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Distribution and significance of seagrass ecosystems in Malaysia

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Seagrasses are the only flowering plants (monocotyledonous Angiosperms) that have adapted themselves to living in marine and estuarine habitats, submerged most of the time. They are rooted in sediments on the sea bottom, with shoots appearing above substrate. Seagrasses occurred at 78 sites scattered in the west and east coasts Peninsular Malaysia and, Sabah and Sarawak in East Malaysia. They are usually found along the coasts growing in association with shallow inter-tidal, mangroves, coral reefs, semi-enclosed lagoons and shoals. In these habitats, seagrass beds or meadows have distinct species assemblage completely adapted to the submerged life. Fourteen species of seagrasses recorded in Malaysia; *Enhalus acoroides*, *Halophila beccarii, H. decipiens, H. ovalis*, *H. minor*, *H. spinulosa*, *Halodule pinifolia*, *H. uninervis*, *Cymodocea rotundata*, *C. serrulata*, *Thalassia hemprichii*, *Syringodium isoetifolium*, *Ruppia maritima* and *Thalassodendron ciliatum*. Although seagrasses made up a small portion of the marine ecosystem, the physical settings, and their interactive community within and from outside account for the high diversity and ensure survival of assortment of vertebrates (fishes), invertebrates (shrimps, starfishes, sea cucumbers, bivalves, gastropods), and seaweeds. Seagrass form the food and habitats for the vulnerable dugongs (*Dugong dugon*), seahorses (*Hippocampus* spp.) and endangered green turtles (*Chelonia mydas*), other fishes and feeding ground for seasonal migratory birds, *Egretta garzetta*. Seagrasses provide conditions for growth and abundance of invertebrates and fish that many local coastal communities collect and catch for their livelihood. Seagrass ecosystems are sources of food and yet they are continually threatened by human activities, in particular causing their degradation and possibly habitat loss. The purpose of this review is to give information on the significant linkages of seagrasses with the coastal inhabitants and to suggest recommendations for the protection and conservation of this important seagrasses and the associated resources.

Keywords: conservation, dugong, habitats, invertebrates and vetebrates, Peninsular Malaysia

Introduction

Seagrasses are not true grasses; they are submersed monocotyledonous plants and form patches to dense extended coastal beds or meadows. Seagrasses, just as terrestrial plants constitute complex and productive ecosystems occurring both in temperate and tropical seas. Healthy seagrass communities provide food for herbivores, habitats and nurseries for invertebrates, fish, turtles and birds, stabilize sediments and recycle nutrients, and are highly productive (Dawes et al., 1995). Seagrass communities, with their structural complexity contribute to the productivity and biodiversity of the areas (Simenstad,

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1994), just as terrestrial ecosystems, e.g. tropical rain forests, or that of aquatics e.g. mangroves and coral reefs) do.

In Malaysia, along its 4800 km coastline, stretching along the Malay Peninsula, Sabah and Sarawak bounding much of the southern part of the South China Sea are environments with coastal habitats - mangroves, coral reefs and seagrasses. In general along the mainland coastal areas between mangroves and corals, from low tide level to the coral reef fringe, form the habitats for seagrasses. Seagrasses are also found around off-shore islands with fringing corals. Here they inhabit the outer region between the corals and the semi-open sea.

The habitats where seagrasses grow are under more threat today than ever before. Increasing numbers of people are utilizing the coasts and the adjacent waters for various activities and such activities are accompanied by major coastal developments. All these and many more, affect the quality of life in the water bodies such as shallow coastal areas, where seagrasses, seaweeds, mangroves and coral reefs thrive. Although these are few examples of why our resources are slowly depleting, they are many more which we do not know as we have very little knowledge on them. We believe that by knowing the resources, one will appreciate the tremendous contribution made by them, one good example is the seagrasses; "seagrasses may appear to be unimportant, but they play an important role in the livelihood of coastal resource-dependent communities. This paper presents the information on distribution and significance of seagrass ecosystems in Malaysia. The purpose of this review is to give information on the significant linkages of seagrasses with the coastal inhabitants and to suggest recommendations for the protection and conservation of this important seagrasses and the associated resources.

Methods

This paper presents a review of the status of distribution and significance of seagrass ecosystems in Malaysia through a study of available information produced over the past decade (1994 to 2004). This is being as part of a research project on the inventory of marine plants and associated organisms under the Intensification in Priorities Research 6, 7 and 8 funded by the Ministry of Science, Technology and Environment Malaysia. The information presented in this review covering various aspects from distribution, taxonomy, diversity, utilization and, natural and human activities are derived from a number of published sources by the authors given in the reference section of this paper. Other supporting sources of information pertaining to seagrass species presence, ecology and uses in Malaysia come from Ridley (1924), Burkill, (1935), Holttum (1954), den Hartog (1970), Sasekumar et al. (1989), Norhadi (1993) and Phang (2000) and, dugongs sightings from Jaaman et al. (1997) and Jaaman (1999, 2000). With the synthesis of the above information, we hope this review represents a more informed evaluation of the seagrass ecosystems and their significance in Malaysia.

