Preliminary observations on the seagrasses of Lampi and neighbouring islands of The Myeik Archipelago, Myanmar

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ABSTRACT
Nine species of seagrass were found around Lampi and neighbouring islands of the Myeik Archipelago, Myanmar. Those species were *Cymodocea rotundata*, *Cymodocea serrulata*, *Enhalus acoroides*, *Halodule pinifolia*, *Halodule uninervis*, *Halophila beccarii*, *Halophila decipiens*, *Halophila ovalis* and *Thalassia hemprichii*. Meadows occurred on the east side of islands on flats inshore of coral reefs where they were sheltered from the monsoons. The largest meadows occurred on the eastern sides of Nyaung Wee, Bo Cho and Lampi Islands, and were mixed intertidal meadows with up to six species, not including *E. acoroides* or *H. decipiens*. The former was concentrated around the Ko Phawt Island group and the latter occurred in clear water greater than five metres deep on the west side of Nyaung Wee Island. The size of the most significant meadow at Lampi Island was estimated to be 28 hectares. Estimates were made of percent seagrass cover along transects across that meadow. Sampled sites with seagrass averaged 43% cover, including 27% *C. rotundata*, 11% *T. hemprichii*, 5% *H. ovalis*. Dugong feeding trails were found in dense patches of *H. ovalis* in March 2008 at Lampi, and at both Nyaung Wee and Lampi Islands in November 2008. Those trails are the first concrete evidence of the occurrence of a resident dugong population in the Myeik Archipelago.

KEYWORDS: seagrass, Lampi Island, Myeik Archipelago, Myanmar

INTRODUCTION

Lampi Island (also known as Sullivan Island or Kyunn Tann Shey Island) is in the Myeik (Mergui) Archipelago, southern Myanmar. Lampi Island was designated as a Marine National Park in 1996 and details of it are described in Box 1. The waters around Lampi Island, and associated islands of the Myeik Archipelago, are known to support a diversity of tropical marine habitats, including coral reefs and mangroves. However, anecdotal evidence suggested that seagrasses were not particularly common in the area, and there has been little published evidence of them in the area (Soe-Htun *et al.*, 2001).

Seagrasses are food for dugongs (*Dugong dugon*) and green turtles (*Chelonia mydas*), both of which are considered endangered, and are the objects of major conservation efforts. Seagrass meadows are also important habitat for fish and invertebrate species that are exploited by local fishermen. They are one of the world's most productive habitats. A study of the economic value of ecosystem services provided by various habitat types (Costanza *et al.*, 1997) found that seagrass meadows are more valuable per hectare than mangroves or coral reefs. To assess the importance of seagrasses in the Lampi area, it was first necessary to record the occurrence of the species and to map the location of any meadows. Secondly, we have begun the process of measuring the size, composition and density of the meadows we found, in order to evaluate their ecological and conservational value.

Box 1. Lampi Island.

National Designation : *Marine National Park*
Status : *Designated*
Established : *1996*
Area : *20461 ha*
Length & Width : *49.9 km & 11.3 km*
Latitude / Longitude : *10° 41'N -10°49'N*
98° 04'E–98°18'E
IUCN Category : *Ib, wilderness area*
International Status : *ASEAN Heritage Park*
Location : *Myeik Archipelago, Bokepyin Township, Tanintharyi Region*
Main protection : *Coral reefs, mouse deer and Salon ethnic culture*

METHODS

The location and species composition of seagrass meadows were recorded in 2008 during sailings of the Sea Nomad, the vessel of the Mergui Archipelago Biodiversity Research Programme. It sailed around Lampi Island and the neighbouring islands of Wa Ale (Blunt) Island, Bo Cho (Pulo Nala or Eyles Island) Island, Ko Phwat Island (Kubo Island) group and Nyaung Wee (Pulau Bada or Sir Wm James) Island. Lampi Island is uninhabited, and is remote and undeveloped. There are only two

permanent settlements on the other islands, at Nyaung Wee and Bo Cho (pop. 116 and 295 respectively).

Seagrasses were recorded during four trips before the rainy season, from January to April, and two trips in November, 2008, following the rainy season. Sites were examined where it was thought that seagrasses might occur, and when time and access permitted. They were examined by foot at low tide, or by kayak and snorkeling over shallow water. The examined sites were usually intertidal, but included the upper reaches of the subtidal zone. Whenever seagrasses were encountered, specimens were taken and identified to species following Waycott *et al.* (2004) . The location of the site was recorded and later entered on maps of the area. Any evidence of dugong feeding trails was photographed. It was not possible to examine the total coastline of Lampi and neighbouring islands. However, a large number of sites were examined, and it became possible to characterize sites where seagrasses were found, and to anticipate other suitable sites.

