

## **MANGROVES AS A HABITAT FOR ENDANGERED SPECIES AND BIODIVERSITY CONSERVATION**

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### **ABSTRACT**

Mangroves forests have long been exploited at a subsistence level for their wood and fisheries. However, increases in the human population, together with increased commercial pressures, have resulted in the extensive clearing of mangrove forests and large scale (and often, destructive) harvesting of the resources. The loss of habitat has resulted in many animals dependent on the ecosystem becoming endangered. Some 213 mammals, reptiles, amphibians and birds use the mangroves as feeding and nursery grounds and for shelter. Proper management of the ecosystem will not only create more jobs and yield good economic returns on a renewable resource, but also help preserve the biodiversity of the ecosystem and its endangered animals.

### **INTRODUCTION**

Mangrove forests have long been exploited for their natural resources on an artisanal level for wood and fisheries, as well as land for settlement (Anon. 1991). However, major increases in population and commercial pressures have resulted in large-scale destruction of this most diverse and productive ecosystem. A high diversity of flora and fauna, represented by every phyla, occurs within the boundaries, making mangrove forests important gene pools, educational tools and the basis for commercial exploitation using sustainable methods.

The value of mangrove forests as habitats for important biodiversity, including some endangered species, is being rapidly diminished. Unregulated exploitation of the mangroves for fisheries and timber using non-sustainable methods has severely degraded the habitat. Conversion of mangrove land to aquaculture ponds, for agriculture, for industrial and urban development has resulted in large reductions in the area of ASEAN mangrove forests. Pollution from oil, industries and near-shore mining, and diversion of freshwater sources are also threats to the ecosystem. The last 30 years has seen a loss of up to 50% or 180,000 hectares of mangrove forests in Thailand (Pitiwong pers. comm.), Indonesia 32% of its 4 million hectares (Anon. 1992), the Philippines 170,000 hectares representing 40% of the total national mangrove resource (Librero 1980) and in Malaysia more than 25% of its 600,000 hectares of mangrove forests have been excised (Chan 1987). Singapore's mangrove forests have almost been wiped out, with only 600 hectares or 1.0% remaining (Chia *et al.* 1988).

The high biodiversity of these forests represents both high economic and genetic potential. There are many potential drugs to be found in the flora and fauna of this ecosystem. Moreover, the forests are self-sustaining systems that will continue to provide harvestable fisheries and forestry products, provided they are managed. Thus there is an urgent need to ensure that there are no further losses in biodiversity and extinction of species.

### **MANGROVE VERTEBRATE SPECIES**

The conservation of mangrove fauna requires that an adequate and sustainable area of habitat be protected and managed. The area involved will depend on the size and range of each animal. Vertebrates (Table 1) are a

major component of the mangroves, functioning not only as predators, but also contributing to the export of nutrients to other ecosystems.

**Table 1.** List of vertebrate species (excluding fish) occurring in the mangroves within the ASEAN region (Rothchild 1971; Berry 1972; Chou *et al.* 1980; Saenger *et al.* 1983; Anon. 1987; Davies *et al.* 1990; Anon. 1991). I=Indonesia, M=Malaysia, S=Singapore, P=Philippines

Family	Species	I	M	S	P
<b>Amphibians</b>					
Bufo	<i>Bufo melanostictus</i>			+	
Rana	<i>Rana cancrivora</i> (Crab-eating frog)			+	
<b>Reptiles</b>					
Agamidae	<i>Hydrosaurus postulosus</i> (Water dragon)				+
Boidae	<i>Python reticulatus</i>	+		+	+
Chelonia	<i>Chelonia mydas</i> (Green turtle)	+			
Chelonia	<i>Cuora amboinensis</i> (Terrapin)	+			
Colubridae	<i>Acrochordus granulatus</i>			+	
Colubridae	<i>Boiga cynodon</i>			+	
Colubridae	<i>Boiga dendrophila</i> (Catsnake)		+	+	+
Colubridae	<i>Cerberus rhynchops</i> (Mangrove snake)		+	+	+
Colubridae	<i>Chrysopelea chrysochlora</i>			+	
Colubridae	<i>Fordonia leucobalia</i>			+	
Colubridae	<i>Homalopsis buccata</i> (Water snake)		+		
Crocodylidae	<i>Crocodylus mindorensis</i>				+
Crocodylidae	<i>Crocodylus porosus</i> (Saltwater crocodile)	+		+	+
Elapidae	<i>Naja naja</i> (Indian cobra)				+
Gekkonidae	<i>Gecko gecko</i> (Large gecko)	+			
Gekkonidae	<i>Hemidactylus frenatus</i> (House gecko)	+			
Gekkonidae	<i>Lepidodactylus lugubris</i>			+	
Hydrophiidae	<i>Laticauda colubrina</i> (Amphibious sea snake)		+		
Scincidae	<i>Lygosoma atrocostatum</i>			+	
Scincidae	<i>Mabuya multifasciata</i> (Skink)		+		+
Varanidae	<i>Varanus dumerili</i>			+	
Varanidae	<i>Varanus salvator</i> (Monitor lizard)	+	+	+	+
Viperidae	<i>Trimeresurus purpureomaculatus</i> (Pit viper)		+	+	
Viperidae	<i>Trimeresurus wagleri</i>			+	
<b>Birds</b>					
Accipitridae	<i>Aviceda leuphotes</i> (Black baza)		+		
Accipitridae	<i>Haliaeetus leucogaster</i> (White-bellied sea eagle)		+		
Accipitridae	<i>Haliastur indus</i> (Brahminy kites)		+	+	+
Alcedinidae	<i>Alcedo atthis</i>			+	
Alcedinidae	<i>Halcyon chloris</i> (White-collared kingfisher)		+	+	+
Alcedinidae	<i>Halcyon coromanda</i>			+	
Alcedinidae	<i>Pelargopsis capensis</i> (Kingfisher)		+	+	
Anatidae	<i>Anas luzonica</i>				+
Anatidae	<i>Anas platyrhynchos domesticus</i>			+	
Anatidae	<i>Anas querquedula</i>				+
Anatidae	<i>Dendrocygna arquata</i> (Tree duck)				+
Apodidae	<i>Apus affinis</i> (House swifts)		+		
Apodidae	<i>Apus facificus</i>				+
Apodidae	<i>Chaetura caudacuta</i> (White-throated spinetail swift)		+		
Ardeidae	<i>Ardea cinerea</i> (Grey heron)		+		
Ardeidae	<i>Ardea purpurea</i> (Purple heron)		+		
Ardeidae	<i>Ardea sumatrana</i> (Dusky-grey heron)		+		+
Ardeidae	<i>Ardeola ibis coromanda</i> (Cattle egret)				+

