status				Remarks
			1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
81	*Murex* sp.								+							-	-	-	-	
82	*Muscullium*												+	+	+	-	-	-	-	
83	*Musculus japonicus*					+										-	-	-	-	
84	*Mycella bidentala*	Montacutidae										+				-	-	-	-	
85	*Mytilus edulis*						+									-	-	-	-	
86	*Mytilus viridis*	Mytilidae											+	+	+	-	-	-	-	
87	*Nemocardium bechei*					+										-	-	-	-	
88	*Neocyrena formis*					+										-	-	-	-	
89	*Nereus sp.*						+									-	-	-	-	
90	*Novathaca sp.*					+	+									-	-	-	-	
91	*Nuculana sp.*					+	+									-	-	-	-	
92	*Ostrea tubulifera*					+										-	-	-	-	
93	*Paphia*						+									-	-	-	-	
94	*Paphia textile*					+										-	-	-	-	
95	*Parricardium ovale*											+				-	-	-	-	
96	*Pecten*					+										-	-	-	-	
97	*Perna viridis*				+	+	+									-	-	-	-	
98	*Phaxas cultellus*					+										-	-	-	-	
99	*Phlyctiderma japonicum*					+										-	-	-	-	
100	*Pholas orientalis*	Pholadidae			+											-	-	-	-	
101	*Pinctada*					+										-	-	-	-	
102	*Pinctada margaritifera*	Pteridae								+						-	-	-	-	
103	*Pinctada maxima*	Pteridae								+						-	-	-	-	
104	*Pinna muricata*									+						-	-	-	-	
105	*Pitar consainuineus*					+										-	-	-	-	
106	*Pitarina striatum*	Veneriidae					+									-	-	-	-	
107	*Placemen*					+	+									-	-	-	-	
108	*Placuna placenta*	Placunidae			+				+							-	-	-	-	
109	*Polymesoda coaxans*											+				-	-	-	-	
110	*Psamotreta ephippium*									+						-	-	-	-	
111	*Pteria pinguin*	Pteridae								+						-	-	-	-	
112	*Saccostrea cucullata*	Ostreidae								+						-	-	-	-	
113	*Sacella confuse*					+										-	-	-	-	
114	*Sarepta speciosa*					+										-	-	-	-	
115	*Semelangulus tokuberii*					+										-	-	-	-	
116	*Senele flavescens*					+										-	-	-	-	
117	*Septa nicobarium*								+							-	-	-	-	
118	*Septiver bilocularis*						+									-	-	-	-	
119	*Siliqua radiata*				+											-	-	-	-	
120	*Siliquaria cumingi*								+							-	-	-	-	

Annex 8 c*ont.* List Species of Bivalve of Indonesia Mangrove Ecosystem in the South China Sea.

No	Scientific Name	Family	Province													Status				Remarks
			1	2	3	4	5	6	7	8	9	10	11	12	13	Gov. Policy	IUCN 1990	IUCN 1994	CITES 1995	
121	*Solemnya sp.*						+									-	-	-	-	
122	*Solen grandis*					+										-	-	-	-	
123	*Solen strictus*	Solinidae							+							-	-	-	-	
124	*Spatperna*						+									-	-	-	-	
125	*Spondylus ducalis*	Pectinidae								+						-	-	-	-	
126	*Strigella* sp.					+										-	-	-	-	
127	*Sunetta alicae*	Glossidae					+									-	-	-	-	
128	*Sunetta concinna*	Glossidae					+									-	-	-	-	
129	*Sunetta menstrualis*	Glossidae					+									-	-	-	-	
130	*Tellina alternata*	Tellinidae	+				+									-	-	-	-	
131	*Tellina crassa*	Tellinidae					+									-	-	-	-	
132	*Tellina ovalina*		+													-	-	-	-	
133	*Tellina* sp	Tellinidae										+				-	-	-	-	
134	*Tellina staurella*		+													-	-	-	-	
135	*Tellina thomboides*		+													-	-	-	-	
136	*Tellina versicolor*	Tellinidae					+									-	-	-	-	
137	*Thracia phaseolina*	Thraciadae										+				-	-	-	-	
138	*Thracia villosiuscula.*	Thraciadae										+				-	-	-	-	
139	*Topes sp.*						+									-	-	-	-	
140	*Trachicardium magnum*	Cardiidae					+									-	-	-	-	
141	*Trachycardium subrugosum*									+						-	-	-	-	
142	*Tridacna crocea*									+						-	-	-	-	
143	*Tridacna maxima*									+						-	-	-	-	
144	*Tridacna squamosa*									+						-	-	-	-	
145	*Venericardia sp*											+				-	-	-	-	
146	*Venerupis aurea*	Glossidae					+									-	-	-	-	
147	*Venus meirenaria*	Veneriidae					+									-	-	-	-	
148	*Venus meretrix*	Veneriidae					+									-	-	-	-	
149	*Venus multicostata*	Veneriidae					+									-	-	-	-	
150	*Vepricardium*					+										-	-	-	-	
151	*Veremolpa minuta*					+										-	-	-	-	
152	*Voluta nivosa*	Volutidae					+									-	-	-	-	

United Nations Environment Programme

UNEP/GEF South China Sea Project

Global Environment Facility

NATIONAL REPORT

on

Mangroves in South China Sea

PHILIPPINES

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Table of Contents

List of Tables, Figures and Annexes

1. INTRODUCTION

In the Philippines, being the maritime nation, boasts with 7,107 islands with a coastline of 36,289km is dependent on a major extent on a healthy coastal environment. Indeed, Philippine coastal areas and seas have served as the lifeblood of communities near and far for hundreds of years if not thousands of years. The Philippines was said by "experts" to be endowed once upon a time with inexhaustible coastal resources. However, it is now on the verge of irreversible descent. The public attributes this condition due to excessive pressures exerted by ever increasing population, unscrupulous exploitation, industrialization and lack of ecosystem appreciation.

2. MANGROVE DISTRIBUTION

The Philippines is a large archipelago of approximately 7,107 islands, with a coastline of 36,289km - third longest in the world, 822 coastal municipalities and 74 coastal cities. These coastal zones are naturally endowed with resources of great socio-economic and ecological significance, mainly the reason why historically, cities grow rapidly along these areas. Coastal zones became centres of social, economic, recreational and other activities, making it vulnerable to man-made pressures. Coastal zones should have been maintained to sustain its environmental services to include food source, shoreline stabilizer, wildlife habitat, natural breakwater and spawning/breeding grounds of aquatic species. Among these major ecosystems, mangroves occupy a highly strategic position in the economy and ecology of the coastal areas in the country. The largest remaining mangrove areas are located in Palawan and Quezon in Luzon, Samar provinces in the Visayas, and Zamboanga del Sur, Zamboanga Sibugay, Surigao del Norte and Sulu provinces in Mindanao as shown in Figure 1 below.

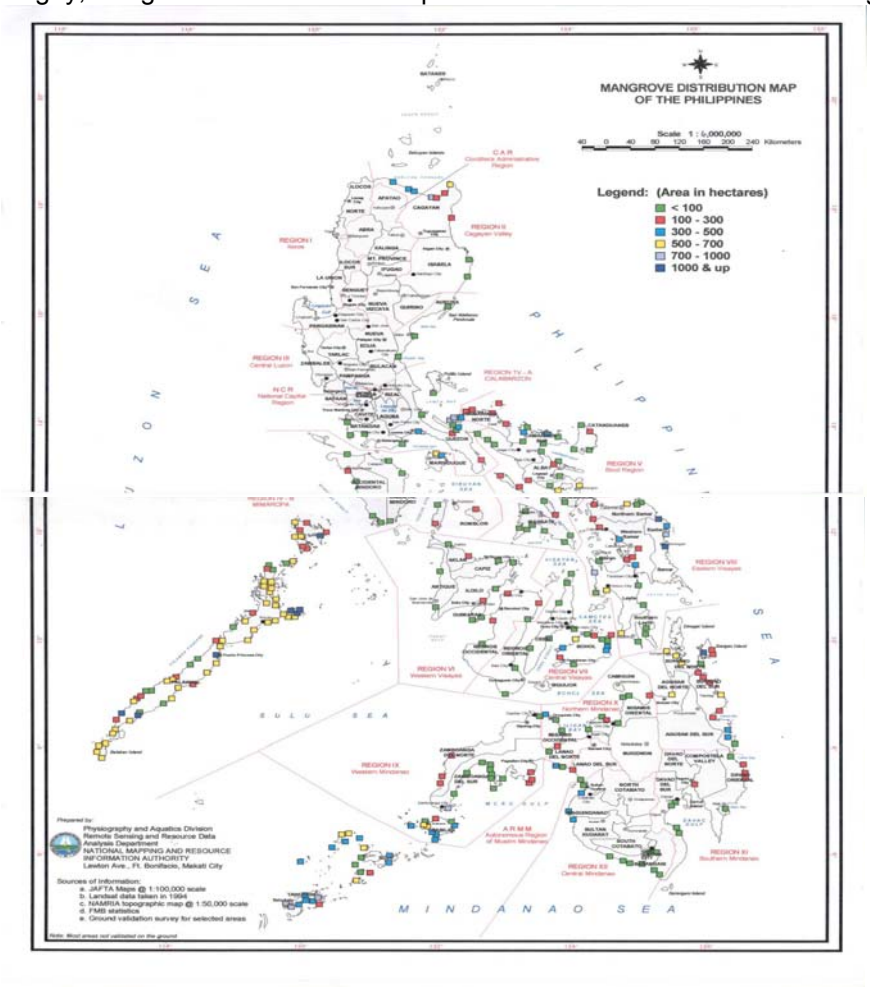

Figure 1 Mangrove distribution in the Philippines.

According to Tomlinson, (1986 as cited in Ong, et al. 2002), 35 of these species (1 hybrid, 1 variety, and 33 species) and several associate species are found in the Philippines. In term of distribution of number of marine species among coastal ecosystems, mangrove community has 370 species including seagrass, seaweeds, corals, other invertebrates, fish, mammals, and reptiles (DENR, 1998).

Based on the survey conducted, as of 1984 a total area of 232,065ha of mangrove forest in the Philippines were recorded as cited in Philippine Forestry Statistics with geographical distribution per major islands shown in Table 1 below.

Table 1 Mangrove forests areas of the Philippines.

Category	Luzon Area in Hectares	Visayas Area in Hectares	Mindanao Area in Hectares	Palawan Area in hectares	Total Area in Hectares
Reproductive Bush	2,583	63,893	23,692	22, 915	113,083
Young growth	14,186	1,226	84,471	9,200	109,083
Old growth	-	-	4,582	5,317	9,899
Total	**16,769**	**65,119**	**112,745**	**37,432**	**232,065**

Source: (Forest Management Bureau, 1984).

Of the estimated total mangrove forest area, approximately 49% is classified as reproductive bush, 47% as young growth and 4 % as old growth. The major genera are of the *Rhizophora*, *Bruguiera*, *Avicennia*, *Xylocarpus*, *Sonneratia*, *Heritiera*, *Ceriops*, *Excoecaria* and *Nypa*. Most of these are timber yielding, while *Xylocarpus* and *Ceriops* are used for the extraction of dyes and *Nypa* is used for thatching leaves and tapping of juice for brewing alcohol.

In view of the drastic decrease of mangrove forests from 450,000ha in 1920 to 232,065ha in 1984, the Department of Environment and Natural Resources of the Philippines, adopted few conservation measures. Presidential Decree No. 705 was promulgated which enforces; (1) a seed tree method of silvicultural system for mangroves, wherein 20 seed trees per hectare are to be retained; (2) adaptation of 50–year rotation and; (3) regulation of annual allowable cut. Besides these thousands of hectares of denuded mangrove areas in the form of open mudflats, sandy beaches and mine tailing areas are available for restoration. Small-scale afforestation with species such as *Rhizophora apiculata, Bruguiera cylindrica, Avicennia officinalis and Ceriops tagal* has been undertaken at various sites of the country.

The forested mangrove area has decreased greatly from an estimated coverage of 450,000ha in 1918 to less than 120,000ha in the late 1990s (DENR 1988, 1998). The most rapid decrease in mangrove coverage occurred during the 1960s and 1970s when national policies encouraged the expansion of aquaculture. Today; fishponds cover about 289,000ha; most of which were formerly mangroves thus; and the culprits of mangrove degradation was due to conversion of mangrove areas into shrimp farming/aquaculture. It was revealed that for the period of 1967-1988, the average rate of decline was about 8,000ha annually.

Mangrove stands remaining in the country are mostly found on the southern and western provinces and islands of Mindanao, eastern island provinces of the Visayas and the whole islands of Palawan. Less than 5 percent of existing areas in old or primary growth forest is found in Palawan. Most mangrove forests in the Luzon and Visayas islands are secondary growth or in plantations. Mangroves are now of much lower quality and cover less than one-third of their original range.

Based on the satellite pictures interpreted by the NAMRIA which had been used as the statistics for mangroves in the Philippines, the reported total mangrove areas are 248,813 hectares. The major regions where substantial mangrove areas are found are presented in Table 2 below:

Table 2 Regions and provinces where concentration of mangrove stands are observed.

Regional geographic location in the Philippines	Total regional mangrove area (ha)	Province with most mangrove area in region	Mangrove forests (ha)
Southwestern Luzon	58,032	Palawan	54,143
Autonomous Region of Muslim Mindanao	46,218	Sulu	24,701
Eastern Visayas	39,294	Samar	16,337
Northeastern Mindanao (CARAGA)	26,731	Surigao del Norte	16,823
Western Mindanao	22,328	Zamboanga del Sur	11,681

However, information shows that there is inconsistency in the presentation on the extent of mangrove forests in the Philippines. It had been reported there were less than 120,000ha in 1998 contrary to what had been stated in the previous paragraphs.

With the foregoing result of analysis of the satellite pictures, the DENR is presently validating the reported mangrove stands in all the 64 coastal provinces of the Philippines. Latest records reveal there are provinces especially in the coasts facing the South China Sea which were not detected in the satellite imagery but ground validation shows there are small patches of mangrove stands in such provinces. These are the provinces of Ilocos Norte, Zambales, Bataan, Pampanga and Bulacan, all in Luzon. The reported 248,813ha in 2003 can increase to about 300,000ha when the ground validation is completed. Moreover, the mangrove statistics after 1988 were projections which had been constantly decreasing due to destructions and on the conversion of some areas to other uses, specially for prawn/fishpond purposes and for charcoal and fuelwood production.

From 1989 to the present, there had been an increased plantation establishment of mangroves in the country. There were international supports for reforestation with the assistance of the ADB, JBIC, USAID, WB, to mention some, other banking institutions, non-government organizations, academe, people organizations and individuals who had contributed much to the increase in mangrove forests nationwide.

One documented accomplishment of coastal communities is what had been initiated by an old man in Banacon Island, Getafe, Bohol (Central Philippines). He started planting in small patches in 1957 which was followed by his neighbours when they observed the good effect in increasing fisheries production in their area. That small island of Banacon which is about 15ha of land area has now man-made mangrove forests of about 500 hectares. That old man, because of his initiation to start mangrove reforestation in that small island, received some awards, one of which he received from the Food and Agriculture Organization of the UNDP in Bangkok in the mid-90s. The same mangrove area is now a show window where interested organizations, groups of fisherfolk and individuals often frequent to see for themselves the successful contribution of an old man who led his neighbours improved the mangrove ecosystem in a small fishing village.

Species composition of mangroves in various regions of the country

The composition of mangroves in various regions of the country representing sixty four (64) sites revealed *Rhizophora apiculata* is the most dominant mangrove species, followed by *R. mucronata*, *Avicennia* marina *Sonneratia* alba and *Ceriops tagal*. There are twenty eight (28) true mangroves species and thirty four (34) mangrove associates. The samples in each region are in the original Coastal Environmental Programme, or Coastal and Marine Management Programme sites now including those sampled in the UNEP-GEF SCS Project.

It could likewise be deduced that there are more representative true mangrove species and associates in Cagayan Valley (Northern Luzon), Quezon, Palawan, Western and Central Visayas. Because of the limited number of samples in Mindanao, the values were likewise low. Studies on the composition of other areas especially in the natural stands remaining expectedly can enhance the information. Another activity which should be undertaken is to gather more information on the menstruational attributes of mangrove stands to have an indication of the productivity of these stands based on productivity of timber and other major products derived from mangroves. This, however, is not an immediate priority since harvesting of timber for lumber is totally banned by the government.

3. THREATS TO MANGROVES

In the Philippines, mangroves are among the major marine ecosystems, which include seagrass and coral reefs, which have suffered the extensive damage and greatest degradation because of their relative inaccessibility and long history of conversion to aquaculture ponds. Estimates of the country's mangroves were not made until 1918 although ponds were already on record since 1863. The former comprised not only primary and secondary forests but also vast stands located near Manila of *Rhizophora* cultivated for firewood and *Nypa* shingles.

In recent times, over-exploitation and destruction of mangroves due to human activities have caused heavy damage to these ecosystems worldwide. Mangrove soil is generally marginal for agriculture, yet conversion of mangrove land for agriculture is widespread. In several parts of the world mangroves have been destroyed to create shrimp, ponds which cannot sustain their production over time due to acid sulphate soils, viral diseases, etc. Mangrove destruction is also due to a variety of other reasons: the need for fuel wood, oil prospecting and production, conversion to cattle ranching, salt industry and coastal development everywhere (harbor, urban and industrial development, airports, power plants and others). International and national demand for mangrove forest resources and land is at present one of the main causes of the destruction of mangroves. Poor polices and

legislation (lack of enforcement) also contribute to mangrove destruction and degradation. This is partly due to the fact that information on mangroves and their importance is often lacking or inaccessible. During the last decade approximately 1000km² of mangroves have been destroyed annually. Mangroves are not wastelands and their destruction, for whatever purpose, invariably results in ecological degradation and social impoverishment of local people. The restoration of degraded mangroves can be extremely costly and time-consuming.

All biotic and abiotic factors acting on mangrove ecosystems vary between and within countries. Over and above this, anthropogenic factors have induced changes in almost all the mangroves of the world, predominantly in a negative manner. Significant changes of all sorts became increasingly damaging during the second half of the 20th century. The changes have affected the distribution, extent and health of single mangrove species and of the ecosystems as a whole. The coastal zone everywhere in the world is extremely dynamic. It may be described as a chaotic system where an infinitely large number of variables are in constant and relentless interaction. The chaotic nature of coastal zone systems makes the impact of changes hard to anticipate and often dramatic.

Mangroves are home to many marine fishes and provide livelihoods for millions of people, but the opinions of local residents regarding their management have seldom been sought. Public awareness regarding mangroves and their conservation is often lacking. Thus, it is an urgent need to bring people and nations together to apply the knowledge and wisdom of experience to use the mangrove forest judiciously.

Offshore fisheries are of considerable importance in the Philippines. There have been few studies to look at the effect on mangrove loss, although anecdotal evidence suggests there have been reduced yields. Mangrove forests used to be source of tanbark for the tannin extract industry, while now there is little or no commercial extraction of timber and mangrove wood is widely used locally for fuel, charcoal and for the manufacture of poles and piles. There has been some mangrove afforestation, notably in the Sulu Archipelago and the Central Visayas, including Negros, Bohol and Cebu, much of this carried out at the local and community level. Research into afforestation methods is also underway. Traditional or non-destructive fishing within mangrove areas is still important, notably in Bohol, Sulu, Tawi-tawi and Cebu. Target species include shellfish and crabs as well as fish caught by net or line. The greatest loss of mangrove areas has been caused by the development of large areas of brackish fishponds, increased from 90,000ha in 1952 to over 210,000ha today. Mangrove reclamation for agricultural or urban development is significant in some areas. Although some legislation exists for the protection on mangroves, for example all of the mangroves of Palawan and other sites have been declared as mangrove forest reserve; there is still evidence that such protection is not effective on the ground.

Research according to Ong, et al. (2002), a few pristine mangrove areas were re-discovered because of their relative inaccessibility (e.g., Aurora and Isabela provinces, and Dinagat-Siargao Islands in Surigao del Norte) and peace-and-order threats (e.g., Western Samar and Sta. Cruz Island in Zamboanga City). Even a very small forest patch, such as the 75-ha mangroves of Ibajay, Aklan (the largest contiguous mangrove in Panay Island), can feature as many as 20 mangrove species, a further confirmation of the country's remarkable mangrove diversity.

Mangrove decline of 120,000ha from 1984 to 1995 maybe traced to exploitation by coastal dwellers and conversion to agriculture, salt ponds, industry and settlements. However, aquaculture remains the major cause–around the world, half of the 279,000ha of mangrove lost from 1951-1988 were developed into culture ponds. Ninety-five percent of Philippine brackish water ponds in 1952 up to 1987 were derived from mangroves. Mangrove–to–pond conversion and its attendant socioeconomic changes have been documented in detail for the village Lincod in Maribojoc, Bohol and for the Municipality of Batan, Province of Aklan.

Pond construction was also the culprits of the mangrove degradation; its peak occurred in the 1950s and 1960s at 4,000 to 5,000 hectares per year with the government incentives in the form of loan. The Fisheries Decree of 1975 (P.D.704) mandated a policy of accelerated fishpond development and A.O. 125 extended 10-year fishpond permits and leases to 25 years. During the Shrimp Fever of the 1980s, pond development again increased to 4,700 hectares per year.

Another widespread mechanism by which mangroves have been lost from the public domain is when local residents or even outsiders stake claim on mangrove areas paying to municipal governments a real estate tax. Because local government are hard – pressed for cash, they accept taxes without checking whether the status of the given area is forest reserve, protected mangrove or alienable & disposable (A&D). These claims are generally handed down to family members or "sold" to other parties. A prerequisite to legal ownership through issuance of titles is having the area declared A&D by the government, if the interested party has adequate finances. And so many mangrove areas passed from government jurisdiction to private hands-through de facto (real estate tax) and or legal means.

According to Dixon's work (1989) as cited by Melana et.al. (2000), valued a complete mangrove ecosystem at US$500 to 1500 per hectare per year. This represents the minimum monetary value that would be lost when such mangroves were converted to other land uses.

Various mechanisms both natural and human-induced activities commonly destroyed and degraded mangrove ecosystem. They are subjected to many biological, physical and chemical stresses because of public ignorance of the capabilities and limitations of mangrove forests including poor valuation methods to quantify non-market goods compared to cost accounting available for residential, commercial and industrial development. The mangrove ecosystems are increasingly threatened and under various kinds of pressures: increasing population, construction, development, tourism, aquaculture development, including short-term management policies and programmes.

Apart from the human impacts and natural threats to the mangrove ecosystems they were also subjected to various land use. The root cause of these threats is failures of existing management system to include:

- *Information failure*- Failure to appreciate the full ecological functions of mangrove ecosystem as well as their biological basis;
- *Market failures*- Failure to correctly value the mangrove ecosystem or where the cost and benefits do not coincide and where the mangrove ecosystem is sacrificed due to their non-market valuation;
- *Intervention and/or policy failure*- A policy result from ineffective governmental interventions to correct market failure in the form of subsidies, credit and inter-sectoral policy inconsistency.

4. ECONOMIC VALUATION

In deciding to maximize economic gain from mangroves, discussions usually focus on the "economic rent" which should be charged to users for alternative uses of the habitat area. In one research effort to determine an optimal system for leasing out mangrove areas for fishpond use, three (3) management scenarios were compared: (i) mangrove plantation; (ii) managed naturally regenerated mangroves; and, (iii) unmanaged under-stocked stands.

The value of wood products from mangrove plantation generates more revenues than alternatives (ii) and (iii) but for practical purposes, scenario (ii) was recommended as a basis for economic rent for mangrove habitats converted to fishpond the higher value in all three options is not the wood products but the fish products (US$538/ha) dependent on the existence of the ecosystem. This amount can be considered as a minimum economic gain from a healthy mangrove ecosystem as shown in Table 3 below:

Table 3 Estimated net annual economic value of Philippine mangrove areas for different levels of management.