One meadow on the east coast of Lampi Island, in the 'second bay' (Ke Aw), was chosen for detailed mapping. It was chosen because it was the most ecologically significant meadow. It had the greatest number of seagrass species, evidence of feeding by dugongs, a large population of sea cucumbers, and is within the area designated as national park. To calculate the area of the meadow, GPS (Global Positioning System) readings were taken at regular intervals while walking around the complete perimeter of the meadow. The readings were taken in March, near the end of the dry season, when the meadow was likely to be at its greatest extent. Those positions were mapped and the area of the meadow calculated using an image analysis program.

Seagrass meadows differ in both density and relative species composition. To measure those differences, percent cover was used as a measure of seagrass abundance. At 'second bay' (Ke Aw) on Lampi Island, estimates of percent cover were made at sites along transects following the mapping technique proposed by Seagrass Watch (McKenzie, 2003). Parallel transects, 100 m apart, were walked in an east-west direction across the meadow using a compass. Distances were estimated from the number of paces known to traverse a given distance. Sampling sites occurred at 50 m intervals along each transect. The location of each site was determined using GPS and recorded on data sheets. A quadrat was thrown down at the site, and two others were tossed haphazardly, one to the right and the other to the left of the first. The quadrats were 50 X 50 cm, and made of 5 mm diameter stainless steel rod. Each of the three quadrats at the site was scored for percent seagrass cover using the photographic sheets of Seagrass Watch. They show typical quadrats for which the cover has been calculated across a range of values. The species within the plot were identified, and the percent contribution of each species to the total cover was estimated and recorded. The percent cover sheets, data sheets, and procedure manuals are available for download at www.seagrasswatch.org. Unfortunately, due to a lack of time and difficult weather conditions, it was not possible to completely map the meadow at 'second bay' (Ke Aw).

Table 1. Seagrass species observed at Lampi and neighboring islands. (Abbreviations of species names in brackets. Gray box represents occurrence and white box represents absence)

	Lampi island	Wa Ale island	Ko Phawt island	Bo Cho island	Nyaung Wee island
Cymodocea rotundata (Cr)	■	■	■	■	■
Cymodocea serrulata (Cs)	■				
Enhalus acoroides (Ea)	■	■	■		
Halodule pinifolia (Hp)	■				
Halodule uninervis (Hu)	■		■	■	■
Halophila beccarii (Hb)	■				
Halophila decipiens (Hd)					■
Halophila ovalis (Ho)	■		■	■	■
Thalassia hemprichii (Th)	■		■	■	■

RESULTS

Nine seagrass species were recorded, as listed in Table 1. The dominant species at most sites was either *Cymodocea rotundata* or *Thalassia hemprichii* (Fig. 1). *Halophila ovalis* was common, but was rarely dominant. *Halodule uninervis* was also widespread, but never abundant. The closely related narrow-leaved species, *Halodule pinifolia*, formed isolated patches at a few exposed sandy sites. *Enhalus acoroides* was common around the Ko Phawt Island group (Fig. 2), but elsewhere was found only as isolated patches. *Cymodocea serrulata* and *Halophila beccarii* were found at only one site, 'second bay' (Ke Aw) on the

east of Lampi Island (Fig. 3). The later species was found only in small patches, high in the intertidal zone on muddy sediment, apart from other species. *Halophila decipiens* was found once in clear water at a depth of approximately 5 m at ebb tide on the west side of Nyaung Wee Island (Fig. 4).

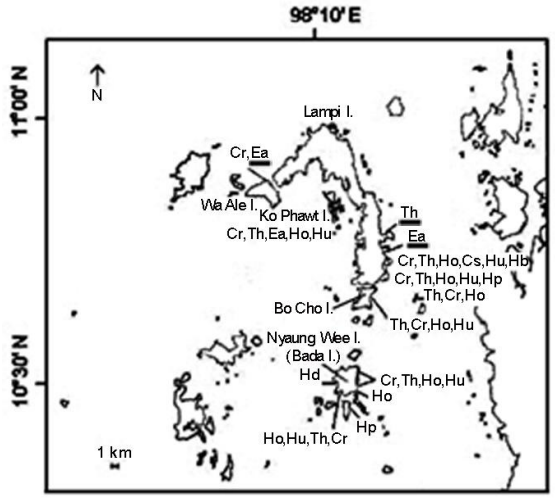

Fig. 1 Distribution of seagrass species around Lampi and neighbouring Islands. Underlined abbreviations indicate a small patch covering an area less than approximately 5 m^2. Abbreviations are ordered according to their approximate relative abundance at the site. Abbreviations as in Table 1.

