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NATIONAL REPORT

on

Seagrass in the South China Sea

INDONESIA

Mr. Tri Edi Kuriandewa
Focal Point for Seagrass
Puslit OSEANOGRAFI, LIPI
Pasir Patih 1 Ancol Timur, Jakarta, Indonesia

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1. INTRODUCTION

The Indonesian Seagrass Committee (ISC) has prepared two documents in review of national data: (1) The Status of Indonesian Seagrass Ecosystems; (2) Past and Ongoing Activities Related to Management of Indonesian Seagrass Ecosystems. Also completed were the Policy, Strategy and Action Plan for National Seagrass Management and the Assessment of Legal and Institutional Arrangements for Seagrass Management. These documents have been presented to the PCU, reviewed by an independent reviewer and the PCU, and discussed during the 4th Seagrass Regional Working Group in Guangzhou, China from 28 November to 2 December 2003. The meeting agreed on the required content of national seagrass reporting as follows: introduction, past and ongoing activities, biological aspects, physical and chemical characteristics, threats, economic valuation, legislation and institutional arrangements and management perspectives.

2. REVIEW OF INDONESIAN SEAGRASS

2.1 Geographic Distribution

Some 12 species of seagrass are reported to occur in Indonesian waters (Brouns, 1985; Kiswara, 2002; Kiswara, 1994). Other species such as *Halophila beccarii* and *Ruppia maritima* are believed to exist in Indonesian waters, although to date they are known only from specimens at Bogor Herbarium. The origin of the *H. beccarii* is unknown, while the *R. maritima* specimens come from mangrove areas at Ancol-Jakarta Bay and Pasir Putih-East Java. To date, the two species have not been rediscovered. Until recently, *Thalassodendron ciliatum* exhibited disjunctive distribution, i.e., it was only observed in eastern Indonesia waters in Maluku and East Nusa Tenggara (Tomascik *et al.* 1997; Kiswara, 1994; Kiswara, 2002). However, according to Tomascik *et al.* (1997) and Kiswara *et al.* (1997), it was also found in the western part of the archipelago in Kangean and Riau Archipelago waters. Two other species, *Halophila spinulosa* and *Halophila decipiens* are only recorded in a few locations. Thus, including *R. maritima,* Indonesian coastal waters are inhabited by 13 species of seagrass. The geographic distribution of the 13 common species is presented in Figures 1, 2, 3, 4 and 5.

Indonesian seagrass communities can be segregated into two types – monospecific and mixed vegetations. They grow on muddy, sandy, coral rubble and mixed substrate, even on rock (*Thalassodendron ciliatum,* at Kuta Bay Lombok) (Brouns *et al.* 1991). Monospecific vegetation refers to seagrass communities which consist of one species which grows by forming dense or meadows, while mixed vegetation consists of two to eight species on the same area. The seagrass species which usually grow as monospecific vegetation are *Thalassia hemprichii, Enhalus acoroides, Halophila ovalis, Halodule pinifolia, H. uninervis, Cymodocea rotundata* and *Thalassodendron ciliatum* (Lindeboom and Sandee 1989; Azkab, 1988a). Muddy substrates on the seaward edges of mangrove formations often have a single species meadow of high biomass. Multi-species meadows mostly occur in the lower intertidal and shallow subtidal zones. Such meadows grow best in well-sheltered, sandy (not muddy), stable and nearly horizontal sediments (Brouns, 1985; Lindeboom and Sandee 1989). High bioturbation, for example by burrowing shrimps, tends to decrease seagrass density and favours pioneering species. Seagrass on terrigenous (land derived) sediment is more influenced by land run off (turbidity, fresh water flooding, nutrient pulses and salinity fluctuations) and subsequent light limitation than those of carbonate (reef derived) sediments of reef islands with less seasonal dynamics (Erftemeijer, 1993).

The most important area for seagrasses is in the lower intertidal and upper subtidal zones, where heterogeneous vegetation sometimes appears with 7 to 8 species in the same bed.

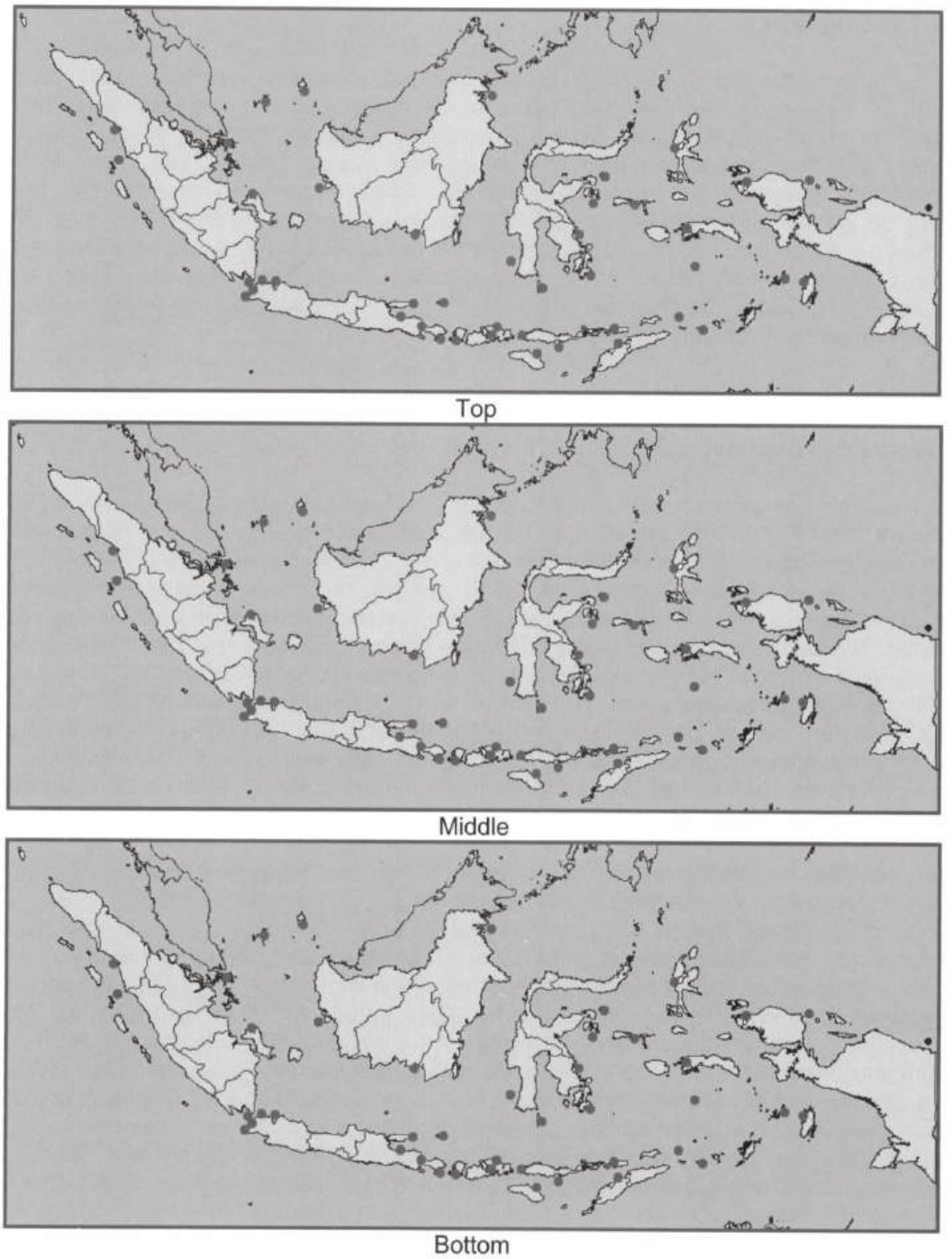

Figure 1 Distribution of *Cymodocea rotundata, Cymodocea serrulata* and *Enhalus acoroides*.
- Top : Distribution of *Cymodocea rotundata*
- Middle : Distribution of *Cymodocea serrulata*
- Bottom : Distribution of *Enhalus acoroides*