Table 1 cont'd.

Family	Species	I	M	S	P
Ardeidae	<i>Butorides striatus</i> (Little Green heron)		+	+	+
Ardeidae	<i>Dupetor flavicollis</i> (Black bittern)		+		
Ardeidae	<i>Egretta alba</i> (Great egret)		+		+
Ardeidae	<i>Egretta eulophotes</i> (Chinese egret)		+		+
Ardeidae	<i>Egretta garzetta</i> (Little heron)		+		+
Ardeidae	<i>Egretta sacra</i> (Pacific reed egret)	+			+
Ardeidae	<i>Ixobrychus involucris</i> (Common bittern)		+		
Ardeidae	<i>Ixobrychus cinammomeus</i>				+
Ardeidae	<i>Ixobrychus sinensis</i> (Little yellow bittern)				+
Ardeidae	<i>Nycticorax caledonicus</i>				+
Ardeidae	<i>Nycticorax nycticorax</i> (Black-crown night heron)		+		+
Bucerotidae	<i>Anthracoceros malayanus</i> (Black hornbill)		+		
Bucerotidae	<i>Anthracoceros malabaricus convexus</i> (Malaysian hornbill)		+		
Bucerotidae	<i>Rhyticeros corrugatus</i> (Wrinkled hornbill)		+		
Campephagidae	<i>Pericrocotus divericatus</i> (Ashy minivet)		+		
Chloropseidae	<i>Chloropsis sonnerati</i>			+	
Chloropseidae	<i>Chloropsis palawanensis</i>				+
Columbidae	<i>Ducula aenea</i>			+	
Columbidae	<i>Ducula bicolor</i>			+	+
Columbidae	<i>Ptilinopus jambu</i>			+	
Covidae	<i>Corvus macrohynchus</i> (crow)		+		
Covidae	<i>Corvus enca</i>				+
Cuculidae	<i>Cacomantis merulinus</i>			+	
Ciconiidae	<i>Ciconia stromi</i> (Storm's stork)		+		
Ciconiidae	<i>Leptoptilus javanicus</i> (Lesser adjutant stork)		+		
Ciconiidae	<i>Mycteria cinerea</i> (Milky stork)		+		
Charadriidae	<i>Charadrius alexandrinus</i> (Kentish plover)		+		+
Charadriidae	<i>Charadrius dubius</i> (Little Ringed plover)		+		+
Charadriidae	<i>Charadrius leschenaulti</i> (Greater sandplover)		+		+
Charadriidae	<i>Charadrius mongolus</i> (Mongolian plover)		+		+
Charadriidae	<i>Charadrius peronii</i> (Malaysian plover)		+		
Charadriidae	<i>Pluvialis fulva</i>				+
Charadriidae	<i>Pluvialis squatarola</i> (Grey plover)		+		+
Columbidae	<i>Geopelia striata</i>				+
Columbidae	<i>Macropygia phasianella</i> (Brown pigeon)				+
Columbidae	<i>Treron fulvicollis</i> (Cinnamon-headed pigeon)		+		
Cuculiformes	<i>Centropus benghalensis</i> (Coucal)				+
Dicaeidae	<i>Dicaeum trigonostigma</i> (Flowerpecker)				+
Dicruridae	<i>Dicrurus paradiseus</i> (Greater racket-tailed drongo)		+		
Estrildidae	<i>Lonchura molucca</i>				+
Fregatidae	<i>Fregata ariel</i> (Frigate bird)				+
Heliornithidae	<i>Heliopais personata</i> (Masked finfoot)		+		
Hirundinidae	<i>Hirundo tahitica</i>				+
Irenidae	<i>Aegithina tiphia</i> (Common ioras)		+		
Laniidae	<i>Artanus leucorhynchus</i> (Swallow shrikes)		+		
Laniidae	<i>Lanius cristatus</i> (Brown shrikes)		+		
Laridae	<i>Chlidonias leucopterus</i> (White-winged black)		+		
Laridae	<i>Sterna albifrons</i>				+
Laridae	<i>Sterna hirundo</i>				+
Laridae	<i>Sterna hybrida</i>				+
Laridae	<i>Sterna sumatrana</i>				+
Malurinae	<i>Gerygone sulphurea</i> (Warbler)				+
Montacillidae	<i>Anthus novaeseelandiae</i> (Pipit)				+

Table 1 cont'd.