Level of management	Wood products (US$/ha)	Fish products (US$/ha)	Total (US$/ha)
i) Mangrove plantation	**156**	**538**	**694**
ii) Managed naturally regenerated	**90**	**538**	**628**
iii) Unmanaged under stocked stands	**42**	**538**	**580**

***Note**: wood harvest value based on average price of about US$12/$m^3$ of wood; fish products based on average annual weight of fish and shrimp/ha associated w/ mangrove areas and an average price of US$0.80/kg; values based on Philippine pesos. US$ 1 was equal to 25 pesos in 1991.*

5. INSTITUTIONAL ARRANGEMENT AND NATIONAL LEGISLATION

The DENR has jurisdiction over mangrove resources as provided for in PD 705 or the Forestry Code of the Philippines. Various issuances enacted pursuant to PD 705 include: DAO 15, s 1990, on mangrove conversion and conservation; DAO 96-29, s 1990, on awarding of mangrove stewardship contracts; and DAO 76, s 1987, on establishment of buffer zones in mangrove areas.

The Local Government Units (LGUs) were also given jurisdiction over specific aspects of mangrove management including that of conversion, as well as implementation of community–based forestry projects (including integrated social forestry projects) subject to the supervision, control, and review of DENR (RA 7160, Sec 71 (2) (i), (ii). The pertinent guidelines to the effect the devolution of these functions are spelled out in DAO 30, s 1990. Community–based forestry projects refer to DENR development projects involving local communities, which include the integrated social forestry projects, family, and community forestry Programmes, and other similar projects. On the other hand, the management, protection, and development of all other areas outside communal forest remain with DENR.

The Community–based Forest Management Agreement (CBFMA), EO 263, 1995 and its IRR as outlined in DAO 96-29 provided tenurial instrument available for communities who wish to manage their mangrove resources. The CBFMA integrates all other forms of tenurial instruments developed by the DENR including the Mangrove Stewardship Agreement and the Community Forest Management Agreement (CFMA).

Cutting of all mangrove species is prohibited under RA 7161: “An act incorporating certain sections of the National Internal Revenue Code of 1977, as amended, to PD 705, as amended, otherwise known as the ‘Revised Forestry Code of the Philippines’ and providing amendments thereto by increasing the forest charges on timber and other forest products.” The law does not provide any exemption.

There are some incentives provided to people’s organization (POs) for participating in CBFM Programmes. These include (i) exemption from paying rent, (ii) exemption from payment of forest charges as per RA 7161; (iii) consultation by government on all proposed projects affecting CBFMA area; (iv) preferential access to DENR financial assistance; and (v) all incomes and proceeds from sustainable management of forest resources will rebound to the benefit of the CBFMA holder.

6. MANAGEMENT PERSPECTIVES

The keys for attaining productive and effective mangrove restoration efforts can be effectively achieved through: (a) understanding of the ecology and morphology of mangroves; (b) environmental requirements or suitability of species; (c) economic and ecological value of mangroves; and, (d) the degree to which they are currently damaged by human activities. This particularly done considering that the management and conservation of mangroves is effected by a need for a variety of policies and the ways these policies affect the mangrove. They range from indirect (unsustainable exploitation of mangrove resources) to direct effects. In addition, the laws related to conservation, management and utilization are not often effectively enforced; hence, coastal law enforcement component should be strengthened to be an effective tool for implementation of conservation and protection policies. In general, change in the use of mangrove systems has been undertaken with inadequate consideration of the goods and services. Over the years, policy changes had shifted continuously. These policies need to be identified and their implications be fully analyzed so that appropriate adjustment or reforms can be instituted.

Therefore, this calls for reform of the policy and institutional framework for mangrove management to create wider participation in the management processes. The implementation of appropriate policy instrument and mechanisms is needed that could curtail sustainable management that undermines the efficiency of resource use and development.

At this point in time, we must review and harmonize existing policies and establish new policies that identify sustainable management as the overall framework across all sectors towards integrated ecosystem management approach. Intersectoral relationships as well as the economics, social and biophysical and environmental aspects must be fully recognized and duly considered in any development activity to minimize mangrove problem or conflict. Hence, policy goals must recognize the diversity of interests related to the conservation and management of mangroves to include as follows:

6.1 Socio-economic aspect

- Any developmental programmes needed by the coastal inhabitants should be prioritized;
- Need to integrate economic and ecology to quantify the monetary values of mangrove ecosystem;
- Build on local people's awareness of mangrove conservation;
- Stewardship agreements should be issued primarily to coastal communities;
- Joint-venture program and/or sharing should be promoted as a management scheme.

6.2 Ecological aspect

- Utilization of mangrove resources should be based on the sustainable limits of particular mangrove areas;
- All mangrove forests should be brought under sustainable management;
- All management efforts should be focused on the prevention of degradation rather than restoration;
- More realistic economic valuation of space and resources within mangrove ecosystems;
- Integrated assessments of the environmental and socio-economic costs and benefits of alternative uses of such systems;
- Research on mangrove ecosystem that is, scientific information and data to include studies of human habitation and traditional uses of mangrove ecosystem in order to evaluate actual and potential use of the resources from both the natural and social science perspectives.

7. PROGRAMME OF ACTIONS

- ***Promote public awareness of mangrove forest issues***. Public awareness should be intensified through Information, Education and Communication (IEC) advocacy and promoting the intrinsic values of mangrove ecosystem to be perceptive on the protection and conservation program of the government. Its central tenet is to promote the rights of local coastal peoples, including fishermen, in the sustainable management of coastal environs.

- ***Participation in management decisions is essential at all levels***. This builds up the bottom-up model by encouraging local level to form management associations and become the effective managers of their coastal resources.

- ***National agencies with jurisdiction over coastal resources need to assist LGUs and provide technical support***. The capacity of local governments to manage their coastal environments and resources is limited, thus, they need technical guidance to mentor in order to achieve significant output facilitated by national agencies.

- ***Collaboration and synergy among agencies is essential***. Integration and collaboration of all institutions with a mandate and concern for coastal resource management. Partnership management of mangrove resources including local communities and NGOs. Collective and sustained efforts by government and the people concerned must be fostered.

- ***Mangrove policies and LGUs should be based on a comprehensive approach***. Improve legal mechanisms to control mangrove misuse. Develop adequate policy and legislation to protect mangrove resource and on ensuring adequate enforcement.

- ***Multi education and communication strategies are required to build a wise base support for CRM***. Management efforts should first be directed towards winning the hearts of coastal communities people must be oriented first for better understanding the issues before they will take action to solve them. This could be done through networks of constituency groups to support initiatives, thus ensuring better sustainability of efforts.

- ***Proven technical interventions must be pursued and applied appropriately*.** The viable coastal management interventions must be pursued, such as integrated planning, habitat protection and management, improved law enforcement, environmentally sensitive livelihood options and others.

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Annex 1 Scientific names, family names and some common names of true mangroves and associates in the Philippines.

No.	*Philippine Mangrove Species (Tree/Shrub/Vine/Grasses/Fern/Palm)*	Family	*Common name*
1	*Acacia farnesiana*	*Mimosaceae*	
2	*Acanthus ebracteatus*	*Acanthaceae*	*Tigbau*
3	*Acanthus ilicifolius*	*Acanthaceae*	*Deliuario*
4	*Acrostichum aureum*	*Pteridaceae*	*Lagolo*
5	*Acrostichum speciosum*	*Pteridaceae*	
6	***Aegiceras corniculatum***	***Myrsinaceae***	***Saging-saging***
7	***Aegiceras floridum***	***Myrsinaceae***	***Tinduk-tindukan***
8	***Aegiceras lanata***	***Myrsinaceae***	
9	*Alstonia macrophylla*	***Moraceae***	
10	*Avicennia eucalyptifolia*	***Avicenniaceae***	
11	*Avicennnia alba*	***Avicenniaceae***	*bungalon puti*
12	***Avicennia lanata***	***Avicenniaceae***	***Piapi***
13	***Avicennia marina***	***Avicenniaceae***	***Bungalon***
14	***Avicennia marina var. rumphiana***	***Avicenniaceae***	***piapi***
15	***Avicennia officinalis***	***Avicenniaceae***	***Api-api***
16	*Barringtonia asiatica*	*Lycythidaceae*	*Butong*
17	*Barringtonia racemosa*	*Lycythidaceae*	*putat*
18	*Brownlowia lanceolata*	*Tiliaceae*	*Maragomon*
19	***Bruguiera cylindrical***	***Rhizophoraceae***	***Pototan lalaki***
20	***Bruguiera gymnorrhiza***	***Rhizophoraceae***	***Busain***
21	***Bruguiera parviflora***	***Rhizophoraceae***	***Langarai***
22	***Bruguiera sexangula***	***Rhizophoraceae***	***Pototan***
23	*Caesalpinia crista*	*Fabaceae*	*kalumbibit*
24	*Caesalpinia nuga*	*Fabaceae*	*sapinit*
25	*Camptostemon philippinense*	*Bombacaceae*	*Gapas-gapas*
26	*Centrosema sp.*	*Leguminosae*	
27	*Cerbera manghas L*	*Apocynaceae*	*baraibai*
28	***Ceriops tagal***	***Rhizophoraceae***	***Tangal***
29	***Ceriops decandra***	***Rhizophoraceae***	***Malatangal***
30	*Chromolaena odorata*	***Euphorbiaceae***	
31	*Clerodendrum siphonospathus*	*Verbenaceae*	
32	*Derris trifoliate*	*Fabaceae*	*Mangasin*
33	*Dolichandrone spathacea*	*Bignoniaceae*	*Tui*
34	***Excoecaria agallocha***	***Euphorbiaceae***	***Buta-buta***
35	*Flagellaria indica*	*Flagellariaceae*	
36	*Glochidion littorale*	*Euphorbiaceae*	*Dampol*
37	*Glochidion mindorense*	*Euphorbiaceae*	
38	*Heritiera littoralis*	*Sterculiaceae*	*Dungon late*
39	*Heritiera sylvatica*	*Sterculiaceae*	
40	*Hibiscus tiliaceus*	*Malvaceae*	*Malubago*
41	*Intsia bijuga*	*Leguminsae*	*ipil*
42	*Intsia retusa*	*Leguminosae*	*ipil laut*
43	*Ipomea pes-caprae*	*Convolvulaceae*	*lambayong*

Annex 1 c*ont.* **Scientific names, family names and some common names of true mangroves and associates in the Philippines.**

No.	*Philippine Mangrove Species (Tree/Shrub/Vine/Grasses/Fern/Palm)*	Family	*Common name*
44	***Kandela candel***	***Rhizophoraceae***	
45	*Kleinhovia hospita*	*Sterculiaceae*	*Tan-ag*
46	***Lumnitzera littorea***	***Combretaceae***	***Tabau***
47	***Lumnitzera racemosa***	***Combretaceae***	***Kulasi***
48	*Mallotus papillaris*	*Euphorbiaceae*	
49	*Morinda bracteata*	*Rubiaceae*	
50	***Nypa fruticans***	***Palmae***	***Nipa***
51	*Oncosperma tigillaria*	*Palmae*	***Anibong***
52	***Osbornia octodonta***	***Myrtaceae***	***Taualis***
53	*Pandanus tectorius*	*Pandanaceae*	
54	*Pemphis acidula*	*Lythraceae*	*Bantigi*
55	*Phanera integrifolia*	*Caesalpiniaceae*	
56	*Pluchea indica*	*Compositae*	*Kalapini*
57	*Pongamia pinnata*	*Fabaceae*	*Bani*
58	*Prosopis vidaliana*	*Legumisae*	
59	***Rhizophora apiculata***	***Rhizophoraceae***	***Bakauan lalaki***
60	***Rhizophora mucronata***	***Rhizophoraceae***	***Bakauan babae***
61	***Rhizophora stylosa***	***Rhizophoraceae***	***Bakauan bangkau***
62	***Rhizopora lamarckeii***	***Rhizophoraceae***	
63	*Sapium indicum*	*Rhamnaceae*	
64	*Scyphiphora hydrophyllacea*	*Rubiaceae*	*Nilad*
65	*Sesuvium portulacastrum*	*Aizoaceae*	*Dampalit*
66	***Sonneratia alba***	***Sonneratiaceae***	***Pagatpat***
67	***Sonneratia caseolaris***	***Sonneratiaceae***	***Pedada***
68	*Strophantus cumingii*	*Apocynaceae*	
69	*Teijsmanniodendron hollrungii*	*Verbenaceae*	
70	*Terminalia catappa*	*Combretaceae*	*Talisay*
71	*Thespesia populnea*	*Malvaceae*	*Banalo*
72	*Thespesia populneoides*	*Malvaceae*	
73	*Tristellateria australasiae*	*Malphigiaceae*	*Binusisi*
74	***Xylocarpus granatum***	***Meliaceae***	***Tabigi***
75	***Xylocarpus moluccensis***	***Meliaceae***	***Piagau***
76	***Xylocarpus rumphii***	***Meliaceae***	

Annex 2 Mangrove species known to occur in the Philippine Islands (CEP/CMMP Sites including UNEP/GEF SCS).

				Regions													
No.	*Philippine Mangrove Spp. (Tree/Shrub/Vine/Grasses/Fern /Palm)*	*Family*	Common name	1	2	3	4A	4B	5	6	7	8	9	10	11	13	Frequency
1	*Acacia farnesiana*	*Mimosaceae*	aroma				1	1									2
2	*Acanthus ebracteatus*	*Acanthanceae*	tigbau		6	1	1	3		1	1						13
3	*Acanthus ilicifolius*	*Acanthanceae*	deliuario		6	1				1							8
4	*Acrostichum aureum*	*Pteridaceae*	lagolo		4	1	1				1						7
5	*Acrostichum speciosum*	*Pteridaceae*				1					1						2
6	*Aegiceras corniculatum*	*Myrsinaceae*	saging-saging		10	1	1	6	5	1	2		1	1			28
7	*Aegiceras floridum*	*Myrsinaceae*	Tinduk-tindukan		9	1	1	7	5	1	3		1		2		30
8	*Aegiceras lanata*	*Myrsinaceae*							2		1	1		1		1	6
9	*Alstonia macrophylla*	*Apocynaceae*															0
10	*Avicennia eucalyptifolia*	*Avicenniaceae*															0
11	*Avicennnia alba*	*Avicenniaceae*	bungalon puti				1			1	2						4
12	*Avicennia lanata*	*Avicenniaceae*	piapi	1		1									1		3
13	*Avicennia marina*	*Avicenniaceae*	bungalon puti	1	10	1	1	7	5	2	9	1	1		2		40
14	*Avicennia marina var. rumphiana*	*Avicenniaceae*	piapi	1		1		5		1			4				12
15	*Avicennia officinalis*	*Avicenniaceae*	api-api		11	2	1	5	5	3	5	1	3	1	1		38
16	*Barringtonia asiatica*	*Barringtoniaceae*	butong		11			1									12
17	*Barringtonia racemosa*	*Barringtoniaceae*	putat		6												6
18	*Brownlowia lanceolata*	*Barringtoniaceae*	maragomon														0
19	*Bruguiera cylindrica*	*Rhizophoraceae*	pototan lalaki	1	5	1		6	5	1	3				1		23
20	*Bruguiera gymnorrhiza*	*Rhizophoraceae*	busain	1	9		2	7	5	2	2				1		29
21	*Bruguiera parviflora*	*Rhizophoraceae*	langarai		5		1	5	2	1		1	2				17
22	*Bruguiera sexangula*	*Rhizophoraceae*	Pototan		9		1	6	2	4	2	1	1		1	2	29
23	*Caesalpinia crista*	*Fabaceae*	kalumbibit														0
24	*Caesalpinia nuga*	*Fabaceae*	sapinit		11	1		1									13
25	*Camptostemon philippinense*	*Bombacaceae*	gaps-gapas					4	5	1					1		11
26	*Centrosema sp.*	*Leguminosae*				1		1									2
27	*Cerbera manghas L*	*Apocynaceae*	baraibai		5												5
28	*Ceriops tagal*	*Rhizophoraceae*	tangal	1	12		1	6	4	3	2	1	1		3	2	36
29	*Ceriops decandra*	*Rhizophoraceae*	malatangal		11		1	5	5	1	5		1	1	1		31
30	*Chromolaena odorata*	*Euphorbiaceae*				1		1									2
31	*Clerodendrum siphonospathus*	*Verbenaceae*				1											1
32	*Derris trifoliate*	*Fabaceae*	mangasin		6	1											7
33	*Dolichandrone spathacea*	*Bignoniaceae*	tui		4										1		5
34	*Excoecaria agallocha*	*Euphorbiaceae*	buta-buta	*1*	12	1	1	2	5	1	6				2	1	32
35	*Flagellaria indica*	*Flagellarianceae*				1		1									2
36	*Glochidion littorale*	*Euphorbiaceae*	dampol					4									4
37	*Glochidion mindorense*	*Euphorbiaceae*						1									1
38	*Heritiera littoralis*	*Sterculiaceae*	dungon late		11	1		2		1	1						16
39	*Heritiera sylvatica*	*Sterculiaceae*						2									2
40	*Hibiscus tiliaceus*	*Malvaceae*	malubago		9	1		3									13

Annex 2 *cont.* **Mangrove species known to occur in the Philippine Islands (CEP/CMMP Sites including UNEP/GEF SCS).**

				Regions													
No.	*Philippine Mangrove Spp. (Tree/Shrub/Vine/Grasses/Fern /Palm)*	*Family*	Common name	1	2	3	4A	4B	5	6	7	8	9	10	11	13	Frequency
41	*Intsia bijuga*	*Leguminosae*	ipil														0
42	*Intsia retusa*	*Leguminosae*	ipil laut														0
43	*Ipomea pes-caprae*	*Convolvulaceae*	lambayong		9	1		2									12
44	*Kandela candel*	*Rhizophoraceae*						1									1
45	*Kleinhovia hospita*	*Sterculiaceae*	tan-ag														0
46	*Lumnitzera littorea*	*Combretaceae*	tabau		2	1		3	5	1	2	1			2	1	18
47	*Lumnitzera racemosa*	*Combretaceae*	kulasi		1	1		2	5	1	5			1	1	1	18
48	*Mallotus papillaris*	*Euphorbiaceae*				1		1									2
49	*Morinda bracteata*	*Rubiaceae*		1	3								1	1			6
50	*Nypa fruticans*	*Palmae*	nipa	*1*	11	1	1	5	5	2	2		1		2	3	34
51	*Oncosperma tigillaria*	*Palmae*	anibong														0
52	*Osbornia octodonta*	*Myrtaceae*	taualis	*2*	5		1		3	1	4					1	17
53	*Pandanus tectorius*	*Pandanaceae*		1	10	1											12
54	*Pemphis acidula*	*Lythraceae*	bantigi		5		1	1	5	1					1		14
55	*Phanera integrifolia*	*Caesalpiniaceae*				1		1									2
56	*Pluchea indica Linn*	*Compositae*	kalapini														0
57	*Pongamia pinnata*	*Fabaceae*	bani	1	8											1	10
58	*Prosopis vidaliana*	*Leguminasae*				1		1									2
59	*Rhizophora apiculata*	*Rhizophoraceae*	bakauan lalaki	*2*	11	1	2	8	6	4	10	2	9	1	3	3	62
60	*Rhizophora mucronata*	*Rhizophoraceae*	bakauan babae	1	9	2	1	8		4	4	1	8	1	2	2	43
61	*Rhizophora stylosa*	*Rhizophoraceae*	bakauan bangkau	1	4		1	5		1	9	2	2		2		27
62	*Rhizopora lamarckeii*	*Rhizophoraceae*															0
63	*Sapium indicum*	*Rhamnaceae*															0
64	*Scyphiphora hydrophyllacea*	*Rubiaceae*	nilad		11	2	2	5		1	1				2		24
65	*Sesuvium portulacastrum*	*Aizoaceae*	dampalit			1		1			2						4
66	*Sonneratia alba*	*Sonneratiaceae*	pagatpat		8	2	1	7		3	4	1	6		2	2	36
67	*Sonneratia caseolaris*	*Sonneratiaceae*	pedada	1	9			4		2	3	2		1	1	1	24
68	*Strophantus cumingii*	*Apocynaceae*															0
69	*Teijsmanniodendron hollrungii*	*Verbenaceae*															0
70	*Terminalia catappa*	*Combretaceae*	talisay		12	1	1	1		1	2						18
71	*Thespesia populnea*	*Malvaceae*	banalo					5									5
72	*Thespesia populneoides*	*Malvaceae*						1									1
73	*Tristellateria australasiae*	*Malphigiaceae*	binusisi					1									1
74	*Xylocarpus granatum*	*Meliaceae*	tabigi	1	9	1	1	6		1	1	1	4	1	1	1	28
75	*Xylocarpus moluccensis*	*Meliaceae*	piagau		9			4									13
76	*Xylocarpus rumphii*	*Meliaceae*															0
	True mangroves[2]			14	23	15	19	24	17	24	24	13	15	9	20	13	27
	Associates			3	17	18	5	22	2	7	7	0	1	1	3	1	34
	All Species			17	40	33	24	46	19	31	31	13	16	10	23	14	61

[2] *The true mangrove species are highlighted by* ***bold.***

United Nations Environment Programme

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NATIONAL REPORT

on

Mangroves in South China Sea

THAILAND

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Table of Contents

List of Tables and Figures

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 Charuppat and Charuppat (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.

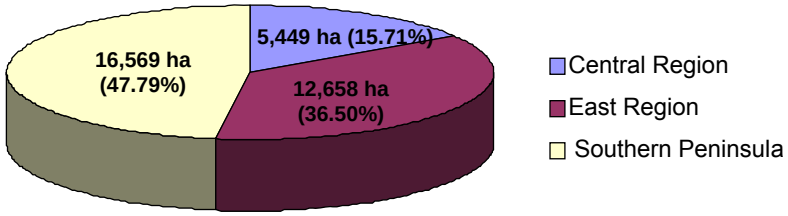

Figure 2 Areas of Mangroves in the Gulf of Thailand in 1996.