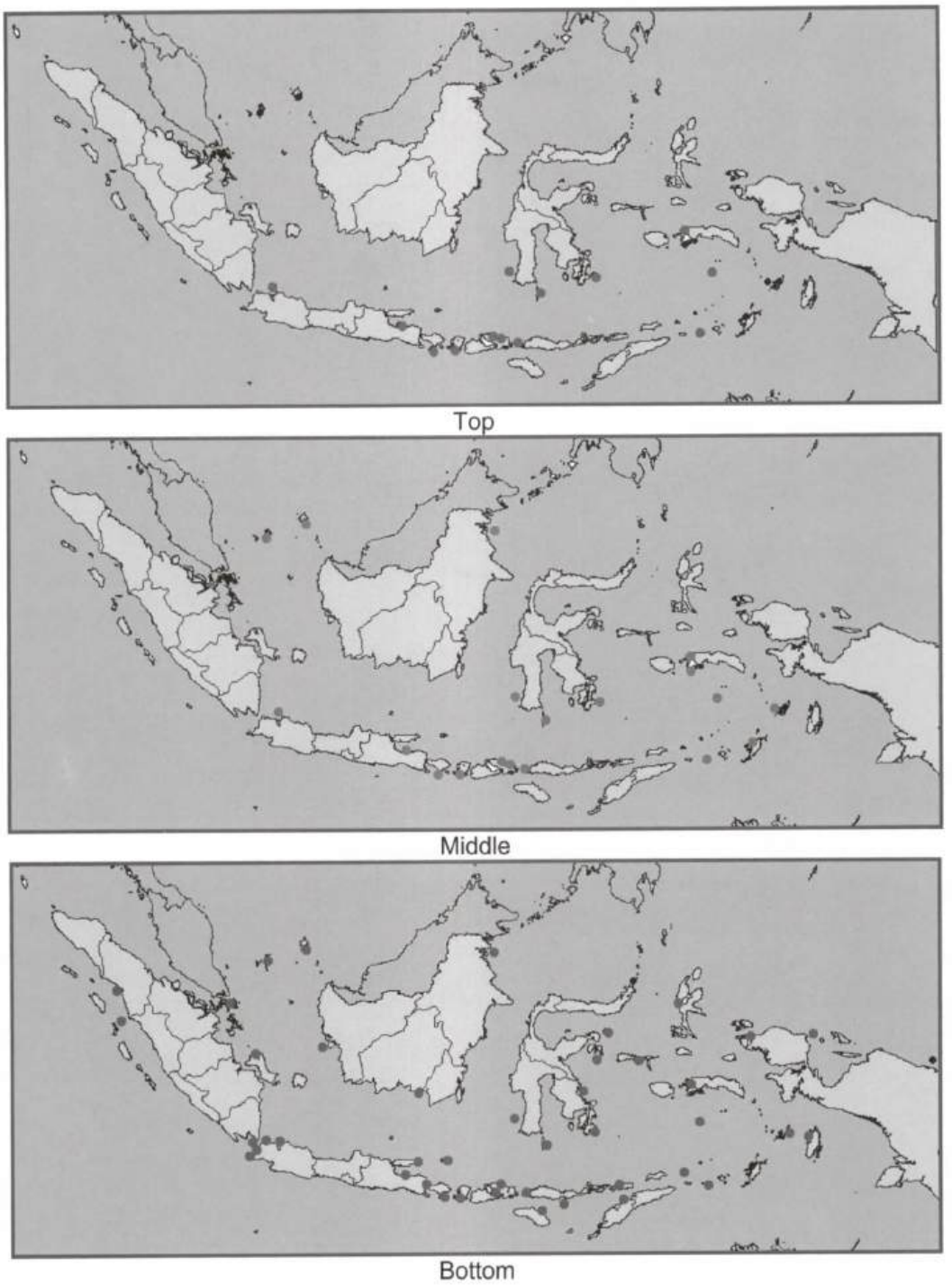

Figure 2 Distribution of *Halophila decipiens, Halophila minor* and *Halophila ovalis*.
- Top : Distribution of *Halophila decipiens*
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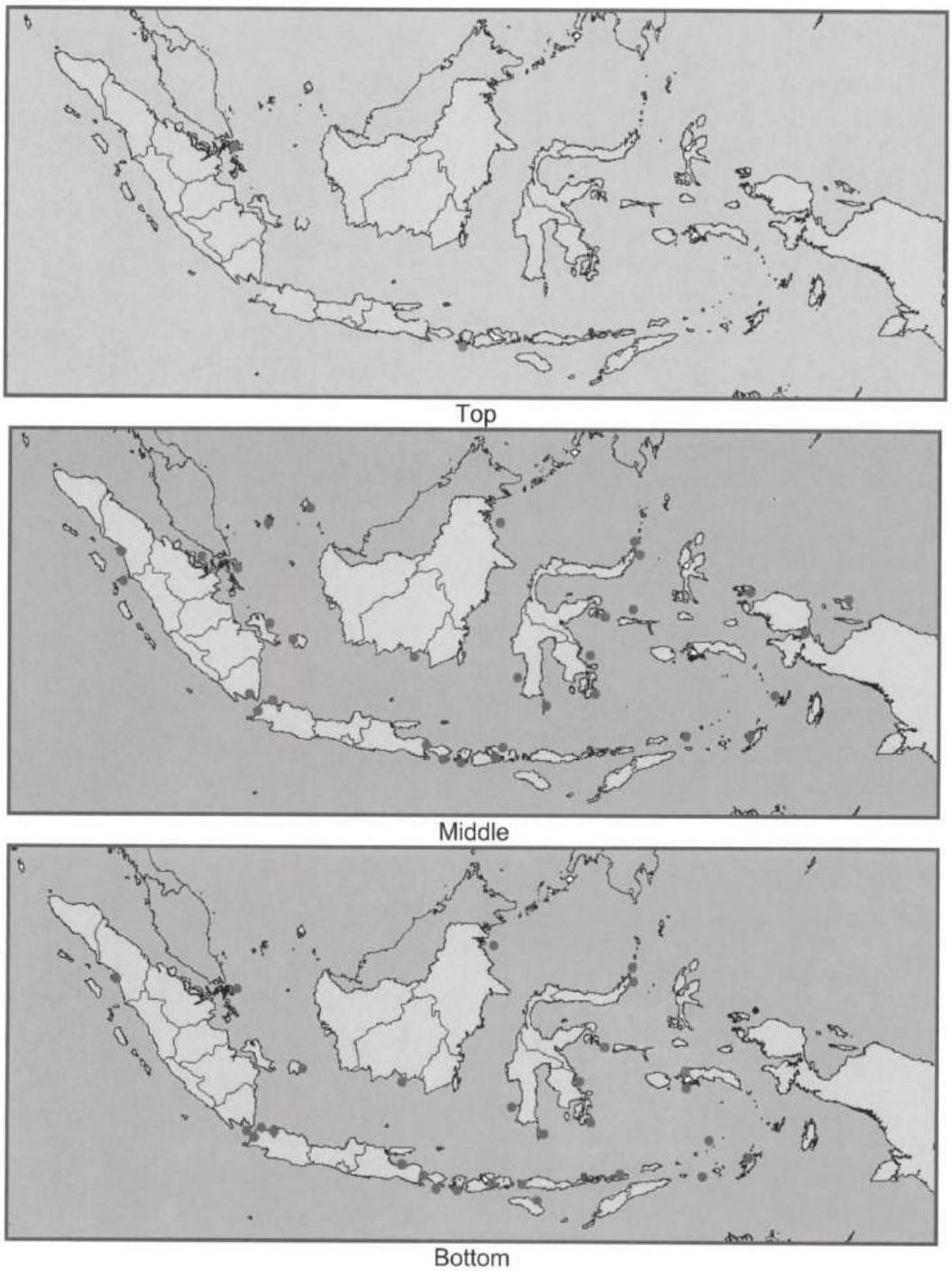

Figure 3 Distribution of *Halophila spinulosa*, *Halodule pinifolia* and *Halodule uninervis*.
- Top : Distribution of *Halophila spinulosa*
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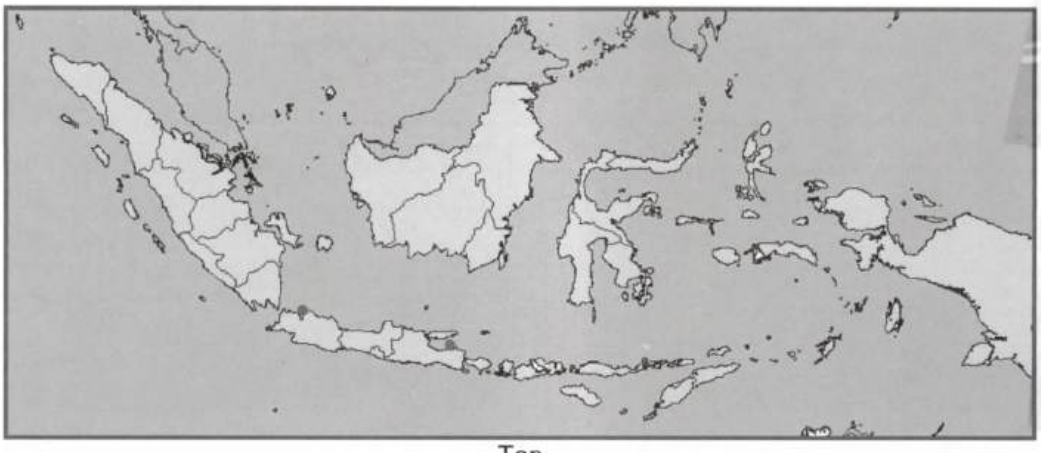

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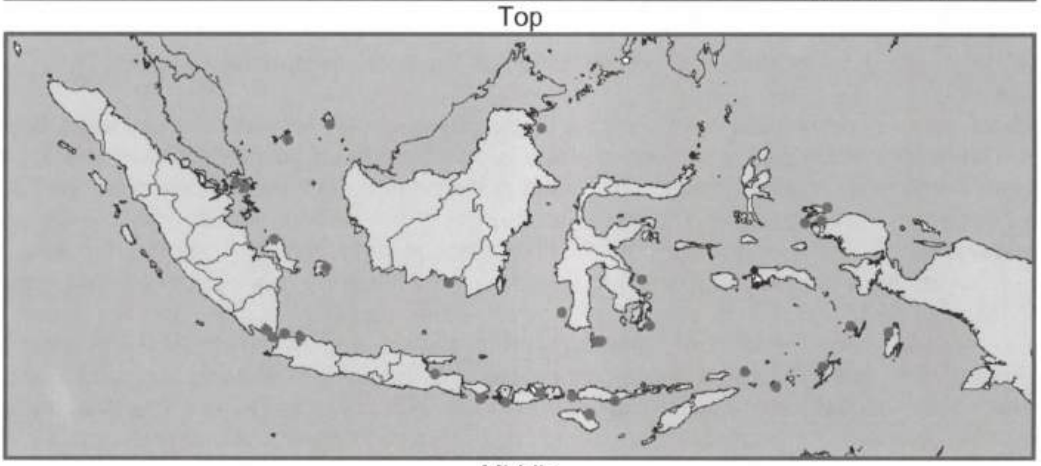

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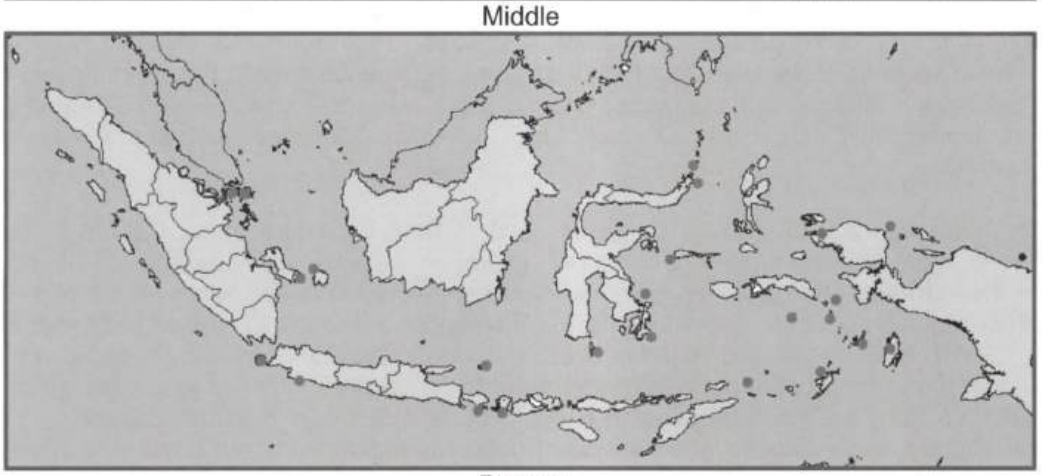

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Figure 4 Distribution of *Ruppia maritima, Syringodium isoetifolium* and *Thalassodendron ciliatum*.
- Top : Distribution of *Ruppia maritima*
- Middle : Distribution of *Syringodium isoetifolium*
- Bottom : Distribution of *Thalassodendron ciliatum*

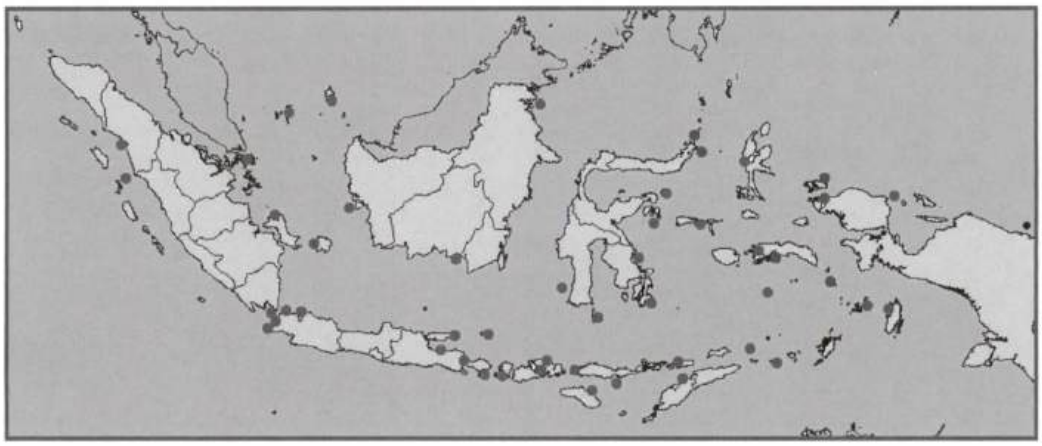

Figure 5 Distribution of *Thalassia hemprichii*.

The intertidal zone is dominated by *Halophila ovalis, Cymodocea rotundata* and *Halodule pinifolia*. However, *Thalassodendron ciliatum* in some areas is dominant in the lower subtidal zone. It can grow in silty sand, medium to coarse grained sand, and coral rubble. The most widespread and dominant species of seagrass in Indonesia is *Thalassia hemprichii*. It can be found on muddy, sandy and coral rubble substrates. It commonly forms both homogenous and mixed vegetations, with vertical distribution ranges from the intertidal down to the lower subtidal zone at a depth of 15m (Tomascik *et al.* 1997; Brouns, 1985). *Enhalus acoroides* is also widely distributed. This species grows well in medium to coarse-grained sediment, although prefers mud and silt sediments. It mostly forms monospecific stands in silty subtidal areas or localities with heavy bioturbation and mixed vegetation. The species shows considerable morphological variations, with the average length and width of leaves generally being greatest in muddy substrate, which has a higher nutrient content (Kiswara, 1994).