Family	Species	I	M	S	P
Muscicapidae	<i>Cyornis rufigastra</i> (Mangrove flycatcher)	+			
Muscicapidae	<i>Muscicapa latirostris</i> (Brown flycatcher)		+		
Muscicapidae	<i>Muscicapa sibirica</i> (Sooty flycatcher)		+		
Muscicapidae	<i>Saxicola caprata</i>				+
Nectarinidae	<i>Nectarinia calcostetha</i>				+
Nectarinidae	<i>Nectarinia jugularis</i>			+	
Oriolidae	<i>Oriolus chinensis</i>				+
Pachycephalinae	<i>Pachycephala cinerea</i> (Mangrove whistler)		+	+	
Pandionidae	<i>Pandion haliaetus</i>			+	
Parulidae	<i>Phylloscopus borealis</i> (Arctic warblers)		+		
Phalacrocoracidae	<i>Phalacrocorax carbo</i> (Common cormorant)		+		
Phasianidae	<i>Gallus gallus domesticus</i>			+	
Picidae	<i>Dinopium javanense</i>			+	+
Picidae	<i>Picoides moluccensis</i> (Brown-capped woodpecker)		+		
Picidae	<i>Picus viridanus</i> (Woodpecker)		+		
Picidae	<i>Picus vittatus</i> (Green woodpecker)		+	+	
Pittidae	<i>Pitta megorhynchus</i> (Mangrove pitta)		+		
Pittidae	<i>Pitta moluccensis</i>			+	
Podicipedidae	<i>Podiceps ruficollis</i> (Grebe)				+
Ploceidae	<i>Passer montanus</i>			+	+
Psittacidae	<i>Tanygnathus lucionensis</i> (Blue-naped parrot)				+
Pycnonotidae	<i>Hypsipetes philippinus</i>				+
Pycnonotidae	<i>Pycnonotus goiaveer</i>			+	
Pycnonotidae	<i>Pycnonotus zeylandicus</i>			+	
Pycnonotidae	<i>Pycnonotus plumosus</i> (Olive bulbul)		+	+	
Rallidae	<i>Amaurornis phoenicurus</i>			+	+
Rallidae	<i>Gallinula chloropus</i> (Moorhen)				+
Rallidae	<i>Gallicrex cinerea</i> (Water-cock)				+
Recurvirostridae	<i>Himantopus himantopus</i> (Black wing stilt)				+
Rhipidurinae	<i>Rhipidura javanica</i>				+
Scolopacidae	<i>Actitis hypoleucos</i> (Common sandpiper)		+		+
Scolopacidae	<i>Arenaria interpres</i> (Turnstone)				+
Scolopacidae	<i>Calidris alba</i> (Sanderling)		+		
Scolopacidae	<i>Calidris ferruginea</i> (Curlew sandpiper)		+		+
Scolopacidae	<i>Calidris ruficollis</i> (Red-necked stint)		+		+
Scolopacidae	<i>Calidris tenuirostris</i>				+
Scolopacidae	<i>Heteroscelus brevipes</i> (Tattler)				+
Scolopacidae	<i>Limosa lapponica</i> (Bar-tailed godwit)		+		+
Scolopacidae	<i>Limosa-limosa</i> (Black-tailed godwit)		+		
Scolopacidae	<i>Limnodromus semipalmatus</i> (Asian dowitcher)		+		+
Scolopacidae	<i>Numenius arquata</i>				+
Scolopacidae	<i>Numenius madagascariensis</i>				+
Scolopacidae	<i>Numenius phaeopus</i> (Whimbrel)		+		+
Scolopacidae	<i>Tringa glareola</i>				+
Scolopacidae	<i>Tringa hypoleucos</i>			+	
Scolopacidae	<i>Tringa nebularia</i>				+
Scolopacidae	<i>Tringa stagnatilis</i>				+
Scolopacidae	<i>Tringa totanus</i> (Common redshank)		+		+
Scolopacidae	<i>Xenus cinereus</i> (Terek sandpiper)		+		+
Sittidae	<i>Sitta frontalis</i> (Velvet-fronted nutbacks)		+		+
Sturnidae	<i>Aplonia panayensis</i> (Starling)				+

Table 1 cont'd.