Seagrass ecosystems

In the sheltered coastal water bodies, seagrasses are in association with shallow inter-tidal (Norhadi, 1993; Japar Sidik et al., 1999a; Muta Harah et al., 1999), semi-enclosed lagoons (Muta Harah et al., 2000), coral reef flats (Japar Sidik et al., 1995, 2001) habitats and also in sub-tidal zones (Japar Sidik et al., 1996). The inter-tidal seagrass communities is not entirely submersed, but inundated twice daily with the rise of the tides. There are 78 seagrass beds scattered throughout the Peninsular and East Malaysia. In term of areal distribution, they range from isolated patches to continuous coverage of several hectares (Japar Sidik and Muta Harah, 2002). The most developed and diverse extensive communities are found in the south, east coasts of Peninsular Malaysia, Sabah and Sarawak where urbanization is minimal. With different communities (Table 1) and environmental parameters, seagrass beds are site specific. Figure 1 illustrates the important and major sites of seagrass ecosystems that have linkages with coastal inhabitants' utilization and other users.

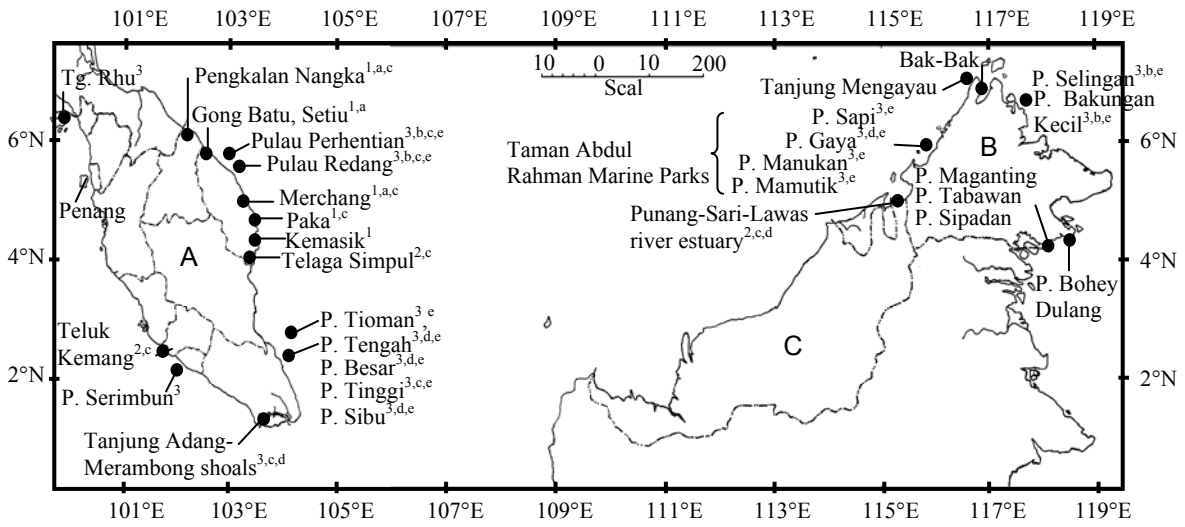

Figure 1. The major and important seagrass areas, associated habitats, utilization by coastal communities and other users in Peninsular Malaysia (A) and east Malaysia- Sabah (B) and Sarawak (C). Lagoon[1], inter-tidal[2], sub-tidal[3]. Aquaculture[a], turtle sanctuary[b], traditional capture fisheries[c], dugong feeding ground[d] and marine park[e].

Distribution in Peninsular Malaysia

Along the west coast, patches of mixed species seagrass beds grow on substrates from the sandy-mud of Tanjung Rhu in the extreme northern region along the coast of P. Langkawi, Kedah to sand-covered corals of Teluk Kemang, Negri Sembilan extending to as far as P. Serimbun, Malacca (Japar Sidik et al., 2001). The Teluk Kemang is the only area in mainland Peninsula that has inter-tidal seagrass bed on reef platform. In the southern region, the calcareous sandy-mud sub-tidal shoals of Tanjung Adang Darat, Tanjung Adang Laut and Merambong at depths of 2 to 2.7 m support nine species of seagrasses (Table 1), the highest species number for any locality in Peninsular Malaysia or Malaysia (Japar Sidik et al., 1996). Most of the inter-tidal areas of the eastern coastline are fringed with sandy to rocky areas and therefore devoid of seagrasses. Beds of two species, *Halophila beccarii-Halodule pinifolia* inhabit the fine sand substrate of the shallow inland coastal lagoons from Pengkalan Nangka, Kelantan to Paka, Terengganu while *Halodule pinifolia-Halophila ovalis* inhabit similar substrate type of Gong Batu and Merchang. A monospecific bed of *H. pinifolia* is found at Kemasik, Terengganu. Monospecific beds of *Halodule pinifolia* or *Halophila minor* or *Halophila decipiens* (e.g. at P. Redang, Muta Harah et al., 2003a) to mixed species seagrass beds occur in the waters of the off-shore islands with fringing coral reefs of P. Sibu, P. Tengah, P. Besar, P. Tinggi, P. Redang and P. Perhentian (Table 1, Japar Sidik et al., 1995; Muta Harah et al., 2003a) and P. Tioman (Zelina et al., 2000). Seagrasses usually inhabit the outer region between the corals and the semi-open sea.