Halodule uninervis and *H. pinifolia* are pioneer species. They form monospecific vegetation in disturbed open sections of the inner reef flat, or on steep sediment slopes in the intertidal and subtidal zones. They grow in silty substrate to coarse grained sands. *Halodule uninervis* can be found in mixed vegetation stands with *E. acoroides, C. rotundata, C. serrulata, S. isoetifolium* and *T. hemprichii* on sandy substrate.

Genus *Halophila* has a wide vertical range and occurs from the intertidal zone down to the lower subtidal zone, more than 20m deep. It commonly grows on disturbed sediments, such as mounds of burrowing invertebrates. *Halophila decipiens* is only encountered in deep-water reef based sediments at a depth between 5 and 35m. It forms monospecific meadows or occurs in mixed beds with *H. ovalis* (Kiswara, 1994). *Halophila minor is* found in sheltered or open localities on sandy bottoms in the lower part of eulittoral and the uppermost part of sublittoral to 2m depth. *Halophila spinulosa* grows on the sandy substrate from the intertidal zone to a depth of 10m. It forms both monospecific and mixed vegetation. *Cymodocea* is found in shallow-water habitat (up to 5m depth, but is mainly confined to the upper 2m) on both carbonate and terrigenous sediments ranging from coral rubble, coarse sand to sandy mud. *Cymodocea rotundata* and *C. serrulata* are found both as a monospecific and mixed vegetation, as although mostly as mixed vegetation.

Syringodium isoetifolium is found on muddy and sandy substratum to a maximum depth of 6m. The species does not occur in places which experience long lasting exposure during the low water of a spring tide.

Thalassodendron ciliatum appears to favour coral substrate, where dense stands are found, but also occurs in mixed vegetation (e.g. with *E. acoroides, C. rotundata, C. serrulata, S. isoetifolium* and *T. hemprichii*) on finer carbonate sediments. Until recently (Kiswara, 2002; Hutomo *et al.* 1988), this species was known as a disjunctive species, distributed only in eastern Indonesian waters. However, it was recently found in western Indonesian waters, i.e., Tanjung Bira, southeast of South Sulawesi; Kangean, Riau Archipelago; and Bujur Island, Bangka (Tomascik *et al.* 1997; Kiswara, 1994; Kiswara *et al.* 1997).

2.2 Biomass

Table 1 provides an example of some seagrass biomass values from different parts of the archipelago. It is apparent that there is higher biomass variability between different regions (i.e., Banten Bay and Kuta Bay) than within a particular locality (i.e., Kuta Bay vs. Gerupuk Bay). In general, average biomass in seagrass beds varies from 1g DW.m^{-2} to 2479g DW.m^{-2}.

Table 1 Average biomass of seagrasses (g DW.m^{-2}) at various locations throughout the Indonesian Archipelago (Kiswara, 1994).

Species	Sunda Strait	Banten Bay	Jakarta Bay	Flores Sea	Lombok
Enhalus acoroides	1976	353-560	50-663	155-546	393-2479
Cymodocea rotundata	7-106	139	18-23	34-113	39-243
C. serrulata	48-104	15-35	240	45-174	111
Halophila ovalis	2-4	8	1-8	1-3	4-46
Halodule pinifolia	-	-	-	29-126	47
H. uninervis	10-36	6-80	64	13-516	29-128
Syringodium isoetifolium	74	102-372	25-90	33-127	85-262
Thalassia hemprichii	87-193	120-257	90-278	115-322	53-263
Thalassodendron ciliatum	-	-	-	231-444	-

2.3 Growth and Production

The oxygen (O_2) evolution (i.e., photosynthesis) technique, using "bell jar" enclosures to estimate seagrass primary production rates, was employed in two Indonesian study sites (Erftemeijer, 1993; Lindeboom and Sandee, 1989). The technique relies on Plexiglas enclosures (bell jars) placed over seagrasses, where changes in O_2 concentrations over time are measured under light (i.e., gross photosynthesis) and dark (respiration) conditions. To convert oxygen evolution and consumption to carbon fixed and mineralised, a conversion factor of 0.29 was applied in both studies. Lindeboom and Sandee (1989) demonstrated that gross primary production rates of various seagrass communities in the Flores Sea varied from 1,230mg c.m^{-2}.day^{-1} to 4,700mg c.m^{-2}.day^{-1}, while seagrass respiration consumption rates were between 860mg c.m^{-2}.day^{-1} and 3,900mg c.m^{-2}.day^{-1}. Lindeboom and Sandee (1989) concluded that net primary production rates of seagrass communities in the Flores Sea varied between 60mg c.m^{-2}.day^{-1} to 1,060mg c.m^{-2}.day^{-1}, amounting to a maximum annual net primary production of about 387g c.m^{-2}, assuming the same rates of production throughout the year as during the study period (October). Table 2 shows the average shoot density of seagrass in various locations in Indonesia and Table 3 provides detail average shoot density of mixed and monospecific seagrass.

Table 2 Average shoot density of seagrass (shoots.m^{-2}) in various locations throughout the Indonesian Archipelago.

Species	Sunda Strait	Banten Bay	Jakarta Bay	Flores Sea	Lombok
Enhalus acoroides	160	40-80	6-96	60-146	50-90
Cymodocea rotundata	38-756	690	26-1136	220-1800	253-1400
C. serrulata	48-1120	60-190	1056	115-1600	362
Halophila ovalis	15-240	820	18-115	100-2160	400-1855
Halodule pinifolia	-	-	-	430-2260	7120
H. uninervis	10-335	40-1160	604	360-5600	160-180
Syringodium isoetifolium	630	124-3920	144-536	360-3740	1160-2520
Thalassia hemprichii	30-315	220-464	68-560	160-1820	200-865
Thalassodendron ciliatum	-	-	-	400-840	-

Table 3 Average shoot density of mixed and monospecific seagrass meadows in the Flores Sea. In all sampling locations foliage cover is >70%, except for *Thalassodendron ciliatum* (>50%).

Species	Mixed Seagrass Meadow (No. of shoots.m^{-2})	Monospecific Seagrass Meadow (No. of shoots.m^{-2})
Enhalus acoroides	54	136
Halophila ovalis	69	-
Thalassia hemprichii	754	1,459
Cymodocea rotundata	324	-
C. serrulata	696	533
Halodule uninervis	2,847	14,762
Syringodium isoetifolium	2,504	-
Thalassodendron ciliatum	-	692

In contrast, the net primary production attributed to epiphytes alone accounts for a maximum annual net primary production of about 84mg c.m^{-2} of leaf surface area (Lindeboom and Sandee 1989). Thus, epiphytes contribute up to 36% to net primary production rates in seagrass communities. Surprisingly, maximum annual net primary production rates of organic carbon on barren sediments were up to 65.7mg c.m^{-2}, which is very close to the net primary production rates of most seagrass communities.

Table 4 summarises the known growth rates of seagrass species from various locations in the archipelago.

Table 4 Average growth rate (mm.day^{-1}) of seagrass leaves using leaf-marking techniques. Production rates in parentheses (g DW.m^{-2}.day^{-1}).

Species	West Java Sea	Spermonde Archipelago	Lombok	Flores Sea
Enhalus acoroides	7.3 (3.6)	2.4 (2.3*)	6.5 (1.5)	-
Cymodocea rotundata	-	-	5.5 (6.8)	-
C. serrulata	5.0 (0.6)	-	-	-
Syringodium isoetifolium	4.1 (6.8)	-	-	-
Thalassia hemprichii	4.9 (1.5)	1.6 (3.5*)	3.8 (8.1)	-
Thalassodendron ciliatum				2.7 (4.7)

*in mg AFDW.m^{-2}.day^{-1}

2.4 Associated Fauna

2.4.1 Molluscs

Molluscs are among the best-known groups of seagrass-associated invertebrates in Indonesia, and are perhaps the most over exploited. Mudjiono *et al.* (1992) recorded 15 species of molluscs (i.e., 11 gastropods and four bivalves) from the seagrass meadows in Banten Bay, West Java. In total, seven gastropod families (i.e., Trochidae, Cerithiidae, Strombidae, Muricidae, Columbellidae, Nassariidae and Fasciolariidae) and three bivalve families (i.e., Arcidae, Veneridae and Mactridae) were present in all associations (Mudjiono *et al.*1992). Unfortunately, nothing of ecological significance can be learned from the abundance records, since the entire bay is heavily exploited, and three study locations are located within a short distance of a large village in Pulau Panjang. Only two gastropods were common to all locations, namely *Pyrene versicolor* and *Cerithium tenellum*. Note that the data presented by Mudjiono *et al.* (1992) are indicative of overexploitation of seagrass resources (e.g., only four juvenile, 3 to 5mm diametre, *Trochus niloticus* were collected) and the effects of pollution (i.e., siltation).

Fifteen species of molluscs were recorded in Banten Bay seagrass meadow with two dominant species i.e. *Pyrene versicolor* and *Cerithium tenellum*. The juvenile stage of economically important species, *Trochus niloticus*, was also recorded. An inventory of seagrass molluscs in Kotania Bay was done by Cappenberg (1995). Among the gastropods, several species are economically important, namely those belonging to the families Bullidae, Conidae, Castellariidae, Cypraeidae, Olividae, Pyrenidae, Strombidae, Trochidae and Volutidae. Whereas, Arcidae, Cardiidae, Glycymeridae, Isognomonidae, Lucinidae, Mesodesmatidae, Mytilidae, Pinnidae, Pteridae, Tellinidae and Veneridae represent the families of bivalves that have economic value. It is worth noting that most bivalves are widely distributed in Indonesian waters, e.g., *Pyrene versicolor, Strombus urceus, Tectus fenestratus, Cymbiola vespertili, Anadara scapha, Trachycardium* sp., *Anodontia* sp., *Codakia tigerina, Tellina* sp. and *Pitar manilae*.

A total of 70 mollusc species were recorded from the seagrass beds, many of which are economically valuable. Among the more abundant gastropods were *Pyrene versicolor, Strombus labiatus, S. luhuanus* and *Cymbiola verspertilio*. Common bivalves were *Anadara scapha, Trachycardium flavum, T. subrugosum, Peryglypta crispata, Mactra* spp. and *Pinna bicolour* (Tas'an and Kusumo, 1979). In addition, a number of *Conus* species and some other economically important shells were also found.

2.4.2 *Crustaceans*

Seagrass-associated crustaceans are a key component of the seagrass food web. The infaunal and epifaunal crustacean form an important link between the primary producers and higher trophic levels, since during their juvenile and adult lives they are a major food source for a variety of seagrass-associated fish and invertebrates. Recent stomach analyses of seagrass-associated fish fauna on the south coast of Lombok (Peristiwady, 1994b) demonstrated that crustacean (mysids) are the dominant food source.

Aswandy and Hutomo (1988) recorded 28 species of crustaceans in the seagrass beds of Banten Bay. Two species of Amphipods, namely *Apseudeus chilchensis* and *Weriopisa elongata*, were the most abundant crustaceans in *Enhalus acoroides* meadow in Grenyang Bay. Until recently, little quantitative work has been conducted on seagrass-associated crustacean fauna. Moosa and Aswandy (1994) have compiled a comprehensive species list for seagrass meadows in Kuta and Gerupuk Bays on the south coast of Lombok. A list of 70 crustacean species was produced from both bays. However, many specimens were apparently collected from coral rubble areas adjacent to the seagrass meadows, and whether they were in fact seagrass-associated remains doubtful. Table 5 provides summary of the Indonesian seagrass associated flora and fauna.

Table 5 Summary of the Indonesian seagrass associated flora and fauna.