Family	Species	I	M	S	P
Strigidae	<i>Ketupu ketupu</i>			+	
Strigidae	<i>Ninox scutulata</i>			+	
Strigidae	<i>Otus bakamoena</i>			+	
Sylviinae	<i>Locustella certhiola</i> (Pallas' grasshopper warbler)		+		
Timaliidae	<i>Trichastoma rostrata</i>			+	
<b>Mammals</b>					
Bovidae	<i>Bos javanicus</i> (Wild cattle)	+	+		
Canidae	<i>Canis familiaris</i>			+	
Canidae	<i>Cuon alpinus</i> (Red dog)	+			
Cercopithecidae	<i>Macaca fascicularis</i> (Long-tailed macaque)	+	+	+	+
Cercopithecidae	<i>Macaca irus</i> (Common monkey)		+		
Cercopithecidae	<i>Macaca nemestrina</i> (Pig-tailed macaque)		+		
Cercopithecidae	<i>Macaca philippinensis</i>				+
Cercopithecidae	<i>Nasalis larvatus</i> (Proboscis monkey)	+	+		
Cercopithecidae	<i>Presbytis aygula</i> (Javan leaf monkey)	+			
Cercopithecidae	<i>Presbytis cristata</i> (Leaf monkey)	+	+	+	
Cercopithecidae	<i>Presbytis rubicunda</i> (Maroon langur)		+		
Cervidae	<i>Cervus timorensis</i> (Rusa deer)	+			
Cervidae	<i>Cervus unicolor</i> (Sambar deer)	+			+
Cervidae	<i>Muntiacus muntjak</i> (Barking deer)	+			
Cervidae	<i>Muntiacus</i> sp. (Mouse deer)	+			
Cervidae	<i>Helarctos malayanus</i> (Malayan sun deer)		+		
Cynocephalidae	<i>Cynocephalus variegatus</i> (Flying lemur)	+			
Dophinidae	(Dolphins)	+	+		
Dugongidae	<i>Dugong dugon</i> (Dugong)		+		
Elephantidae	<i>Elephas maximus</i> (Asian elephant)		+		
Felidae	<i>Felis domesticus</i>			+	
Felidae	<i>Felis viverrina</i> (Fishing cat)	+			
Felidae	<i>Felis bengalensis</i> (Leopard cat)	+			
Felidae	<i>Felis marmorata</i> (Marbled Cat)		+		
Felidae	<i>Neofelis nebulosa</i> (Clouded leopard)	+			
Felidae	<i>Panthera tigris sumatrae</i> (Sumatran tiger)	+			
Felidae	<i>Panthera pardus</i> (Leopard)	+			
Hipposideridae	<i>Hipposideros larvatus</i> (Javan leaf-nosed bat)	+			
Hominidae	<i>Homo sapiens</i>			+	
Hystriidae	<i>Hystrix javanica</i> (Javan porcupine)	+			
Lorisidae	<i>Nycticebus coucang</i> (Slow loris)	+			
Manidae	<i>Manis javanica</i> (Scaly ant eater)	+			
Mustelidae	<i>Lutrogale perspicillata</i> (Clawless otter)	+			
Mustelidae	<i>Lutra perpicillata</i> (Smooth otter)		+		
Mustelidae	<i>Lutra sumatrana</i> (Hairy-nosed otter)	+	+		
Muridae	<i>Rattus rattus (diardii)</i> (House rat)	+		+	
Pongidae	<i>Hylobates moloch</i> (Javan gibbon)	+			
Pongidae	<i>Pongo pygmaeus</i> (Orang-utan)		+		
Pongidae	<i>Hylobates mulleri</i> (Bornean gibbon)	+			
Pteropodidae	<i>Macroglossus lagochilus</i>		+	+	
Pteropodidae	<i>Pteropus vampyrus</i> (Malaysian flying fox)	+	+	+	
Pteropodidae	<i>Eonycteris spelaea</i> (Cave nectar bat)	+			
Rhinocerotidae	<i>Rhinoceros sondaicus</i> (Javan rhinoceros)	+			
Rhinocerotidae	<i>Didermoceros sumatrensis</i> (Sumatran rhinoceros)	+			
Sciuridae	<i>Callosciurus notatus</i> (Red-bellied squirrel)	+	+	+	
Sciuridae	<i>Ratufa bicolor</i> (Black giant squirrel)	+			

Table 1 cont'd.

Family	Species	I	M	S	P
Suidae	<i>Sus barbatus</i> (Wild pig)		+		
Suidae	<i>Sus celebensis philippinensis</i>				+
Suidae	<i>Sus scrofa</i>			+	
Suidae	<i>Sus scrofa-yitatta</i> (wild pig)	+			
Suidae	<i>Sus verrucosus</i> (wild pig)	+			
Tragulidae	<i>Tragulus javanicus</i> (Musk deer)	+			
Tupaiaidae	<i>Tupaia glis</i> (Common tree shrew)	+			
Tupaiaidae	<i>Tupaia javanica</i> (Small tree shrew)	+			
Viverridae	<i>Arctictis binturong</i> (Bearcat)	+			
Viverridae	<i>Arctogalidia trivirgata</i> (Yellow palm civet)	+			
Viverridae	<i>Herpestes brachyurus</i> (Short-tailed mongoose)	+			
Viverridae	<i>Herpestes javanicus</i> (Javan mongoose)	+			
Viverridae	<i>Paradoxurus hermaphroditus</i> (Palm civet)	+			
Viverridae	<i>Viverricula malaccensis</i> (Javan civet)	+			

Many of these species are wholly or partly dependant on the mangroves for food, shelter or as breeding grounds. Examples include such important endangered species as the proboscis monkey, *Nasalia larvatus* (Chan & Lai 1984), which feeds on the young leaves and growing tips of the mangrove trees *Sonneratia* and *Avicennia* (Saenger *et al.* 1983) and the estuarine crocodile, *Crocodilus porosus* (Soemodihardjo *et al.* 1992). Many bird species are also endangered, among them herons (*Ardea* spp.), egrets (*Egretta* spp.); the storks are specifically threatened.

### MANGROVE INVERTEBRATE SPECIES

While this group of animals are not dealt with here, they comprise an important component of the ecosystem, and should not be neglected. Crabs and shrimps are important food sources for a host of predators, including man. Molluscs, too are harvested, and are also predated on by birds, as are the polychaete worms. Wood-boring mangrove insects, play a key role in the breakdown of deadfalls, releasing nutrients to the environment (Meadows & Meadows 1991). Herbivory of insects, and other invertebrates, on mangrove trees are also important, as significant damage to the trees could indicate a decline in health of the trees (Murphy 1990). The biology, ecology and taxonomy of these animals are thus of interest to scientists who are striving for a better understanding of the dynamics of the mangrove ecosystem. Even in Singapore's highly degraded system, new species are still being discovered (see Sawada 1991; Cookson & Cragg 1991; Tan & Ng 1994).