Table 1. Seagrass communities in different areas in Peninsular Malaysia and East Malaysia.

	Site																
	Peninsular Malaysia													**East Malaysia**			
Family/Species/Site	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Hydrocharitaceae																	
Enhalus acoroides (L.*f.*) Royle	+	+				+					+			+	+		
Thalassia hemprichii (Ehrenb.) Aschers.	+	+	+											+	+		+
Halophila beccarii Aschers.							+	+					+				
Halophila decipiens Ostenfeld	+									+	+			+		+	
Halophila minor (Zoll.) den Hartog		+							+	+	+			+		+	+
Halophila ovalis (R. Br.) Hook. *f.*	+	+	+	+	+	+			+		+	+		+	+	+	+
Halophila spinulosa Aschers.		+		+										+			
Cymodoceaceae																	
Cymodocea rotundata Ehrenb. & Hempr. ex Aschers.		+	+	+										+	+		+
Cymodocea serrulata (R. Br.) Aschers. & Magnus	+	+	+		+	+								+	+		
Halodule pinifolia (Miki) den Hartog	+	+			+		+	+	+	+	+	+	+	+	+	+	+
Halodule uninervis (Forssk.) Aschers.	+	+	+	+	+	+								+	+		
Syringodium isoetifolium (Aschers.) Dandy	+	+	+	+													
Total	**8**	**10**	**6**	**5**	**4**	**4**	**2**	**2**	**3**	**3**	**5**	**2**	**2**	**10**	**7**	**4**	**5**

Note: *Ruppia maritima* and *Thalassodendron ciliatum* are not included as they are rare in occurrence.

1	Teluk Kemang	2	Tanjung Adang-Merambong	3	Pulau Tinggi	4	P. Besar
5	P. Tengah	6	P. Sibu	7	Telaga Simpul	8	Paka
9	Merchang	10	P. Redang	11	P. Perhentian	12	Gong Batu, Setiu
13	Pengkalan Nangka	14	Pulau Gaya	15	Sepangar Bay	16	P. Selingan, P. Bakungan Kecil
17	Punang-Sari						

Distribution in East Malaysia

Sabah

The west and south-eastern coasts of Sabah harbour mixed species seagrass beds in substrates ranging from sand, muddy-sand to coral rubble of the inter-tidal zone down to a depth of 2.5 m. There are six areas of inter-tidal mixed associations of seagrass and coral reef along the west coast at Bak-Bak, Tanjung Mengayau, Sepangar Bay and Pulau Gaya. The four isolated off-shore islands of P. Maganting, P. Tabawan, P. Bohey Dulang and P. Sipadan along the south-eastern coast have sub-tidal seagrasses growing on coral rubble (Norhadi, 1993; Japar Sidik et al., 1997; Japar Sidik et al., 1999a, b; 2000; Josephine, 1997, Figure 1).

Sarawak

In Sarawak, records of the presence of seagrasses were those of *Halophila beccarii*, collected in Sungai Bintulu (den Hartog, 1970) and *Halophila decipiens* at P. Talang Talang, Semantan (Phang, 2000). A survey in 2003, discovered an extensive inter-tidal beach front of Punang-Sari-Lawas river estuary, Sarawak (Figure 1), comprising sandy flatland transverse by shallow channels and intermittent pockets of pools harbouring five seagrass species (Table 1, Muta Harah and Japar Sidik, 2003b).

Seagrass diversity

Table 1. summarizes the occurrence of seagrass species in the different areas. Malaysia has a total of 14 seagrass species belonging to 8 genera (Table 1, Figure 2). Two other species, *Thalassodendron ciliatum* (Phang, 2000) and *Ruppia maritima* (Burkill, 1935) are not included in Table 1 as they are rare in occurrence.

Several localities along the coasts of Malaysia supported well-developed seagrass communities and a large proportion (40%-71%) of all known seagrass species in Malaysia. The Teluk Kemang and Tanjung Adang-Merambong shoals of the Peninsular Malaysia, P. Gaya, Sabah and Punang-Sari-Lawas river estuary, Sarawak has a greater diversity of seagrass (Table 1).

Significance of seagrass ecosystem

Direct utilization of seagrasses is few. The fibers from softer part of tropical eel grass, *E. acoroides* can be made into fishing nets (Burkill, 1935) and the leaves were one of the chief foods (Ridley, 1924) of the dugong, which was then common in Malaysia. *Ruppia maritima* plants are used in fish ponds to aid in the aeration of the water, and the milk fish (*Chanos* sp.) feeds on it (Burkill, 1935). Human consumption of seagrass is not entirely confined to the past. Seeds of *E. acoroides* are consymed by the coastal communities of Sungai Pulai, Johore. The nutritional value of the flour derived from *E. acoroides* seeds is comparable to that of wheat and rice flour in terms of carbohydrate and protein content and energy values and surpasses these types of flour in calcium, iron and phosphorus content (Montano et al., 1999).