Taxon	Banten Bay	Jakarta Bay	Lombok	Ambon Bay	Kotania Bay	South Sulawesi
Algae	-	-	37	-	34	117
Meiofauna	-	-	6 groups	-	-	-
Molluscs	15	-	55	-	143	-
Crustaceans	28	32	70	-	30 (hermit crabs)	-
Echinoderms	3	-	45	-	-	10
Fishes	180	78	85	168	205	-
Fish larvae	-	-	53	-	-	-

2.4.3 *Echinoderm*

Information on echinoderms in seagrass beds was obtained from Lombok Island by Aziz and Soegiarto (1994). The most significant species was a sea star, *Protoreaster nodosus,* which feed on detritus and film surface of broken seagrass leaves (Yamaguchi, 1995). The population of sea cucumber has rapidly declined due to intensive use by local people. The common seagrass leaf grazing sea urchin, *Tripneustes gratilla,* was also found and its population likewise declined. A decline in economically important echinoderm also occurred in the seagrass beds of Kotania Bay, Seram Island, Maluku (Wouthuyzen and Saplete, 1994). It is likely that the decline of economically important benthic resources of seagrass beds is a common phenomenon in Indonesia.

Aziz and Soegiarto (1994) recorded 45 echinoderm species in seagrass beds located in Kuta and Gerupuk Bays on the south coast of Lombok. All major groups were present: Echinodea, Holothuridae, Ophiuroidae and Crinoidae. They noted that several economically important holothuroid species (*Holothuria* and *Actinopyga*) and the sea urchin *Tripneustes gratilla* have declined in abundance. Similar depletions in echinoderm populations were reported in Kotania Bay (west Seram Island, Maluku), where seagrass meadows formerly supported a high abundance of economically important holothuroids.

In 1983, the extensive seagrass meadows in Kotania Bay supported a high population density (i.e., 1 to 2 individuals.m^{-2}) of nine economically important sea cucumber species, namely *Bohadschia marmorata, B. argus, Holothuria* (*Metrialyta*) *scabra, H.* (*Microthele*) *nobilis, H. vagabunda, H.* (*Thymiosycia*) *impatiens, H.* (*Halodeima*) *edulis, Thelenota ananas,* and *Actinopyga miliaris.* In a 1993 inventory of the same area, only three sea cucumbers were recorded within a distance of 500m (Suharti, 1999). Average body size of sea cucumbers decreased from ca. 22cm in 1983 to less than 15cm in 1993. The decline of the stock and size are attributed to intensive collection by local people to

supply the lucrative *teripang* (*bêche de mer*) market. Another heavily overexploited echinoderm species that has sharply declined in abundance during the past 10 years is the edible *Tripneustes gratilla*.

2.4.4 Fish

Seagrass beds at Kotania Bay were inhabited by the most diverse fish fauna (205 species) (Peristiwady, 1992). The second most diverse seagrass fish area studied was at Banten Bay (180 species) (Hutomo, 1985). The significant character of seagrass fishes in Banten Bay is the domination of economically important species. In the seagrass beds of Grenyang Bay, 8 out of 10 of the most important species are economically significant and form 63.72% of the total individuals of all species. The earliest study of a seagrass fish community was that conducted in the seagrass of Jakarta Bay by Hutomo and Martosewojo (1977). It was dominated by *Siganus canaliculatus*. The domination of siganid in the Indonesian seagrass fish community is common, except for that of Lombok Island, which is dominated by syngnathid and labrid species *Syngnathoides acoroides* and *Cheilio enermis*.

A study on seagrass fish larvae and juveniles was first conducted by Suharti (1999) in Kuta Bay, Lombok Island. She collected 53 species. Species belonging to the families Channidae, Ambassidae, Engraulidae and Gobiidae dominated the collected specimens. High numbers of species and individuals were found in bare areas with a lot of broken seagrass leaves, and at the *Enhalus acoroides* beds.

Hutomo and Martosewojo (1977) studied fish fauna in *Thalassia hemprichii* and *Enhalus acoroides* seagrass meadows, which were associated with a multi-lagoonal patch reef (Pari Island) in the Kepulauan Seribu complex. A total of 78 seagrass-associated fish species were collected during the study. However, out of the 32 fish families collected, only six (Apogonidae, Atherinidae, Labridae, Gerridae, Siganidae and Monacanthidae) could be considered as an important resident group. Hutomo and Martosewojo (1977) classified the Pari Island's seagrass fish into four main categories as follows:

a. Permanent residents; refers to fishes which spend most of their lives in seagrass beds (e.g., *Apogon margaritophorus*);
b. Temporary residents; refers to fishes which spend their lives during their juvenile through adult life cycle in seagrass beds, but spawn outside the seagrass beds (e.g., *Halichoeres leparensis, Pranaesus duodecimalis, Paramia quinquelineata, Gerres macrosoma, Monacanthus tomentosus, Monacanthus hajam, Hemiglyphidodon plagiometopon, Sygnathoides biaculeatus*);
c. Temporary resident; refers to fishes which occur in seagrass beds only during their juvenile stage (e.g., *Siganus canaliculatus, S. virgatus, S. chrysospilos, Lethrinus* spp., *Scarus* spp., *Abudefduf* spp., *Monacanthus mylii, Mulloides samoensis, Pelates quadrilineatus, Upeneus tragula*);
d. Occasional residents or transients; refers to the fishes that visit seagrass beds to seek shelter or food.

2.4.5 Meiofauna

Susetiono reported on meiofauna associated with monospecific *Enhalus acoroides* seagrass beds in the south coast of Lombok (Hutomo, 1994). The sediment infauna consisted of nematodes, foraminiferans, copepods, ostracods, turbelarians and polychaetes. The high abundance of nematodes (as shown by a high nematode-copepod abundance ratio index) was indicative of nutrient enrichment, which is most likely associated with land run-off. Actively emerging meiofauna observed were copepods, nematodes, amphipods, cumaceans and ostracods. Generic or species level analyses have not been conducted thus far. Based on available information from Kuta Bay, Susetiono (Hutomo, 1994) constructed a simplified food web within the *Enhalus acoroides* seagrass beds.

Benthic foraminiferans are an important component of seagrass communities, but have received only rudimentary attention (Aziz and Soegiarto, 1994). In the Kepulauan Seribu patch reef, seagrass beds were abundant and frequently dominated by *Enhalus acoroides* and *Thalassia hemprichii* (Azkab, 1977). Benthic foraminifera in these associations were dominated by the Suborders Miliolina and Rotaliina (Aziz and Soegiarto, 1994). The miliolinids are characterised by smooth, porcelaneous tests consisting of calcite crystal, while the rotaliinids have glassy, double-walled tests consisting of radial luminated hyaline calcite.

The most abundant rotaliinids were *Ammonia beccarii, A. umbonata, Calcarina calcar, Elpidium advenum, E. crispum, E. craticulatum* and *Rosalina bradyi.* Genus *Ammonia* is a well-known euryhaline group, common in shallow-water tropical environment. The presence of *Calcarina calcar* (Family Calcaridae) is indicative of coral reef habitats.

The abundance of *Elpidium* spp. (Family Elpidiidae) is interesting, since this euryhaline, shallow-water species is extremely tolerant of low salinities, and can be found a long distance up into estuaries (De Longh, 1996). The miliolinids are represented by *Adolesina semistriata, Milionella sublineata, Quinqueloculina granulocostata, Q. parkery, Quinqueloculina* sp., *Spiroloculina communis, Spirolina cilindrica* and *Triloculina tricarinata.* Both genera, *Quinquiloculina* and *Triloculina* (Family Miliolidae), are characteristically shallow water and tropical foraminifera.

2.5 Marine Endangered Species

2.5.1 Dugong

Dugong (*Dugong dugon*) is a herbivorous marine mammal which has become endangered and is protected under decree of the Minister of the Department of Agriculture No. 327/Kpts/Um/1972. It depends as much on the seagrass beds for habitat as it does for feeding, obtaining about 90% of its food from seagrass. Dugong mainly consumes *Halodule pinifolia, H. uninervis, Cymodocea rotundata, C. serrulata, Syringodium isoetifolium, Halophila ovalis, H. spinulosa, Thalassia hemprichii* and *Zostera capricorni.* De Longh (1996) pointed out that dugong like to feed on *Halodule uninervis.* Based on his research it became apparent that there is a correlation between the number of dugongs and food availability. Moreover, the change in seagrass abundance and nutrient quality will influence the movement and mating cycle of the dugong.

Severe hunting pressure has depleted dugong populations throughout the Indo-Pacific region, especially in Southeast Asia (Kiswara, 1994). The remaining groups are scattered over vast areas. Although, the remote Indonesian islands are inhabited by fair numbers of dugong, they are regarded as a rare and endangered species, and protected under Indonesian law. Dugong populations in Indonesia are seriously under threat. The threats are mostly anthropogenic. The results of a study in Ambon and Lease Islands, Maluku, summarised that there were two major threats to dugong populations, (1) capture of dugong in fishing nets, and (2) destruction of major dugong habitats (Kiswara, 1994).

This decline of dugong populations is mostly due to excessive hunting to obtain their meat for food and other parts of their body, such as teeth and skeleton, for other purposes. In Belitung Island and surroundings, for example, dugongs are reported in severe decline because they are frequently caught by local fishers and sold. It is estimated that one dugong per month is usually landed at Manggar or Tanjung Pandan.

2.5.2 Turtle

The two largest herbivorous marine animals that feed on seagrass are the green turtle (*Chelonia mydas*) and dugong. Immature green turtle may feed on algae or seagrass, where the combination and composition of which depends on the growth stage of the turtle. Green turtles appear to graze on algae in some habitats, e.g., coral reef areas, but in inshore bays and estuaries, they graze almost totally on seagrass. In terms of their feeding habits, there is a significant difference between green turtle and dugong. Unlike dugongs, green turtles do not disturb the substrate during feeding and feed principally on young leaves. In some studies, green turtles were found to eat more young leaves than rhizome and old leaves and appear to prefer fresh green seagrass. Seagrass species preferred by green turtle are *Halodule pinifolia, H. uninervis, Cymodocea serrulata, Halodule ovalis, H.spinulosa* and *Zostera capricorni.* A study by COREMAP in Senayang-Lingga reveals that the occurrence of *Halophila ovalis* and *Halodule uninervis* in this area has significant correlation with the nesting sites of turtle.

2.6 Threats to Seagrass

2.6.1 Natural Stresses

Herbivores can account for 10 to 15% of seagrass meadow production while the rest supports the local detritus food web (Hatcher, Johannes and Robertson, 1989). In Indonesia, green sea turtle, dugong and some fish species are known as seagrass feeders. Dugong feeds on intertidal meadows of *Halodule, Halophila* and *Cymodocea* in eastern part of Indonesia where it consumes both leaves

and the root/rhizomes mats (Sloan, 1993). In Papua New Guinea's meadows, Hattori *et al.* (1985) found that grazing sea urchins consumed 1.4 % of daily meadow production.

2.6.2 Human Induced Stresses

In general, there are three types of marine environment degradation in Indonesia which are caused by human activities, i.e.:

- Physical degradation of habitat such as mangrove cutting, coral reef damage and seagrass loss;
- Marine pollution from both land-based as well as marine-based activities;
- Overexploitation of living marine resources such as fish, molluscs, sea cucumbers and other animals.

2.6.3 Causal Chain Analysis of Threats to Seagrass in the South China Sea

To determine the root causes of the degradation, a Causal Chain Analysis was performed involving the following three locations: Riau Archipelago, Batam Island and Natuna Islands.