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
Central Region										
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
Subtotal	**66,890.0**	**36,50**	**31,23**	**1,015.8**	**59**	**406.0**	**5,363.0**	**5,450.7**	**12,053.6**	**10,874.0**
Eastern Region										
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
Subtotal	**54,844.9**	**49,00**	**44,14**	**27,980.6**	**20,708.8**	**11,084.3**	**13,047.6**	**12,657.9**	**22,740.9**	**26,40**

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
Region of Eastern Coast of Peninsula										
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
Subtotal	**56,449.1**	**35,50**	**33,77**	**19,643.5**	**17,08**	**13,973.6**	**16,424.6**	**16,571.3**	**32,808.4**	**34,063.0**
Region of Western Coast of Peninsula										
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
Satoon	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
Subtotal	**194,172.3**	**191,70**	**194,15**	**147,795.8**	**142,218.2**	**148,351.6**	**133,847.2**	**132,90**	**170,726.8**	**181,381.4**
Total area of country	**372,356.4**	**312,700.0**	**303,308.0**	**196,435.8**	**180,607.0**	**173,822.0**	**168,682.5**	**167,584.0**	**238,329.9**	**252,751.3**

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	*Acanthus ebracteatus*	Ngueak Plaamo	Acanthaceae	S	+	+
2	*A. ilicifolius*	Ee kreng	Acanthaceae	S	+	+
3	*Acrostichum aureum*	Prong thale	Pteridaceae	S	+	+
4	*A. speciosum*	Prong nuu	Pteridaceae	S	+	-
5	*Aglaia cuculatta*[xx]	Daeng nam	Meliaceae	T	+	+
6	*Aegiceras corniculatum*	Lep mue naang	Myrsinaceae	S	+	+
7	*Allophyllus cobbe*	Tosai	Sapindaceae	S	+	+
8	*Ardisia elliptica*	Raamyai	Myrsinaceae	S/ST	+	+
9	*Avicennia alba*	Samae khao	Avicenniaceae	T	+	+
10	*A. marina*	Samae thale	Avicenniaceae	T	+	+
11	*A. officinalis*	Samae dam	Avicenniaceae	T	+	+
12	*Barringtonia asiatica*	Chik le	Barringtoniaceae	T	+	+
13	*B. racemosa*	Chik suan	Barringtoniaceae	ST	+	+
14	*Brownlowia tersa*[xx]	Nam Nong	Tiliaceae	S	+	+
15	*Bruguiera cylindrica*	Thua Khao	Rhizophoraceae	T	+	+
16	*B. gymnorrhiza*	Kongkaanghua sum	Rhizophoraceae	T	+	+
17	*B. hainesii* [xx]	-	Rhizophoraceae	T	+	+
18	*B. parviflora*	Thua dam	Rhizophoraceae	T	+	+
19	*B. sexangula*	Prasak dok khao	Rhizophoraceae	T	+	+
20	*Calophyllum inophyllum*	Saraphee thale	Guttiferae	T	+	+
21	*Cerbera manghas*	Teepet saai	Apocynaceae	ST	+	+
22	*C. odollam*	Teenpet thale	Apocynaceae	T	+	+
23	*Ceriops decandra*	Prong khao	Rhizophoraceae	S/ST	+	+
24	*C. tagal*	Prong daeng	Rhizophoraceae	T	+	+
25	*Clerodendrum inerme*	Sammangaa	Verbenaceae	S	+	+
26	*Cynometra iripa*	Kaa tong	Leguminosae	S	+	-
27	*C. ramiflora*	Maang kha	Leguminosae	T	+	+
28	*Cycas rumphii*	Prong thale	Cycadaceae	ST	+	+
28	*Dendrolobium umbellatum*	Chamaep	Leguminosae	S	+	+
29	*Derris indica*	Yee nam	Leguminosae	T	+	+
30	*Diospyros ferrea*	Lambit thale	Ebenaceae	S	+	+
31	*D. areolata*	Maa plab	Ebenaceae	T	-	+
32	*Dolichandrone spathacea*	Khae Thale	Bignoniaceae	T	+	+
33	*Excoecaria agallocha*	Taatum thale	Euphorbiaceae	ST/T	+	+
34	*Ficus microcarpa*	Sai Yoi bai thuu	Moraceae	T	+	+
35	*Glochidion littorale*	-	Euphorbiaceae	ST	+	+
36	*Guettarda speciosa*	Kangkaang huuchang	Rubiaceae	ST	+	+
37	*Heritiera littoralis*	Ngonkai thale	Sterculiaceae	T	+	+
38	*Hibiscus tiliaceus*	Po thale	Malvaceae	T	+	+
39	*Horsfieldia irya*	Kruai	Myristicaceae	T	+	+
40	*Intsia bijuga*	Lumpho thale	Leguminosa	T	+	+
41	*Kandelia candel*	Rang ka thae	Rhizophoraceae	T	+	+
42	*Lumnitzera littorea*	Faat daeng	Combretaceae	ST/T	+	+
43	*L. racemosa*	Faat Khao	Combretaceae	S/ST	+	+
44	*Melaleuca cajuputi*	Samet	Myrtaceae	T	+	+
45	*Melastoma villosum*	Khlongkhleng khom	Melastomaceae	S	+	-
46	*Myrisine porteriana*	Phrong nok	Myrsinaceae	S	+	+
47	*Nypa fruticans*	Chaak	Palmae	ST	+	+
48	*Oncosperma tigillaria*	Laao cha on	Plamae	T	-	+
49	*Pandanus odoratissimus*	Toei thale	Pandanaceae	ST	+	+
50	*Peltophorum pterocarpum*	Non see	Legumminosae	T	+	+
51	*Pemphis acidula*	Thian le	Lythraceae	S	+	+
52	*Phoenix paludosa*	Peng thale	Palmae	T	+	+
53	*Planchonella obovata*	Ngaa saai	Sapotaceae	T	+	+
54	*Pluchea indica*	Khluu	Compositae	S	+	+
55	*Premna obtusifolia*	Chaa lueat	Verbenaceae	S	+	+
56	*Rhizophora apiculata*	Kongkaang bailek	Rhizophoraceae	T	+	+
57	*R. mucronata*	Kongkaang baiyai	Rhizophoraceae	T	+	+
58	*Sapium indicum*	Samo thale	Euphorbiaceae	ST/T	+	+
59	*Scaevola taccada*	Rak Thale	Goodeniaceae	ST	+	+
60	*Scolopia macrophylla*	Takhob Thale	Flacourtiaceae	ST	-	+
61	*Scyphiphora hydrophyllacea*	Chee ngam	Rubiaceae	ST	+	+
62	*Sonneratia alba*	Paat	Sonneratiaceae	T	+	+
63	*S. caseolaris*	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	*S. griffithii*	Lam phaen hin	Sonneratiaceae	T	+	-
65	*S. ovata*	Lam phaen hin	Sonneratiaceae	T	+	+
66	*Sueda maritima*	Cha khraam	Chenopodiaceae	US	+	+
67	*Terminalia catappa*	Huu kwaang	Combretaceae	T	+	+
68	*Thespesia populnea*	Pho thale	Malvaceae	T	+	+
69	*Xylocarpus granatum*	Ta buun khao	Meliaceae	T	+	+
70	X. *rumphii*	Ta buun	Meliaceae	T	+	-
71	X. *moluccensis*	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, [xx] = 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. Prachaub 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 *Metaplax*. 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 ephippium*) 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 *Crassotrea 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 *Ambassidae, Clupeidae* and *Engraulidae* as dominant Groups.
Trat Bay, Trat	111 species of fish from 47 families, with *Cypridinae, Gobididae, Sigainindae* and *Engraulidae* 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
Birds			
Aquila clanga	Greater spotted eagle	Globally threatened	Khao Sam Roi Yot National Park
Aythya baeri	Baer's pochard	Globally threatened	Khao Sam Roi Yot National Park
Charadrius peronii	Malaysian plover	Globally threatened	Khao Sam Roi Yot National Park Ban Don Bay, Pattani Bay
Columba punicea	Pale-capped pigeon	Globally threatened	Khao Sam Roi Yot National Park
Eurynorhynchus pygmaeus	Spoon-billed sandpiper	Globally threatened	Khao Sam Roi Yot National Park
Heliopais personata	Masked finfoot	Globally threatened	Ban Don Bay, Pattani Bay
Leptoptilos dubius	Greater adjutant	Globally threatened	Khao Sam Roi Yot National Park
Limnodromus semipalmatus	Asian dowitcher	Globally threatened	Khao Sam Roi Yot National Park Pak Phanang Bay
Pelecanus philippensis	Spot-billed pelican	Globally threatened	Khao Sam Roi Yot National Park
Tringa guttifer	Spotted greenshank	Globally threatened	Khao Sam Roi Yot National Park
Anous stolodus	Brown noddy	Critically endangered	Mu Koh Chang National Park
Bubo coromandus	Dusky eagle-owl	Critically endangered	Khao Sam Roi Yot National Park
Leptopilos javanicus	Lesser adjutant	Critically endangered	Klong Kone and Klong Yeesan Pak Phanang Bay
Acrocephalus tangolum	Manchurian reed warbler	Endangered	Khao Sam Roi Yot National Park
Aquila heliaca	Imperial eagle	Endangered	Khao Sam Roi Yot National Park
Ardea cinerea	Grey heron	Endangered	Khao Sam Roi Yot National Park Thung Kha Bay / Savi Bay, Don Hoi Lot
A. purpurea	Purple heron	Endangered	Khao Sam Roi Yot National Park Thung Kha Bay / Savi Bay
Ciconea nigra	Black stork	Endangered	Khao Sam Roi Yot National Park
Egretta eulophotes	Chinese egret	Endangered	Klong Kone and Klong Yeesan
Milvus migrans	Black kite	Endangered	Khao Sam Roi Yot National Park
Myeteria leucocephala	Painted stork	Endangered	Klong Kone and Klong Yeesan Khao Sam Roi Yot National Park
Phalacrocorlax carbo	Great cormorant	Endangered	Klong Kone and Klong Yeesan Khao Sam Roi Yot National Park
Sterna bergii	Great crested tern	Endangered	Mu Koh Chang National Park Khao Sam Roi Yot National Park
Threskionis melanocephalus	Black-head ibis	Endangered	Khao Sam Roi Yot National Park
Aerodramus fuciphagus	Edible-nest swiftlet	Near-threatened	Mu Koh Chang National Park Khao Sam Roi Yot National Park Pak Phanang Bay, Don Hoi Lot
Amandava amandava	Red avadavat	Near-threatened	Khao Sam Roi Yot National Park
Aquila nipalensis	Steppe eagle	Near-threatened	Khao Sam Roi Yot National Park
Botaurus stellaris	Great bittern	Near-threatened	Khao Sam Roi Yot National Park
Buceros bicornis	Great hornbill	Near-threatened	Mu Koh Chang National Park
Burhinus oedicnemus	Eurasian thick-knee	Near-threatened	Khao Sam Roi Yot National Park
Cotunix chinensis	Blue-breasted quail	Near-threatened	Khao Sam Roi Yot National Park
Ducula bicolour	Pied imperial pigeon	Near-threatened	Mu Koh Chang National Park Khao Sam Roi Yot National Park
Emberiza aureola	Yellow-breasted bunting	Near threatened	Khao Sam Roi Yot National Park
Falco severus	Oriental hobby	Near-threatened	Khao Sam Roi Yot National Park Thung Kha Bay / Savi Bay
Fiecdula narcissina	Narcissus flycatcher	Near-threatened	Khao Sam Roi Yot National Park
Gallicrex cinerea	Watercock	Near-threatened	Khao Sam Roi Yot National Park
Gallinago megala	Swinhoe's snipe	Near-threatened	Khao Sam Roi Yot National Park
Gorsachius melanolophus	Malayan night-egret	Near-threatened	Thung Kha Bay / Savi Bay
Haliaeestrus leucogaster	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
Haliastur indus	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
Ixobrychus eurhythmus	Schrenck's bittern	Near-threatened	Khao Sam Roi Yot National Park
Nettapus coromandelianus	Cotton pygmy-goose	Near-threatened	Khao Sam Roi Yot National Park
Numenius madagascariensis	Eastern curlew	Near-threatened	Khao Sam Roi Yot National Park
Ploceas philipinus	Baya weaver	Near-threatened	Khao Sam Roi Yot National Park
Rhyticeros subruficollis	Plain-pouched hornbill	Near-threatened	Mu Koh Chang National Park
Sterna albifons	Little tern	Near-threatened	Khao Sam Roi Yot National Park Pak Phanang Bay, Don Hoi Lot
Treron bicincta	Orange breasted pigeon	Near-threatened	Khao Sam Roi Yot National Park
Vanellus cinereus	Grey-headed lapwing	Near-threatened	Khao Sam Roi Yot National Park
Aythya nyroca	Ferruginous pochard	Vulnerable	Khao Sam Roi Yot National Park
Garrulax merulinus	Spot-breasted laughing thrush	Vulnerable	Mu Koh Chang National Park
Ploceas manyar	Streaked weaver	Vulnerable	Khao Sam Roi Yot National Park
Terpsiphone atrocaudata	Japanese paradise-flycatcher	Vulnerable	Khao Sam Roi Yot National Park
Fish			
Hippocampus kuda	Seahorse	Endangered	Welu River Estuary
Anodontostoma chacunda	Chawnda gizzard-shad	Vulnerable	Welu River Estuary
Chiloscyllium burgeri	Bambooshark	Vulnerable	Welu River Estuary
C. indicum	Slender bambooshark	Vulnerable	Welu River Estuary
Clarius batrachus	Walking catfish	Vulnerable	Khao Sam Roi Yot National Park
Pampus argenteus	Silver pomfret	Vulnerable	Welu River Estuary
P. chinensis	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 (Charnsnoh, 1999; Erftemeijer & 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
Avicennia spp.	*Samae*	Fruits	Food
Bruguiera spp.	*Thoa*	Fruits	Food
Nypa fruticans	*Jaak*	Leaves, flowers, fruits	Sugar Production, vinegar alcohol production, foods
Phoenix paludosa	*Pang*	Young leaves	Food
Sonneratia spp.	*Lume-Paan*	Young flowers, fruits	Food

Source: Bamroongrugsa 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 (Bamroongrugsa 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
Acrostichum spp.	*Prong-talae*	Rhizomes	Extract from rhizomes is an antiseptic.
Acanthus ebracteatus *A. ilicifolius*	*Ngueak-Plaamo-Dokkaw* *Ngueak-Plaamo-Dokmuang*	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.
Avicennia alba *A. officinalis*	*Samae-Kaw* *Samae-Dum*	Fruits, heart wood, seeds, bark, roots	Extract from fruits is an antiseptic and extract from fresh heart wood sooths stomach pains, has tonic properties, and treats abscesses.
Barringtonia racemosa	*Chick-Suan*	Roots, fruits	Anti-diarrhoeal.
Bruguiera sexangula *B. parviflora*	*Phangka-Huasum-Dokkaw* *Thua-Dum*	Bark	Anti-inflammatory.
Cerbera manghas	*Teen-Peed*	Seeds	Treats heart problems.
Ceriops decandra *C. tagal*	*Prong-Kaw* *Prong-Dang*	Shoots, bark	Anti-diarrhoeal, anti-inflammatory, treats malaria.
Excoecaria agallocha	*Taatum-Talae*	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
Hibiscus tiliaceus	*Po-Talae*	Roots, leaves, flowers	Laxative. Fresh flowers boiled with fresh milk can treat ear infections.
Heritiera littoralis	*Ngonkai-Talae*	Seeds	Anti-diarrhoeal.
Phoenix paludosa	*Khluu*	Leaves	Antiseptic.
Phoenix paludosa	*Pang*	Shoots	Sooths stomach pains.
Rhizophora apiculata *R. mucronata*	*Kong-Kang*	Barks, roots	Extract from bark is anti-diarrhoeal and extract from roots is provides nourishment.
Scaevola taccada	*Rak-Talae*	Leaves	Treats colds and headaches.
Xylocarpus granatum, Moluccensis	*Taboon-Kaw, Taboon-Dum*	Seeds, bark	Extract from seeds is an antiseptic and extract from bark is anti-diarrhoeal.

Source: Aksornkoae (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 (Aksornkoae, 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 (Aksornkoae, 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* (Aksornkoae, 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. (Aksornkoae, 1993). Nypa palm is also important as a source of roof shingles and is an important source of income for many coastal villagers (Bamroongrugsa 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 (Aksornkoae, 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 (Aksornkoae, 1993). At the present time tannin is rarely used for dyeing because the introduction of nylon net fishing equipment has made this use redundant (Aksornkoae, 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 (*Ophichthyus microcephalus*), catfish eel (*Plotosus canius*), and milk fish (*Chanos chanos*); the most commonly caught species of shrimp are *Penaeus merguiensis, 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 (Aksornkoae, 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 (*Modiota senhausenii*), 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.

Date	Summary of Resolution
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	Five-year action plan approved for recovery and establishment of mangrove areas, together with a 750 million baht (US$30 million) budget. Actions included: • Provincial mangrove management plans to be drawn up. Plans to take local conditions and requirements into account. • Mangrove areas to be defined and marked. • Remote sensing techniques to be applied. • Ground surveys and marking to be conducted every two years. • Mangrove propagation to be encouraged through replanting. • Degraded forests to be restored and replanted. • Privately owned mangrove plantations to be supported. • Seed source areas to be developed in conservation forests and plantations. • Encroachment into mangrove areas to be reduced. • Patrolling to be intensified and public awareness increased. • Support to be requested from the Navy and Navy officers designated as additional forestry officers according to the Forestry Act. • Intensive aquaculture to be promoted away from mangrove areas. • Programme evaluations to be conducted by inspectors from the Prime Minister's Office. • Budget needed for plan implementation to be allocated by the Budget Bureau.
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	Provincial Mangrove Management Units ordered to: • Monitor whether mangrove concessionaires follow conditions of their concessions. • Monitor the licensing of land use in mangrove areas granted after 1991. • Monitor the licensing of shrimp farm operators in mangrove areas. • Persuade concessionaires to surrender their concessions after the expiry date.
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^2).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.

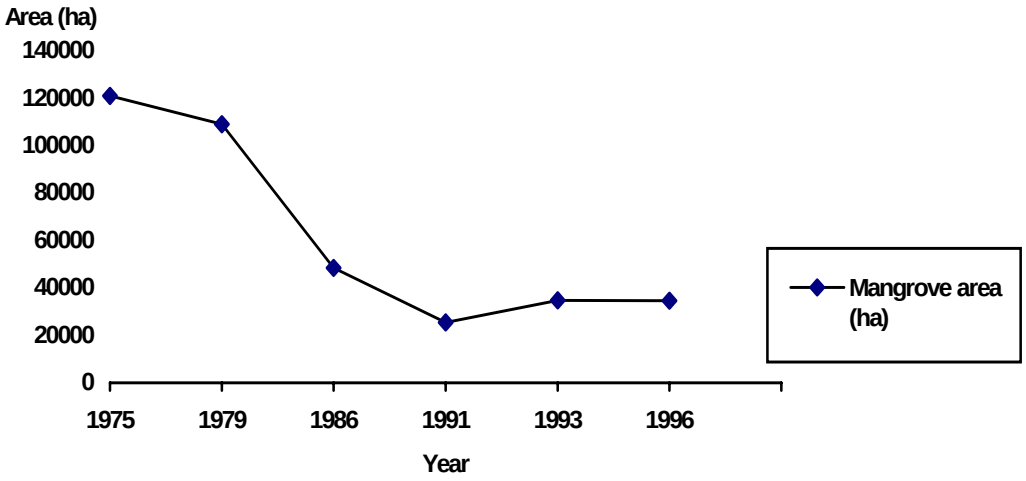

Figure 3 Change in Mangrove Areas in the Gulf of Thailand from 1975-1996.

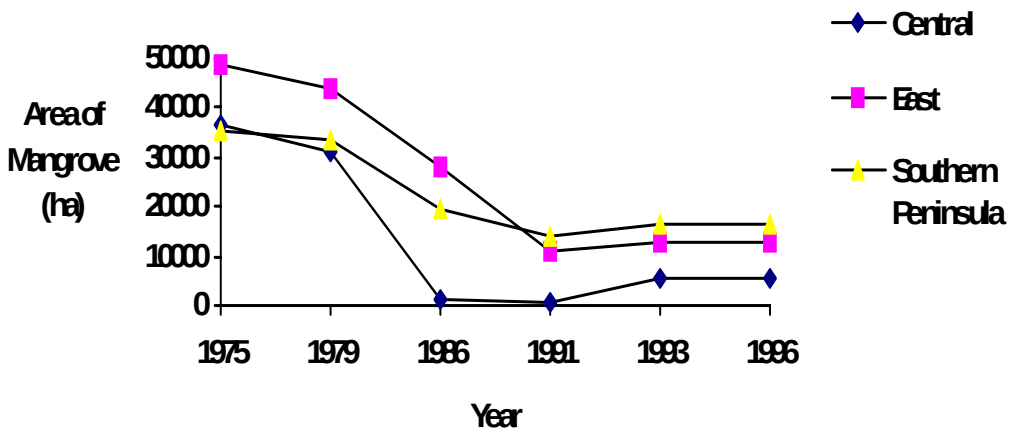

Figure 4 Change in Mangrove Areas around the Gulf of Thailand Coast from 1975 – 1996.

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 Charuppat and Charuppat (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
Total	**66,981**	**55,845**	**56,448**	**179,274**

Adapted from Charuppat and Charuppat (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): Charuppat 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 Charuppat 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: Charuppat 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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Global Environment Facility

NATIONAL REPORT

on

Mangroves in South China Sea

VIET NAM

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VIET NAM

Table of Contents

List of Tables and Figures

1. GEOGRAPHICAL DISTRIBUTION OF NANGROVE FOREST IN VIET NAM

1.1 Maps

The Forest Inventory and Planning Institute is a governmental agency responsible for monitoring and updating the forest resources inventory for Viet Nam. All maps relevant to forest state and distribution of forest types are also carried out by Forest Inventory and Planning Institute. The information and data sources for map production are based on satellite, arial photos and a network of stable sample plots. Every 5 to 10 years the process of surveying and updating the forest inventory is implemented nation wide.

The maps of current land use and land use planning were produced in 1997 by the Forest Inventory and Planning Institute for a number of provinces in the Mekong River Delta such as Tra Vinh, Soc Trang, Bac Lieu and Ca Mau provinces. These maps were produced at the scale of 1/100,000 based on SPOT photos taken in 1995 and topographical maps with scale of 1/100,000 and 1/50,000.

During the year 2000 the Forest Inventory and Planning Institute as part of the national forest inventory programme followed by decree No 286/TTg dated 2nd May 1997 produced up-to-date mangrove state and distribution maps for 12 coastal provinces. Paper and GIS maps were produced for the following provinces Quang Ninh, Thai Binh, Nam Dinh, Hai Phong, Ninh Binh, Tien Giang, Long An, Kien Giang, Dong Thap, Ca Mau, Bac Lieu and Ben Tre provinces. All maps are digitized and produced at a original scale of 1/100,000.

1.2 Geographical Distribution of Mangrove Areas

1.2.1 Classification of Mangrove Areas

According to researches of Phan Nguyen Hong (1991, 1999) mangrove forest of Viet Nam is classified into 4 main regions and sub-divisions as follow:

Region I: North-East coastal area, from Ngoc cape to Do Son cape. In this area 3 sub-divisions of mangrove distribution are identified:

- **Sub-division 1:** From Mong Cai to Cua Ong
- **Sub-division 2:** From Cua Ong to Cua Luc
- **Sub-division 3:** From Cua Luc to Do Son cape

Region II: Costal area of Red River Delta, from Lach Truong cape to Vung Tau cape. This area is divided into following sub-division:

- **Sub-division 1:** From Do Son cape to Van Uc estuary
- **Sub-division 2:** From Van Uc estuary to Lach Truong estuary

Region III: Central costal area, from Lach Truong cape to Vung Tau cape. This area is divided into 3 sub-divisions as below:

- **Sub-division 1:** From Lach Truong cape to Ron cape
- **Sub-division 2:** From Ron cape to Hai Van pass
- **Sub-division 3:** From Hai Van pass to Vung Tau cape

Region IV: Costal area of the South, from Vung Tau cape to Nai cape. In this area 4 sub-divisions for distribution of mangrove forest are identified as follow:

- **Sub-division 1:** From Vung Tau to estuary of Soai Rap River (Coast of South-East area)
- **Sub-division 2:** From Soai Rap estuary to My Thanh estuary (Coast of Mekong River Delta area)
- **Sub-division 3:** From My Thanh estuary to Bay Hap estuary (South-West area of Ca Mau peninsula)
- **Sub-division 4:** From Bay Hap estuary to Nai cape (Coast of West area of Ca Mau peninsula)

However as researches of Forest Science Institute of Viet Nam and Forest Inventory and Planning Institute on classification of distribution of mangrove forest have identified 6 geographical regions for mangrove distribution corresponding to guidelines on evaluation and inventory of forest resources that are North-East, Red River Delta, North Central, South Central, South East South and Mekong River Delta regions.

1.2.2 Geographical Distribution of Mangrove Areas

Viet Nam has a total inland natural area of 32,894,398ha, with a 3260km length of coastline, starting from the North (Mong Cai of Quang Ninh province) from $22^0$5 North latitude, to the South (Ha Tien of Kien Giang province) to $8^0$33' North latitude. From $102^0$10' East Longitude to $109^0$26' East Longitude.

According to the national forest inventory results as of 31/12/1999, Viet Nam has a total forest area of 10,915,592ha, of which natural forest is 9,444,198ha and plantation forest is 1,471,394ha. Present forest cover is 33.2%.

Also according to the national forest inventory results conducted by the Forest Inventory and Planning Institute and Decision No 03/2001 QD/TTg signed by the Prime Minister of the Government of Viet Nam on 5/1/2001 and promulgated in July 2001, then, the total mangrove area of Viet Nam as of 21/12/1999 is 156,608ha. Of which the natural mangrove area is 59,732ha accounting for 38.1% and mangrove plantation forest area is 96,876ha accounting for 61.95%.