Human habitation near or adjacent to seagrass areas is common in Malaysia. The dwellers are the natural fisheries dependent. They also belong to the seagrass ecosystem, in that at least at the subsistence level; the community's uses seagrass associated resources as a source of food. The economic contribution of seagrass associated resources though harvested or utilized is difficult to quantify as there are no records or figures quantifying such resources. Here we are providing information on the significant linkages of the seagrass ecosystem as service provider to the local coastal inhabitants and other users (Table 2).

Aquatic life can be diverse in various seagrass areas in Malaysia. Fishes are by far the most diverse and abundant vertebrates as the habitat are important refugia for many species. The dense seagrass beds of sub-tidal shoals of Tanjung Adang-Merambong, Johore, Pengkalan Nangka, Kelantan and Paka shoal, Terengganu support many juvenile to adult fishes and prawns. In Tanjung Adang-Merambong seagrass areas, approximately 70-76 species of fish in 41 families have been observed in seagrass beds and the

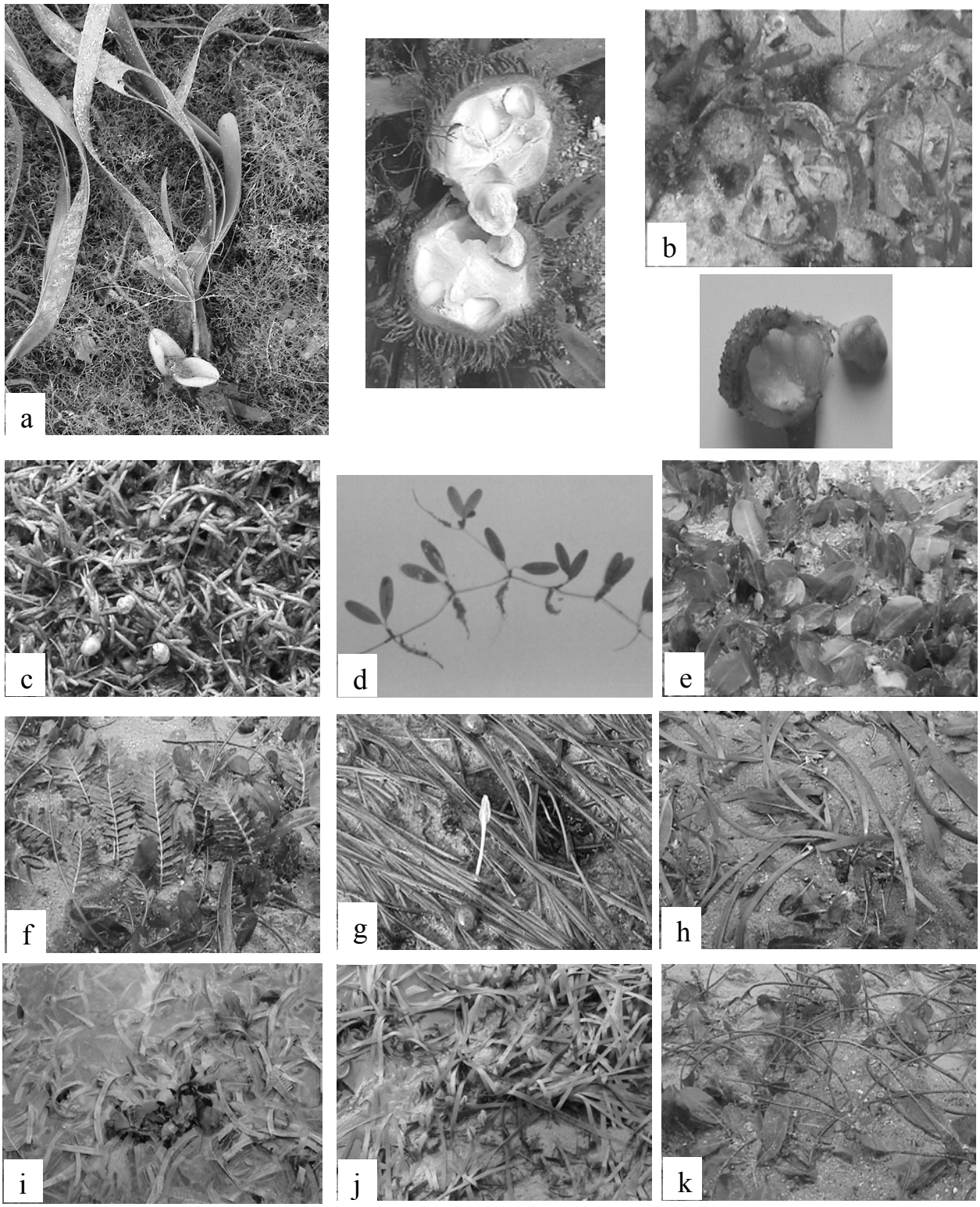

Figure 2. The common seagrasses of Malaysia.

a-*Enhalus acoroides* and the edible seeds, b-*Thalassia hemprichii* and the edible seeds, c-*Halophila beccarii,* d-*Halophila decipiens,* e-*Halophila ovalis,* f-*Halophila spinulosa,* g-*Halodule pinifolia,* h-*Halodule uninervis,* i-*Cymodocea rotundata,* j-*Cymodocea serrulata,* k-*Syringodium isoetifolium*

Table 2. Major and important seagrass areas of significant important and the threats they are facing.