### SUSTAINABLE USES OF MANGROVES

Mangrove habitats are of primary importance to the commercial community, the world community, and for their scientific and educational value. They are nursery and feeding grounds for many commercial fish and shrimps, which constitute the main source of protein for much of the population of most ASEAN countries. Approximately 60% of the animal protein in the region comes from the sea (Yong 1989). Mangrove trees are good sources of timber, charcoal, wood chips and tannins. The high biodiversity and complex inter-relationships of the organisms are of interest to scientists, who view the mangroves as an important gene pool and educational tool. Some mangroves are a major source of nutrients to other near-shore ecosystems, such as seagrasses and mudflats (Sasekumar *et al.* 1994). The mangroves also serve as breeding and wintering grounds for many species of migratory birds (Hawkins & Silvius 1986).

The governments of ASEAN countries are realising the value of this resource and have passed regulations and laws to prevent loss and over-exploitation (Atmadja *et al.* 1994). Mangrove forests of various sizes have also been gazetted as forest reserves or nature parks (Table 2).

**Table 2.** Nature Parks and managed mangrove areas in ASEAN (from Aksornkoea & Khemnark 1984; Hamilton & Snedaker 1984; Philips 1984; Abdullah 1986; Chan 1987; Anon. 1987; de Leon *et al.* 1991; UNDP/UNESCO 1991; de Leon *et al.* 1993; IUCN/GBRMPA 1993). M=Mangrove, CrM=Coral reef, mixed with mangrove.

Conservation Area	Location	Area (ha)	Remarks
<b>INDONESIA</b>			
<b>Mangrove Reserves</b>			
Kelumpang Bay	South Kalimantan	13,500	
East coast of Jambi	Jambi	6,500	
Muara Angka	Jakarta	15	
Lozentz Mountain	Irian Jaya	301,500	
Taluk Bintuni Nature Reserve	Irian Jaya	450,000	M
Perairan Kangean Game Reserve	Java	3,000	M
Pulau Sepanjang	East Java	2,430	
Estuary of Kahayan River	East Kalimantan	150,000	
Adang & Apar Bay	East Kalimantan	28,000	
Ujong Kulon (1993)	West Java	44,337	CrM
Leuwang Sancang Strict Marine Nature Reserve	West Java	7,150	M
Pulau Pombo Marine Recreation Park	Maluku	1,000	M
Pulau Dua Strict Marine Reserve	West Java	30	M
Bukit Barisan Selatan Strict Marine Nature Reserve	Sumatra	201,600	M
Bali Barat National Park	Java	77,727	CrM
Barisan Selatan National Park	Sumatra	365,000	CrM
Baluran National Park	Java	25,000	CrM
Teluk Maumere Marine Recreation Park	East Nusa Tenggara	59,450	M
Kepulauan Seribu Strict Marine Nature Reserve/ Marine National Park	Java	108,000	CrM
Bunakan Menado Tua Strict Marine Nature Reserve/ Marine National Park	North Sulawesi	75,265	CrM
Arakan Wowontulap Strict Marine Nature Reserve	North Sulawesi	13,800	CrM
<b>Wildlife Sanctuary</b>			
Tanjung Puting	Central Kalimantan	11,000	
Pleihari Tanah Laut	East Kalimantan	4,000	
Pulau Dolok	Irian Jaya	99,000	
Wassur	Irian Jaya	6,180	
<b>MALAYSIA</b>			
<b>Nature Park/Mangrove Reserve</b>			
Bako National Park	Sarawak	2,728	
Kuala Selangor Nature Park	Selangor	379	
Jugra Mangrove Reserve	Selangor	3,410	
Kuala Bernam Mangrove Reserve	Selangor	3,004	
Kelang Mangrove Reserve	Selangor	11,794	
Matang Mangrove Reserve	Perak	40,929	M
Merbok Mangrove Reserve	Kedah	5,370	
Sungai Pulai Mangrove Reserve	Johor	10,329	
Linggi Mangrove Reserve	N. Sembilan	254	
Tawau Mangrove Reserve	Sabah	40,198	
Pulau Payar Marine Park	Penang	33,670	CrM
Pulau Perhentian Besar Marine Park	Trengganu	51,023	CrM, proposed
Tunku Abdul Rahman Park	Sabah	3,640	CrM
Pulau Tiga Park	Sabah	15,257	CrM
Pulau Sipadan Marine Reserve	Sabah	208	CrM, proposed
Samporna Islands Marine Park	Sabah	31,267	CrM, proposed
<b>Wildlife Sanctuary</b>			
Kuala Gula Bird Sanctuary	Perak	1,298	
Kulamba Wildlife Reserve	Sabah	20,682	