Riau Archipelago (Annex 1)

There are two sources of threats in the Riau Archipelago: (1) soil/sand mining on land and on sea-beds; and (2) operation of marine resort activities and infrastructure development. The former prevails at Trikora Beach and on the Senayang-Lingga Islands, and the latter at Trikora Beach and on Mapor Island. Below is the status of the threats:

1) **Soil/sand mining on land and on seabed:** This threat exists at Trikora Beach and on Senayang-Lingga Islands. The mining process has caused erosion, sedimentation and siltation, resulting in degradation of coastal habitats, including seagrass beds. Weak law enforcement, improper regulation and uncontrolled mining have augmented the problems. Some factors responsible for the situation include strong demand for filling materials, involvement of executive and legislative officers in the mining business, lack of public awareness, and lack of community support. All of these prove to have significant socio-economic impacts, in the form of decreased fisheries productivity, local community income, aesthetic value and devalued tourism industries.
2) **Operation of marine resort activities and infrastructure development:** This type of threat exists at Trikora Beach and Mapor Island. Effluent from these activities causes eutrophication from increased organic pollution. Untreated domestic waste and inappropriate civil works have significantly contributed to this distressing situation. Algal blooms triggered by nutrient accumulation causes high water turbidity, which inhibits seagrass growth. The root causes of these problems are lack of regulations and guidelines for environmentally friendly tours and civil works, lack of public awareness and weak law enforcement. From a socio-economic stand point, this decreases fisheries production, aesthetic value, and income from tourism.

Batam Island (Annex 2)

There are two main threats to seagrass in Batam Island: (1) coastal development and sea transportation; and (2) tourism and recreation activities. The following is a brief description of each threat:

1) **Coastal development and sea transportation:** The side effects of these activities on Batam Island include increased erosion, sedimentation and water turbidity. Also increased marine pollution, suspended solids and a loss of aesthetic value. Together it means habitat/seagrass degradation and loss. Factors influencing the situation include improper civil works and inappropriate coastal land spatial planning. Significant contributions to the problem include improper regulation, weak law enforcement and less coordination among stakeholders. The root causes of the problems are poor awareness of environmental protection, inability of scientists to provide information on the economic value of seagrass, and inadequate capability to develop coastal management plans. Socio-economically, the threat causes some negative impacts, i.e., diminished fisheries landings, declining fisher income, and lower income from tourism.
2) **Tourism and recreation activities:** On Batam Island, tourism and recreation activities have caused some negative impacts, such as coastal pollution, eutrophication, increased water turbidity, uprooted seagrass, and solid waste accumulation on the beach. The combined effect will be seagrass degradation and loss. Improper regulation, no speed limit for recreational

boats, and the littering of beaches are among the influencing factors. Meanwhile, poor understanding of the value of coastal ecosystems and weak enforcement of regulations exacerbate the problem. The root causes are low awareness, failure of academics to provide information on the value of seagrass, and lack of coordination among major stakeholders. The socio-economic impacts of this threat include decreased income from tourism, decreased fisheries landings, and lower fisher incomes.

Natuna Islands (Annex 3)

Destructive fishing and mangrove cutting: The notorious threats to the seagrass of the Natuna Islands are destructive fishing techniques and mangrove cutting. Fishing with explosives and poisons is causing damage to surrounding reefs. Damaged coral reef has a diminished ability to provide protection for inshore waters from open ocean areas, and this will likely impact on nearby seagrass communities. Similarly, mangrove cutting impairs the function of mangroves against erosion and as a sediment trap. It disturbs the well-being of the neighbouring seagrass bed and may even lead to seagrass degradation and loss. Weak law enforcement, limited alternative livelihood options and ineffective management measures have been the cause of this situation. This is augmented by a lack of monitoring and control of mangrove resources in remote areas, and a lack of understanding of the value and functions of mangroves. The root causes of these problems are a lack of personnel, lack of awareness, and inadequate community empowerment. The combined socio-economic effects are lower fish catches and incomes for fishers.

3. ECONOMIC VALUATION

Scientists have mentioned several uses of seagrass, both direct and indirect. Direct uses of seagrasses, mostly in terms of fish resources that depend on them, have been identified. However, there is no evidence of indirect uses, such as sediment traps and substrate stabilisers, or connectivity with other ecosystems. The following is the analysis of the economic valuation of Indonesian seagrass, based on their identified direct uses. The authors followed the approach agreed by the Economic Valuation Task Force of the UNEP/GEF-SCS Project.

***Syringodium isoetifolium* as dugong feed:** Dugongs are kept at several institutions, such as Gelanggang Samudera Jaya Ancol, Jakarta (Ancol Oceanarium), Kebun Binatang Surabaya (Surabaya Zoo Garden) and the Seaworld Aquarium Indonesia, Jakarta (SWIJ). These captive dugongs are fed 30 to 40kg of wet *S. isoetifolium* per individual per day (Tas'an, 1976). In Surabaya Zoo, they are also fed *S. isoetifolium* mixed with *Halophila ovalis, Cymodocea rotundata,* and *Thalassia hemprichii* (De Longh and Bauer, 1996). According to Tjhin (2001), each individual dugong consumes 18 to 20kg wet weight of *S. isoetifolium* per day.

The SWIJ purchases *S. isoetifolium* from fishers in Banten Bay, West Java at Rp.2,800/kg wet weight (Sumitro 2003, personal communication), requiring daily expenditure of Rp.55,000/day to feed the captive dugong. Based on the results of several studies (Azkab and Kisawar, 1994; Brouns 1987; Aioi and Pollard, 1987) on *S. isoetifolium* leaf production in Indonesia, mainly at Kuta and Gerupuk Bay, Lombok, monospecific *Syringodium* beds produce 68.36g wet weight leaves/day/m^2. While in mixed seagrass beds, *Syringodium* produced 9.1g wet weight leaves/day/m^2. From the above Syringodium production data, the economic value of seagrass, particularly *S. isoetifolium,* as feed for captive dugong is Rp.191/day/m^2 or Rp.1,910,000/day/ha for monospecific beds, and Rp.25/day/m^2 or Rp.250,000/day/ha for mixed seagrass beds. The annual economic values of *Syringodium isoetifolium* as dugong feed are Rp.695,150,000/year/ha for a monospecific bed and Rp.96,750,000/year/ha for a mixed bed.

Seagrass as animal feed: In the dry season, particularly from Kuta Bay to the east of Awang Bay, Lombok Island, the local people have difficulty in obtaining fresh grass to feed their cattle and other stock, particularly goats and sheep. As an alternative feed, they feed their cattle seagrass, (particularly *Enhalus acoroides* and *Thalassia hemprichii*. They collect the seagrass during low tide. One goat needs a basket of seagrass for food per day, weighing approximately 15kg (wet weight). Since they harvest the seagrass directly, it is difficult to valuate. Maybe the value is similar to the value of land grass i.e. Rp.2,000/basket. Data from several studies of seagrass production in Indonesia (Azkab, 1988a; Azkab, 1988b; Moro, 1988; Azkab and Kisawar, 1994) gave average values of 4g DW/day/m^2 or 40kg DW/day/ha. Average ratio wet weight: dry weight is 7:1. The annual production, therefore, is 14,600kg DW/ha/year or 102,200kg WW/ha/year, and this means that economic value of seagrass as animal feed is 102,200 x Rp.2,000/15 = Rp.13,626,667/year/ha.

***Enhalus acoroides* fruit as food for fishers:** Fishers commonly eat *Enhalus* fruit for breakfast, particularly in areas of Seribu Island and the eastern part of Indonesia. They cook the fruit and mix it with ground coconut. Fishers typically consume 10 fruits for breakfast, costing Rp.500. There are two fruiting seasons per year, each lasting for one month. A stand of *Enhalus* produces 2 fruits. The average density of *Enhalus acoroides* per one m^2 is 20 stands. Thus the value of seagrass in terms of *Enhalus* fruit as human food is (20 x 2/10) x Rp.500 = Rp.2,000/m^2/season or Rp.20,000,000/ha/season (2 months).

Seagrass as raw material for handicrafts: There is information that in some places in Indonesia, particularly Bali, leaves of seagrass *Enhalus acoroides* and *Thalassia hemprichii* are used as raw materials for making handicraft products such as handbags, chairs and baskets. The leaves are processed, including removal of attached organisms, drying and dyeing. Data on the price of seagrass as a raw material for making these products is still required in order to calculate the monetary value of this use.

Seagrass beds as fisheries resources: The data presented here was collected by Ms. Nuraini (Marine Fisheries Research Institute) for seagrass beds in Banten Bay, West Java, and is used with her permission. It was generated by interviews and visual observations. There are about 50 fishers operating several kinds of fishing gears in seagrass areas dominated by *Enhalus acoroides* and *Thalassia hemprichii* and covering an area of 330ha. This table shows the economic value of the Banten Bay seagrass bed in terms of fisheries resources at Rp.555,640,000 per year or Rp.1,683,758/year/ha.

Seagrass ornamental snail as a raw material for handicrafts: Collection of the "ornamental snail" *Pyrene versicolor* occurs in *Enhalus acoroides* beds (120ha) at Kepuh Island, Banten Bay. The snails are used for decorating curtains, lampshades and picture frames. Ten fishers are involved in the fishery on a full-time basis. Density of snail population and shoots of seagrass in a $1m^2$ metal frame were counted. The sampling plots of 1 m^2 metal frame were placed in areas of different seagrass densities, i.e., less, medium and high densities with 10 replications. Mean densities of *Enhalus* at different beds are 38.2 (sd:+/- 7.32) shoots/m^2 at the less dense bed, 59.80 (sd:+/- 7.32) shoots/m^2 at the medium density bed, and 100.8 (sd:+/-15.39) shoots/m^2 at the high density bed.

Fishers advise that they can collect at least 20cans/day/fisher and can sell each can for Rp.1,000. Thus, each fisher can earn 20 x Rp.1,000 = Rp.20,000 per day for an annual income of 365 x Rp.20,000 = Rp.7,300,000. There are 10 fishers, thus the annual value of the Kepuh Island seagrass bed in terms of its ornamental snail is 10 x Rp.7,300,000 = Rp.73,000,000. Thus the economic value of the seagrass bed in term of production of its ornamental snail is Rp.73,000,000: 120 = Rp.683,300/ha/year.

4. LEGAL ASPECTS AND INSTITUTIONAL ARRANGEMENTS[2]

4.1 Legal Aspects

Marine resource management and marine exploitation in Indonesia is managed by a very extensive, complex policy and regulatory framework. The foundation for this is laid out in Section 33, Para 3 of the 1945 Constitution which reads: "land and water and natural resources therein shall be controlled by the State and shall be utilised for the greatest benefit of or welfare of the people."

There is no one Indonesian law or regulation that specifically addresses the use and management of seagrass and coastal resources. Conservation and management of seagrass resources are regulated by a group of natural resource laws and regulations which are implemented in a sectoral manner.

More than a dozen parliamentary laws and hundreds of regulations and ministerial decrees relate to the management of coastal resources. However, only sixteen laws on natural resources management relate to coastal and coral reef management (Dirhamsyah 2005). These include fourteen laws on natural resources management and ocean activities, and two laws for the ratification of international conventions. Those laws are listed in Table 6 where the fourteen national laws are grouped into six broad categories.

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[2] *Most information in this section is cited from Dirhamsyah (2005) Critical Review of Institutional Arrangements for Coastal and Coral Reef Management in Indonesia. In Maritime Studies Journal (forthcoming); Dirhamsyah (2005) Indonesian Legislative Framework for Coastal and Coral Reef Resources Management: A Critical Review and Recommendation. In Ocean and Coastal Management Journal (forthcoming).*

Table 6 Legislations affecting seagrass management and marine resources management.