Seagrass area	Associated Habitat	Importance of the area	Threats	
			Human activities:	**Natural causes:**
Teluk Kemang, Negeri Sembilan	Coral reef flats	- Association of seaweeds and seagrasses and associated fauna - Biodiversity (corals, gastropods, seaweeds, seagrasses, sea cucumbers, eels) - Traditional capture fisheries	- Sedimentation due to coastal development (e.g. hotel, marina), - Sand mining, oil pollution e.g. tar balls - Public recreational area	- Wind blown waves, sediment movement
Tanjung Adang-Merambong, Johore	Sub-tidal shoals	- Biodiversity (gastropods, seaweeds, sea cucumbers, fishes, Echinoderms) - Traditional capture fisheries supporting local coastal population - Gleaning site for gastropods and bivalves - Nursery ground for invertebrates and vertebrates - Feeding ground for dugong and birds	- Land reclamation for port facilities causes sedimentation and burial of seagrass bed and totally destroying a shoal - Transportation avenues	- Invasion by macroalgae e.g. *Amphiroa fragilissma*, *Gracilaria fisherii*
P. Tinggi, P. Besar, P. Tengah, P. Sibu, Johore	Sub-tidal, off shore island	- Shore line stabilization - Traditional capture fisheries supporting local coastal population - Pristine area for scientific study - Turtle and dugong feeding ground	- Transportation avenues - Tourism	- Wind blown waves, shifting of sand during north-east monsoon
Telaga Simpul, Terangganu	Inter-tidal	- Shoreline stabilization against wave and tidal currents - Traditional capture fisheries - Polycheate collection by the local for fish baits	- Sand mining for shoreline stabilization against the north-east monsoon - Digging activities for polycheates	- Wind blown waves, shifting of sand during north-east monsoon

continue…

Paka, Terengganu	Semi-enclosed lagoon and shoal	- Traditional capture fisheries supporting local coastal population - Gleaning site for bivalves (e.g. *Modiolus senhausii*) - Breeding ground for bivalves	- Transportation avenues - Pull net - Sand dredging and mining for flood control	- Freshwater, wind blown waves, shifting of sand during north-east monsoon
Merchang, Terengganu	Semi-enclosed lagoon	- Traditional capture fisheries supporting local coastal population - Site for oyster (*Saccostrea cucullata*) culture	- Transportation avenues	- Freshwater, wind blown waves, shifting of sand during north-east monsoon
Gong Batu, Setiu, Terengganu	Semi-enclosed lagoon	- Site for fish (*Lates calcifer*, *Epinephelus sexfasciatus*) cage culture	- Transportation avenues - Sand dredging and mining for flood control	- Freshwater from rain during north-east monsoon
P. Redang, P. Perhentian, Terengganu	Sub-tidal	- Marine park protected - Traditional capture fisheries supporting local coastal population - Turtle santuary - Area for scientific study	- Illegal fishing - Tourism	- Wind blown waves, shifting of sand and erosion during north-east monsoon
Pengkalan Nangka, Kelantan	Semi-enclosed lagoon	- Traditional capture fisheries supporting local coastal population - Site for fish (*Lates calcarifer, Epinephelus sexfasciatus*) cage culture - Gleaning site (*Geloina coaxans*, *Meretrix meretrix, Hiatula solida*) - Migrant bird (*Egretta garzetta*) feeding ground	- Pull net - Digging activities for collection of *Hiatula solida, Meretrix meretrix* - Sand dredging and mining for flood controls and land based-development	- Freshwater from rain during north-east monsoon - Competition among seagrass (*Halodule pinifolia* invasion to the *Halophila beccarii* area)