Out of the total mangrove plantation forest area in Viet Nam, the *Rhizophora apiculata* plantation forest accounts for 80,000ha (accounting for 82.6%) and the remaining area of 16,876ha is plantation forest with species such as: *Kandelia obovata*, *Sonneratia coseolaris* and other mangrove species (accounting for 17.4%) (Forest Inventory and Planning Institute, 1995).

However, according to the data recorded by coastal provinces in December 2000, Viet Nam possess a total mangrove area of 155,290ha, a reduction of 1,318ha (0.84%) from the data issued in December 1999. Of the 155,290ha, natural mangrove covers only 32,402ha (accounting for 21%) whilst plantation mangrove area is 122.892ha, accounting for 79% (Forest Science Institute of Viet Nam – 2001).

The total coastal wetland area of Viet Nam in 1982 was 494,000ha (General Department of Land Management – frequently salted land). While in 2000, frequently salted land along the coastal area of Viet Nam remains at 446,991ha, a reduction of 47,009ha, due to a large salted area along the coastal line having been converted to brackish water shrimp farming areas.

At present, along coastal areas of Viet Nam where the development of blackish water shrimp farming is being promoted, in many localities of Viet Nam where salted water has been introduced into waterlogged rice fields for blackish water shrimp farming activities.

According to statistical data compiled by the coastal provinces and Ministry of Fisheries 1999 - 2000 as well as Forest Science Institute – 2000, If the coastal brackish water shrimp farming areas included into coastal wetland (Salic fluvisols) along the coast (permanently salted land affected by high tidal inundation), then, total area will be 606,782 ha (increased as compared with wetland area in 1982 is 11,2792ha), of which:

+ 155,290ha are coastal mangrove area
+ 225,394ha are coastal wetland (Salic fluvisols) area without mangrove forest; and
+ 226,075ha are coastal brackish water shrimp farming area with dykes and water gates.

The map below shows the distribution of mangrove forest in the coastal areas in Viet Nam (Figure 1). The detailed data relevant to mangrove areas and distribution in coastal provinces and regions of Viet Nam is synthesized in Table 1.

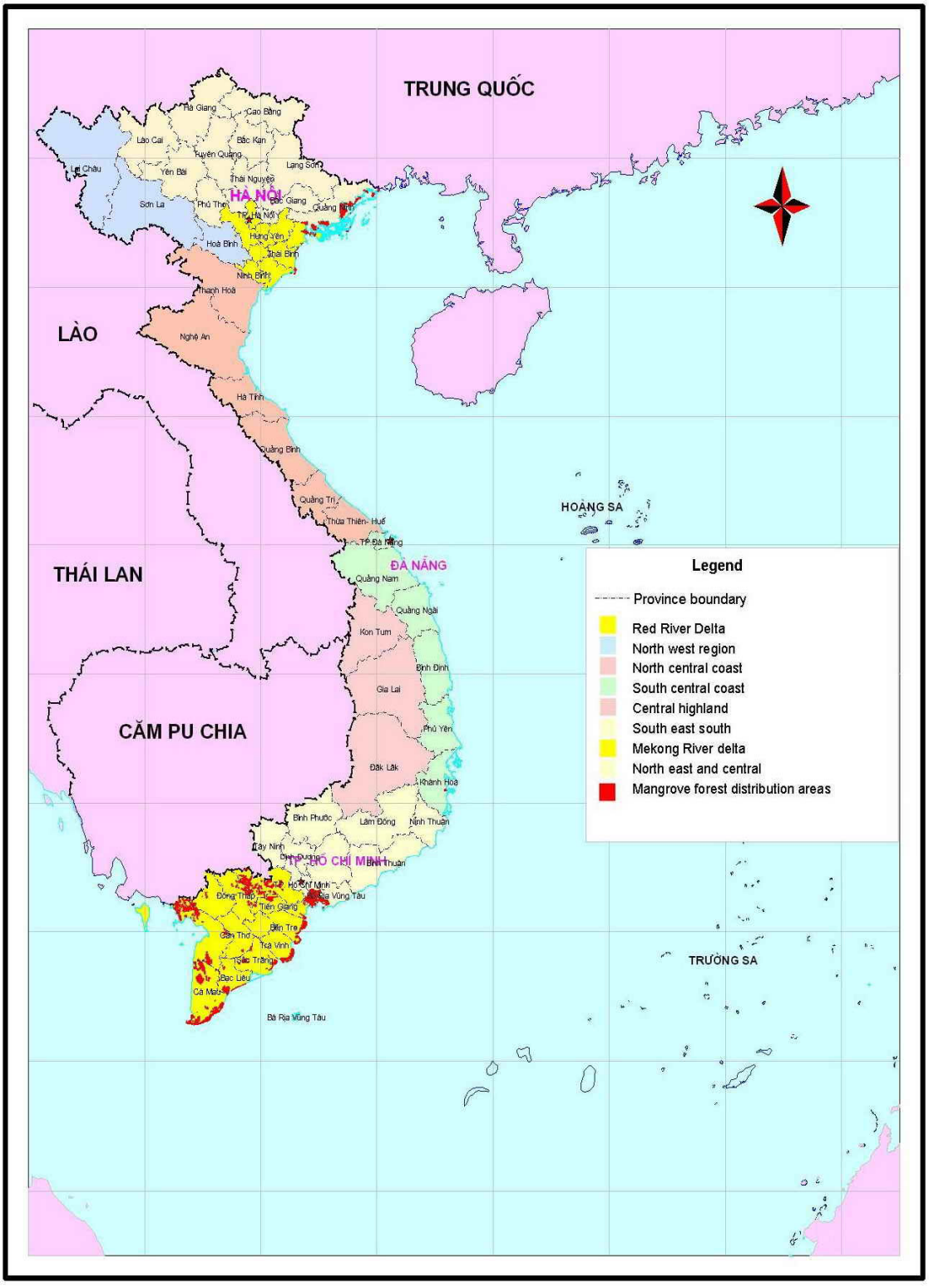


Figure 1 Map of mangrove distribution in Viet Nam.

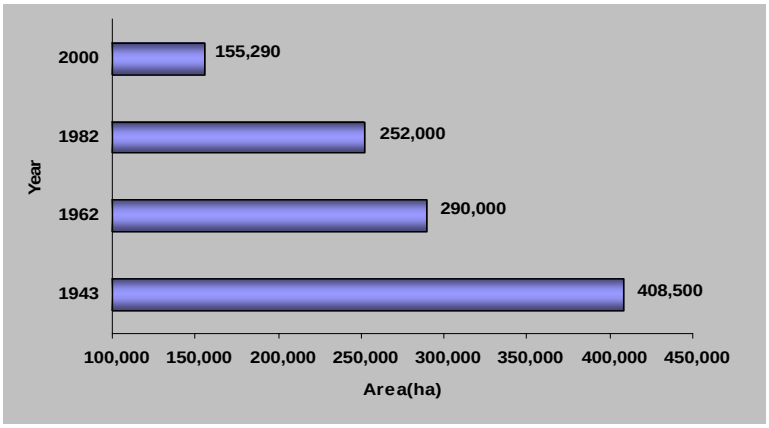
Table 1 Distribution of coastal wetland and mangrove areas by provinces and ties along the coastal zone of Viet Nam.

No	Province	Area with mangrove forest		Area without mangrove forest		Brackish water shrimp farming area	
		Area (ha)	**%**	**Area** (ha)	**%**	**Area** (ha)	**%**
Total		**155,290**	**100**	**225,394**	**100**	**226,075**	**100**
1	Quang Ninh	22,969	14.8	27,194	12.1	14,837	6.6
2	Hai Phong	11,000	7.1	1,000	0.4	5,000	2.2
3	Thai Binh	6,297	4.0	14,526	6.4	2,852	1.3
4	Nam Dinh	3,012	1.9	6,031	2.7	5,800	2.6
5	Ninh Binh	533	0.3	1,084	0.5	200	0.1
6	Thanh Hoa	1,000	0.6	15,848	7.0	1,152	0.5
7	Nghe An	800	0.5	2,137	0.9	1,035	0.4
8	Ha Tinh	500	0.3	8,182	3.6	318	0.1
9 ÷ 19	Remaining 10 provinces and cities in the Central part	700	0.4			12,368	5.5
20	Ba Ria - Vung Tau	1,500	1.0	34,360	15.2	1,240	0.5
21	Ho Chi Minh	24,592	15.8	3,180	1.4	2,228	1.0
22	Long An	400	0.2	300	0.1	1,050	0.5
23	Ben Tre	7,153	4.6	9,023	4.0	20,100	8.9
24	Tien Giang	560	0.4	120	0.05	2,148	0.9
25	Tra Vinh	8,582	5.5	22,007	9.8	8,481	3.7
26	Soc Trang	2,943	1.9	6,423	2.8	25,468	11.3
27	Bac Lieu	4,142	2.7	1,411	0.6	20,533	9.1
28	Ca Mau	58,285	37.5	71,718	31.8	92,000	40.7
29	Kien Giang	322	0.2	850	0.4	9,265	4.1

(Source: Ministry of Agriculture and Rural Development, 2001).

1.3 Change in Mangrove Areas

The mangrove area of Viet Nam is recorded in 1943, 1962, 1982 and 2000. During the past 57 years, the mangrove area of Viet Nam has reduced 253,210ha accounting for 61% of mangrove area in 1943 (Figure 2). The latest data in the year of 2000 shows that the existing mangrove area of Viet Nam is about 38% compared to mangrove area in 1943. The deforestation of mangrove forest in Viet Nam is very high. From the recorded data it can be said that average loss of mangrove area during past 57 years is about 4,400ha per year. The chart below shows the changes in mangrove area of Viet Nam.



(Source: Forest Inventory and Planning Institute, 1995; Forest Science Institute of Viet Nam, 2001)

Figure 2 Chart of changes in mangrove area of Viet Nam, 1943 – 2000.

2. SPECIES DISTRIBUTION AND FORMATION

2.1 Species Distribution

In a study conducted by Phan Nguyen Hong (1999) on mangrove ecosystems of Viet Nam, 109 mangrove species have been identified belonging to 2 groups:

- "True" mangrove species group: This group has 37 mangrove species belonging to 20 genuses of 14 families (in 1999, one species added).
- "Associate" mangrove tree group: This group has 72 species, belonging to 36 genuses of 28 families.

Out of 77 mangrove tree species, "True" mangrove species with wooded stems belonging to *Rhizophoraceae*, including 4 genuses: *Rhizophora, Buguiera, Ceriops and Kandelia.*

For Rhizophora genera, there are 6 tree species in the world, of which 3 species have been found in Viet Nam:

- *Rhizophora apiculata* Bl is widely and naturally distributed in the Southern part, scattered in south central region, but not naturally distributed in the Northern part of the Central Region, Red River Delta and North Eastern Part of Viet Nam. *Rhizophora apiculata* plays a very important economic and environmental role along the coastal area of the Southern Deltas. Out of the total mangrove plantation forest area of 96,876ha presently in Viet Nam, then, *Rhizophora apiculata* plantation forest occupies 80,000ha (82.6%).
- *Rhizophora mucronata* Poir in Lamk only distributed on a limited and scattered area in South of Viet Nam and not naturally distributed in the North (from 16^0 North Latitude to 22^030 North Latitude).
- *Rhizophora stylosa* Griff most commonly distributed in the North of Viet Nam, but not naturally distributed or if yes, individual trees are very rarely seen.

For genus of *Bruguiera,* out of 6 species of *Bruguiera* found in the world, 4 species existed in Viet Nam including *Bruguiera gymnorrhiza* (Lam) distributed widely from the North to the South. There are three (3) species of *Bruguiera* genera include*:*

- *Bruguiera cylindrica* (L)
- *Bruguiera sexangula* (Lour) Poir in lamk
- *Bruguiera parviflora* (Roxb) W. & Am. ex Griff

These three species of *Bruguiera* are rather commonly distributed in South of Viet Nam, especially along the coastal areas of Ca Mau peninsular (Mekong River Delta) but not naturally distributed in the North of Viet Nam.

For genera of *Ceriops,* 3 *species* have been found in the world, of which 2 species are present in Viet Nam and include:

- *Ceriops decandra* (Griff)
- *Ceriops tagal* (Pers) C.B.Rob. Ding Hou

These species are naturally distributed in a large area along the coastal area of the Delta in the South and are naturally scattered in the Central Southern part of Viet Nam and not found naturally distributed in the North of Viet Nam.

For *Kandelia* genera*,* there is only one species *of Kandelia,* i.e. *Kandelia obovata* (L) Druce. This species is very commonly and widely distributed in the North of Viet Nam, especially in the North

The Eastern part of Viet Nam and the Northern Delta, but vary rarely distributed naturally in the coastal area of the Southern Delta.

For *Avicenniaceae*, there is only one genus of *Avicennia* distributed worldwide, consisting of 8 species of *Avicennia*, of which 4 species are found in mangrove ecosystems of Viet Nam. They play a crucial role in mangrove ecosystems of Viet Nam after *Rhizophoraceae*. There are 2 species of *Avicennia* which play an important role in sea encroachment, fixing newly built up mud flats along the coastal area, where deeply inundated with tide and with low tide, i.e.:

- *Avicennia marina* (Forsk) Vierh in the North
- *Avicennia abba* Bl extensively distributed in the South and in some places where *Avicennia marina* exists. This species also contributes to fixation of alluvial sediment and is deeply inundated during low tide, on the accumulated soil mixed with clay mud.

Besides the two above-mentioned species, there existed species of *Avicennia lanata* Ridl distributed scatteredly from the South to the North, but not creating into a clear population or association in which *Avicennia lanata Ridl* dominated.

Lastly is *Avicennia officinalis* L. This species is most commonly distributed along the southern coastal regions in Viet Nam, especially along the Ca Mau peninsular. In addition *A. officinalis* L has a limited and scattered distribution within the southern part of the central region. This species is not naturally distributed in the North of Viet Nam.

Sonneratiaceae has one genera of *Sonneratia*. There are 6 different genus of *Sonneratia* in the world, while 3 of them are present in Viet Nam including:

Sonneratia caseolaris O.K Niedenzu. This species is rather common and widely distributed in the South, North and Central regions. It grows in bed of alluvial sediment in the estuaries, rich in mud and clay. This species prefers condition of low salinity, i.e. brackish water whereby the salt level does not more exceed 20‰ and survive in conditions where there is a large annual water salinity variation. For example salinity in rainy seasons below 5‰ and dry seasons up to 20‰.

Sonneratia alba J.Sm in Rees is naturally distributed in the coastal area of the South and South of the Central region, deposited *alluvial* bed consisting of rich mud and clay within the estuaries. Water salinity in these locations has been found to be higher as compared with the distribution of *Sonneratia caseolaris* (salinity from 7‰ - 27‰).

Sonneratia ovata Backer or Sonneratia acida has a natural distribution scattered along the coastal areas of the Southern Delta and it is not distributed naturally in the central and the Northern regions.
Myrsinaceae with genera of *Aegiceras,* of which there are two species of *Aegiceras*:

- *Aegiceras comiculation (L)* Bleo is wooded tree in shrub form, usually not exceeding 3 m high. This species is naturally distributed throughout the North of Viet Nam, especially in the North East of Viet Nam and in the coastal area of the Red River Delta. According to Le Cong Khanh (Ministry of Forestry, 1965) *Aegiceras comiculation* accounts for 54% of the total coastal mangrove area in the North while in the South it only occupies 2.5% of the total regional mangrove area.
- *Aegiceras floridum* Roem. et. Schult has highly restrictly natural distribution within Viet Nam. Recently (1993) Phan Nguyen Hong found a population growing within gravel and sand at Con Dao in South of Viet Nam.

Finally, there are two genera of mangrove trees belonging to *Palmeae* or *Arecaceae*, consisting of 2 genera. Of which *Nypa* genus has only two species in the world that are Wurmb and *Phoenix paludosa*. These two species are also naturally distributed in Viet Nam and have a variety of economic activities: leaves for house roofing, coconut fruit, and milk for drinking or its liquid for alcohol production. In addition these species are highly effective at soil erosion and protecting river banks and canals.

The distribution of *Nypa fruticans* is concentrated mainly in the Southern Delta with scattered populations along the southern part of the central region. *N. fruiticans* is not naturally distributed in the North of Viet Nam. Details of distribution of "True" mangrove species are shown in Table 2 bellow.

Table 2 Distribution of "True" Mangroves by Regions.

No	True mangroves species	Northern Region		Central Region		Southern Region	
	Scientific name Family *Species*	**Zone I** North East	**Zone II** Northern Delta	**Zone III** North Central	**Zone IV** South central	**Zone V** East South	**Zone VI** Mekong River Delta
Total "True" Mangrove species		**16**	**14**	**18**	**23**	**32**	**33**
	Sonneratiaceae						
1	*Sonneratia alba* J. Sm in Rees	0	0	0	x	x x	x x
2	*S. caseolaris* OK. Niedenzu	x	x x x	x x	x x	x x	x x x
3	*S. ovata* Backer	0	0	0	0	X	x
	Avicenniaceae						
4	*Avicennia alba* Bl.	0	0	0	x	x x	x x x
5	*A. officinalis* L.	0	0	0	x	x x	x x x
6	*A. marina* (Forsk.) Vierh	x x x	0	x x	x	X	x
7	*A. lanata* Ridl	0	X	x	x	X	x
	Rhizophoraceae						
8	*Rhizophora apiculata* Bl.	0	0	0	x	x x	x x x

Table 2 *cont.* Distribution of "True" Mangroves by Regions.

No	True mangroves species	Northern Region		Central Region		Southern Region	
	Scientific name Family *Species*	**Zone I** North East	**Zone II** Northern Delta	**Zone III** North Central	**Zone IV** South central	**Zone V** East South	**Zone VI** Mekong River Delta
9	*R. mucronata* Poir. In Lamk	0	0	0	x	X	x
10	*R. stylosa* Griff	x x x	0	x x	0	X	0
11	*Bruguiera gymnorrhiza* Lam.	x x x	0	x	x	X	x x
12	*B. parviflora* (Roxb) W.& Arn. Ex Griff	0	0	0	0	X	x x
13	*B. cylindrica* (L.) Bl.	0	0	0	0	X	x
14	*B. sexangula* (Lour.) Poir. in Lamk						
15	*Ceriops decandra* (Griff.)	0	0	0	x	X	x x
16	*C. tagal* (Pers) C.B Rob. Ding Hou	0	0	0	0	x	x x
17	*Kandelia obovata* Sheue, Liu & Yong	x x x	x x x	x x x	x	0	x
18	*Kandelia candel* (L.) Druce	0	0	0	x	x	x
	Myrsinaceae						
19	*Aegiceras corniculatum* L. Blco	x x x	x x x	x x	x	X	x
20	*A. floridum* Roem.et.Schult	0	0	0	0	0	x
	Combretaceae						
21	*Lumnitzera littorea* (Jack.) Voigt.	0	0	0	0	X	x
22	*L. racemosa* Willd	x x	X	x	x	X	x
23	*L. rosea*	0	0	x	0	0	0
	Euphorbiaceae	TG					
24	*Excoecaria agallocha* L.	x x	x x x	x x	x x	x x	x x x
	Meliaceae						
25	*Xylocarpus granatum* Koenig	x	X	x	x	X	x x
26	*X. mekongensis* (Lam) Pierre	0	0	0	0	X	x
27	*X. moluccensis* (Lamk) Roem	0	0	0	0	X	x
	Arecaceae/Palmeae						
28	*Nypa fruticans* Wurmb.	0	0	0	x	x x x	x x x
29	*Phoenix paludosa* Roxb.	0	0	0	x	x x	x x x
	Acanthaceae						
30	*Acanthus ilicifolius* L.	x x x	x x x	x x	x x	x x x	x x x
31	*A. ebracteatus* Vahl.	x x	x x	x x	x x	x x x	x x
	Sterculiaceae						
32	*Heritiera littoralis* Dry and Exh. Ait	x	X	x	x	X	x
	Rubiaceae						
33	*Scyphiphora hydrophyllacea* Gaertn	x x	X	x	x	X	x
	Aizoaceae						
34	*Seasuvium portulacastrum* L.	x	X	x	x	X	x
	Araceae						
35	*Cryptocoryne ciliata* (Roxb.) Scott	0	0	0	0	X	x
	Pteridaceae						
36	*Acrostichum aureum* L.	xxx	Xx	x	xx	Xx	xxx
37	*Acrostichum speciosium*	x	X	x	x	X	x

(Source: Phan Nguyen Hong, 1999; Dang Trung Tan, 2001).
Remarks: 0: Not distributed; x: Distributed; xx: Widely distributed; xxx: Very widely distributed

However it must be noted that the experts of UNEP/GEF of project *"Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand"* supposed that *Xylocarpus mekongensis* was named as *Xylocarpus rumphii* (Kostel) Mabb and was considered as associate species.

There are also 2 opinions for *Dolichandrone spathacea* (L.f) K. Schum belongs to *Bignoniacea*. According to Phan Nguyen Hong (1999) this species is considered as true mangrove species. But this species is considered as associate mangrove species.

For *Cynometa ramiflora,* Dang Trung Tan (2001) considered as true mangrove species, but in the second meeting of regional working group on mangroves has agreed that this species is associate species, therefore *Cynometa ramiflora* is put into associate species. *Acrostichum speciosum* is amended to list of true mangrove species in Viet Nam as research results of Dang Trung Tan (2001).

In addition, according to Phan Nguyen Hong *Kandelia obovata* Sheue, Liu & Yong, Gn has been found recently in North Central region. As this consequence the total true mangrove species will be 37.

In 1993, Phan Nguyen Hong has made in public a list of "Associate" mangrove species that includes 42 species belonging to 28 families but in recent years, the author and some botanists have added plant species involving in mangrove forest up to 70 species belonging to 32 families (Phan Nguyen Hong, 1999).

It has been identified that the development of a set of standard criteria for the addition of new "Associate" mangrove species should be explored further. Table 3 below shows the list of "Associate" mangrove species, in which 2 new species are added to.

Table 3 List of "Associate" Mangrove Species and Distribution by Regions.

No	Scientific name Family *species*	Distribution area		
		Northern region	**Central region**	**Southern region**
Total "Associate" mangrove species		**36**	**41**	**68**
	Amaryllidaceae			
1	*Crinum asiaticum L.*	xx	x	x
	Annonaceae			
2	*Annona glabra* L.	xx	x	xx
	Apocynaceae			
3	*Cerbera manghas* L.	x	x	xx
4	*C. odollam* Gaertn.	x	x	xx
	Araceae			
5	*Aglaodora griffithii* (Schott) Schott	0	0	x
6	*Lasia spinosa* (L.) Thu.	x	0	x
	Asclepiadaceae			
7	*Gymnanthera nitida* Wall.	0	0	xx
8	*Finlaysonia obovata* R. Br	0	0	xx
9	*Sarcobolus globosus* Wall.	0	x	xx
	Asteraceae			
10	*Pluchea indica* (L.) Lees	xxx	xxx	xxx
11	*P. pteropoda* Hemsl	x	x	x
12	*Wedelia biflora* (L.) DC	xxx	xxx	xxx
13	*Tridax procumbens* L.	0	0	x
	Boraginaceae			
14	*Cordia cochinchinensis* Gaertn	0	0	x
	Bignoniacea			
15	*Dolichandrone spathacea*	x	x	xx
	Ceasalpiniacea			
16	*Cynometra ramiflora*	0	0	x
	Chenopodiaceae			
17	*Suaeda maritima*	xxx	xxx	xxx
	Combretaceae			
18	*Combretum quadrangulare* Kurz	x	x	xx
19	*Terminalia catappa* L.	x	x	xx
	Convalvulaceae			
20	*Inpomea pes -caprae* (L.) Sw subsp. Brasiliense (L.) Ooststr.	xxx	xxx	xxx
	Cyperaceae			
21	*Cyperus elatus* L.	0	0	x
22	*C. malaccensis* Lam.	xxx	xxx	xx
23	*C. stoloniferus* Vahl.	xx	xx	x
24	*C. tagetiformis* Roxb	x	x	x
25	*Fimbrystylis ferruginea* (L.) Vahl.	0	x	x
26	*F. littoralis*	0	0	x
27	*F. milliacea* Vahl.	xxx	0	0
28	*Scirpus kimsonensis* K. Khoi	x	0	0
	Euphorbiaceae			
29	*Glochidion littorale* Bl.	x	x	x
	Flacourtiaceae			
30	*Scolopia macrophylla* (W.et.A.) Clos.	0	0	x
	Flagellariaceae			
31	*Flagellaria indica* L.	xx	xx	xxx
	Goodenicaeae			
32	*Scaevola taccada* (Gaertn.) Roxb	xx	x	xx

Table 3 *cont.* List of "Associate" Mangrove Species and Distribution by Regions.