No.	Regulations	Subject
I	**International Level**	
1	Act No.17/1985	Ratification of United Nations Convention on the Law of the Sea
2	Act No. 5/1994	Ratification of United Nations Convention on Biological Diversity
II	**National Level**	
A	**Ocean Jurisdiction Claims**	
1	Act No. 6/1996	Indonesian Waters
2	Act No. 5/1983	Indonesian Exclusive Economic Zone
3	Act No. 1/1973	Indonesian Continental Shelf
B	**Ocean Resources and Activities on the Sea**	
4	Act No. 21/1992	Shipping
5	Act No. 11/1967	Basic Provisions for Mining
C	**Terrestrial Spatial and General Planning Laws**	
6	Act No. 24/1992	Spatial Use Management
7	Act No. 9/1990	Tourism
D	**Coastal and Marine Resources Management**	
8	Act No. 31/2004	Fisheries
9	Act No. 41/1999	Forestry
10	Act No. 16/1992	Quarantine of Agriculture, Cattle, and Fish
E	**General Legislation of Environmental Management**	
11	Act No. 23/1997	Environmental Management
12	Act No. 5/1990	Conservation of Biological Resources and Their Ecosystems
F	**Legislation of Decentralisation**	
13	Act No. 32/2004	Regional Government
14	Act No. 33/2004	Financial Distribution between Central and Regional Government

4.2 Institutional Arrangements

There is no doubt that institutions are important for the management of coastal and ocean activities. In the case of resource management, institutions are created by the government in order to allocate scarce resources and to resolve conflicts among resource users. Thus, the performance of institutions determines the success or failure of the management of coastal and marine activities.

Coastal and ocean resources governance in Indonesia is the primary responsibility of the state. At the national level, the authority for coastal and ocean resources management is under the responsibility of state ministries. However, this responsibility is shared among various agencies. Table 7 shows the institutional arrangements for coastal management in Indonesia.

Table 7 Institutional arrangements for coastal management in Indonesia.

Government Agencies	Major Duties and Functions in Coastal Management	Relevant Regulations
Line Agencies		
Ministry of Marine Affairs and Fisheries (MOMAF)	Responsible for overall coastal and marine resources management, from policy development to control of implementation of the policy.	1. Act No. 9 of 1985 2. Presidential Decree No. 102 of 2002
Ministry of Forestry (MOF)	To manage and control forestry resources, including mangroves. Through the Directorate General of Forest Protection and Nature Conservation, this department also has responsibility for managing the trade and conservation of endangered plant and animal species, and marine parks and reserve areas.	3. Act No. 41 of 1999 4. Act No. 5 of 1990 5. Act No. 5 of 1994 6. Government Regulation No. 68 of 1998 7. Presidential Decree No. 43 of 1978 8. Presidential Decree No. 102 of 2002
Line Agencies		
Ministry of Energy and Mineral Resources (MOEMR)	To regulate mining exploitation activities in all Indonesian territory, including coastal areas. To prevent negative impacts of mining activities on marine and coastal ecosystems.	9. Act No. 11 of 1967 10. Act No. 22 of 2001 11. Govt. Regulation No. 17 of 1974 12. Presidential Decree No. 102 of 2002
Ministry of Home Affairs and Regional Autonomy (MOHARA)	To coordinate national and regional policies and programmes, including spatial planning. Through Directorate General of Regional Development, this ministry also has responsibility for supervising the regional government agencies.	13. Act No. 22 of 1999 14. Act No. 24 of 1992 15. Presidential Decree No. 102 of 2002
Ministry of Transportation and Communication (MOTC)	To reduce and prevent pollution from ship operations. To supervise the development of ports, harbours, and navigational aids and safety.	16. Act No. 21 of 1992 17. Presidential Decree No. 102 of 2002
Ministry of National Education (MONE)	To manage national educational systems, through its universities, and responsibility for conducting research in marine science.	18. Act No. 20 of 2003 19. Presidential Decree No. 102 of 2002

Table 7 *cont.* Institutional arrangements for coastal management in Indonesia.

Government Agencies	Major Duties and Functions in Coastal Management	Relevant Regulations
Ministry of Resettlement and Regional Infrastructure (MORRI)	To establish national policy for water resources. To develop national spatial planning. To coordinate and implement coastal engineering, coastal erosion and coastal infrastructures.	20. Act No. 24 of 1992 21. Presidential Decree No. 102 of 2002
Ministry of Defense and Security (MODS)	To conduct national and regional security and defense, including in coastal and marine areas. To conduct hydrographic surveys and mapping.	22. Act No. 20 of 1982 23. Act No. 9 of 1985 24. Act No. 8 of 1981 25. Act No. 6 of 1996 ▪ Act No. 5 of 1983 ▪ Presidential Decree No. 102 of 2002
Ministry of Trade and Industry (MOTI)	To regulate industrial development in coastal areas. To administer trade activities of coastal and marine resources, including the trade of endangered species and sea-sand mining.	26. Act No. 5 of 1984 27. Presidential Decree No. 33 of 2002 28. Presidential Decree No. 102 of 2002
Coordinating Ministries or Agencies		
Coordinating Ministry for Economic (MENKO EKU)	To coordinate and synchronise economic policy that relates to ocean and coastal activities.	29. Presidential Decree No. 100 of 2001
State Ministry for Environment (KLH)	To develop national policy for the living environment. To establish national guidelines for the management and conservation of all natural resources.	30. Act No. 23 of 1997 31. Presidential Decree No. 101 of 2001
State Ministry for Cultural and Tourism (SMCT)	To develop and establish national policy for culture and tourism. To encourage community involvement in eco-tourism industries. To protect natural ecosystems, including coral reefs.	32. Act No. 9 of 1990 33. Presidential Decree No. 101 of 2001
State Ministry for Research, Science and Technology (SMRST)	To develop and establish government policy on research, science and technology activities, including marine science and technology.	34. Presidential Decree No. 101 of 2001
Non-Department Government Agencies		
National Development Planning Agency (BAPPENAS)	To develop and establish national development planning. To coordinate sectoral and regional development planning and institutional control for international projects.	35. Presidential Decree No. 103 of 2001
Indonesian Institute of Sciences (LIPI)	To establish national guidelines for basic scientific studies. Through the Research Centre for Oceanography, this institute plays an important role in coral reef management in Indonesia. LIPI also is a scientific authority for biodiversity management.	36. Presidential Decree No. 103 of 2001
National Coordinating Agency for Survey and Mapping (BAKOSURTANAL)	To establish national guidelines for surveys and mapping. To conduct surveys and mapping in all areas, including coastal areas.	37. Act No. 24 of 1992 38. Presidential Decree No. 103 of 2001
Board of Implementation and Assessment of Technology (BPPT)	To review and establish national policy for the application of technology. To carry the research on technology development related to natural and energy resources.	39. Presidential Decree No. 103 of 2001
Permanent Inter-ministerial Council		
Indonesian Maritime Council (DMI)	To establish general national policy for the maritime sector.	• Presidential Decree No. 161 of 1999

4.3 Problems Associated with Laws and Regulations

A. Lack of detailed information and clarity

Conflicts often arise within Indonesian laws because most of them are vague and broad. Sometimes conflicts arise within a single law or with the regulation made under the law. Inconsistencies in the Fisheries Act have also resulted in confused fisheries management at the local level.

B. Conflict in the use of terms "conservation area" or "protected area"

Many natural resource management laws use the term "conservation area" or "protected area", but they have a different meaning under different laws, thus giving rise to different interpretations[3]. This raises conflicts amongst those laws.

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[3] *There are four laws that specifically establish protected areas. These are:*
- *Article 7 of Act No. 31 of 2004 establishes protected areas relating to fisheries;*
- *Articles 14 and 29 of Act No. 5 of 1990 establishes protected areas relating to conservation;*
- *Article 7 of Act No. 24 of 1992 establishes protected areas relating to spatial use planning; and*
- *Article 7 of Act No. 41 of 1999 establishes protected areas relating to forestry.*

C. Conflict in the meaning of "conservation"

Almost all sectoral and general laws on natural resources management have a definition of the term "conservation"[4]; however, different acts have different meanings and scope for the term.

D. Conflict in the scope of definitions of marine species

Broader definitions of terms for some species also exist in other natural resource management laws.

E. Conflict in the penalties and liability

Differences in standards of enforcement also occur among the natural resource management laws. Most sectoral laws establish sanctions and liability for similar offences but sanctions for similar violations vary widely.

F. A short-cut approach for conflict resolution

Most conflicts among the natural resource management laws cannot be resolved through the judicial process. In Indonesia most conflicts are resolved through the issuance of a presidential decree or ministerial decree. A process that further complicates clarity of the law is that some decrees actually contradict the very laws they are mandated to support.

G. Conflict of jurisdiction among the national laws

Enactment of the Regional Government Act (Autonomy Law) has highlighted the need to revise several laws that relate to resource management at the regional level.

H. Gaps in local legal framework for coastal and seagrass management

Originally, some national legal instruments provided the authority to regional governments to enact local regulations for managing their coastal and marine resources. The absence of local regulations for coastal and marine spatial planning has resulted in unclear jurisdiction over fishing and conservation areas. This has led to conflict between resource users from local coastal communities and intruders from other outside areas. All three districts had, and still have, this problem.

4.4 Specific Issues of Institutional Arrangements of Coastal Management in Indonesia

4.4.1 Overlapping Jurisdictions of Government Agencies

The establishment of the Ministry of Marine Affairs and Fisheries (MOMAF) was originally expected to address the problems of coordination in the implementation of coastal and ocean management in Indonesia. This ministry was mandated as the coordinator of several government agencies for coastal management. Table 8 provides other examples of functional overlaps among Indonesia's government agencies in coastal and marine resources management.

Table 8 Functional Overlaps between Agencies Involved in Coastal and Marine Resources Management in Indonesia.

Coastal Resource Management Activities		Agencies Involved
1	National Policy Formulation on:	
	- Exploitation, Exploration, Conservation, incl. mining	MOMAF, MOEMR, MOF
	- Research, including marine science	SMRST
	- Pollution, including marine waters	KLH, MOCT
	- Marine Transportation	MOCT
	- General Development Planning	BAPPENAS, DMI
2	Research and Resources Assessment	MOMAF, LIPI, BPPT, University
3	Exploitation, Exploration, Conservation Management:	
	- Regency waters	District Unit (DU)

[4] *The terms "conservation" has been defined in several laws, including:*
- *Article 1.15 of Act No. 23 of 1997;*
- *Article 1.2 of Act No. 5 of 1990;*
- *Article 1 of Act No. 41 of 1999; and*
- *Article 1 of Act No. 31 of 2004.*

Table 8 *cont.* Functional Overlaps between Agencies Involved in Coastal and Marine Resources Management in Indonesia.

Coastal Resource Management Activities		Agencies Involved
	- Provincial waters	Provincial Unit (PU)
	- Outside 12 nautical miles, EEZ, and Seabed	MOMAF, MOEMR, KLH
4	Conservation Management	
	- Establishment of Marine Protected Areas	MOF, MOMAF
	- Trade of Endangered Species, incl. marine plant and biota	MOF, MOTI, LIPI
	- Fisheries, Wild Animal and Plant Quarantine	MOMAF, MOF
5	Spatial Planning, include marine waters	
	- National Spatial Planning	MOHARA, MOMAF, MOF, KLH, MORRI, BAKOSURTANAL
	- Provincial Spatial Planning	PU
	- Regency Spatial Planning	DU
6	Pollution Monitoring, include marine waters	KLH, DU, PU, MOCT
7	Law enforcement activities	POLRI, Navy, MOMAF, MOF, KLH, MTOC, DU, PU.
8	Tourism Management	DU, PU, SMCT
9	Reclamation	DU, PU, MOMAF, MOF, MOTC, KLH
10	Maritime Transportation and Port Development	MOTC

Note:
Acronyms:
DU: District Unit; PU: Provincial Unit; MOMAF: Ministry of Marine Affairs and Fisheries; MOF: Ministry of Forestry; KLH: State Ministry for Environment; MOEMR: Ministry of Energy and Mineral Resources; MOHARA: Ministry of Home Affairs and Regional Autonomy; MOTI: Ministry of Trade and Industry; MOTC: Ministry of Transportation and Communication; MORRI: Ministry of Resettlement and Regional Infrastructure; SMRST: State Ministry for Research, Science and Technology; SMCT: State Ministry for Cultural and Tourism; BAPPENAS: National Development Planning Agency; LIPI: Indonesian Institute of Sciences; BPPT: Board of Implementation and Assessment of Technology; BAKOSURTANAL: National Coordinating Agency for Survey and Mapping; DMI: Indonesian Maritime Council.