**Table 2 cont'd.**

Conservation Area	Location	Area (ha)	Remarks
Kota Belud Bird Sanctuary	Sabah	12,200	CrM
Sepilok Wildlife Reserve	Sabah	4,295	
Samunsam National Park	Sarawak	6,092	
<b>Degraded Mangrove Reserve</b>			
Byram Mangrove Reserve	Penang	240	
Pulau Indah Mangrove Reserve	Selangor	4,559	
<b>Degazetted Mangrove Reserve</b>			
Klias Mangrove Reserve	Sabah	135,000	
<b>PHILIPPINES</b>			
<b>Mangrove Sanctuaries</b>			
Talabong Game Refuge, Wildlife Sanctuary & Tourist spot	Bais Bay, Negros	206	
Mison Sanctuary	Baliangao, Mindanao	7	
Pagbilao Forest Reserve	Pabilao, Quezon	114	
Apo Island MR/TZ		-	M
Sumilon Island Marine Park		23	CrM
Tubbataha Reefs National Marine Park		33,200	CrM
Camiguin Island TZ/MR		-	M
Fugo Island MR/TZ		-	CrM
Guindolman		-	CrM
Guiuan MS		-	M
Malampaya Sound MS/TZ		-	M
Nasugbu MS		-	M
Olango Island Migratory Bird Sanctuary	Cebu	500	
Panglaon Island Balicaag Area MR/TZ		-	CrM
Puerto Galera Marine BioS		-	M
Sombrero Island MR/TZ		-	CrM
Tagbilaran MR		-	M
Polillo Islands		-	M
Panguil Bay Marine Sanctuary		-	M
Ulugan Bay Naval Reserve	Ulugan Bay, Palawan	1,880	
<b>THAILAND</b>			
<b>Mangrove Reserves</b>			
Ranong Mangrove Reserve	Ranong Province	22,600	
Ao Phangna National Park	Phangnga Province	40,000	CrM
Mu Ko Surin National Park		13,500	CrM
Tarutao National Park		149,000	CrM
Hat Nai Yang National Park		9,000	CrM
Khao Laem Ya-Mu Ko Samet National Park		13,100	CrM
Khao Sam Roi Yot National Park		9,808	CrM
Hat Nopharat Thara - Mu Ko Phi Phi National Park		38,996	CtM
Khao Lam Pi-Hat Thai Muang National Park		7,200	M
Mu Ko Ang Thong National Park		10,200	CrM
Hat Chao Mai National Park		23,800	M
Laem Son National Park		31,500	M
Mu Ko Chang Islands National Park		65,000	M
Mu Ko Phetra National Park		49,438	M
<b>Degraded Mangrove Reserve</b>			
Amphoe Khlung Mangrove Reserve	Changwat Chantaburi	19,000	
<b>SINGAPORE</b>			
Sungei Buloh Nature Park	Singapore	87	M



Legislation and enforcement should enable the government to:

1. Systematically manage the harvesting and replanting of the mangrove forest resources at a sustainable level.
2. Protect and preserve mangrove forests, maintaining the ecosystem at a high productivity for use as a breeding and feeding ground.
3. Conserve and protect foreshore and riverbanks from erosion damage by tides and strong winds.
4. Establish wildlife sanctuaries to protect endangered species from extinction by providing natural regeneration habitat.
5. Establish nature parks for eco-tourism and educational purposes.
6. Establish compatible aquaculture activities, such as fish cage, mussel and cockle culture.

### **MANGROVE PARKS/RESERVES/SANCTUARIES**

#### **Singapore**

The gazettement of Sungei Buloh as a bird sanctuary in 1990, and its recent opening in December 1993, was a direct result of petitions from the public, and desire of the government to preserve the natural heritage of the country. Apart from serving as sanctuary to some 141 species of birds (Anon. 1993), the Park also aims to preserve the existing mangrove habitat. There is still a need to protect the adjacent mudflats of the Mandai mangroves, which serve as feeding grounds for the herons, egrets, sandpipers and plovers. The main problem faced by the Park management was the impact of the 10,000 visitors that visited during the first month of opening.

#### **Malaysia**

There are several acts and regulations currently being enforced that govern mangrove and park reserves in Malaysia. The National Park Act (1980) which was introduced to regulate the gazettement and management of National Parks, is at present applied to Peninsula Malaysia only. The States of Sabah and Sarawak have their own state legislation for the establishment of parks and reserves. This is because the states under the Malaysian Constitution have total right over all land matters. State legislation, however, varies considerably from one to another. With the introduction of the Protection of Wildlife Act, 1976 (amended), the establishment of the wildlife sanctuaries has been facilitated. Control over creation, alteration and excision of wildlife reserves and wildlife sanctuaries though lies with the State Government, but all management procedures adopted is in the hands of Federal Government. Generally, apart from a few degazetted and degraded reserves (Table 2), the set up yields encouraging results. Further refinement in the acts, coupled with greater support and emphasis from the government would enable the conservation objectives be achieved.

The best example of mangrove management in ASEAN is the Matang Forest Reserve on the west coast of Peninsular Malaysia. This reserve has been successfully managed for 80 years with high production rates of timber for charcoal and construction and particularly important fishery within the forest and immediately offshore.

#### **Indonesia**

Many mangrove parks have been established, such as Ujungkulon National Park in south-west Java. The need for establishment and management of the reserve areas in Indonesia has seen the introduction of several Acts and Degrees: the Act of the Republic of Indonesia (1967, 1990), Director General of Forestry Decree (1978) and Presidential Decree (1990).

Ujungkulon received nature reserve status in 1921, was proposed as a national park in 1980 and finally gazetted as National Park and 'World Heritage Site' in February 1992. The land section of the park has an area of 77,000 ha, 40% of which is mangroves. Over 310 species of mammals, reptiles, birds and insects have been recorded. The Kalejetan area of the south coast is inhabited by the estuarine crocodile, while at Karang Panjang, monitor lizards, wild pigs, deer and rhinoceros are commonly sighted. The Jamang area in the north coast is home to a wide variety of birds, wild pigs and leopards.

## **Philippines**

Proclamation 2152 declared all mangrove swamps as forest reserves. The Asian Wetlands Bureau (1990) has identified 50 areas with mangrove forests in the Philippines. Only a few are at present managed either by government or non-government agencies. Some private landowners have taken measures to protect mangroves fringing their land. With the coastal environment program of the Department of Environment and Natural Resources, it is expected that more mangrove forests will be declared as wildlife sanctuaries.