continue…

Taman Tuanku Abdul Rahman Marine Parks P. Gaya, P. Manukan, P. Mamutik, P. Sapi, Sabah	Sub-tidal, off-shore island	- Marine park protected for conservation of local fauna and flora - Area for scientific study - Site for monitoring of seagrass communities on effect of global warming - Dugong feeding ground	- Illegal fishing, fish bombing - Illegal collection of invertebrate e.g. sea cucumbers, sea urchins, seaweeds (*Caulerpa* sp.), gastropods - Tourism	
Sepangar bay, Sabah	Inter-tidal	- Shore line stabilization - Traditional capture fisheries supporting local coastal population - Gleaning site for bivalves, gastropods, sea cucumbers, macroalgae - Collection of peanut worms for fish baits	- Digging activities for peanut worms	- Wind blown waves, shifting of sand and erosion during south-west monsoon - Displacement a of seagrasses e.g. *Cymodocea rotundata*, *H. pinifolia*
P. Selingan, P. Bakungan Kecil, Sabah	Sub-tidal, off-shore islands	- Marine park protected - Turtle sanctuary, totally protected	- Illegal fishing, fish bombing	
Punang-Sari-Lawas river estuary, Sarawak	Inter-tidal	- Traditional capture fisheries (smoked fish, *Ilisha elongata* or locally known as Tahai) supporting local coastal population - Gleaning site (*Meretrix meretrix*) - Feeding ground for dugong and birds	- Digging activities for collection of *Meritrix meritrix*	- Wind blown waves, shifting of sand and erosion during south-west monsoon.

adjacent mangrove areas (Sasekumar et al., 1989). 35 fish species are of commercial important, among them; *Ilisha* spp., *Stolephorus indicus*, *Thryssa hamiltoni*, *Hippocampus* spp., *Lates calcarifer*, *Lutjanus chrysotaenia*, *Plotosus canius*, *Apolynemus sextarius*, *Rastrelliger kanaqurta, Siganus guttatus*, *S. javus*, *Siganus* sp., *Epinephalus* sp. and *Therapon* spp. (Arshad et al., 2001). The rest are under low-grade fish category and are consumed locally. Seahorses species (e.g. *Hippocampus kuda*, status: vulnerable VU A4cd) are very much in demand locally and abroad for the Chinese traditional medicine. Species of commercially important prawns; *Alpheus* sp., *Macrobrachium* sp., *Penaeus indicus, Penaeus merguiensis, Penaeus monodon, Penaeus semisculcatus*, *Parapeneopsis* sp., *Metapeneopsis barbeensis*, *Metapenaeus* sp., *Lucifer* sp. and *Acetes* sp. and stomatopods (*Oratosquilla* sp.) have been recorded from the seagrass areas. Other crustaceans include crabs: *Dorippe* sp., *Hemigrapsus* sp., *Parthenope longimanicus*, *Portunus pelagicus*, *Scylla serrata*, *Thalamita* sp., *Matuta* sp. and horse-shoe crab, *Carcinoscorpius rotundicauda* have been observed (Arshad et al., 2001). In Pengkalan Nangka, Kelantan and Paka shoal, Terengganu, fishes such as *Caranx sexfasciatus*, *Leiognathus equulus*, *Lutjanus russelli*, *Mugil cephalus*, *Periophthalmus* sp., *Scatophagus argus*, *Tylosurus crocodilus* and *Scomberoides lysan* are found in abundance (Muta Harah, 2001). In all the areas mentioned, traditional capture fishing is done through the use of gill nets, drift nets, cast nets, pull nets and hook and lines. Juvenile and young stages of economic fish species are captured. Catch is either sold in fresh state in local markets and salted or sundried for home consumption. The same seagrass areas during low tide are used as collection and gleaning sites for gastropods (*Lambis lambis*, *Strombus canarium*), bivalves (*Gafrarium* sp., *Geloina coaxans*, *Meretrix meretrix*, *Modiolus* sp., *M. senhausii*, *Hiatula solida*). Common echinoderms e.g. *Archaster* sp., *Astropecten* sp., *Protoreaster nodusus*, *Macrophiothrix* sp. and sea cucumbers; *Phyllophorus* sp., *Pentacta quadrangularis* and *Mensamaria intercedens* though present were not harvested. Although seagrass ecosystems provide services, it become evident that seagrasses are a vulnerable resource. Small-scale destructive fishing by pull net at Pengkalan Nangka, Kelantan, Paka shoal, Terengganu, and harvesting of bivalves, *Hiatula solida*, *Meretrix meretrix* (Figure 3) and *Geloina coaxans* at Pengkalan Nangka, Kelantan, have been shown to cause mechanical damage, reduce seagrass cover and retard the spread and colonization of seagrasses (Japar Sidik and Muta Harah, 2003).

In Sabah, most seagrass and coral reef associated ecosystems are gleaning sites for food collection. Uncontrolled collection of flora such as *Caulerpa* spp., *Gracilaria* sp. and fauna such as sea cucumbers, gastropods and bivalves (e.g. Sepangar bay, P. Gaya, Figure 3) and illegal fishing (e.g. P. Selingan, P. Bakungan Kecil) with explosives are among the major causes of damage to coral reefs and associated seagrasses. In Sarawak, the known seagrass area of Punang-Sari-Lawas river estuary is a fishing ground for the traditional fishermen. The fish *Ilisha elongata* (locally known as Tahai) harvested from the seagrass area and adjacent areas is smoked and sold in the market.

