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A Review of Seagrass Communities in Singapore

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ABSTRACT

The seagrass communities in Singapore were not studied in depth until the ASEAN-Australia Living Coastal Resources Project. The last known work on seagrass communities was in 1973. To date, seven species of seagrasses have been observed. The study of associated fauna recorded 13 fish and 23 mollusc species. Productivity studies conducted on *Enhalus acoroides* gave a value of 6.03 $mMolO_2cm^2day^1$ for gross 24 hour production ($P24_{(gross)}$).

INTRODUCTION

Seagrass beds are an important ecosystem. They are amongst the most productive of submerged aquatic ecosystems (Zieman & Wetzel 1980; Hillman *et al.* 1989) and are rich in marine fauna. With their complex structure, they provide habitats and shelter from predation for many invertebrates and fishes (McRoy & McMillan 1977; Zieman & Wetzel 1980). Seagrasses constitute a major food source in detrital based food chains and also provide a direct food source for grazing animals. Together with the mangrove and coral reef ecosystems, they form a network for the transfer of organic and inorganic materials and for the seasonal migration of animals, depending on their life cycle (Thorhaug 1981). They also serve as important nursery grounds for many reef animals, including commercially important prawns and fish (Bell & Pollard 1989). In addition, their extensive root system help to stabilise sediments, and thus contribute to the control of coastal erosion and siltation of reefs.

The seagrass communities in Singapore have never been studied in depth until recently. Earlier work on seagrass communities in Singapore were limited to passing references and qualitative observations of the seagrasses themselves (Chuang 1961, 1973; Johnson 1973). These reports showed that the seagrasses were common between late 1950's and the early 1970's, on reef-flats and the intertidal zones.

Organisms closely associated with the seagrass *Enhalus acoroides* were studied in detail by Itoggi (1971) and Low (1973). Itoggi studied the prawn *Periclimene indicus* and Low studied the molluscs of *Enhalus* beds.

Under the ASEAN-Australia Marine Science Project: Living Coastal Resources, different aspects of seagrass ecology and biology were studied. These include quantitative and qualitative assessments of their distribution and associated fauna. Preliminary energetics studies (basically productivity) have also been initiated.

STATUS REPORT

Species distribution and biomass

Chuang (1961) and Johnson (1973) recorded three species of seagrasses, namely *Enhalus acoroides, Cymodocea rotundata* and *Halophila ovalis* at Kranji and West Johore Strait. From quadrat studies carried out under the ASEAN-Australia Living Coastal Resources Project, two additional species, *Halophila minor (H. ovata)* and *Halophila spinulosa*, were recorded from locations south of the main island of Singapore which