Managed forests include the Pagbilao Forest Reserve (officially known as the Agroforestry and Mangrove Forest Research Center and Mangrove Experimental Forest and Nursery), in Talipon, Pagbilao Bay, Quezon Province, which was established by the Forest Research Institute in 1975. Olango Island Migratory Bird Sanctuary in Cebu was established by the Asian Wetland Bureau Philippines Inc., while the Talabong Game Refuge, Wildlife Sanctuary and Tourist Spot is managed by the local government of Bais City, and the Dept of Environment and Natural Resources.

## **HABITAT CONSERVATION**

With the increasing rate of destruction of mangroves in recent years, particularly through clear felling for woodchips and conversion to aquaculture ponds, there is now an urgent need for conserving this ecosystem. It is important that mangrove forests in different regions and containing different communities throughout ASEAN be included in plans for marine protected areas. It is also important to ensure that the full range of zones within the mangrove forests, and the adjacent related ecosystems, be included in conservation plans (Murphy & Sigardsson 1990). The distribution of mangrove fauna follows closely the zonation patterns of mangrove vegetation (Berry 1972), determined by factors such as feeding habits, breeding and spawning requirements, shelter from predators and basic physiological needs. On a broad scale, for example, the mangroves can be categorised into terrestrial and aquatic habitats. The terrestrial niche is shared by crustaceans, molluscs and a formidable variety of mammals, reptiles, amphibians and birds, and includes those found in the tree canopy. The aquatic environment is inhabited by pelagic and benthic species of fish, crustaceans (crabs and shrimps) and molluscs (bivalves and gastropods).

Specific habitat requirements of these mangrove-associated animals, especially for those endangered species, need to be ascertained. The tree canopies of Bako mangrove in north-western Sabah are colonised by the leaf-eating Proboscis monkey, which are threatened by the disappearance of habitat and food source. As they range over a large area, creation of a series of mangrove forest reserves along the coastline, linked by 'corridors' of undisturbed habitat will function just as well as conserving a thick belt of mangroves, thus balancing the need for coastline development and free movement of the endangered monkeys from one food source to another (Hamilton & Snedaker 1984).

The Sumatran rhinoceros is also among the most endangered mammals on earth, and have largely been exterminated due to loss of habitat, and for their horns, which supposedly have aphrodisiac and medicinal properties. These large animals have home ranges between 15 to 30 km<sup>2</sup> (van Strien 1986), and would require large areas to be protected for a viable community to survive. An alternative to a single large reserve is the creation of several 'core' areas, also linked by corridors. This patchwork of protected areas allow the rhinoceros freedom of movement, and protection of important habitat areas for breeding, shelter and food.

## MANGROVES FOR THE FUTURE

The wanton destruction of the mangrove forests and its resources by illegal or unregulated harvesting for short-term benefits must be arrested if the ecosystem is to survive beyond the 21st century. Properly managed mangroves are able to provide long-term economic benefits from a variety of industries and providing employment to the populace. The preservation of areas of high diversity, and for protection of endangered species, plays an important part in maintaining the country's cultural, historical and natural heritage.

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## REFERENCES

- Abdullah, A. 1984. Conservation and the role of mangrove forest in Indonesia. **Proceedings "Seminar II Ekosistem Mangrove"** Baturaden, 3-5 August 1982. Pp. 104-111.
- Aksornkoae, S. and Khemnark, C. 1984. Nutrient Cycling in mangrove forest of Thailand. **Proceedings of the Asian Symposium on Mangrove Environment - Research & Management** University of Malaya, Malaysia, and UNESCO, 1984. Pp. 545-557.
- Anonymous, 1987. **Malaysian Wetland Directory** Department of Wildlife and National Parks, 1987 Kuala Lumpur.
- Anonymous, 1991. **Integrated multidisciplinary survey and research program of the Ranong mangrove ecosystem** UNDP/UNESCO regional project-research and its application to the management of the mangroves of Asia and the Pacific (RAS/86/120), Bangkok, March, 1991. 183 pp.
- Anonymous, 1992. **Indonesian Country Study on Biological Diversity** Ministry of State for Population and Environment, Republic of Indonesia. 209pp.
- Anonymous, 1993. Govt committed to nature conservation, says PM Goh. **The Straits Times** Tuesday December 7, 1993.
- Atmadja, W.S., Man, A., de Leon, R.O., Tantichodok, P. 1994. Government policy for mangrove management in ASEAN. In: Wilkinson, C.R., Sudara, S. & Chou, L.M. (eds.) **Proceedings Third ASEAN-Australia Symposium on Living Coastal Resources, Vol: 1, Status Reviews**, Chulalongkorn University, Bangkok, Thailand, May 1994 (in press).
- Berry, A.J. 1972. The natural history of West Malaysian Mangrove faunas. **Malayan Nature Journal** 25:135-162.
- Chan, H.T. 1987. **Mangroves of Asia and the Pacific: Status and Management: Malaysia** Technical Report of the UNDP/UNESCO Research and Training Pilot programme on Mangrove Ecosystems in Asia and the Pacific (RAS/79/002). 538pp.
- Chia, L.S., Khan, H. & Chou, L.M. 1988. **The coastal environmental profile of Singapore** ICLARM Technical Reports 21. International Center for Living Aquatic Resources Management, Manila. 92pp.
- Chou, L.M., Ho, S.H., Khoo, H.W., Lam, T.J., Murphy, D.H. & Tan, W.H. 1980. **The present state of mangrove ecosystems in Southeast Asia and the impact of pollution: Singapore** FAO/UNEP report