Seagrass e.g. *Halodule pinifolia* when locally abundant can improve water quality of a particular environment. Such areas have been utilized for fish (*Lates calcarifer* and *Epinephelus sexfasciatus*) cage farming, for example at Pengkalan Nangka, Kelantan, and Gong Batu, Terengganu, which started in 1991, or oyster (*Saccostrea cucullata*) farming as at Merchang since 1998 (Japar Sidik et al., 1999a).

Very rarely is the seagrass ecosystem has a large number of mammals or reptiles. *Dugong dugon* (status: vulnerable, VU A1cd) and *Chelonia mydas* (green turtle, status: endangered, EN A1bd) are found associated and feed on seagrasses. Dugongs are common in the 50's and later became rare because they were hunted for meat and hide (Holttum, 1954). Presently dugongs are found in areas with abundant seagrasses such as P. Sibu, P. Tengah, P. Besar and P. Tinggi on the east coast and around Tanjung Adang-Merambong shoals of Sungai Pulai, Johore (Japar Sidik and Muta Harah, 2002). In Sabah, sighting reports and surveys conducted from interviews on fisherman and local villagers have indicated that dugongs are encountered occasionally in Tunku Abdul Rahman Marine Park (Jaaman, 2000). Other areas with possible viable populations are the shallow coastal waters from Semporna, Kudat, Kota Kinabalu, Sepangar bay, Sabah (Jaaman et al., 1997; Jaaman, 1999) to Lawas, Sarawak. Green turtles are abundant at Cagar Hutang, P. Redang, Peninsular Malaysia and in P. Selingan and P. Bakungan Kecil, Sabah. These areas are the nesting ground of turtles and the presence of seagrass meadows in the vicinity may serve as feeding ground.

Many bird species occasionally land on exposed seagrass areas along the shores. Wading birds, such as some of the herons and egrets, *Egretta garzetta* are occasionally seen feeding in seagrass areas e.g. Pengkalan Nangka, Kelantan, Tanjung Adang-Merambong shoals, Johore.