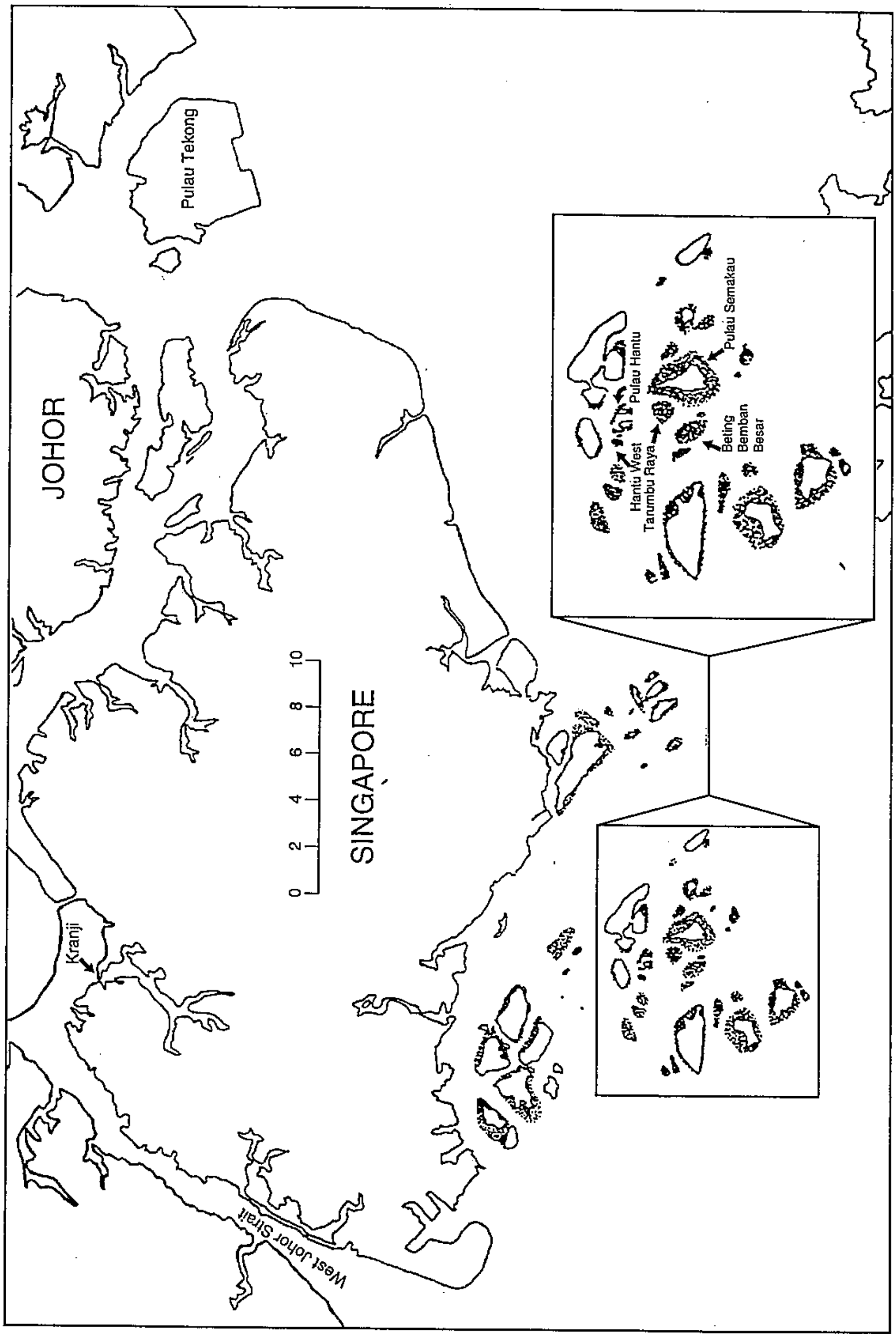

Figure 1. Map of Singapore showing locations where seagrasses have been observed.

included Pulau Hantu, Pulau Semakau, Terumbu Raya (patch reef) and Hantu West (patch reef) and Pulau Tekong, located in the north (Hsu & Chou 1989a&b). Visual observations were also made of two other species, *Halodule uninervis* at Changi beach and *Cymodocea serrulata* at Beting Bemban Besar (patch reef) (Fig. 1).

Zonation of the seagrasses was noted by Chuang (1961), who found that *Halophila ovalis* formed thick carpets at the low neap tide level, and favour mud-sand soil for growth. These are hardy plants, however, and can withstand exposure to air. *Enhalus acoroides* and *Cymodocea rotunda* are the dominant plants below the mean low water spring tide, and are always submerged in water. These plants prefer muddy substrates and sheltered locations.

Seagrasses in Singapore no longer form extensive beds. Instead, they occur in isolated patches and their distribution is limited to the reef-flat and upper reef-crest zones. The lower limits of seagrass distribution is dependent upon their photosynthetic ability, which in turn is dependent upon the availability of photosynthetically active radiation (PAR), and the amount of PAR at any depth is a function of the light attenuation of the water body. Singapore waters are highly sedimented (Low & Chou 1994), and this reduces the penetration of light tremendously. Light attenuation in Singapore waters were measured at 0.47 (Tun *et al.* 1994a), which is high compared to waters of other regions (Cheshire & Wilkinson 1991). Thus, the availability of PAR, together with the added stresses imposed by sedimentation, exposure to air during low tides and land reclamation have drastically reduced the distribution and abundance of seagrasses in Singapore waters.

Work on seagrass biomass has so far been limited to studies on *Enhalus acoroides* (Hsu & Chou 1989b). The work was done at four sites, and the average shoot biomass ranged from 112.8 to 173.4 g dry weight m^{-2} while the average rhizome biomass ranged from 239.7 to 387.6 g dry weight m^{-2}. Studies by Fortes (1982) have shown that seagrasses contribute a large portion (in the form of litter production) of the carbon pool of the surrounding waters and associated ecosystems. This may not necessarily be the case for Singapore, given the low seagrass abundance and biomass in these waters.

Associated fauna

Studies on organisms associated with seagrasses has been limited. Itoggi (1971) researched the shrimp *Periclimenes indicus* found in *Enhalus* beds at the reef flat of Pulau Hantu. Low (1973) recorded 22 species of molluscs in *Enhalus* beds. These studies were conducted before development of the island, which involved the reclamation of the reef flat and the lagoon separating P. Hantu Besar and P. Hantu Kechil. Itoggi (1971) reported luxuriant *Enhalus* growth on the sub-littoral zone.

Fifteen years after the seagrass beds were devastated, Loo *et al.* (1990) studied the distribution of the seagrasses that had regenerated within the lagoon, and its fish community. They found that *Enhalus acoroides* was the dominant species, growing in patches inside the lagoon, with isolated patches of *Halophila ovalis.* Thirteen fish species from nine families, mostly juveniles, were observed (Table 1).