No	Scientific name Family *species*	Distribution area		
		Northern region	Central region	Southern region
33	*S. hainamense* Hance	x	0	0
	Guttiferae			
34	Calophyllum inophyllum L.	0	0	x
	Lauraceae			
35	*Cassytha filiformis* L.	xx	x	x
	Lecythidaceae			
36	*Barringtonia acutangula* (L.) Gaertn.	0	0	x
37	*B. asiatica* (L.) Kurz.	0	0	x
38	*B. macrostachya* (Jack.) Kurz.	0	0	x
39	*B. racemosa* (L.) Spreng.	0	0	x
	Leguminosae			
40	*Caesalpinia bonduc* (L.) Roxb.	xx	x	xx
41	*Instsia bijuga* (Colebl.) O. Ktze	0	0	x
42	*Canavalia cathartica* Du Petit. Thouars	xx	x	x
43	*Dalbergia candenatensis* (Dennst) Prain.	x	x	x
44	*Derris trifoliata* Lour.	xxx	xx	xxx
45	*Derris heptaphylla* (L.) Merr	0	x	x
46	*Pongamia pinnata* (L.) Pierre	xx	x	x
47	*Canavalia lineata* (Thunb.) A.P. de Cand	x	x	x
48	*Canavalia maritima* (Aubl.) Piper	xx	x	xx
	Loranthaceae			
49	*Dendrophtoe pentandra* (L.) Miq	0	x	x
50	*Viscum orientale* Willd	0	x	x
	Malvaceae			
51	*Hibiscus tiliaceus* L.	xxx	xx	xxx
52	*Thespesia populnea* (L.) Soland.ex. Correa	xx	x	xx
	Myoporaceae			
53	*Myoporum bontioides* A. Grey.	x	0	0
	Myrtaceae			
54	*Eugenia jambolana*	0	0	x
55	*Melaleuca cajuputi* Powell	0	x	x
	Pandanaceae			
56	*Pandanus odoratissimus* L.	xx	xx	xx
	Poaceae/Gramineae			
57	*Cynodon dactylon* L.	xxx	x	xx
58	*Leptochloa fusca* (L.) Kunth	x	x	x
59	*Paspalum vaginicum* Swort	xx	x	x
60	*Phramites vallatoria* (L.) Vedk.	x	x	x
61	*Sporobolus virginicus* (L.) Kunth	xxx	xx	xxx
	Rubiaceae			
62	*Guettarda specinosa* L.	0	0	x
63	*Gardenia lucida* Roxb.	0	x	x
64	*Psychotria serpens* L.	0	x	x
	Rutaceae			
65	*Limnocitrus littorale* (Miq.) Sw.	0	0	x
66	*Acronychia pedunculata* (L.) Miq.	0	0	x
	Salvadoraceae			
67	*Azima sarmentosa* (Bl.) Benth. & Hook.	0	0	x
	Sterculiaceae			
68	*Kleinhovia hospita* L.	0	0	x
	Styracaceae			
69	*Styrax agrestis* (Lour.) G. Don.	0	0	x
	Verbenaceae			
70	*Clerodendron inerme* (L.) Gaertn.	xxx	xxx	xxx
71	*Premma integritolia* L.	xx	xx	xx
	Xyridaceae			
72	*Cayratia trifolia* (L.) Domino	0	x	xx

(Source: Phan Nguyen Hong, 1991; Phan Nguyen Hong, 1999; Dang Trung Tan, 1998 & 2001).
Remark: 0: Not distributed; x: Distributed; xx: Widely distributed; xxx: Very widely distributed

Research results show that in the North of Viet Nam, there are 17 species of "True" mangrove tree species out of total 36 "True" mangrove tree species in Viet Nam representing 47% of total "True" species. While in the South, there are 33 "True" mangrove tree species out of 36 "True" mangrove tree species in Viet Nam estimating at 92% of total "True" species in Viet Nam.

In the North Eastern coastal area (Quang Ninh province) there are 16 species over 36 species of "True" mangrove species, accounting for 41.6%, including commonly and very commonly wooded stem species with important economic value in the region and country such as *Rhizophora stylosa, Bruguiera gymnorrhiza, Kandelia candel.* In addition, also there are *Aegicennia marina and Aegiceras comiculatum.*

In the coastal area of the Northern Delta there are 14 "True" mangrove tree species out of 36 in total, representing 36% of total true species, of which there exist wooded stem species which are widely distributed and of importance in the region and the whole country, i.e.: *Sonneratia caseolaris, Kandelia candel.* Besides, there is *Aegiceras comiculatum.*

In the coastal area of the Northern part of the Central region there are 18 "True" mangrove tree species out of total 36 species, accounting for 47% of total species, but distributed scatteredly into small and narrow areas, along river sides, streams, channels along coastal area.

In central South Coastal Region there are 23 "True" mangrove tree species out of total 36 species, occupying 61% of total species. Although more species are found than three above-mentioned regions, but scarily distributed in small and narrow areas, along rivers or streams, canals inside

seashores. Here, in some places, the rainfall is very low, less than 1000mm/year, unsuitable for distribution and growth of "True" mangrove tree species (Ninh Thuan and Binh Thuan provinces).

In the coastal area of Ba Ria - Vung Tau (belonging to the Eastern part of the South), due to favourable climatic conditions, without winter and alluvial grounds are rather large, therefore, number of "True" mangrove tree species increases considerably up to 32 species out of 36 species in total, representing 86%, of which there are wooded stem tree species of large diameter which are of value for the region and the whole country, i.e. *Rhizophora apiculata, Sonneratia caseolaris, Avicennia alba, Avicennia officinalis* and *Nypa fruticans .*

Attention should be finally given to the coastal area of the Mekong River Delta where existed the largest mangrove land area of Viet Nam, about 373,305ha, accounting for 61,5% of the total mangrove land area of Viet Nam with total 82,387ha of existing mangrove area, estimating at 53% of the total mangrove area in Viet Nam. The climate is warm all year round, no winter, relatively high rainfall ranging from 1500 mm to 2500 mm/year, with large alluvial grounds and fertile accumulated alluvium. Here, it is found that number of "True" mangrove tree species is 33 species, representing nearly 89% of total "True" mangrove tree species of the country. Of which there are wooded stem tree species, commonly and very commonly distributed, playing an important role in terms of economy and environment in the Region, such as *Rhizophora apiculata, Sonneratia caseolaris, Avicennia alba, Avicennia officinalis, Avicennia alba, Bruguiera gymnorrhiza, Bruguiera parviflora, Ceriops tagal, Ceriops decanda, Nypa fruticans, etc.*

Regarding respectively to "Associate" mangrove species in Viet Nam up to 72 species belonging to 34 families are found. Their distribution becomes richer and diversified from the North to the South, i.e.:

- In the Northern region there are 36 species out of 72 species, accounting for 50%;
- In the Central region there are 41 species out of 72 species, accounting for 56%; and
- In the Southern region there are 68 species out of 72 species, accounting for 94%.

2.2 Formation

In Viet Nam, Phan Nguyen Hong was recognised as the first person to conduct research on formations of mangrove communities and his research studies were published in 1970, 1975, 1991 and 1996. Within Viet Nam there is a rich diversity of mangrove communities, of which there are 45 identified communities and 6 distinctive populations. Their regional distributions follow below:

2.2.1 North East Coastal Region (Quang Ninh Province)

The main mangrove communities include:

- *Avicennia marina* community - pioneer, fixed alluvial flats, deeply inundated when high tide appears, rich in sand grain, together with grasses of *Cynodon deotylon and Suaeda maritima.*
- *Aegiceras corniculatum* Community - mixed with other species like *A. marina* and *Cyperus stoloniferus.*
- *Bruguiera gymnorrhiza* community - dominated by *Bruguiera gymnorrhiza* mixing with other species i.e. *Rhizophora stylosa, Kandelia candel* and *Aegiceras corniculatum*. They all grow on the tidally flooded areas when high or medium tides occur.
- Mixed community - codominated species including *Rhizophora sylosa, Kandelia candel, Bruguiera gymnorrhiza*, combined with *Aegiceras corniculatum.* These species naturally distributed on inundated tidal areas when the tide is at medium level.
- *Excoecaria agallocha* community*, Lumnitzera racemosa* and dominant *Xylocarpus grasatum*, combined with *Scyphiphora hydrophyllacea, Ileritiera littoralis and Hibiscus tiliaceus, Scaevola taccada, Cebera odolans, Clerodendrom inerm* developed on inundated alluvial areas when the tidal is high and extremely high within the year, on relatively well developed or fully developed land.

In addition to the above-mentioned naturally distributed mangrove communities, a number of man-made communities have been established during recent years along the coastal area of Viet Nam that include *Kandelia candel* and *Bruguiera gymnorrhiza* plantation forest.

2.2.2 Coastal Area of the Northern Delta (Red River Delta)

Main mangrove tree communities include:

- *Sonneratia caseslaris* Community - dominated in high layer combining with *Acanthus sp, Cyperus malaensis and Aegiceras corniculatum* at lower layer. These species distributed on rich mud and clay alluvial flats, deeply inundated with high tides raised at estuaries.
- Shrubs community - *Aegiceras corniculatum* developed and distributed on alluvial flats rich in sand and mud.
- From estuary of Van Uc (Hai Phong) along the southern coastal line where existed a lot of tidal mud flats flooded when tide rises, only salt-resisted grasses such as *Cyperus stoloniferus, Cyperus deotylon* and *Scirpus kimsonensis* grow naturally and well develop attracting many species of water
- birds like gooses, wild duck, spoon-beaked storks visiting this area for food such as in nature reserves of Giao Thuy (Nam Dinh province) and Kim Son (Ninh Binh province).

In addition to the above-mentioned naturally distributed mangrove tree communities, in recent years, in the coastal area of the Northern part of Viet Nam, efforts have been made to establish mangrove forest in order to protect and prevent from salt water along the coastal area; fix alluvial plains and encroach further to the South China Sea, i.e.: Man-made *Kandelia candel* community; Man-made *Sonneratia caseolaris* community; Man-made *Sonneratia caseolaris* community in high layer and *Kandelia candel* community in low layer.

2.2.3 Coastal Area of the Central North Region

This region is still affected by the North East monsoon, which carries cold wind from the North. Along the coastal area where sand dunes are found without mangrove forest distributed. Inundated communities in the region are only developed along the river banks, near estuaries or inland canals, streams near the seashores.

Avicennia marina Community combined with salt-resisted grasses like *Cyperus stoloniferus, Cynodon deotylon* and distributed naturally on deeply flooded alluvial plains when high tides, along both river banks near estuaries. This is a permanent and pioneer mangrove tree community on the alluvial plains with rich sand grains mixed with mud and sand.

Rhizophora stylosa and *Kandelia candel* codominant community and mixed with some species of *Bruguiera gymnorrihiza and Aegiceras corniculatum on* alluvial plains flooded by medium tides.

Aegiceras corniculatum dominant *c*ommunity developed on alluvial plains flooded by medium tides.

Aegiceras corniculatum dominated community mixed with some *Bruguiera gymnorrhiza and Avicennia marina* distributed on flooded alluvial plains when high tides occur and with less flat topography.

Rhizophora stylosa community distributed on alluvial plains along streams, canals, far from river mouths, inundated when medium tides take place, and salinity is rather high, less changes in the year (10 - 25‰) along the coastal area of Quynh Luu district of Nghe An province).

Sonneratia caseolaris community occupies dominantly on high tree layer while at low layer *Acanthus sp and Cyperus malaensis* are seen. Community of *Sonneratia Caseolaris* is in most cases distributed naturally on alluvial plains, flooded blackish water, near estuaries, even going further to mainland up to 30 - 40km.

2.2.4 Central South Coastal Region

This region extends from the South direction of Hai Van pass up to Ba Ria - Vung Tau belonging to South of Viet Nam.

This region almost has no winter season, the climate is warm all year round, therefore, number of mangrove plant species is more abundant than other regions except 2 provinces of Ninh Thuan and Binh Thuan, and where rainfall is too low, less than 1200mm, unsuitable for distribution of many mangrove tree species, in the coastal of the Central Southern Part, main communities of mangrove species are as follows:

- Population of *Rhizophora mucronata* is a pioneer population with fixed alluvial plains, deeply flooded when high tides and situated in the West of some islands.
- Community of *Rhizophora mucronata and R. apiculata* is dominant, combined with other species like *Bruguiera gymnorrhiza, Bruguiera parviflora and Xylocarpus granatum,* distributed on alluvial areas along the rivers, canals, streams, pretty steep and not flat topography.
- Community of *Avicennia lanata* and *Avicennia officinalis* developed dominantly mixed with some secondary species like *Scyphiphora hydrophyllaceae, Lumnitzera littoralis, and Ceriops decandra* on alluvial plains flooded when high tides arrive.
- Community of *Excoecaria agollocha, Xylocarpus sp* and *Hibiscus tiliaceus, Cerbera manghas* mixed with *Scaevola taccada, Heritiera littorallis* and *Phoenis paludosa,* distributed on alluvial plains to be only inundated by high tides and irregularly high tides in the year.
- Community of *Sonneratia caseolaris* occupies dominantly on high tree layer mixed with *Acanthus sp and Cyperus malaensis, Derris trifoliata, Flagellaria indica* on lower layer.

2.2.5 The Coastal Area of Ba Ria - Vung Tau – Ho Chi Minh City

This area has been built up by sediments of the system of Dong Nai and Sai Gon rivers, with fairly large alluvial flats, alluvium with rich mud and clay, warm climate all year round, no winter season, no typhoons, rather favourable for mangrove trees growing. In this area, the mangrove communities and populations are identified as follows:

- Population of *Sonneratia alba* is population of pioneer mangrove trees, fixed on new alluvial grounds, deeply submerged, when high tides, in some places mixed with some trees of *Rhizophora mucronata* like along Soai Rap River.
- Community of *Rhizophora apiculata* and *Sonneratia alba* distributed on alluvial grounds flooded by tides and with rather sustainable land sources.
- Community of *Rhrizophora apiculata, Ceriops tagal* and *Avicennia alba* distributed on alluvial grounds flooded with medium water level when tide rising.
- Community of *Rhrizophora apiculata, Ceriops tagal* and *Aegiceras officinalis, Ceriops decandra*. In addition, it is found that *Xylocarpus granatum* and *Xylocarpus moluccensis* distributed on alluvial grounds to be flooded when high tides arrive.
- Community of *Excoecaria agollocha* and *Phoenis paludosa*, mixed with *Xylocarpus moluccensis, Heritiera littorallis,* distributed on alluvial plains to be only inundated by high tides and irregularly high tides in the year.

In the brackish water area of the estuaries in this region where main mangrove tree communities and populations are seen as follows:

- Population of *Sonneratia caseolaris* is a population of pioneer and permanent mangrove trees in the alluvial grounds of blackish water estuaries and deeply inundated areas.
- Community of *Nypa fruticans* and *Cryptocoryne ciliata, Acanthus sp and Cyperus malaensis* distributed on the alluvial grounds of blackish water estuaries and flooded when tides rise at medium height.
- Community of *Dalbergia candenatensis, Hibiscus tiliaceus* and *Thespesia populnea* and *Clerodedron inerme, Pluchea indica* distributed on high alluvial plains to be only inundated by high tides and irregularly high tides in the year.

According to Vien Ngoc Nam (2002), apart from this, in the region, in recent years, many populations of mangrove trees have been established, especially in the World Biosphere Reserve in Can Gio belonging to Ho Chi Minh City recognized by UNESCO. Additional plantation forest has also been established including:

- Population of *Rhrizophora apiculata* planted on an area of 21,000ha;
- Population of *Rhizophora* with area of 68 ha;
- Population of *Rhizophora candel* with area of 3 ha;
- Population of *Nypa fruticans* with area of 28 ha;
- Population of *Avicennia sp* with area of 18 ha;
- Population of *Xylocarpus granatum* with area of 19 ha.

2.2.6 Coastal Area of Mekong River Delta

This area has been created by sediments of Mekong River system, which has the highest water current and content of alluvium in Viet Nam. Large and fertile alluvial plains, very favourable climate for the growth and distribution of mangrove trees. In the region there are 33 “True” mangrove tree species, accounting for 89% of total “True” mangrove tree species of Viet Nam. The followings refer to the mangrove communities and populations in main estuaries and the Camau peninsula in the southern region.

In in estuary of Tien River (Ba Lai) there are the following populations and communities:

- Population of *Sonneratia alba*, dominated on alluvial, salty, narrow and mud areas, outside of the estuaries.
- Community of *Avicennia alba, Sonneratia alba* together with other species like *Rhizophora mucronata, Bruguiera parviflora* growing scatteredly. This Community is distributed inside pioneer population of *Sonneratia alba* developed on alluvial ground to be flooded when medium tides arriving.
- Community of *Lumnitzera racemosa, Xylocarpus granatum occupied* dominantly, mixed with *Ceriops tagal, Ceriops decandra, Avicennia lanata* and distributed on alluvial flats to be flooded only when having high tides.
- Community of *Excoecaria agollocha, Hibiscus tiliaceus*, occupied dominantly, mixed with some species like *Thespessia populnea, Phoenis paludosa* and *Sesuvium portulasstrum* distributed on high alluvial grounds and less flooded by tides.
- Mangrove trees populations and communities in estuaries of Cua Dai, Cua Tieu and Ham Luong belonging to Tien River (Cuu Long River).
- Mangrove trees populations and communities in estuaries of Co Chien River

The following populations and communities have been identified as bellows:

- Population of *Avicennia alba* develops strongly on weak alluvial ground, with relatively high salinity and not many changes in the year.
- Community of *A. alba* and *A. officinalis*
- Population of *Sonneratia alba* as pioneers on alluvial ground with a wide range in salinity between the dry season and the rainy season.
- Community of *Rhizophora mucronata* mixed with *R. apiculata and Ceriops decanda* distributed on alluvial ground, inundated by medium tides.
- Mangrove tree populations and communities in coastal area of Ca Mau Peninsular.

This is a sediment area, which operates vigorously in the Mekong River system, with low and large alluvial flats, rich in mud, clay and nutrients. Salinity of the water is suitable for mangrove trees to be distributed and growing and salinity has little change in the year. In this region, there are communities and populations of main mangrove trees as follows:

- Population of *Avicennia alba* as pioneer on permanent alluvial soils with rich mud and clay.
- Community of *A. alba and Rhrizophora apiculata* distributed on alluvial soils flooded by low tides.
- Population of *Rhrizophora apiculata* distributed on alluvial flats and be inundated by medium tides.
- Community of *Rhrizophora apiculata, Bruguiera parviflora* distributed on alluvial soils and be flooded by medium and high tides.
- Population of *Bruguiera parviflora* distributed on alluvial grounds that are flooded when medium and high tides occur.
- Community of *Rhrizophora apiculata* and *Ceripos decanda* in low layer, on fairly well developed alluvial plains and is flooded during having high tides.
- Community of *Rhrizophora apiculata* and *Rhizophora mucronata* distributed on alluvial flats along the rivers, deeply flooded with water (not large area).
- Community of *Lumnitzera racemosa* and *Ceriops tagal* usually grow on high alluvial flats, with rather tight soil and irregularly flooded by tides.
- Community of *Excoecaria agollocha* mixed with *Acanthus ilicifolius*, grow on high and well developed soil and being less flooded by tides.

Besides, there is a community of *Avicennia marina* mixed with *A. officinalis* and *Excoecaria agollocha,* distributed on alluvial flats with abundant sand and mud, be flooded when tides are high and medium.

Community of *Nypa fruticans* mixed with *Acanthus ilicifolius* at lower layer, distributed naturally along the rivers, canals, channels and interior fields.

In addition to the above natural communities and populations, in Ca Mau peninsular area and Mekong River *Delta* where population of mangrove trees have been established by people such as population of *Rhizophora apiculata,* population of *Sonneratia caseolaris* and man made secondary communities, i.e. community of *Phoenix paludosa* mixed with *Acanthus ilicifolius* after exploitation of mangrove forest.

3. ENVIRONMENTAL AND BIOLOGICAL STATES

3.1 Physical Factors

3.1.1 Climatic Conditions

Temperature regime

The coastline of Viet Nam has a length of 3260 km, extending from Ca Mau (South Viet Nam) at $8^0$25' North Latitude to Mong Cai (North Viet Nam) at $25^0$50' North Latitude, a length of over 14 latitudes. Generally, the entire coastal area of Viet Nam lies within the tropical belt with annual average temperature ranging from 22.7 ^{0}C (in Mong Cai) to 27.6 ^{0}C (in Rach Gia – Kien Giang). The climate within coastal Viet Nam exhibits tropical humid characteristics with two relatively distinctive climatic zones.

Northern Viet Nam

From the latitude of16^0 North (North of Hai Van pass) to 22050' North (Mong Cai). This area locates in the transitional location of two climatic belts, i.e. tropical and sub-tropical, and heavily influenced by monsoonal regime belonging to the South East Asia where a complicated rotation of atmospheric pressure from the equator, tropics and North Pole converges. Therefore, there are two distinct seasons for this area. Summer season is hot with much rain, from May to October. Winter season is cold with less rain. However, in winter, usually no hoarfrost appears and not seriously lacking of water for crops) lasting from November to April. Every year, North East wind occurs 20 up to 25 times which carries cold wind from the North. Averagely in one month of winter, there are 3 up to 5 turns of appearance of North East moonsoon. When the North East wind arrives that makes the temperature suddenly drop to about 4^0 to 5^0C and sometimes down to 10^0C.

The North Easterly winds blow along the country from the North to the South and significantly influences the temperature along the coastal areas at different latitudes. This type of weather pattern differs from that experienced by neighboring tropical countries located on the same latitudes.

South of Viet Nam

Between Hai Van Pass (16^0 North latitude) to Ca Mau peninsular ($8^0$25' North latitude). The climate is less influenced by the North East monsoon. To the southern Delta the influence of this moonsoon is minimal and is characterized by monsoon tropics, near equator with total annual average temperature of 9000-10,000^{0}C and annual average temperature is relatively high, between 26 - 27^{0}C.

In the South, there are two distinct seasons: rainy season and dry season. The rainy season begin in May and last until October whereas dry season commences in November and last until the end of April. The temperature variation between months is very low ranging from 3^{0}C to 5^{0}C and the daily temperature difference is only about 1^{0}C. Table 4 shows Annual changes in temperature regime by Regions in Viet Nam.

Table 4 Annual changes in temperature regime by Regions in Viet Nam.

Part	Regions	Number of months in the year have temperatures		
		< 20^{0}C	20-25^{0}C	>25^{0}C
North Viet Nam	North East Region (Quang Ninh province)	5 months	2 months	5 months
	Northern Delta	4 months	2 months	6 months
	Central North Region	2-3 months	2-3 months	9-10 months
South Viet Nam	Central South	0 month	3-5 month	7-9 month
	Ba Ria – Vung Tau (South Eastern part of the South) Ho Chi Minh City	0 month	0 month	12 month
	Mekong River Delta	0 month	0 month	12 month

(Source: General Department of Hydrology and Meteorology, 2000).