4.4.2 Lack of Management Capacity for Implementation

The lack of professional personnel is a critical problem in the development of institutional arrangements for managing coastal and marine resources in Indonesia. This occurs at all government levels, from the national to the regional, and extends to the scientists.

Despite national investment in developing institutional and professional capacity for the marine sector, there is a scarcity of professional staff in the scientific research and educational sectors. Many universities and research centers are still lacking scientists and lecturers. Since the economic crisis in 1998, the Indonesian economy has not fully recovered.

4.4.3 Lack of Political Will for Implementation

Another crucial problem in developing institutional arrangements for coastal management in Indonesia is the lack of political will and commitment of Indonesian politicians for conservation and environment issues. Although discussions about marine and coastal issues have taken place over more than ten years throughout the central line agencies, the positive impact of these discussions is very limited.

4.5 Possible Solution and Policy Implications

4.5.1 Legal Framework

A. Amendment of existing legislation

The need to recognise the *adat* law in all natural resources management laws and in national policy is urgent. One of the central concerns is the lack of recognition of community rights in the management of coastal and marine resources. Initial efforts were made to recognise the *adat* law through amendment of the Basic Constitution of Indonesia[5]; but, this amendment has not been followed through with subsequent amendment of existing laws and regulations.

Recognition of traditional resource rights for local communities would have a significant positive impact on their welfare and increase the potential for improving the natural ecosystems. The government and private sectors have now recognised the commercial potential of biodiversity resources especially the use of traditional knowledge. This recognition is also in line with the Convention on Biological Diversity (CBD), which states that there is a close relation between the indigenous people and the conservation

[5] *Through the amendment of Article 18 of the Constitution of 1945 in 2000 (Amendment no. 2 of 2000), the traditional community rights have formally been recognised in the Indonesia's legal systems.*

of their natural resources. The Act which need to be amended to recognise traditional resource rights, include the Fisheries Act No. 31 of 2004, the Forestry Act No. 41 of 1999, the Spatial Use Management Act No. 24 of 1992, and the Tourism Act No. 9 of 1990.

B. Development of a new, integrated law for managing natural resources

Another option worth considering is to enact a natural resource management Act. It can be argued that the increasing conflicts among coastal and marine resources users in Indonesia is due in to part the absence of a single, integrated natural resources management Act that addresses a broad range of issues including small island and coastal management. The benefits of such an Integrated Act would include:

- Resolution of several conflicts amongst existing laws concerning the terms or definitions regarding coastal and marine ecosystems management.
- Reduction in the overlap among and gaps in the existing legislation, for example, the overlap in management authority for mangrove ecosystems.
- Addressing the relationships between ministerial decrees and regional government regulations. This should reduce the overlap in regulations between the central and regional government agencies.

C. Strengthening local regulations or PERDA

The first is to accommodate *adat* law on coastal and marine resources management. Recognition of this traditional law in PERDA should not be a big challenge, because some provinces have already successfully undertaken maritime activities, including licensing for fishing, mining, tourism, agriculture, tambak (fishpond) development, and marine preservation. The most important thing in the recognition of *adat* law is the "political will" of regional governments (local parliament and governor and/or mayor) to accommodate this issue in their PERDA.

The second is the need to accommodate the issues arising from transnationals law. Transnational marine resource management patterns are becoming an important issue that should be considered by the districts and provinces that border neighbouring countries when they develop their PERDA. There are two aspects that should be considered by the regional governments in establishing their local regulations. These include:

- Economic interdependency. The economic interdependency between Indonesia and neighbouring countries is increasing significantly. For example, due to the inter-relatedness of regional communities (economic, social and cultural) many residents of Singapore live in the Riau Archipelago district and other districts of Riau province.
- The historical aspect: Indonesia and other ASEAN member countries have signed several bilateral agreements concerning the recognition of traditional fishing rights in the border areas, as historical rights[6].

4.5.2 Institutional Arrangements

A. Improvement of coordinating mechanisms (revitalisation of DMI)

The improvement of coordinating mechanisms can be done through the revitalisation of the existing inter-ministerial council, such as the Indonesian Ministerial Council. This option assumes that the responsibilities are so widely dispersed and so well entrenched within the existing government agencies that a major restructuring of government departments would require significant funds, personnel and time, all of which are not realistic at the present time. Therefore, to minimise public expenditure resulting from a major of restructuring, the revitalisation of the Indonesian Ministerial Council is a better choice. Coordinating mechanisms are necessary to exchange information and develop homogenised viewpoints on maritime issues.

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[6] *Besides these aspects, some regional agreements have been signed by Indonesia that relate to the management of natural resources in the districts and/or provinces that border with neighbouring countries. For example, a Memorandum of Understanding on Fishery cooperation for border area (Sulu Sea) has been signed by between Indonesia and the Philippines in 2001. Sulu Sea borders with the Province of North Sulawesi.*

Revitalising the Maritime Council will work provided: (i) there is a political will and commitment from all parties; and (ii) this commitment is demonstrated by the government agency that has a responsibility for the Council. The key problem appears to be the lack of executive leadership for the Council. On a day-to-day basis one ministerial responsibility is not viable when there is an obvious conflict of interests among the ministers. An alternative is for the vice-president to assume this role with a set time frame for results from each minister. Procrastination is an age-old political maxim and can only be overcome by leadership. If political will is not demonstrated, the Maritime Council will suffer the same fate as its predecessors.

B. Expand the powers and duties of an existing agency (creation of a super-agency)

This option is based on the assumption that the existing MOMAF lacks sufficient legal authority or power to address the full range of complicated maritime activities. As noted earlier, many other government agencies are involved in coastal and marine management in Indonesia. Legally, the MOMAF has the authority and responsibility for fisheries management and marine affairs only. This option suggests that the enhancement of powers and duties of the MOMAF from fisheries and habitat management and marine affairs to all related functions of ocean activities, such as marine transportation, ocean mining, marine tourism, marine conservation, coastal forestry (mangroves management) and other ocean activities, may merit consideration as a potential solution.

A super ministry system is not new in institutional arrangements for coastal and ocean management. This approach has been used by the Republic of Korea. The MOMAF of Korea has extensive powers and duties for coastal and ocean management activities ranging from the development and coordination of marine and fisheries related policies, promotion of the shipping industry, safe navigation of vessels, port operations and port development, promotion of the fishing industry, support for the development of marine resources, and integrated coastal management for scientific research and development. Noteworthy also, is the Department of Fisheries and Oceans in Canada which now, after the cod fishery collapse, includes fisheries science, oceanography, hydrography, management, enforcement, coastal system management, the Canadian Coast Guard (former Ministry of Transport) for all sea marine and ports management, search and rescue, navigational aids and general enforcement.

C. Establishing a new coordinating ministry

The option, therefore, to address the coordination mechanism problem for national institutional arrangements is to establish a new ministry, which will have a special function for the coordination of all ocean and coastal management activities.

There are some advantages in the creation of a Coordinating Ministry for ocean activities (Menteri Koordinator Kelautan). First, it attempts to improve a flawed system through cosmetic changes. Second, the Coordinating Ministry could also act as the facilitator for conflict resolution regarding functional overlaps of the technical and state ministries, e.g., the conflict of national marine park management between the MOMAF and the MOF as mentioned earlier. The existing Coordinating Ministry for Economics, include the MOMAF and the MOF as parties, but it cannot resolve conflict due to its economic focus with respect to managing coastal and ocean resources. The Coordinating Ministry for ocean activities could also act as a mediator for conflict between the national and regional government agencies.

This option may be the best and least costly one, as it does not require a major restructuring of existing government agencies. As a large country with two thirds of its territory being ocean, it is reasonable for Indonesia to create a new coordinating ministry for ocean activities.

Three elements should be addressed before deciding on the options. The first is the legal regime. The ultimate effectiveness of a super-ministry, an inter-ministerial council, or coordinating ministry as a management vehicle will rest primarily on the legal framework upon which it draws its mandate. An appropriate legal framework will avoid possible conflict and will ensure support for the implementation of policy and programmes that have been produced at a higher level. This suggests that whichever option is selected, it must have an authority greater than that of a current line ministry to be able to clearly resolve ministerial mandate conflicts. The second is scientific backup. The effectiveness of the implementation of the ocean policy will be dependent on how the policy has been developed. The availability and correct use of knowledge determines the quality and credibility of the final policy. Therefore, it is reasonable, and perhaps a necessity, for a new super-ministry, new inter-ministerial council, or new Menko to develop a research and development unit for its own organisation. The third

is the autonomy issues. Whichever option is chosen, the government should consider the roles and responsibilities of local governments and communities for coastal and ocean resources management. The development of a new ministry or council cannot be allowed to reduce rights and the authority of regional governments. All regulations produced by the central government will need to accommodate the existing Autonomy Law.

5. MANAGEMENT PERSPECTIVES: NATIONAL AND REGIONAL SEAGRASS ACTION PLANS

5.1 National Level

Strategy 1

To promote the awareness and understanding of stakeholders of the important roles and functions of seagrass ecosystems in coastal waters.

Action Plans

1. Enhance awareness and understanding of the important role and function of seagrass in integrated coastal zone management, and the responsibility of government officials, community at large, NGOs, private sectors through discussion, seminar, lectures, and education tours.
2. Establish publication and communication programmes concerning the role and function of seagrass resources using mass media and educational institutions, formal as well as non-formal.
3. Enhance concern, capability and a sense of responsibility of stakeholders in the management of seagrass ecosystems which suits local conditions.

Strategy 2

To strive for sustained, conserved and improved condition of seagrass ecosystems for the well-being of the community, in compliance with regulations in force, as well as with national and international standards of natural resource management.

Action Plans

Develop demonstration plots representing effective and efficient management of seagrass ecosystems.

1. Develop criteria for selecting seagrass ecosystems which are of national and international importance to be protected and allocated for conservation areas.
2. Conduct national inventory programmes on species composition, geographical distribution and potency of seagrass resources and note which serve as feeding grounds for dugong and green turtle.
3. Develop guidelines to detect, identify and prevent the growth of factors that may degrade seagrass environments.

Strategy 3

To promote the development of science and technology, research programmes, training and information systems on seagrass resources, for which the active participation of the private sector and international cooperation are to be strongly stimulated and encouraged.

Action plans

1. Develop a national database and information system on seagrass and to implement a mapping programme that supports sustained utilisation of the ecosystem.
2. Conduct research programmes on the interaction between seagrass, coral reef and mangrove ecosystems, and to explore further utilisation of seagrasses by means of biotechnological techniques.
3. Promote cooperation involving national institutions, private sectors and international agencies in implementing joint research, training, monitoring activities, and in developing seagrass management systems.

Strategy 4

To develop support systems and a legal framework for a balanced and sustained utilisation of seagrass resources, while exploring further development to meet growing needs.

Action Plans

1. Revise and restructure existing legislations and create new legislation as necessary so as to better meet the need of sustained seagrass management.
2. Formulate and develop a draft of coastal zone spatial plan that will meet the needs of all relevant stakeholders, at local, national and international levels.
3. Develop monitoring, controlling and surveillance (MCS) systems, including effective law enforcement units.
4. Socialise and disseminate information on seagrass and relevant resource legislation to all members of society, including decision makers, government officials, non-government organisations, and the coastal community at large.

Strategy 5

To develop the capacity and capability of central and local governments by way of enhancing cooperation among institutions, so as to enable them to formulate and implement programmes on management of seagrass resources based on balanced principles of resource utilisation, in accordance with local wisdom as well as biophysical and area development characteristics.

Action Plans

1. Enhance the quality and quantity of infrastructure and man power, in order to improve the capability to manage seagrass ecosystems in the most appropriate manner.
2. Encourage greater participation of Non-Government Organisations in empowering coastal communities.
3. Provide technical assistance to enhance the capability of local government and coastal communities in formulating development programmes that meet local environmental needs.