Productivity

To date, the only productivity work done on seagrasses has been on *Enhalus acoroides.* Whole plant specimens (i.e. shoots, rhizomes and roots) of *E. acoroides* were obtained from a reef-flat fringing Pulau Hantu, an island south of mainland Singapore and the photosynthetic production and respiration of four replicate samples were determined *in situ* using an automated respirometer (Tun *et al.* 1994b). Maximum instantaneous gross production ($Pm_{(gross)}$) and respiration (Rd) were measured at 30.98 and 2.57 $\mu molO_2cm^{-1}$ min^{-1} while gross 24 hour production ($P24_{(gross)}$) and respiration (Rd24) were 6.03 and 3.01 $mMolO_2cm^2day^1$ respectively. These gave ratios for instantaneous $Pm_{(gross)}$/Rd and $P24_{(gross)}$/Rd24 of 11.1 and 2.6 respectively.

Table 1. Species of molluscs and fish observed at *Enhalus* beds at Pulau Hantu, Singapore (from Low 1973; Loo *et al.* 1990).

Family	Species	Family	Species
FISH		MOLLUSCS	
Apogonidae	*Apogon* sp 1 (juvenile)	**Gastropods**	
Bleniidae	*Petroscirtes* sp 1	Trochidae	*Trochus* sp
	Blenny sp 1	Neritidae	*Clithon oualaniensis*
Gerridae	Gerrid sp 1	Cerithiidae	*Cerithium coralium*
Gobiidae	*Amblygobius* sp 1		*Cerithium* sp.
	Goby sp 1	Strombidae	*Strombus urceus*
Labridae	*Choerodon anchorago* (juv)		*Strombus isabella*
	Halichoeres chloropterus	Pyrenidae	*Pyrene philippinarum*
	Halichoeres scapularis		*Pyrene versicolor*
Monachanthidae	*Monacanthus* spp		*Pyrene mytriformes*
Nemipteridae	*Pentapodus canius* (juv)	Nassidae	*Nasa hepaticus*
Nettastomatidae	sp 1	Melongenidae	*Melongena pugilina*
Pomacentridae	*Dishistodus prospotaenia* (adult/juv)	Muricidae	*Drupa margariticola*
		Volutidae	*Voluta nobilis*
		Aplysiidae	*Aplysiella* sp.
		Bivales	
		Arcidae	*Anadara auriculata*
			Anadara granosa
			Anadara antiquata
		Pinnidae	*Pinna atropupurea*
			Atrina pectinata
		Mytilidae	*Perna viridis*
		Veneridae	*Anomalocardia squamosa*
			Gafarium tumefactor

THREATS TO SEAGRASS RESOURCES

Singapore embarked on an extensive land reclamation programme in the 1960's, which modified the coastline of the main island and a few of the southern islands. This resulted in the destruction of the extensive fringing reefs along the south coast. Such activities have also longer, more chronic effects - the increase in the sedimentation load of the water effectively decreases light penetration, resulting in the eradication of much of the seagrass beds from deeper coastal zones. No surveys of seagrasses were made prior to the reclamation and thus, it is not possible to quantify the effect of such impacts.

Singapore boasts of having one of the busiest ports in the world. With more than 300 merchant ships and many more leisure craft plying her waters daily, the impacts of such heavy shipping activities are detrimental to seagrass ecosystems and have been implicated in the loss of seagrasses (Thorhaug 1981) and their associated flora and fauna. Oil spills, cropping by propellers of smaller craft and the stirring up of sediments are but a few effects of such activities.

Urban Singapore depends greatly on industry for its economic stability; one of them being the petro-chemical industry. Since many of the petro-chemical refineries are situated on the southern islands, they thus pose a potential threat (oil spills/leaks, heated water discharge, industrial discharges, etc.) to marine habitats in the surrounding coastal waters.

With an ever increasing population producing huge quantities of refuse, sites currently in use as refuse dumps are quickly being filled. This, coupled with an acute shortage of land, has prompted the government to earmark an area east of Pulau Semakau as a land-fill for refuse dumping, thus resulting in the obliteration of seagrasses found there.

The loss of seagrass beds has had little observable impact, despite its importance to fisheries as nursery grounds (Wood *et al.* 1969). This is due to the near non-existence of commercial fisheries in Singapore waters. There has been a reduction in subsistence fishing (Tham 1973), but there was no evidence to link this with the degradation of seagrass beds, whereas increased economic activity and the availability of more lucrative employment are more likely reasons.

MANAGEMENT

The importance of seagrass ecosystems as a sustainable resource has not been recognised yet. As such, no management plans for the conservation of existing seagrass stands or the restoration of denuded beds have been initiated. For successful management of this rapidly deteriorating ecosystem, better knowledge and understanding of the biology is needed (this includes systematics, ecology, symbioses, response/s to the environment as well as to natural and anthropogenic threats). With an estimated recovery period of 5-15 years (Patriquin 1975), plans for the protection of this important ecosystem must be implemented soon, if healthy seagrass beds are to remain part of Singapore's natural heritage.

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