Scientists who research on physiology if mangrove trees all have assumed that atmospheric temperature from 25^{0}C to 28^{0}C are very suitable for the growth of mangrove trees. Therefore, the temperature regime in the South of Viet Nam remains through the year round (12 months); it is very suitable for the growth and distribution of coastal mangrove trees.

Rainfall

Viet Nam is situated along the eastern seaboard of the Asian continent, adjacent to the Eastern Sea and falling within the tropical belt. The long 3,260km coastline forms a type of ocean influenced climate where there is high annual rainfall and humidity. Generally, the coastal areas of Viet Nam have rather high annual average rainfall ranging from 1,800mm to 2,500mm/year (see Table 5). However, there are also some localities with low rainfall of below 1,500 mm/year like Vung Tau (1,357mm/year) or with very low rainfall, i.e. under 1,200mm/year, e.g. Ninh Thuan and Binh Thuan provinces (total annual rainfall is 794mm/year) and Phan Thiet province (total annual rainfall is 1,152mm/year). The low rainfall influences significantly the distribution of mangrove forest.

Table 5 Changes in annual rainfall between coastal areas.

S.N	Region	Annual rainfall (mm/year)
1	North East (Quang Ninh province)	2016 - 1749
2	Northern Delta	1757 - 1865
3	Central North	1944 - 2867
4	Central South	1152 - 2290
5	Ba Ria – Vung Tau (South East South) and Ho Chi Minh City	1357 - 1684 (Vung Tau), (Can Tho)
6	Mekong River Delta	1473 - 2366

(Source: General Department of Hydrology and Meteorology, 2000).

Mangrove trees distributed in the Northern hemisphere develop well in the locations having relatively high rainfall, from 1,800 to 3,000mm/year. In Viet Nam, there are 3 regions: North East, Northern Delta and North central where annual rainfall range from 1,757 to 1,867mm which is very favorable for the growth of mangrove trees. In addition, the Ca Mau Peninsular has annual rainfall varying from 1,800 to 2,366mm also very suitable for the growth and distribution of mangrove trees. Especially, this region

with a very suitable temperature, fertile and large coastal wetland area, therefore, it becomes a good place where many types of mangrove trees distribute and provide a high production of timer i.e. *Rhrizophora apiculata* growing in natural *Rhizophora* forest, at the age of 60, it can reach a diameter of 1.3m and height of 28m. The timber productivity of *Rhizophora apiculata* plantation forest averages between $8m^3$-$12m^3$/year and occasionally as high as $13,5m^3$/year. On contrary, in the localities where the annual rainfall is under 1,200mm. the mangrove forest seem not to be appeared or if any the forest are in poor growth.

3.1.2 Water Temperature

Coastal North East Region(Quang Ninh)
Water temperature is affected by the cold winter climate. During the winter, the temperature may drop down to 10^0C, however along the coast of Quang Ninh, the water surface temperature ranges from 15 to 18^0C. Seawater temperature e.g. Luc estuary as low as 12^0C on some days. Seawater temperature gradually increases from the water surface to deeper water varying between 1 and 2^0 C. In summer, average temperature of the surface water ranges from 28-30^0C and the temperature gradually reduces from the surface water to deep water level. Its difference is from 2-3^0C. This justification resulted from pilot planting of *Rhizophora apiculata* trees in this area, *Rhizophora apiculata* trees died after 1 to 2 cold winter seasons.

The Red River Delta
The influence of the above mentioned North East moonsoonal wind is less profound at the Red River Delta, however, a cold winter wind continues to blow for the three months of December to February.

During this time the average monthly seawater temperature close to the shore is under 20^OC, varying between 17.9^0C and 19.5^0C. From the March to November (Remaining nine months) the average seawater temperature is always higher than 20^OC and varies between 21.4 and 28.6^0C. The coldest average seawater temperature of about 17.9^OC is in the month of January and conversely, the warmest average seawater temperature is in June, about 28.6^OC.

Central North Region
Influence of the North East moonsoonal wind becomes minimal and in this region it is not very cold during the winter. About 1 or 2 months in the year, normally during December and January, seawater temperature is lower than 20^0C.

The Central South Region
There is no distinctive winter climate within this region and the influence of the North East monsoonal wind is negligible. The average seawater temperature throughout the year is higher than 20^OC, which provides ideal conditions for *Rhizophora* trees to grow naturally along the coastal mangrove land.

The Ba Ria - Vung Tau and the Mekong River Delta Region.
This region is characterized by a typical tropical equatorial climate where the mean monthly temperature in all months of the year is higher than 25^0C, thus, the average seawater temperature is always higher than 25^0C, varying from 26.5^0C (in September) as the lowest water temperature in the year, to 30.7^OC (in March) which has the highest water temperature in the year. Here, different mangrove types are abundant and grow very well in Viet Nam.

3.1.3 Hydrological Characteristics

River system
The total average annual water rainfall volume of Viet Nam is approximately $630km^3$. The network of rivers and streams is quite dense and if drainage lines whose length has more than 10 km were considered, Viet Nam would have almost 2,500 streams and rivers. Density of river network varies from 0.5 to $2km/km^2$.

The rivers and streams annually discharge between 800-$900km^3$ of water into the South China Sea. If outside water volume discharges into Viet Nam is not included, then water volume derived from territory of Viet Nam is about $300km^3$ of water (Nguyen Viet Pho, 1984).

The two largest rivers in Viet Nam are Mekong and Red Rivers. They discharge approximately 70% of the country's total water volume from their catchment systems.

Tide

The driving force and highly important element in formation of mangrove ecosystem is tide. Along the coast of the South China Sea of Viet Nam, there are 4 different types of tides i.e. diurnal tide, semi-diurnal tide, irregular diurnal tide and irregular semi-diurnal tide. Irregular diurnal tide and irregular semi-diurnal tide is produced by a mixture of diurnal and semi-diurnal tide where either on variety exits more dominance than other at that location.

Pure diurnal tide area may be clearly observed along the coast from Mong Cai (Quang Ninh province) to Do Son (Hai Phong). In this area, tide range is the greatest in Viet Nam ranging from 4.0- 4.5m. In one day and night, there appears one time of leap tide and one time of ebb tide.

In addition, Northern Delta area experiences a diurnal tide regime, however tide range gradually reduces from Do Son to Ninh Binh, with tide ranging from 3.2 to 3.6m. Within one year there are more than 165 days where high tide exceeds 3 m. In this region the tide is most active yearly in December, January, June and July.

In the Central North area tidal patterns are rather complicated. From Thanh Hoa to Ha Tinh an irregular diurnal tide regime occurs and from Ha Tinh to Hue an irregular semi-diurnal tide regime appears. From Thanh Hoa to Hue, tide range gradually reduces in height, from 3.0 m to Thuan An (the lowest tide range in Viet Nam) where there is only 0.5-0.7m range.

In Central South Area, the tidal regime changes from irregular semi-diurnal tide (Quang Nam – Da Nang) to irregular diurnal tide (Nghia Binh-Phu Khanh) and then from Phu Thanh to Thuan Hai returns to irregular semi-diurnal tide with a gradually increased tide range of 0,7-2,5m

In the South East South (Ba Ria-Vung Tau) and Can Gio (Ho Chi Minh City), tidal regime is semi-diurnal and has a relatively high tide range, from 3.6- 4.0m. In one day and one night, there are 2 times of leap tides, one incomplete tide and one main tide is higher. In the year the highest tide range appears in September, October, November and December and the lowest tide range occurs in May and June.

The Mekong River Delta coastal area experiences semi-diurnal tidal regime where tide ranges from 2.0-3.0m. The speed of tide during leap tide is 6.9m/s. Especially in the Western part of Ca Mau peninsular, from Bay Hap estuary (Ca Mau province) to Ha Tien (Kien Giang province) the tidal regime changes its partern to diurnal tide regime with low tide range varying between 0.7 and 1.0m. In addition, from Dat Mui area to Bay Hap estuary of Ca Mau province where experiences a mixture of semi-diurnal tide and diurnal tide (transitional area).

The influence of rivers within the North Eastern coastal area (Quang Ninh province) is minimal. During the rainy season, the volume of water pouring into the sea contributes between 20-40% of the total volume of water near the shore and during the dry season this drops to between 5-10%. Sediments derived from river water is low, therefore, the dominant driving force behind the formation of tidal flats is the daily rise and fall of tides. This process creates the formation of tidal flats with very dense branched canals perpendicular to the coastline. The influence of the tide has increased 40,000ha of high tidal flats where mangrove forest have colonized and over 27,000ha of low tidal flats which are ideal environment for the development of fishery products (i.e. brackish and salty water fishery farming) of high economic value.

Sea waves

Estuaries and tidal flats along the coastal areas of Viet Nam are strongly affected by coastal sea waves. Coastal sea waves in Viet Nam tend to be influenced by two seasons in the year: Rainy season from April to September dominated by North East waves and during the dry season from October to March dominated by South East waves. Waves from the Sea traveling to the seashore usually have an average height of 1.5 to 2.5m. During the days of the formidable seas and strong North East monsoonal wind, the sea waves may reach between 3.0-4.0m. During the typhoons take place the sea waves along the coastline vary greatly rising between 4 to 6m and even higher than 7m.

In Viet Nam, there are on average between 4-6 storms which more towards the mainland, with wind speed of 20-40m/s. Storms cause great impact on the existence of coastal mangrove forest and destroy sea dyke system where no mangrove protection forest exist. Only along the coastal area of Southern Delta area where storms rarely occur.

A notable exception to the above mentioned process is the coastal area of Quang Ninh (North East of Viet Nam) with a coastal length of more than 250 km. 2077 islands and limestone mountains rise out of the sea near the seashore and create a closed bay. As a result, the waves arriving on the shoreline become rather calm while wave height averages at 0.5m. 85.4% of the time the sea conditions are calm. Table 6 represents Wind Direction and Speed and Seawave Range in the Red River Delta (Hon Dau Observation Station); and Table 7 shows Prevail seawave Direction and Ranges in the Western Part of Ca Mau Peninsula.

Table 6 Wind Direction and Speed and Seawave Range in the Red River Delta (Hon Dau Observation Station).

Month	**Wind**			**Ranges of seawave (m)**	
	Prevail direction	Speed (m/s)		Average	Max
		Average	Max		
JAN	North East - East	4.5	24	0.66	1.9
FEB	East	4.8	20	0.68	2.2
MAR	East – South East	4.1	28	0.65	2.2
APR	East – South East	4.9	28	0.72	2.8
MAY	East – South East	5.7	40	0.83	2.4
JUN	South – South East	5.9	34	0.80	2.2
JUL	South – South East	6.1	40	0.92	5.6
AUG	South – South East	4.8	45	0.70	5.0
SEP	North East - East	4.8	45	0.66	4.2
OCT	North East - East	5.1	28	0.75	2.3
NOV	North East - East	4.9	24	0.69	2.0
DEC	North East - East	4.8	30	0.65	2.0

Table 7 Prevail seawave Direction and Ranges in the Western Part of Ca Mau Peninsula.

Month	**Prevail seawave direction**	**Seawave rangs (m)**	
		Average	**Max**
JAN	East – North East	0.80	1.80
FEB	East – North East	0.95	2.00
MAR	North East	1.10	2.30
APR	East – South East	0.80	2.00
MAY	West – South West	0.85	3.00
JUN	West – South West	0.95	4.00
JUL	West – South West	0.95	4.00
AUG	West – South West	0.90	3.50
SEP	West – South West	0.90	3.50
OCT	West – South West	0.85	3.00
NOV	North East	0.92	2.50
DEC	East – North East	0.92	2.50
Anunual average		**0.91**	**4.00**

Oceanic water current

Currents of water in the Ocean also have a great impact in distribution of mangrove tree species along the coastal area of Viet Nam.

The South West monsoon brings water currents from Indian Ocean through Indonesia and Malaysia to the coastal area of South Viet Nam, therefore, the composition of mangrove trees within the Mekong River *Delta* is similar to mangrove tree species in South East Asian countries, e.g. *Rhizophora apiculata*, *Rhizophora mucrosata*, *Bruguiera parviflora*, *Bruguiera cylindrica, etc.*

The water current along the coast flowing from the South to the North of Viet Nam, up to 12^{o} North latitude then to the Sea. While in the North where the coastal water current runs from the North to the South or from the North East to South West and down to 12^{o} North latitude. Therefore, the difference of the composition of mangrove plant species between two parts of Viet Nam is clearly seen. In addition to climatic conditions, there is impact of coastal oceanic water current.

3.1.4 Salinity of Coastal Seawater

The North East region (Quang Ninh province)
Salinity of coastal seawater is rather high and varies slightly in the year. Salinity of seawater in rainy season is about 20% and in dry season about 30%. In the locations close to the estuaries, the salinity may reduce and varies widely, about 10% in rainy season and 25% in dry season. However, this fluctuation occurs in small area.

The Red River Delta region
Salinity of water in the river mouth areas has a small change. In Van Uc estuary, the salinity varies between 1.0 % in rainy season and 11% in dry season. In Ba Lat estuary it ranges between 1.1% in rainy season and 13.8% in dry season.

Salinity of water in coastal alluvial flats varies rather clearly. In Do Son, the salinity changes from 16.4% in rainy season to 27.5% in dry season. In Thuy Anh it fluctuates between 10.5% in rainy season and 20.7% in dry season. In Van Ly water salinity is between 20% in rainy season and 30% in dry season.

The Central Coastal Region
Salinity of seawater differs relatively greatly between seasons. Salinity of seawater in Lach Truong (Thanh Hoa province) ranges from 10.3% in rainy season to 20.4% in dry season. In Thuong estuary of Thua Thien – Hue province it is 13.23% in rainy season and 20.5% in dry season. In Cau Hai lagoon (Hue) the salinity differs between 5%- 23% in rainy season and 20‰ - 33% in dry season.

The Ba Ria – Vung Tau – Can Gio Region
Coastal seawater has a relatively high salinity and fewer changes throughout the year. In rainy season, water salinity ranges from 12 to 18% and in dry season, water salinity varies from some 20 to 30%.

The Mekong River Delta Region
Salinity of water has a big difference between seasons. Water salinity in Tien estuary in rainy season is between 1%- 4% and in dry season it is 18-20%. In the place far from estuary (forest enterprise of Thanh Phu, Ben Tre province) water salinity is from 7% *to* 12% in rainy season and from 20% to 24% in dry season. In Ca Mau peninsular (Ca Mau province) salinity of coastal seawater is fairly high and has a small fluctuation throughout the year. In rainy season, water salinity ranges between 19% and 23% and between 26% and 31% in dry season.

3.1.5 Suspended solid particles

North East Region (Quang Ninh province)
All estuaries in this region have low water flow and there are approximately 30 rivers and streams whose length is over 10km. The annual water flow of these rivers is very low, ranging from 3.07-23.5m^3/s. The distribution of rivers along the coastline is highly dense, in some places a river mouth may be found every 4 to 5 km along the coastline. However the total volumetric discharge into the sea within the Quang Ninh province is small, with approximately 6.56 billion m^3 of fresh water/year.

During the dry season, the suspended solid particle content is measured at 3.5g/m^3 and hence the water is rather clear. Where as during the rainy season, this content only increases to a maximum of 189g/m^3.

The suspended mud and sand content in water at Ha Coi (Tien Yen – Quang Ninh) ranges from 5-10g/m^3 in dry season to10 - 50g/m^3 in rainy season. At Sa Bach Dang this content is higher with 10-30g/m^3 in dry season and between 50-120g/m^3 in rainy season.

The Red River Delta Coastal Region
Water turbidity in Red River estuary varies greatly from that within the North East region. The suspended solid content in the water at Ba Lat estuary is 44.3g/m^3 in dry season and 1,400g/m^3 in rainy season. In the Tra Ly estuary is 30.67g/m^3 in dry season and 1,050g/m^3 in rainy season. Finally in the Van Uc estuary this content is 359g/m^3 in dry season and 876g/m^3 in rainy season.

Generally, the suspended solid content along the coastal area of Red River Delta Region in dry season is between 50-100g/m^3 and during the rainy season, this content increases to 200 or sometimes to as high as 500g/m^3.

The Central Coastal Region
Within this region, the suspended solid particle content in the water during the dry season is very low, about 5-10g/m^3. During the rainy season, this content increases to between 20 -100g/m^3. As a result, coastal seawater in Central Region is clear all year round.

The Ba Ria - Vung Tau - Can Gio Region (South Eastern Part of the South)
At Dong Nai River mouth, suspended solid particle content in the water ranges from 10-20g/m^3 during dry season and about 40-100g/m^3 in the rainy season. Generally, the suspended solid particle content at Dong Nai River mouth is not high.

The Mekong River Delta Coastal Region
Within the Mekong estuaries the suspended solid particle content in the water is between 10 -50g/m^3 during the dry season and increases to around 80 -150g/m^3 in the rainy season. At the Ca Mau peninsular area (observation at 11 different localities throughout over the region), during dry season (measured in April 2001), the suspended solid particle content in the water ranges from 200g/m^3 (Genh Hao) to 423g/m^3 (Bay Hap estuary). During the rainy season, from July to October, this content at Genh Hao River is 25.6-447g/m^3 and at the Cua Lon River is between 342-550g/m^3.

So, within the Ca Mau peninsular region, sea water near the seashore is always muddy, the content of alluvial material in the water is rather high and there is very little difference between the dry season and the rainy season.

3.1.6 Particle Composition of High Tidal Flats

Other than the Ca Mau peninsula which has the highest clay content of 56-60% in its deposited sediment. The clay content found in the deposited sediments of the Thai Binh River and the Bach Dang estuary is about 15 - 30%. This content is between 15-25% in the Dong Nai estuary, in the Cuu Long River is 12 -22% , in the Red Rriver mouth is10-15% and the lowest clay content found in the estuaries of Central coastal region, less than 1%.

The rivers of the Central region of Viet Nam have the highest sand content deposited within its sediments, with between 80-95%, this is followed by the rivers of North East region (Quang Ninh province), about 12-15%; the Red River, about 6-10/%; the Mekong River, between 5-10%; and the lowest being the Dong Nai River, about 2.5-10% and the Thai Binh river (Bach Dang estuary) at between 3-12%. Table 8 shows Particle composition of surface sediments of high tidal flats of estuaries in Viet Nam.

Table 8 Particle composition of surface sediments of high tidal flats of estuaries in Viet Nam (Mean value calculated).

Areas of estuaries	Particle class, mm (%)				
	> 0.05 (sand)	0.05-0.01 (fine sand)	0.01-0.005 (silt)	0.005-0.001 (fine silt)	< 0.001 (clay)
Tien Yen – Ha Coi	12-18	15-25	15-28	20-30	10-25
Bach Dang (Thai Binh River)	3-12	10-22	20-30	25-32	15-30
Red River	6-10	15-25	15-25	20-25	10-15
Central rivers of Viet Nam	80-95	5-10	1-3	<1	<1
Dong Nai River	2.5-10	12-20	25-30	25-35	15-25
Cuu Long River	5-10	12-25	15-30	20-28	12-22

(Source: State Sea Programme KT03, 1995).

3.2 Chemical Factors

3.2.1 Chemical Characteristics and Nutrient Contents (N, P)

pH value of water
Generally, water has neutral reaction or almost neutral reaction during the rainy season whereas in the dry season, pH value of water may increase up to 7 and in some places the pH of water may be lightly alkaline of pH = 8.04 (Red river estuary). Seawater along the coastal area of the Central region usually has pH higher than other regions, although not much.

Dissolved N (mg/liter)
The location with the highest content of dissolved N is along the coast of Ba Ria - Vung Tau - Can Gio where there is about 0.585 –1.170mg/litre. The most likely explanation for this may be wastewater flowing downstream from Ho Chi Minh City. Following is the Red River estuary and the lowest content of dissolved N found along the coast of the Mekong River *Delta*, ranging between 0.108- 0.284mg/litre.

Dissolved P (mg/liter)
Generally, the content of P dissolved in water is quite low and there is small variation between regions.

The data from the study of pH, N and P along the coastal region of Viet Nam is described in the Table 9 below:

Table 9 Chemical characteristics and content of the nutrients of N, P dissolved in water along the tidal flats of the coastal regions of Viet Nam.

S.N	Regions	pH	Dissolved N (mg/litre)	Dissolved P (mg/litre)
1	North East (Quang Ninh)	6.85-7.33	0.121-0.514	0.008-0.010
2	Red River Delta	7.68-8.04	0.225-0.268	0.001-0.009
3	Central Coastal	6.90-7.90	0.100-0.320	0.001-0.005
4	Ba Ria - Vung Tau - Can Gio	6.62-7.48	0.585-1.170	0.032-0.073
5	Mekong River Delta	6.80-7.30	0.108-0.284	0.002-0.005

(Source: Forest Science Institute of Viet Nam, 2001; State Sea Programme, 1995).

3.2.2 Percentage of Nutrient Contents (N, P, C ,S)

Content C,% (organic)
It is generally low, some localities in the North West of Viet Nam and Ba Ria – Vung Tau record a medium value of 2.8-3.0%.

Content N,% (total)
Generally, deposited materials along the coast of Viet Nam all have a medium level of N content. Some localities in the Ba Ria-Vung Tau and North East of Quang Ninh province have a higher content of Nitrogen, about 0.25%.

Content P_2O_5, %(total)
Sediments of the Red River have P_2O_5 total content (%) of highest, followed by those of the Mekong River. The poorest in P_2O_5 total content is sediments along the cost of the Ba Ria-Vung Tau and North East of Viet Nam as the sediments in these regions formed by humid tropical weathered products.

Content Sulfur, %
The percentage content of Sulfur contained within deposited sediment materials of the tidal flats varies distinctively between regions. The tidal flats in North Eastern Viet Nam and the Ba Ria-Vung Tau have the highest sulfur content. In these regions the weathered sediments are rich in Fe_2O_3 and Al_2O_3 and accumulated sulfur at levels between 1.0 and 4.5%. Comparatively, the Mekong River Delta and the Red River Delta have sulfur content between 0.20-1.0%. This characteristic has explained rather clearly about the forces of formation of potential sulfate mangrove land in the coastal area of Viet Nam.

3.3 Mangrove Biodiversity in Viet Nam

Viet Nam has so far no systematic researches on bio-diversity of mangrove ecosystems, therefore, the below summary only derive from separate research documents carried out in individual region or coastal ecological areas by many authors. As non-identical research methodology used in different researches, thus, the collected data should be regarded as for references.Table 10 below lists out biodiversity by geographical distribution areas in Viet Nam.

Table 10 Biodiversity at different ecological regions along the coastal area of Viet Nam.

Regions	Total species*	Mangrove trees		Plankton		Zoobenthos		Fish	Birds	Amphibians	Reptiles	Animals
		True	Associate	Phytoplankton	Zooplankton	Mollusca	Crustacea					
North East (Quang Ninh)	651	52		355		400		194	57	-	-	-
		16	36	185	170	113	65					
Red River Delta	428	50		245		136		130	113	10	16	6
		14	36	64	181	55	65					
Central Coastal	378	64		204		150		150	15	5	3	10
		23	41	171	33	16	20					
Ba Ria – Vung Tau – Can Gio	388	98		82		116		127	130	9	31	19
		32	66	63	19	32	52					
Mekong River Delta	364	101		198		82		69	171	6	34	28
		33	68	119	79	52	30					

(Source: Vu Trung Tang, 1997; Dang Trung Tan, 2001; State Sea Programme, 1995).
*Note: *: Total species is calculated for important species groups only that include Mangrove trees; Zoobenthos, Fish and Birds.*

Data synthesized from the resaerches on biodiversity of mangrove ecosystem revealed that biodiversity of mangrove ecosystem is very abundant. The detailed statistical on biodiversity of mangroves ecosystem is described as follows:

- ***Phytoplankton:***

To date 537 species of Phytoplankton have been identified, in which:

- Bacillariophyta has a largest number of species with 348 species, accounting for 71,5%.
- Seaweed: 662 species are found, in which there are some species that play an important role in economic value and are being commonly grown: *Gracilaria verrucosa, Gracilaria arucata, Gracilaria temtstipitata* which belong to Rhodophyta with about 309 species.
- Seagrass: There are 15 species of 9 genus and 3 family.