Strategy 6

To foster cooperation, coordination and partnership amongst central government, local government, and community in developing seagrass ecosystem management, covering the process of planning, implementation, monitoring, evaluation, controlling and law enforcement.

Action Plans

1. Provide legal assurance and delegation of authority and responsibility to coastal communities whilst recognising the mutual consultancy tradition of coastal communities.
2. Define the role and responsibility of various institutions and bodies involved in the management of seagrass ecosystems and other relevant resources.
3. Develop mechanisms and facilities that are capable of strengthening cooperation and co-ordination within and among institutions.

5.2 Local Level

Based on the results of the causal chain analysis above (Annex 1, Annex 2, Annex 3) it is apparent that there are 6 categories of threats to be managed in order to achieve a sustainable use of seagrass in these three areas. To reach that management state, the following interventions are proposed.

1. Promote local coordination and improve the ability of local government sectors to properly manage their coastal resources, particularly seagrass ecosystems.
2. Enforce legal measures and/or refine existing regulations and develop guidelines for the protection of seagrass beds and the environment.
3. Develop guidelines to manage and control sustainable tourism.
4. Promote local community empowerment and encourage alternative livelihoods for local communities in order to compensate for reduced fishery activities.
5. Provide knowledge and enhance awareness concerning the values and importance of the seagrass ecosystem to local government, private sectors and local communities.
6. Conduct integrated research pertaining to management of the seagrass beds.

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ANNEX 1

Main seagrass environmental problems and causal chain analysis in Riau Archipelago.

Locations	Major Problems	Ecological Issues	Source	Causal Chain			Socio-economic Impact	Intervention
				Immediate	Intermediate	Root Cause		
Trikora Beach and **Senayang-Lingga**	Degradation of coastal habitats	Erosion, sedimenta-tion siltation and seagrass bed degradation	Soil/sand mining on land and on sea bed	Uncontrolled mining activities	Weak of law enforcement and improper regulation	- Involvement of executive officers and legislative members in the sand mining business - Lack of public awareness on the importance of seagrass - Lack of community right - Strong demand for filling materials	- Decrease fisheries productivity at seagrass bed - Decrease of local community income - Decrease of aesthetic value disturb tourism activities - Decrease income from tourism industry	- Revising regulation - Strengthening law enforcement - Executing public campaign - Clean sea programme - Developing proper spatial planning - Community empowerment - Generating alternative income of local community
Trikora Beach and **Mapor Island**	Degradation of coastal habitats	Nutrient and organic pollution and eutrophication	Operation of marine resort activities and infrastructure development	High turbid water algal bloom due to eutrophication soil erosion and sedimentation	Untreated domestic waste water inappropriate civil work	- Lack of regulation and guideline on environmentally friendly tour and civil works - Lack of public awareness - Weak of law enforcement	- Decrease fisheries production - Decrease income of fisheries - Decrease of aesthetic value - Lower income from tourism activities	- Wise use regulation - Establishing new regulation - Public campaign on clean beach - Creating alternative income for fishers/local community

ANNEX 2

Main seagrass environmental problems and causal chain analysis in Batam Island.

No.	Major Ecological Problems	Environmental Issues	Source	Causal Chain			Socio-Economic Impact	Action/ Intervention
				Immediate	Intermediate	Root causes		
1.	**BATAM**							
	Habitat /Seagrass Degradation and Lost	Increased erosion, sedimentation and turbidity disturbed aesthetic value	Coastal Development	Improper Civil Works	Improper regulation	Low awareness on environment protection	Lower fishery catch	Revising regulation
				Inappropriate coastal land spatial planning	Weak of law enforcement, less coordination among stakeholders	Inability of scientists to provide information on the economic value of seagrass	Lower income of local fisher Lower income from tourisms activities	Strengthening law enforcement Develop proper coastal land spatial planning
	Seagrass Degradation and Lost	Marine pollution water turbulent and solid suspension charge disposal that contribute to coastal pollution and eutrophication water turbulent and uprooted seagrass solid waste accumulation on beach	Sea transportation Tourisms and recreational activities	Improper regulation No regulation on speed limitation of boat Carelessness on clean beach	Weak enforcement Less understanding on the value and function of coastal ecosystem	Less capability of developing coastal plan Low awareness In ability of Academicians to provide information on value and lack coordination among major stakeholders	Disturb aesthetic value that decrease income from tourisms Decrease fishery catch Lower income of coastal fisher	Strengthen law enforcement Modify and develop regulation/guideline on sustainable tourisms Modify coastal spatial planning Build capacity of local government in developing ICZM

ANNEX 3

Main seagrass environmental problems and causal chain analysis in Natuna Island.

No.	Major Ecological Problems	Environmental Issues	Source	Causal Chain			Socio-Economic Impact	Action/ Intervention
				Immediate	Intermediate	Root causes		
1.	**NATUNA** *Seagrass degradation and lost*	Coral damage impacted to seagrass Loss of mangrove load to erosion and sedimentation Indirect impact on seagrass	Destructive fishing Mangrove Cutting Turtle egg collection	Weak law enforcement Limited alternative livelihood No application of regulation measurer	No monitoring control and surveillance Lack of understanding on the value and function of mangrove	Lack of personnel and infrastructure No empowerment & low awareness	Lower fish catch Lower income of local fisher	Strengthen MCS capacity

ANNEX 4

Institutional hierarchy relevant to seagrass management at national and local levels.

INSTITUTION	LEGAL BASIS	PARTICULAR
State ➢ Department of Forestry & Plantation ➢ Dept. Marine Affairs & Fisheries ➢ Navy and Police ➢ Dept. Home Affair ➢ Ministry of Environment	Act No. 5/1990 Act No. 41/1999 Act No. 9/1985 Act No. 22/1999 Act No. 23/1997	Conservation and Forestry Fisheries Maritime security Administrative Living environment
Province	Act No. 22/1999	Administrative authority to manage sea area 12 miles from the coastline toward the open sea
District/Municipality	Act No. 22/1999	Administrative authority to manage sea area 4 miles from the coastline toward the open sea
Village Village Community Council Awig-awig, Ninik Mamak, Sasi, Forum Desa	Act No. 22/1999	Communal agreement

ANNEX 5

Legal aspects relevant to management of seagrass ecosystem*.

No.	Legal Basis	Relevancy
1	Constitution 1945 Article 33	Land and water and other natural resources contained therein shall be placed under state control and be used for the highest welfare of the population.
2	Act No. 1/1973 on marine affairs	Article 8 concerns with the prevention of marine pollution: Any person carrying out exploration, exploitation and scientific research on natural resources in the Indonesian continental basin is obliged to take preparatory measures to overcome possible marine pollution in the Indonesian continental basin and to prevent it from spreading further out.
3	Act No. 5/1983, concerning Indonesian Economic Exclusive Zone	Article 11 stipulates: Taking into consideration the maximum limit of indemnity, any person who caused marine pollution or destruction of natural resources in the Indonesian EEZ shall be compelled to bear the absolute responsibility of funding the rehabilitation process of the marine environment of the natural resources immediately, the amount of which shall be determined through in-depth ecological research and assessment.
4	Act No. 17/1985, concerning Ratification of UN Convention on the Law of the Sea	Article 145: a. Prevention, reduction and control of pollution and hazards that threaten the marine environment and the coastal areas. b. Protection and conservation of natural resources and prevention against destruction of marine flora and fauna.
5	Act No. 5/1990, concerning Conservation of the Living Resources and their Ecosystems	➢ Article 1 (2): Conservation of Living Resources is to manage the living resources wisely so as to guarantee its existence while maintaining and enhancing the quality of its biodiversity and value. ➢ Article 5 it shall be implemented in accordance with the following principles: i. Protection of life support system, ii. Conservation of flora and fauna diversity and their ecosystem, iii. Maintain the utilisation of living resources.
6	Act No. 24/1992, concerning Spatial Planning	➢ Article 1, Paragraph 1: Space in this context cover land, sea and air spaces which together form a single entity, and functions as living space for mankind and other living creatures. ➢ Article 5, Paragraph 7: Protection area is an area designated to protect the living environment which covers natural resources and artificial resources. ➢ Article 7: i. Spatial planning based on primary function of the area covers "Protection Area and Cultivation Area" ii. Spatial planning based on administrative aspects includes "National Area, Provincial Area or Regional Area Level 1, and District/Municipal Area or Regional Area Level 2. iii. Spatial planning based on function and activities include Village Area, City Area, and Specific Area. ➢ Article 8 (1): Spatial of National Area, Provincial Area, and District/Municipal Area shall be done in an integrated way instead of separately.

ANNEX 5 *cont.* **Legal aspects relevant to management of seagrass ecosystem.**

No.	Legal Basis	Relevancy
7	Act No. 5/1994, concerning UN Convention on Biodiversity	Clarification of Act No. 5/1994, General provision point b: Natural resources on land, in the sea and on air shall be managed and utilised in such a way that it maintains the environment to function normally and to enable the environment enhance the carrying capacity so as to provide the best possible utilisation for the highest welfare for the present as well as future generations.
8	Act No. 23/1997, concerning Management of Living Environment	➢ Article 9: The Government stipulates a national policy on environmental management and spatial planning with due respect to religious norm, tradition and human values that prevail in the society. Environment management shall be done in an integrated manner by the state institutions in line with the tasks and responsibility they are conferred with, as well as by the community and other development actors. In so doing the integration of planning and implementation of the national policy on environmental management shall be taken into account. ➢ Environmental management shall be implemented in an integrated manner with spatial planning, protection of non-living resources, protection of artificial resources, conservation of living resources and their ecosystems, cultural reservation, biodiversity and climate change. ➢ Article 14: To ensure sustained function of living environment, every effort or activity shall be forbidden to violate the quality standard and standard criteria for environmental degradation. ➢ Article 16: Any person who holds the responsibility over corporate activities or others shall manage the wastes that are produced by his/he/corporate activities.
9	Act No. 22/1999, concerning Local Government	Article 7: Stipulates conservation activities by the central government. Article 10: Stipulates conservation activities by local government.
10	Act No. 41/1999, concerning Forestry	Article 18 (1): The Government assigns and maintains adequate forest areas and forest covers for every river basin and islands to optimise environment and socio-economic benefits of the local community.

** None of the regulations listed above refer directly to management of seagrass ecosystem.*

ANNEX 6

Legal constrain and actions required for management of seagrass ecosystem.

No.	Legal Basis	Problem/Constrain	Action Plan
1	Act No. 1/1973 on continental shelf	Effort to prevent oil spill pollution has gone very slow	It is necessary to assign an institution to be endowed with a specific authority to coordinate the campaign against pollution and degradation of the sea.
2	Act No. 5/1983, concerning Indonesian Economic Exclusive Zone	Studies on the distribution areas of pollution and their impacts on the marine biota are very inadequate.	Same as above.
3	Act No.9/1985, concerning Fisheries	All living organisms are taken as fish, therefore can be categorised as animals for hunt.	Should be revised.
4	Act No. 17/1985, concerning the Law of the Sea	Efforts to prevent marine pollution and sea deterioration, and to foster conservation of the sea, are still far from being satisfactory.	Law enforcement in the sea by the Navy and Police should be more firm.
5	Act No.5/1990, concerning natural resources and their ecosystems	➢ Management through conservation approach is very limited, ➢ Overlapping of authority between Dept. Forestry and Dept. Marine Affairs and Fisheries.	Law enforcement in the framework of sustaining area function, To be revised.
6	Act No. 5/1994, concerning Biodiversity	Over exploitation of natural resources surpassing the growth capacity, thereby disturbing the environment to function properly.	Sustainable utilisation and development of mariculture.
7	Act No.24/1992, concerning Spatial Planning	Spatial planning has not been implemented in an integrated manner, particularly in coastal area.	Integrate terrestrial spatial planning with that of coastal and sea on the basis.