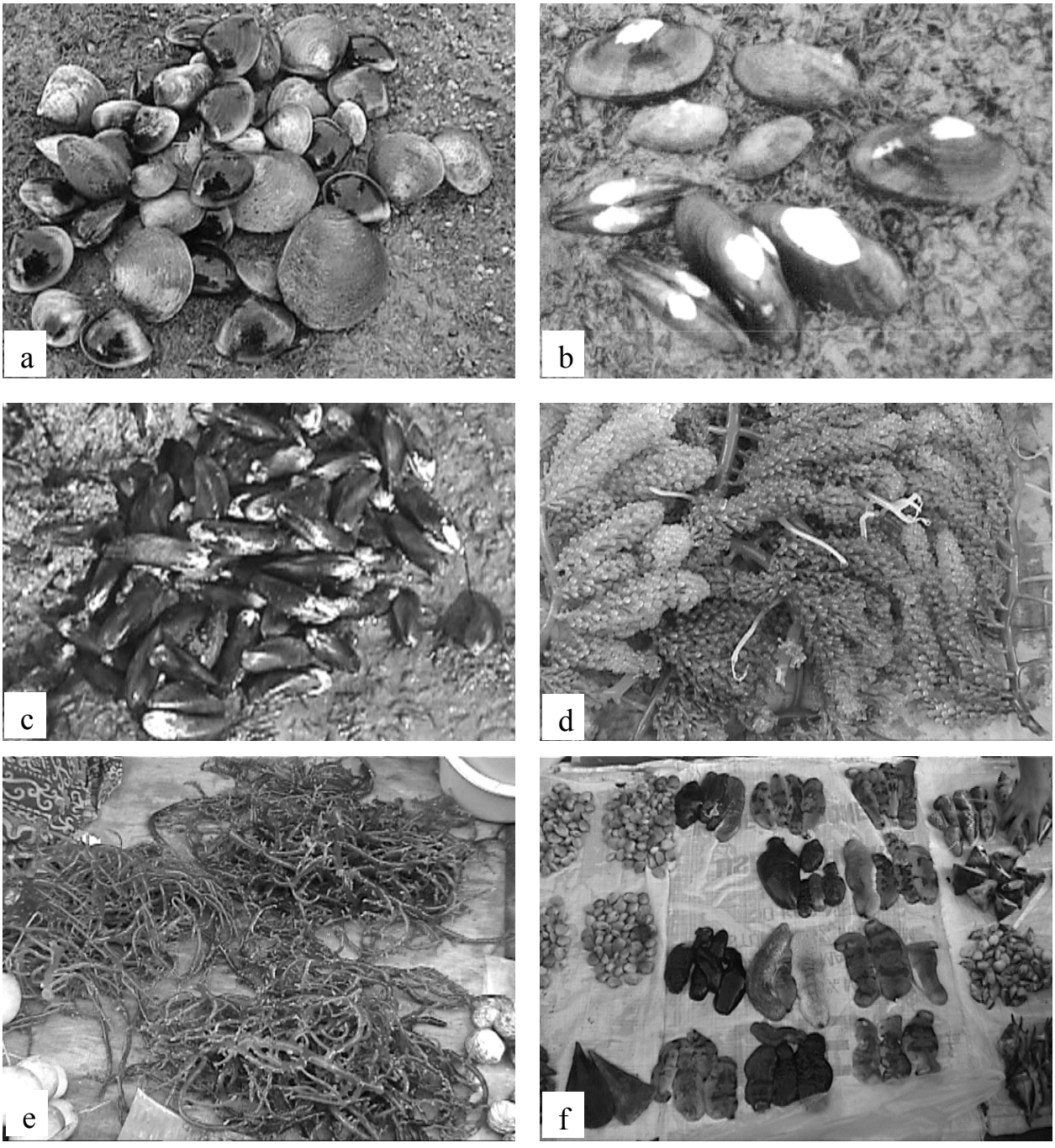

Figure 3. Food resources harvested from seagrass areas. Bivalves (e.g. a-*Meretrix-meretrix, b-Hiatula solida* are harvested at *Halophila beccarii* seagrass bed of Pengkalan Nangka, Kelantan; c-*Modiolus senhausii* is harvested at *Halophila beccarii* seagrass bed of Paka shoal, Terengganu). In Sabah, macroalgae (d-*Caulerpa* sp. and e-*Gracilaria* sp.) and assortments of invertebrates f-sea cucumbers, gastropods and bivalves are harvested from seagrass-coral reef associated ecosystems.

Seagrass protection and conservation

Seagrass ecosystems are teeming with life, providing essential habitat for associated fauna and algal flora. In addition given the importance of seagrass as fisheries habitat, nursery and feeding ground, this relatively lesser known resource must be afforded the same priority as well-managed as mangroves and corals to provide for future renewable resource utilization, education and training, science and research, conservation and protection. Seagrasses contribute to the coastal fisheries resources and biodiversity and, are valued by the local coastal communities. Continued human activities (Table 2) in the coastal areas threatened and caused degradation and possibly habitat loss of seagrass.

The protection and conservation of seagrass resources is not confined to managing the seagrass areas themselves. The management of seagrass resources requires efforts directed towards identifying, understanding and solving the natural and man-induced changes to seagrass resources. It is strongly recommended that seagrass ecosystem being an integral part of the larger marine ecosystem be given protection. Those around offshore islands that have been gazetted as marine parks (e.g. P. Redang, P. Perhentian of Terengganu, P. Tioman of Pahang, P. Tengah, P. Besar, P. Sibu, P. Tinggi of Johore) be given protection as marine parks or reserves under the Fisheries Act 1985. Under part IX, Act 4(1) and (2) of the Fisheries Act 1985 the Minister of Agriculture may order in the Gazette the establishment of any area or part of an area in Malaysian fisheries waters as a marine park or marine reserve in order to:

(a) afford special protection to the aquatic flora and fauna of such area or part thereof and to protect, preserve and manage the natural breeding grounds and habitat of aquatic life, with particular regard to species of rare or endangered flora and fauna;
(b) allow for the natural regeneration of aquatic life such area or part thereof where such life has been depleted;
(c) promote scientific study and research in respect of such area or part thereof;
(d) preserve and enhance the pristine state and productivity of such area or part thereof and
(e) regulate recreational and other activities in such area or part thereof to ovoid irreversible damage to its environment.

Furthermore:

4(2) The limits of any area established as a marine park or marine reserve under subsection (1) may be altered by the Minister by order in the Gazette and such order may also provide for the area or part of the area to cease to be a marine park or marine reserve.

Conclusions

The question of affording comprehensive protection to marine ecosystems gazette under the present Fisheries Act 1985 has been the subject of intense scrutiny by marine scientist, government officials and conservationists the bone of the contention being the separation of the land on islands gazette as marine parks and reserves from the waters surrounding the islands. Under these circumstances, while the authorities have powers to manage and enforce the marine park laws can do so at sea, they have no jurisdiction whatsoever over what happens on land.

This could be resolved based on practices adopted in Sabah Parks and the present trend of promulgating state parks enactment for the protection of ecosystems. At present, the Sabah Parks has under its auspices three marine protected areas: Tunku Abdul Rahman Marine Parks (part of P. Gaya, P. Manukan, P. Mamutik, P. Sapi and P. Sulug), Pulau Tiga Parks and Turtle Island Parks (e.g. P. Selingan, P. Bakungan Kecil) all harbour seagrasses and were gazetted as State Parks under the State Parks Enactment 1984. These parks are protected in their entirety without separating the marine and terrestrial components. Several states in Peninsular Malaysia have promulgated enactments for the gazettement of

state parks. Johore has gazetted the National Parks (Johore) Corporation Enactment 1991. Terengganu has a Terengganu State Parks Enactment. Concurrent gazettement of marine protected areas under both Federal and State Legislations using both The Fisheries Act 1985 to gazette the protection of the waters surrounding the islands as Marine Parks or Reserves, and State Park Enactments to gazette the terrestrial component of the marine protected areas as state parks should be practiced. The above policies can be applied for the management of marine protected areas in Peninsular Malaysia.

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