- ***Zooplankton:*** It has identified 468 species

- ***Zoobenthos:*** 450 species are found, which include the main groups as bellows:
  - Crustacea and Mollusca: For shrimp only there are 101 species of 11 different families found. In teh family of Penaenidae there are 75 species found, in which some important species for economic values for coastal area that are *Penacus merguiensis, Penacus semisulcatus, Penacus indicus, Penacus erguiensis, Penacus monodon, and Metapenacus ensis*.
  - Crab: It has known about 60 species of crab, of which some crab species with high economic values are *Scylla serrata, Portunus trituberculatus*.
  - Mollusca: In class of Bivalvia there are 35 common species and the high economic values species are *Arca antiguata, Arca granosa, Arca subcrenata, Mactra luconica, Meretrix meretrix, and Meretrix lusoria*.

- ***Fish:***

There are about 516 species of 97 families found in coastal areas in Viet Nam (Vu Trung Tang, 1997). Of those there are many species with high economic value, for xample *Epinephelus maculatus, Epinephelus awoara, Monodactylus argenteus, Psenopsis anomala, Pangasius polyuranodon* and some endemic species having close relation with mangroves that are:

- Mugilidea (11 species)
- Lates calcarifer
- Eleotridae
- Plotosus anguillaris

Panagasus polyuranodon (The fish eats directly ripe fruit of Avicennia and is very famous for Ca Mau peninsula).

- ***Birds:***

In Viet Nam, there are about 386 species found, in which 77 species are migrant and some of those are rare and endangered species according to IUCN criteria such as: *Tringa gutlifer, Limnodromus semipalmatus, Eurynohynchus pygmeus, Platea minor, Pelecanus philippinensis, Mycteria leucocephala, Egretta eulophotes.*

Tidal flats in estuaries like Red River estuary where provide good and vailable food sources is the place which attracts about 120,000 waterbirds to live in this area.

- ***Mammals:***

With in coastal mangrove ecosystem in Viet Nam, 28 species of mammal have been found, in which 7 species are recorded in Red book of Viet Nam and IUCN.

- ***Reptile:***

There are 54 species, in which 11 species are recorded in Red book of Viet Nam and IUCN.

- ***Ambiphian:***

It has been identified 10 species of ambiphian related to mangrove ecosystem in Viet Nam.

4. SOCIAL USE AND TENURE INFORMATION

4.1 Tenure

Viet Nam has promulgated a number of laws relating to land use rights, forest resources and protection and development of natural resources, including forest resources. Main laws are:

- Land Law issued in 1993, revised and added in 1998 and 2000 and revised in 2003.
- Law on Forest Protection and Development in 1991, revised in 2004
- Law on Environment Protection in 1994.

Under-law documents include important degrees and decisions of the Government such as:

- Decision 01/CP promulgated in 1995 on the allocation of forest and agriculture land and aquaculture land within State enterprises.
- Degree No 163/1999/ND-CP of the Government on land allocation and leasing forest land to organizations, households and individuals for a long-term and sustainable use for forestry purposes.
- Decision No. 661/QD-TTg in 1998 of the Prime Minister on the objectives, tasks, policies and organization for the implementation of 5 Million Hectare Reforestation Programme.
- Decision No 08/2001/QD-TTg by the Prime Minister on Regulation of the management of three natural forest types: Special use forest, Protection forest and Production forest.
- Decision No 178/2001/QD-TTg of the Prime Minister on beneficiaries, obligations of households and individuals who are permitted to allocate, lease, receive forest contracting and forest land.

The local authorities with mangrove forest should be flexible in applying legal documents, regulations issued by the Government and Prime Minister. The main contents of the laws, decrees and decisions of the Government in relation to management, protection and development of forest can be summarized as follows:

Constitution and Land Law states that land belongs in the people's ownership whilst the State manages land according to the plans and laws to ensure effective use and for the correct purposes. Land ownership is clearly defined in the Land Law, which has been revised and amended in 1998, 2000 and being revised in 2003. Land is allocated to organizations, households and individuals for duration of 50 years to use for a long term and correct purposes. After 50 years has elapsed and the landusers have efficiently used the land according to the terms of the contracts, they may wish to continue their landuse rights. Their application for further use will be considered and the decision will be made and. The allocated area depending on the allocated objects and land availability within the localities. Forestland to be allocated to households and individuals completely depends on local land availability. The maximum area of forestland allocated to households and individuals is 30ha. Land users (mainly households and individuals) have 6 rights as stipulated in current Land Law, they include: (i) Right to change; (ii) Right to transfer; (iii) Right to inherit; (iv) Right to mortgage; (v) Right to lease and use; and (vi) Right to use the land as a part of contribution to business funds.

At present, the Law on Forest Protection and Development is being revised and focusing on forest ownership by communities, usually it is called village forest.

Forest are classified into three forest types: production forest, protection forest including watershed protection forest, sand-breaking protection forest, sea wave protection forest..., and special-use forest including national parks and nature reserves. Ownership and management of three forest types are also different.

Natural forest is generally managed by the State through State agencies like forest enterprises or forest management boards, commune people's committees, etc. Presently, discussion on policy is underway to consider whether natural forest can be allocated to communities or households to manage.

For protection forest and special use forest (national parks, nature reserves) forest management boards will be established for management and protection. Certain forest areas, especially protection forest, will be allocated to households to protect on contractual basis.

For production forest as natural forest will be mainly managed by forest enterprises as forest owners.

In case of plantation forest, if funding has been provided by the state, then tending and protection will be provided by the state, i.e. state enterprises. In addition, plantation forest may be allocated to either individuals or households who are responsible for protection through contracts and/or benefit sharing.

If the establishment of plantation forest is funded by households or individuals on their allocated land, then, its ownership will belong fully to those households and individuals. They have the right to decide the time of harvesting and sell the products freely on the market.

Forest policy pays much attention to the benefits of the people involved in forest resources protection and development. Those who sign forest protection contracts receive payment from the State (through forest enterprises, forest management boards) as stipulated: 50,000 VND/ha/year (about USD 3.4 as of current rate: 1 USD = 15,000 VND). In addition, they are allowed to collect fuelwood, minor forest products, thinning products when necessary for protection forest. Upon exploitation of production forest, benefits will be shared depending on the increase in forest volume. Each locality ha sits own regulation and depending on the status of the forest, households and individuals may receive 70 - 100% of forest products.

The State concentrates its National budget on protection and rehabilitation of protection and special use forest, while production forest depends on preferential rate floating capital and credit policy.

People are encouraged to apply the integrated Agriculture-Forestry-Fisheries measures on their land and enjoy the benefits of these products from these combined agriculture-forestry and fishery activities.

Statistical data on the area of wetland and mangrove land allocated and contracted during the period from 1998 – 2000 (according to degree 02/CP) was 128,741ha, with 32,077 households and 62 organizations involved. Details are given in Table 11 below.

Table 11 Contracted area of land and mangrove forest in provinces of West – South region.

Unit:ha

S.N	Provinces	Land and mangrove areas contracted	No. of contracted households	No. of contracted organizations
	Total	**128,741**	**32,077**	**62**
1	Ca Mau	88,990	18,232	35
2	Tra Vinh	17,053	7,102	1
3	Bac Lieu	2,100	428	16
4	Ben Tre	11,200	7,780	5
5	Soc Trang	6,127	2,067	3
6	Kien Giang	3,271	870	2

In the Northern coastal provinces mangrove forest are mainly designated for coastal protection and managed by the State. The protection of mangrove forest is undertaken through forest management boards, local authorities and contracts with households.

4.2 Present Use

Mangrove forest in Viet Nam are used mainly for:

Providing timber and fuelwood, this is especially the case for mangrove forest of the Mekong River Delta where there is large volume of timber. Whereas, in the North, mangrove forest are poorly developed and hence timbered. Their main role therefore is of protective function. Timber is mainly used for house construction and fuelwood for basic survival needs of the local people. *Rhizophora* timber is used for charcoal production, as *Rhizophora* charcoal created is very effective. The bark of *Rhizophora apiculata* and *R. stylosa* is used for tannin production.

All above-mentioned values of mangrove forest occupy a small property compared to indirect values through mangrove forest. Fishery sources are of great sources of mangrove forest. Mangrove forest play a great role in protection of environment and development of ecotourism, especially, mangrove area of Can Gio (Ho Chi Minh City) which has been recognized by UNESCO as a biosphere reserve and an ecological area of Ho Chi Minh City.

Mangrove forest in Viet Nam are mainly concentrated within Mekong River Delta, mainly in the Ca Mau province where the largest area of mangrove forest exist and are well developed. The following data demonstrates the utility of mangrove forest during the period from 1975 to 2000 in Ca Mau province. Table 12 shows the Utilization of mangrove forest in period from 1975 to 2000.

Table 12 Utilization of mangrove forest in period from 1975 to 2000.

Year	Utilization		
	Timber (m^3)	Fuelwood (stere)	Charcoal (tonne)
1975	25,787	35,011	669
1981	20,662	174,026	2,162
1983	10,826	51,909	2,641
1991	30,903	272,610	830
1993	16,207	176,150	343
1995	15,000	100,000	368
1998	15,911	311	-
2000	17,357	-	-

(Source: Dang Trung Tan, 2001).

Since 1975 there has generally a decline in timber exploitation due to the plantation forest not being at a suitable age for harvesting. Between 1991 and 1995 volume of fuelwood harvested decreased significantly.

The value of aquaculture products is related to the mangrove forest in Ca Mau means reference only because the data collected based on estimation and deduction. According to the research results of the Forest Science Institute of Viet Nam (Dang Trung Tan, 1998), 1 ha of forest drops into the water 13.5 tonnes of dry matter and it is an important food sources for fisheries. The total area of mangrove forest at Ca Mau is approximately 64,000 ha (figure of 2000). This forest is estimated to provide the fishery sector with 205,000 tonnes of shrimp and fish (both aquaculture and fishing) with an estimated value of US$265 million. In addition, the mangrove forest act as a nursery and provide large numbers of baby shrimp. The Ministry of Fisheries estimated in 1990 that the Ca Mau forest area annually produced 8 billions baby shrimps.

The implementation of the silvo-fishery model at Ca Mau province has seen a progressive increase in shrimp production within mangrove forest:

- In 1986, shrimp production in mangrove forest was 6,000 tonnes, productively is 0.19 tonnes /ha.
- In 1990, shrimp production in mangrove forest was 24,450 tonnes, productively is 0.41 tonnes /ha.
- In 1995, shrimp production in mangrove forest was 33,600 tonnes, productively is 0.27 tonnes /ha.
- In 1998, shrimp production in mangrove forest was 42,362 tonnes. In 1999, shrimp production was 46,718 tonnes and in 2000 it was 64,000 tonnes.

However, the increased production of shrimp aquaculture in mangrove forest in some years has resulted in over-exploitation of mangrove forest for shrimp farming. The models on mangrove afforestation combining with shrimp farming regulates that the forest percentage ranges from 50-70% depending on specific conditions.

4.3 Potential Use

In the future, the mangrove forest in Viet Nam will perform the following functions:

- Protect and fix alluvial grounds along the coast and extend the mainland further towards the sea;
- Prevent sea waves from damaging dykes and prevent saline intrusion along the coastal area;
- Protect and safeguard aquatic resources and conserve mangrove forest;
- Develop ecotourism especially in some province of Mekong River Delta; and
- Establish plantation forest with diversified tree species of high economic value to provide raw materials to paper industry, chips production etc.

With its important functions in protection and development of aquatic sources, therefore, in Mekong River Delta, one project is being implemented entitled ”Protection and Development of Coastal Wetland ” in Ca Mau, Bac Lieu, Soc Trang and Tra Vinh provinces, funded by the World Bank with a total investment capital of US$ 65 million, with a duration of 6 years starting from May 2000 to May 2006.

In Ca Mau province, the establishment of a mangrove national park has been proposed at Ca Mau cape. The proposed national park will cover an area of 13,401 ha. It is also proposed to protect 14,346 ha of mangrove forest to prevent soil erosion of the coast of the South China Sea and to accelerate the deposition process for the area extension towards the western part (Gulf of Thailand).

Eco-tourism in the mangrove areas of the Ca Mau province is also being considered and special attention is now being paid to the development of projects and to existing ecotourism now conducted in the mangrove area.

4.4 Present management Structure

4.4.1 Organizational Structure

Presently, the Ministry of Agriculture and Rural Development (MARD) is the agency on behalf of the government takes the responsibility for the protection and development of forest resources. Under the Ministry, there are two professional forestry departments, i.e. Forestry Department (FD) and Forest Protection Department (FDP).

At the provincial level, there is Provincial Department for Agriculture and Rural development (DARD) in which there is Provincial Forestry Department (PFD). In addition, there is a Provincial Forest Protection Department (PFPD) under direct supervision of Provincial People’s Committee. At the district level, there is district forest protection unit. PFD and PFPD have a close relationship with Forestry Department and Forest Protection Department at Ministerial level through different projects or issues relating to management and technical aspects. The organizational structure is described in the diagram below (Figure 3).

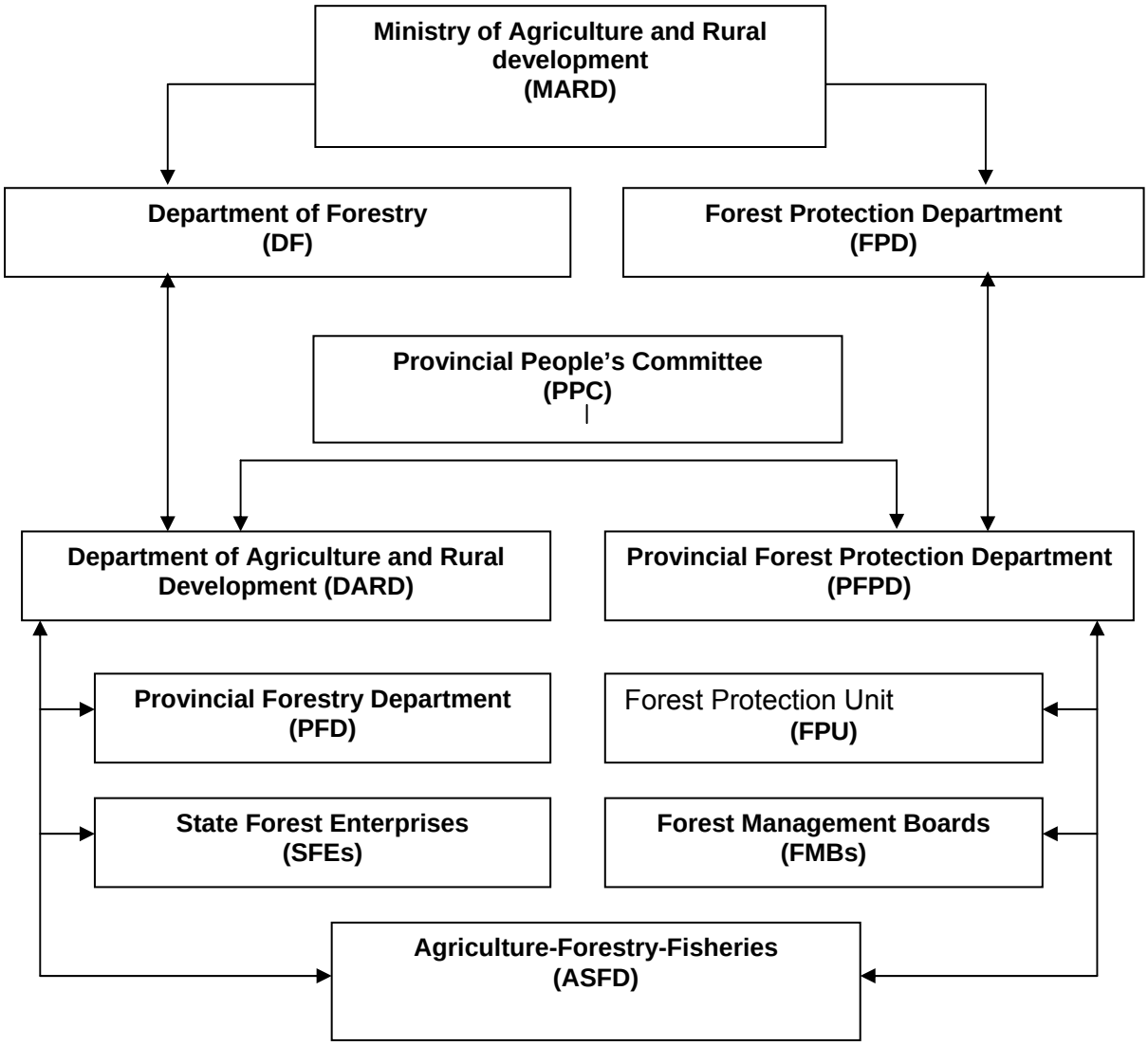


Figure 3 Organizational diagram on the forest management in Viet Nam

4.4.2 Current Management Regime

According to general classification of forest, the mangrove forest in the North belong to coastal protection forest and nature reserves like RAMSAR Xuan Thuy (Nam Dinh province).

In the Mekong River Delta, the mangrove forest are usually divided into three types of forest (mainly in Ca Mau province), they include Protection forest, nature reserves and production forest.

According to future land use projections in the Ca Mau province, it is expected that by 2005 there will be 13,737ha of protection forest, 15,941ha of Special use forest and 84,833ha of Production forest.

Mangrove areas of Mekong River Delta have been divided into three zones (according to the World Bank project).

Strictly protected zone: is an intended length and adjacent to the coastline, mangrove forest is fully protected. Its width extends hundreds of meters and based on the characteristics of each zone, it will vary from 500 to 1000m.

Buffer zone: located between the strictly protected zone and economic development zone. The forest cover here is about 70%. The width of this area may potentially reach thousands of meters.

Economic zone: it is situated before the buffer zone in support of sustainable economic and social development. Protection forest and nature reserves as mentioned earlier are the responsibility of the forest management boards and mostly managed by silvo-fishery enterprises, provincial protection forest departments or districts. This area has been allocated to the people for protection on contractual basis.

Some areas of production forest are managed by forest and fishery enterprises. Some are managed by households and individuals, when land has been allocated to them for afforestation combined with aquaculture. Production forest protection contracting and benefit sharing systems are also implemented and based on the above-mentioned general regulations.

The Ca Mau province has concrete regulations as follows: In 1991, Provincial People's Committee of Minh Hai province has issued a Decision No.64/QD/UB promulgating policy and measures for management, protection and use of land, forest and water resources including the following contents:

- Land allocation of an area of 10ha and forest contacting to people for production purpose;
- People have to reserve 75% of the allocated land for establishing mangrove forest whilst the remaining area is to be reserved for aquaculture activities; and
- Regulate the rights and obligations of individuals and households when receiving land and forest area

At present, draft forest land planning includes the following regulation details:

- If Individuals and households are allocated more than 5ha, then 70% of the area should be used for forest plantation and 30% of the area for fishery and forestry combination activities.
- If Individuals and households are allocated from 3 to 5ha, then 60% of the area should be used for afforestation and 40% for fishery and agriculture combination.
- If Individuals and households are allocated less than 3 ha of land, then 50% of the area must be used for afforestation and 50% for fishery and agriculture combination.

Land and benefit sharing policy states clearly that:

- Issuing landuse certificates(Red Book) to households who involve in fishery and forestry production as stipulated by the policy;
- Forest owners of production forest have the right to decide the time of exploitation and are free to sell the products on the market and must reforest within 12 months after exploitation.
- Households who invest in forest plantation on their allocated land are allowed to benefit 95% of the forestry products from the exploitation.

In brief, management of the three types of mangrove forest has to follow the promulgated laws, decrees and decisions of the Government. In addition, each locality where mangrove forest is found has more specific regulations.

At the present, the constraints and problems in management of mangrove forest are mainly the reclamation of aquaculture development. In some localities where landuse plans for aquaculture development have been prepared but the destruction of mangrove forest for this activity is still not controlled.

In actual management of mangrove forest, the community based forest management ha snot yet been formulated. To date only forest are protected by household groups through contracts. Community forest and community based forest management are being tested in Viet Nam and this kind of management model is being started with mountainous and watershed protection forest areas.

5. ECONOMIC VALUATION OF MANGROVE FOREST

5.1 North East Region

Dong Rui commune, Tien Yen district, Quang Ninh province is selected as a typical mangrove area from the North East region of Viet Nam. The commune has a total area of 5,000ha, of which 4.000ha are tidal flats and where about 3,000ha of mangrove forest exist. These natural forests include *Bruguiera gymnorhiza*, *Rhizophora stylosa*, *Kandelia candel*, *Avicennia marina* and *Aegiceras corniculatum* forest. Mangrove trees in this region are normally not higher than 6m with DBH less than 15cm (Forest Science Institute of Viet Nam, National project on Research on integrated economic and technical solutions for restoration of mangrove and Melaleuca forest in some distribution area in Viet Nam, 2000 – 2001).

In term of direct values of mangrove forest, in Dong Rui there are 480 households with 1905 inhabitants (2000 - 2002). The people in the commune chiefly use the fuelwood collected from the mangrove forest. According to the report by the commune people's committee (2002), annually every person consumes about 1 stere of firewood, therefore about 1,905 steres of firewood per year are consumed within the commune, valued at 228,600,000VND (Based on local price: 120,000VND/1 stere). This is considerable direct benefit from the mangrove forest which plays a crucial role in livelihood of the people in the commune.

In the case of indirect values derived from mangrove forest, the people in the commune collect sea worm in the tidal flats where mangrove forest is present for 5 months of the year. Each month, about 50 tonnes are collected and exported to China with a value of about 3 billions VND per year.

The people also collect clam (Bivalve) all year round such as *Meretri* and *Dodinia*. One person can collect about 8-10kg in one workday, valued at between 48,000 – 60,000VND/workday. In one year the commune's total income from clam collection is approximately 3.6 billions and a further 1.2

billions VND from squid and octopus. Thus excluding the value of fishery breeding products and fishing production (fish, shrimp, and crab). The people in the commune can earn an annual of about 7.8 billion from only *Mollusca*. This is a great income source compared to the income of 1.5 billion VND derived annually from agricultural production on the commune's 170ha paddy fields. Table 13 below analyses economic the economic values of mangrove forest in Quang Ninh province.

Table 13 Analysis of economic values of 1ha of mangrove forest in Quang Ninh.

Unit: VND

Benefit sources				Value	Remarks
Direct value 120,000 (2.6%)		Timber, fuelwood (bole, branches)		120,000	Productivity Timber/ha/yr
		Flowers (bee breeding)			Few people
Indirect value 4,590,000 (97.4%)	Fisheries 4,510,000	Mollusca	Sea worm	300,000	
			Bivalves	480,000	
			Squid, octopus	130,000	
		Shrimp		3,500,000	Wild shrimps (200kg)
		Crab, fish		100,000	Wild crab, fish (2-3kg)
	Environment services	Mitigation of typhoons, salt water encroachment, dam protection		0	- Quiet sea wave - No dam - Bumpy seashore
		Extension of alluvial grounds		0	Tidal flats eroded
		Conservation		-	-
	Eco-tourism	Visit, eco-tourism		-	-
Total economic values				**4,630,000**	
Investment in plantation		Planting forest		420,000	
		Maintenance, protection		100,000	
Total investment in mangrove plantation *(25 years rotation)*				520,000	Investment value: 20,800/ha/yr

(Source: Nguyen Ngoc Binh, 2001).

5.2 Northern Delta Region

The typical mangrove forest selected in this region is RAMSAR Xuan Thuy of Giao Thuy district (Xuan Thuy district in the past), Nam Dinh province.

In this area there are a number of rare and precious species of birds recognized by the world that need to be protected such as *Platalea minor*, *Erynorhynchus pygmeus*. This area is also an eco-tourism and study venue for international and national visitors. Data on the analysis of economic value of mangrove forest is shown in Table 14 below.