- SCS/80/WP/94d. South China Sea Fisheries Development and Coordinating Programme, Manila, Philippines. 97pp.
- Clarbrough, M. & Clarbrough, M. 1993. **Ujungkulon National Park Trail Guidebook** Government Project, Ujung Kulon National Park 1993/1994. 16pp.
- Cookson, L.J. & Cragg, S.M. 1991. *Limnoria cristata* (Isopoda: Limnoriidae), a new species of marine wood-borer from Singapore. **The Raffles Bulletin of Zoology** 39(1):87-98.
- Davies, J., Magsalay, P.M., Rigor, R., Mapalo, A. & Gonzalez, H. 1990. **A Directory of Philippines Wetlands**. AWBPFI/HF, Cebu, Philippines. 230pp.
- de Leon, R.O.D., Alcala, A.C. & Raymundo, R.J. 1991. Potential levels of primary production and community structure of the Talabong mangrove forest, Negros Oriental, Philippines. **Proceedings of the Regional Research in Coastal areas** Pp. 453-458.
- de Leon, R.O.D. & Cadiz, P.L. 1993. **Mangroves: Report on the conduct of resource assessment of Misom Sanctuary, Balingao, Misamis Occidental** Pipuli Foundation, Siliman University Marine Laboratory Dumaguete City, Philippines, 1993. Pp. 4-19.
- Hamilton, L.S. & Snedaker, S.C. (eds.) 1984. **Handbook for mangrove area management** United Nations Environment Program and East-West Center, Environmental and Policy Institute. 123 pp.
- IUCN/GBRMPA. 1993. **A global representative system of marine protected areas**. A report to the World Bank Environment Department. The World Conservation Union, Gland Switzerland and Great Barrier Reef Marine Park Authority, Canberra, Australia. 171pp.
- Librero, A.R. 1980. Mangrove management in the Philippines. **Proceedings of the Second International Symposium on Biology and Management of Mangroves and Tropical Shallow Water Communities** Port Moresby, Papua New Guinea.
- Meadows, P.S. & Meadows, A. 1991. The environmental impact of burrowing animals and animal burrows. **Symposia of the Zoological Society of London** 63:251-263.
- Murphy, D.H. 1990. The natural history of insect herbivory on mangrove trees in and near Singapore. **The Raffles Bulletin of Zoology** 38(2):119-204.
- Murphy, D.H. & Sigurdsson, J.B. 1990. Birds, mangroves and man: Prospects and promise of the new Sungei Buloh Bird Reserve. **Essays in Zoology** Papers commemorating the 40th anniversary of the Department of Zoology, National University of Singapore. pp. 233-243.
- Paul-Chai, P.K. & Lai, K.K. 1984. Management and utilisation of mangrove forests in Sarawak. **Proceedings of the Asian Symposium Mangrove Environment - Research & Management** University of Malaya, Malaysia, and UNESCO, 1984. pp. 785-795.
- Philips, C. 1984. Current status of mangrove exploitation, management and conservation in Sabah. **Proceedings of the Asian Symposium on Mangrove Environment - Research and Management** University of Malaya, Malaysia, and UNESCO, 1984. pp. 809-820.
- Rothschild, G. 1971. Animals in Bako National Park. **The Malayan Nature Journal** 24(3&4): 163-169.
- Saenger, P., Hegerl, E.J. & Davie, J.D.S. (eds.) 1983. Global Status of Mangrove Ecosystems. Commission on Ecology Papers Number 3, Gland, Switzerland: International Union for the Conservation of Nature and Natural Resources. **The Environmentalist** 3 (1983), Supplement No. 3.

- Sawada, K. 1991. On new genera and species of intertidal Aleocharinae (Coleoptera: Staphylinidae) and Goniacerinae (Pselaphidae) from Singapore and Japan. **The Raffles Bulletin of Zoology** 39(1):141-152.
- Soemodihardjo, S., Wiroatmodjo, P., Abdullah, A., Tantra, I.G.M. & Soegiarto, A. 1992. Condition, socio-economic values and environmental significance of mangrove areas in Indonesia. **Technical report of the project, the economic and environmental values of mangrove forests and their present status of conservation in the South East/Pacific Region**. Int. Soc. for Mangr. Eco. Pp. 17-40.
- Tan, C.G.S. & Ng, P.K.L. 1994. The Camptandriinae of Singapore and Malaysia, with description of one new species of *Paracleistostoma* de Man, 1985 (Crustacea: Decapoda: Brachyura: Ocypodidae). In: Sudara, S., Wilkinson, C.R. & Chou, L.M. (eds.) **Proceedings Third ASEAN-Australia Symposium on Living Coastal Resources, Vol: 2, Research Papers**, Chulalongkorn University, Bangkok, Thailand, May 1994 (in press).
- Yong, S.K.T. 1989. Coastal resources management in the ASEAN region: problems and directions. In: Eng, T.-E. & Pauley, D. (eds.) **Coastal Area Management in Southeast Asia: Policies, Management Strategies and Case Studies**. ICLARM Contribution No. 543 xi.
- van Strien, N.J. 1986. The Sumatran rhinoceros - *Dicerorhinus sumatrensis* (Fisher, 1814) - in the Gunung Leuser National Park, Sumatra, Indonesia: its distribution, ecology, and conservation. **Mammalia dipicta** 12. 200pp.