Table 14 Analysis of economic value of 1ha of mangrove forest in Nam Dinh (Coastal area of Red River)

Unit:VND

Benefit source			Value	
			Low price	High price
Direct value 229,653 (1.4% → 0.86%)		Timber, fuelwood (bole, branches)	110,313	110,313
		Flower for honey bee	119,340	119,340
Indirect value 15,362,000 to 26,328,000 (98.6% - 99.1%)	Fisheries 10,703,000 to 21,669,000 (67.1% - 81.6%)	Shrimp	200,430	266,220
		Crab	801,720	1,604,970
		Fish	361,080	396,270
		Mollusca, bivalve	71,910	143,820
		Breeding of *Dodinia*	9,628,290	19,258,110
	Environment service 3,858,000 (24.2% - 14.5%)	Mitigation of typhoons, salinity encroachment, dam protection	3,476,160	3,476,160
		Extension of alluvial ground	133,110	133,110
		Conservation	249,390	249,390
	Tourism 801,720 (3% - 5%)	Visit, tourism	804,720	801,720
Total economic values			**15,953,310**	**26,559,270**
Investment in forest plantation		Planting	1,224,000	1,530,000
		Maintenance, protection	459,000	765,000
Total investment of forest plantation			**1,683,000**	**2,295,000**

*Notes: * Benefit from breeding; Exchange rate: 1USD = 15,300 VND.*

5.3 Southern Delta Region

Three typical mangrove areas in Southern Delta region selected are: (i) Mangrove area of the Ben Tre province, (ii) Mangrove area of Ca Mau, and (iii) Mangrove area of Can Gio, Ho Chi Minh City. Mangrove forest in this region grow very well, with the highest timber productivity in Viet Nam. Excluding the indirect values from fishery production the fishery fishing generates a great benefit within the region. The direct values of mangrove forest in this region are fuelwood and timber. For example, the Thanh Phu forest enterprise of Ben Tre province annually harvests 50ha of *Rhizophora apiculata* plantation at the age of 12 year established in model of R*hizophora apiculata* plantation in combination with shrimp farming on an area of 700ha (mixture ratio is 70% of the area for *Rhizophora apiculata* plantation and 30% of the area for shrimp farming and canals, water drainage, boundaries) and has gained value of 1 billion and 295 millions VND from selling timber and fuelwood.

In case of the Ca Mau province, *Rhizophora apiculata* plantation aged between 6 up to 35 years annually drops 11 - 8 tonnes of litterfall (calculated in dry weight), of which the leaves accounts for 38,3 - 80,9% of the total amount (Dang Trung Tan, 1998). The 80,000ha of *Rhizophora apiculata* plantation annually provides about 712,800 tonnes of dry leaves as an important feed source which is rich in protein to the aquatic species living in coastal areas of the Mekong River Delta.

The Ca Mau province has an estimated area of 2,170 ha of mangrove forest harvested annually. The harvesting is mainly operated in *Rhizophora apiculata* plantation. According to Department of

Agriculture and Rural development of Ca Mau province (2001), the average forest production between 1991 and 1995 within the Ca Mau province was as follows:

- Timber: 21,844 m^3/year with a total value of 8.737 billion VND (mean price is 400,000 VND/m^3).
- Fuelwood:196,990m^3/year valued at 23.638 billion VND (average price is 120,00VND/m^3)
- Charcoal: 488 tonnes/year

Between 1992 and 1997 the thinning of the mangrove area of Can Gio (Ho Chi Minh City) was annually undertaken. 1,205 to 1,530 ha of mangrove forest, mostly *Rhizophora apiculata* plantation was thinned at 14-15 years of age. These plantations produced 12,972 – 16,863 steres per year of fuelwood at a value of 1.556 to 2.23 billion VND (Vien Ngoc Nam, 2002).

The Mangrove forest of Can Gio plays a vital role in mitigating influence of typhoons, big winds and tsunami. For example, in 1981 there were small areas of mangrove forest and the mangrove plantations were newly established where the mangrove trees were small. Typhoons, big winds and tsunami damaged approximately 70% of existing houses in the area, causing estimated losses of 10 billion VND. As of 1997, mangrove plantation covered an area of 28,000 ha and by this time mangrove trees were quite large. Damages to housing caused by typhoons, big winds and tsunami were estimated at 30% of that during 1981, i.e. 3 billion VND.

Protection forest at Can Gio also plays an important role in fixing sediment and encouraging the deposition of the suspended mud and sand from the water which in turn results in decreasing the turbidity of the river water considerably. For example in 1990 7cm of mud and sand was being deposited on the river bed and passages of Sai gon harbour. Despite there being forest cover of 42%, the annual costs for dredging the passages and the river bed was 21 billion VND. As of 1998 the mangrove cover has increased to 78%, since then the thickness of mud and sand layer deposited in canals, passages and river bed of area of Sai Gon harbour has decreased to 4cm. Consequently the costs of dredging has been greatly reduced 5 billion VND to 16 billion VND per year. Table 15 and Table 16 below show the analysis of the economic values of mangrove forest in Ben Tre in estuary of Cuu Long River and Ca Mau peninsula.

Table 15 Analysis of economic value of 1 ha mangrove forest in the estuary of the Cuu Long River (Ben Tre province).

Unit:VND

Benefit source			Low price	Remarks
Direct value 2,166,700 (19.3%)		Timber	2,041,700	3500 trees (7000 VND/tree 12 year old)
		Fuelwood	125,000	1500trees (30% for fuelwood) (price: 200.000 VND/$m^{3)}$
Indirect value 9,054,500 (80.7%)	Fisheries 9,054,500	Natural shrimp	6,360,000	353 kg/ha/year (price: 18.000VND/kg)
		Natural crab	1,200,000	30 kg/ha/year (price: 40.000VND/kg)
		Natural fish	200,000	40 kg/ha/year (price: 5,000VND/kg)
		Mollusca, bivalve	1,294,500	Meretric: 335,500 VND Shell: 959,000 VND
	Environment service	Mitigation of typhoons, water rising, salinity encroachment, dam protection	0	- Few typhoons - No dam
		Extension of alluvial ground		Alluvial grounds extended
		Conservation	-	-
	Tourism	Visit, eco-tourism	-	-
Total benefit			11,221,200	
Investment in forest plantation		Seed	375,000	250 kg seed of *R. apiculata*/1 ha
		Vegetation clearing	300,000	10 workday
		Planting	300,000	10 workday
		Maintenance, protection	360,000	12 workday
Total investment in forest plantation *(12 years rotation)*			1,335,000	Investment level: 112,250 VND/year

(Source: Nguyen Ngoc Binh, 2001).

Table 16 Analysis of economic value of 1 ha mangrove forest in Ca Mau peninsula.

Unit:VND

Benefit source			Low price	*Remarks*
Direct value 3,060,000 (28.8%)		Timber	2,520,000	6,3m^3/ha/year (price: 40,000VND/m^3)
		Fuelwood	540,000	2,7m^3/ha/year (price: 200,000VND/m^3)
Indirect value 7,567,000 (71.2%)	Fisheries 7,492,000 (70.5%)	Natural shrimp	6,330,000	317 kg/ha/year (price: 20,000VND/kg)
		Natural crab	932,000	23,3 kg/ha/year (price: 40,000VND/kg)
		Natural fish	230,000	46 kg/ha/year (price: 5.000VND/kg)
		Mollusca, bivalve	-	-
	Environment service (1.3%)	Mitigation of typhoons, water rising, salinity encroachment, dam protection	-	- Few typhoon - No protection dam
		Extension of alluvial ground	* 75,000	Alluvial ground deposited annually
		Conservation	-	-
	Tourism	Visit, eco-tourism	-	-
Total economic value			10,627,000	
Investment in mangrove plantation		Seed	375,000	250 kg seed of *R. apicilata*/1 ha
		Vegetation clearing	300,000	10 workday
		Planting	300,000	10 workday
		Maintenance, protection	360,000	12 workday
Total investment in mangrove plantation *(25 years rotation)*			1,335,000	Investment level: 112,250 VND/year

(Source: Nguyen Ngoc Binh, 1999).

Notes: The price used to calculate the above values are referred to market price at research area.

**: As influence of 1466 ha of Avicennia alba plantation in the West of Ngoc Hien district (Ca Mau province), annually a area extents toward the South China Sea is about 138 ha (average data recorded for 60 years) and price for land used for fishery production is 800.000 VND/ha.*

6. THREATS TO MANGROVES

6.1 Human Pressure

6.1.1 Effect of Toxic Chemical used during the American War

During 1962-1971, the American military used toxic chemical to destroy an area of 104,939ha of mangrove forest in the Southern region. For example, in the Can Gio mangrove forest, the American military used 665,666 gallons of orange herbicide plus 343,385 gallons of white toxic and 49,200 gallons of blue toxic to destroy more than 10,000ha of mangrove forest. Since 1975, most of mangrove areas damaged by toxic chemicals have been reforested and restored.

6.1.2 Reclamation of Mangrove Forest for Agriculture

During the 38 years, between 1954 and 1992, the coastal areas of Hai Phong province and Quang Yen district – Quang Ninh province approximately 6,039ha of tidal flat areas mainly covered by mangrove forest were converted into paddy fields by dam construction and land reclamation. Some 1,154ha of land has been abandoned due to saline contamination.

From 1976 to 1982(6 years) Minh Hai province (now split into Cau Mau and Bac Lieu provinces) allocated 26,300ha of mangrove forest land to local people. Many people from Nam Dinh and Ninh Binh provinces who came to Minh Hai province for their new settlement to take advantage of this allocation and to undertake agricultural business. As low terrain and soil with low maturity (very loose mud) thus salty water came out from the center of the field although local people had made a lot of affords to build bordering edges to control salty water. It was costly. Therefore the reclamation areas in mangrove forest for agriculture business after using for a short time had to leave abundant again (Phan Nguyen Hong, 1999). Obviously now deforestation of mangrove forest for agricultural cultivation no longer happens in Viet Nam.

6.1.3 Over Exploitation of Mangrove Forest

Within the Ca Mau province some silvo-fishery enterprises pay a lot of attention to exploitation of fuelwood and timber to increase economic income. The mangrove forest is therefore significantly declined in quality and quantity and in some areas no forest remain.

6.1.4 Environmental Pollution

The crucial issue at present and particularly for the future is pollution of water source in tidal flat including mangrove forest that are of our concern.

6.1.4.1 Oil pollution

Oil pollution has occurred in tidal flats in river estuaries with presence of harbor, i.e. Hai Phong, Sai Gon, Hon Gai harbors, etc.

At present it has been concluded that in all the coastal areas of river estuaries of Viet Nam there is evidence of oil pollution in both water and soil. If suitable measures for controlling pollution are not implemented properly In the future, the pollution caused by the oil extraction industry and through motor boat transportation will increase.

6.1.4.2 Pollution due to excess pesticide used for agriculture

Viet Nam is an agriculture based country. The production of rice and vegetables is dramatically increasing within the Delta areas along the coast. Results of research conducted in the estuary of the Red River revealed five (5) chemical pesticide residues in the water, sediment and *Zoobenthos* in the tidal flats, they included Lindane, DDT, Endin, DDE and Hepta chlor.

Only two (2) chemical pesticide residues were found within the water of the Red River estuary that are Lindane and DDE. Lindane was found to have a concentration of 0.59mg/litre and DDE of 0.176mg/litre.

In the near future, strict measures need to be implemented for the prevention of pesticide pollution resulting from agricultural cultivation.

6.1.5 Reclamation of Mangrove Forest for Shrimp Farming

In most coastal provinces in Viet Nam (18 provinces) the leaders at all levels, from commune, district and provincial authorities, as well as the people are well aware that strong development of brackish water shrimp farming towards commodity production will create job opportunities and eliminate poverty and hunger.

As calculated only for 8 provinces in the North of Viet Nam, in 1998 production of *Penaeus monodon* reached 838 tonnes, was 1612 tonnes in 1999, increasing 200% compared to that in 1998 and was 3,090 tonnes in 2000, going up 368,7% in comparison to the production of 1998.

Production value of *Penaeus monodon* in 8 provinces in the North for the year of 2000 is 309 billions VND, although productivity is not high, productivity on average is ranging from 200 to 230 kg/ha/yea (Sale price of *Penaeus monodon* is 80.000 - 120.000VND/kg, average is of 100.000VND/kg).

Average interest from shrimp (*Penaeus monodon*) farming fluctuating between 25 millions and 30 millions VND/ha/year. While the real interest for one hectare of salt production in coastal areas is 8 millions VND maximum. One hectare of *Cyperus malaccenisi* plantation is 3 - 3,5 millions VND/ha/year of interest. And interest for one hectare of high quality rive field (i.e. in Rang Dong enterprise of Ninh Binh province) with 2 crops per year and productivity of 10 tonnes/ha/year, sale price at 1,600 VND/kg, is 16 millions VND/ha/year.

In the year of 2000 government board for price of goods has investigated and evaluated cost price of rice production in Northern provinces and the cost price is 1.3 millions VND/tonne of rice. Thus the real interest of one hectare of paddy field with 2 crops per year is only 3 millions VND.

In comparison income of mangrove plantation in Northern coastal provinces is only 1%-2.6% of income of one hectare of fishery production, even fishery farming in this area is extensive farming (breeding source of shrimp, crab and feed is depend on nature).

In the Southern provinces as climatic condition, water environment and soil are more favorable than that of the North in brackish fishery in the coastal area, therefore mangrove area used for fishery development, in particular *Penaeus monodonin* farming, is much bigger than fishery farming in the North. Table 17 shows Area of shrimp pond on mangrove land (salic fluvisols) in Viet Nam from 1994 to1998; and Table 18 shows Farming area of Penaeus monodon in Viet Nam during 1998-1999.

Table 17 Area of shrimp pond on mangrove land (salic fluvisols) in Viet Nam from 1994 to1998.

Year	Area (ha)	Production (tonne)
1994	230,000	56,000
1995	243,000	60,000
1996	260,000	65,000
1997	290,000	70,000
1998	295,000	70,000

(Source: Ministry of Fishery, 2001).

Table 18 Farming area of *Penaeus monodon* in Viet Nam during 1998-1999.

Region	1998		1999	
	Area (ha)	Production (tonne)	Area (ha)	Production (tonne)
The North	6,493	838	9,155	1,612
Central	15,000	9,500	16,000	11,200
The South	184,000	42,000	182,000	40,000
Total	**205,000**	**52,000**	**207,000**	**53,000**

(Source: Ministry of Fishery, 2001).

With the high benefits from shrimp farming, there is therefore a tendency in Viet Nam and provinces located along the coast to reclaim spontaneously mangrove areas for brackish shrimp farming and they not follow master planning prepared by the collaboration of forestry, agriculture and fishery departments. The Table 19 below shows the damatical changes in mangrove area and shrimp farming area during 1893 and 1999 within the Ca Mau province.

Table 19 Change in mangrove areas and shrimp farming areas in Ca Mau from 1983 to 1999.

Year	Mangrove area (ha)	Shrimp farming area (ha)
1983	117,745	3,000
1988	83,637	28,701
1990	67,550	45,701
1991	58,844	47,480
1992	51,129	67,072
1995	51,492	76,036
1999	64,572	92,000

In case of the Quang Ninh province, during 1995 -1996, 14,837 ha of mangrove land area were used for construction of shrimp farming ponds by deforestation of 8,501ha of mangrove forest. And this province planned the area for development of fishery farming in brackish and coastal areas till the year of 2010 is 29,000ha, of which about 13,000ha of mangrove forest will be converted to fishery farming areas.

The Ca Mau province with coastal mangrove area is up to 222,000ha, in 1983 the estimated area of 117,745ha was mangrove forest, but as of 1999 mangrove areas decreased to 64,572ha, reducing 54,8% compared to mangrove area remained in 1983.

In the coming time (from 2003 to 2010) Ca Mau province plans only 114,507ha of mangrove area of the province for forestry, accounting 51,6% of mangrove area of the province where mangrove forest were naturally distributed, reducing 22,863ha compared to that in 2000.

In total coastal mangrove areas planned for management and utilization by forestry department in Ca Mau province are designated for following functions of forest as follows:

- Protection forest with 13,737ha;
- Special use forest with 15,941ha (Ca Mau cape National park, 2 bird gardens and used for scientific purpose); and
- Production forest with 84,832ha. For this type of forest people are allowed to carry out business on forest land by following silvo-fishery models: 60-70% of the area will be used for mangrove plantation forest (mainly *Rhizophora apiculata*) and a further 30 - 40% of the area will used for the canals, bordering edges, culverts (mostly semi-intensive shrimp farming). At present 76,000ha of mangrove area within the Ca Mau province is utilised as a combination of shrimp farming and mangrove plantation (Dang Trung Tan, 2001).

At the beginning of August 2002 an interdisciplinary scientific conference was held in Ho Chi Minh City to discuss the development of economics for the Ca Mau peninsula during the years 2002 to 2005. It was agreed that:

- Fisheries account for 72% of total GDP;
- Agriculture accounts for 22% of total GDP;
- Forestry accounts for 1,9% of total GDP; and
- The remainders are from other economic sectors.

Thus, the forestry sector which produces timber, fuelwood and other non-timber products in coastal areas plays an important role in the local and national economy.

If we do not recognize and understand their importance of mangrove forest in coastal areas, in the future there will be the increasing pressure on mangrove as the results of population growth, decrease of land area for production per capital and increasing need for living.

In summary, the main causes for the destruction of mangrove forest by the human is generalized in order as bellows:

- The fishery farming in is widely developed in the coastal areas;
- The high benefits from fishery farming and domestic and internaltional markets available for the fishery products;
- Lack of the appropriate and scientific master land use planning for the coastal mangrove land and forest; and
- Inadequacy of policies on utilization of the coastal mangrove land and forest.

6.2 Natural Phenomena

In Viet Nam there are annually, on average, 4 - 6 typhoons which travel from the South China Sea to the mainland, with wind speed blowing from 20-40m/second. Typhoons have had a large impact upon coastal mangrove forest and damaged sea protection dam networks where no protective mangrove forest are present. An exception to this is the southern Delta region where typhoons rarely occur.

Erosion is a considerable problem on the Eastern side of the Ca Mau peninsula i.e. from Rach Goc village to the estuary of the Genh Hao, a length of 30km. Over a duration of 27 years (1964-1991) an area of 7,000ha has been eroded, an annual average of over 259ha of erosion. On average the

coast encroaches upon the mainland between 5 to 10m per year and sometimes as high as 15-20m/year.

In the Northern Delta, however, there is a small area along Van Ly coastal area in has not been deposited. During 60 years (1936-1996) an area of 650ha was eroded, annually the coast of Van Ly was eroded towards the mainland over 10ha or 3m/year.

7. CONCLUSION

Based on data and information on mangrove ecosystem collected and analyzed, general conclusions can be drawn as follows:

1. Mangrove forest in Viet Nam, although the mangrove area is not so big compared to other countries in the region but it plays a significant role in environment, ecology and socio-economic, in particular in Mekong River Delta. The international and national scientists have indicated the abundance and diversity of mangrove ecosystem with differently distinct communities and about 109 mangrove species. Out of 109 mangrove species there are 37 true mangrove species and 70 associate mangrove species. Direct use value of mangrove species has been known as: 30 species for timber and fuelwood; 14 species for tannin; 21 species for medicine; 21 species for bee farming, etc. Researches have found 516 fish species for brackish water in coastal and estuaries which have high economic value, about 450 zoobenthos species in which many species of shrimp, crab, shell, etc, having a close relation with mangrove ecosystem and contribute greatly to coastal economic development and improvement of local livings.

Bird species in mangrove areas are also diverse and bird grounds have been formed, for example Xuan Thuy, Bac Lieu, Dam Doi. It has presently recorded 386 bird species; 77 species are migrant species, in which many of them are rare species. There are 28 mammals, of which 7 species are recorded in the Red book and there are 54 reptile species found, etc.

Initial economic valuation of mangrove forest showed that indirect use value of mangroves ecosystem occupied 70 - 90% which is derived from fishery, eco-tourism and environment. Direct use value of timber and fuelwood is not so high, about 10 – 30%. Obviously the value of mangrove forest is not only the mangrove trees but also diverse mangrove ecosystem and the most abundance is fishery sources. Tow biggest mangrove areas in Viet Nam are Mekong River and Red River Deltas that are also the habitats for many fishery species and oviparous area and maintenance of shrimp larva. Besides, mangrove forest also plays an irreplaceable role in coastal protection such as sea wave, typhoons and floods control. However, to date the research on this value of mangrove forest is still limited.

2. Although the value of mangrove ecosystem is very big but due to inadequate view and understanding of this ecosystem, therefore past pressure on mangrove ecosystem was high and it still shows potential for the coming time. Until 2001, statistical data given by Forest Inventory and Planning Institute showed that mangrove area was 156.608ha. In comparison with 1943, mangrove area was 408.500ha, thus loss of mangrove area was about 62% (In 1982 mangrove area was 252.000ha). It can be seen that mangrove area has been always decreasing even though there has been the affords in protecting and restoring mangrove forest. Major causes for decrease of mangrove area are: Deforestation of mangroves for agriculture production, use of chemical during the war and particularly deforestation of mangroves for fishery farming. The third cause is being the most important. The root cause for that is high benefits from shrimp farming and local people who live in and vicinity of mangrove area are very poor, therefore all people, organizations, enterprise, etc want to invest in coastal areas, especially mangroves areas, for shrimp farming.

3. Management of mangrove ecosystem is ineffective and lacks of coordination and/or incomprehensive cooperation between relevant managing agencies, particularly in local level. Inappropriate management of mangrove ecosystem led to fishery planning approaching mangroves areas in many cases. Mangrove forest is one of important elements of wetland. In national wetland management strategy, it has been indicated the roles of ministries in management of wetland. Mangrove forest is managed by Ministry of Agriculture and Rural Development. Under Ministry of Agriculture and Rural Development are Department of Agriculture and Rural Development, Forest Protection Department, Forest Protection Station, Management Boards for protection and special use forest. Mangrove forest covers small area compared to other forest types of the country, thus less attention is paid to with in forest management system except for the provinces with rather big mangrove area. Knowledge and understanding of managers on mangroves are limited and that cause ineffective management of mangroves.

4. Over the past few years, Viet Nam has paid the affords to protection of mangrove ecosystem. Some national parks have been designated and approved, for example Xuan Thuy and Ca Mau headland national parks, Can Gio protection and nature reserve is approved by UNESCO as biosphere area, Thanh Phu Natural reserve. Non-governmental Organizations also concern the protection and restoration of mangroves, for example Red Cross of Japan, Denmark, Swiss, United Kingdom, etc. Viet Nam is also implementing a project on reforestation of coastal mangroves forest in 4 provinces in Mekong River Delta including Tra Vinh, Soc Trang, Bac Lieu and Ca Mau. However it must be noted that these affords can not be the force for tendency of decreasing mangrove areas in Viet Nam.

5. To sustainably manage and utilize mangrove ecosystem, there will be three basic aspects need to be considered as bellows:

Firstly, there will be a need to measure and monitor the changes of mangrove areas to get reliable data on mangrove area for nation wide. Up to date, statistical data on mangrove area is not realistic because the Melaleuca forest are also included into mangroves in some places. Furthermore, the classification of natural and planted forest for statistical is also not feasible as it is difficult to differ these two types in reality.

Secondly, strengthen researches, basic inventory to get better and more reliable data on biodiversity of mangrove ecosystem. It is needed to carry out economic valuation for mangrove ecosystem as the basics for sustainable and effective management of mangrove forest.

Thirdly, reinforce management systems of mangroves for different levels, from central down to local, in conjunction with wetland management and inter-sectional relation.

There will also be the need to supplement appropriate policies on management of mangrove ecosystem as the legal foundation for managing agencies and people to take right and responsibilities in mangrove management.

Protection and development of mangrove ecosystem as well as improve livings of local people and communities in mangrove areas are the concern of many countries in the region. That is favourable opportunities for us to cooperate and implement the actions for national and regional objectives.

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