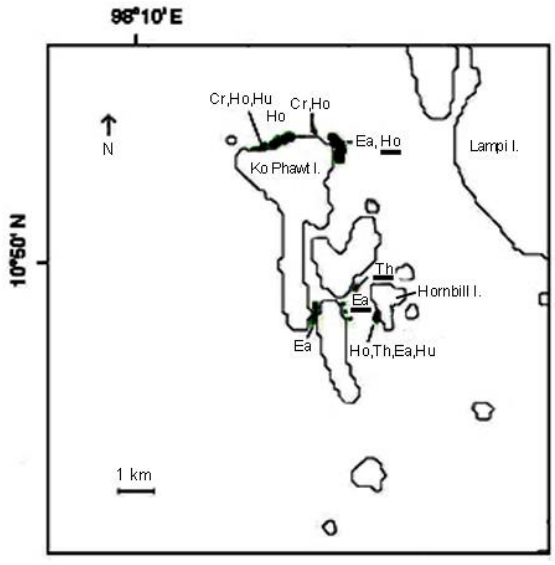

Fig. 2 Details of the distribution of seagrass meadows and species around the Ko Phawt island group. Abbreviations as in Table 1

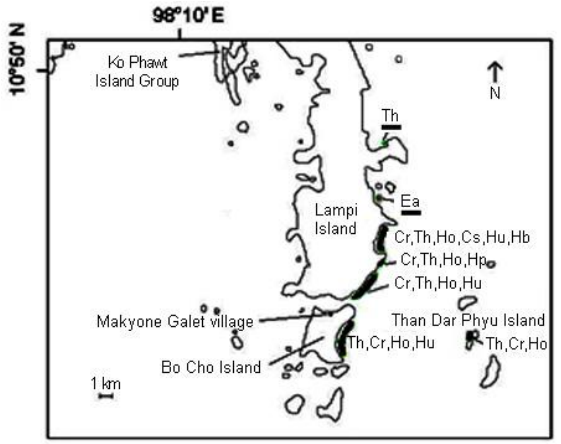

Fig. 3 Details of the distribution of seagrass meadows and species around southern Lampi and Bo Cho islands. Abbreviations as in Table 1

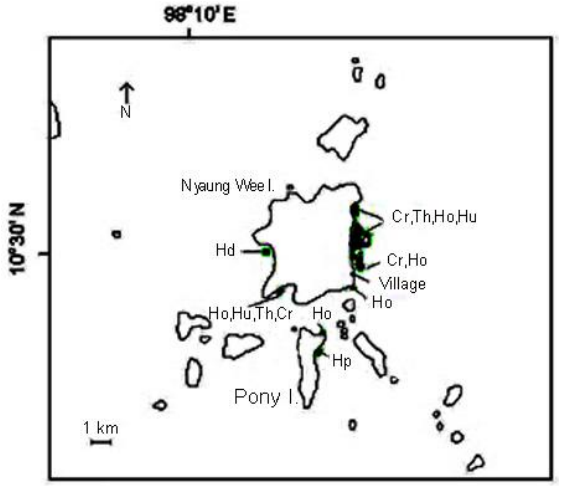

Fig. 4 Details of the distribution of seagrass meadows and species around Nyaung Wee (Bada) Island. Abbreviations as in Table 1

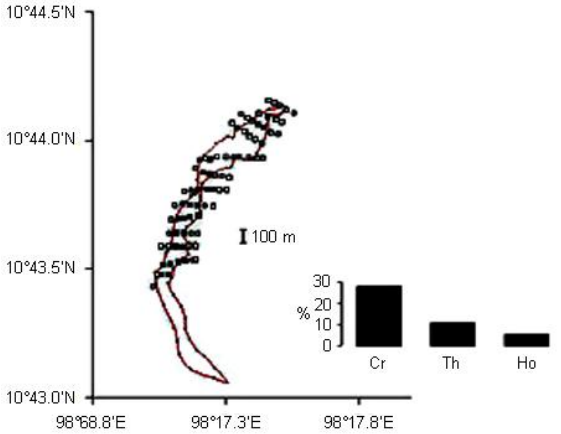

Fig. 5 Outline of seagrass meadow at 'second bay' (Ke Aw) Lampi Island in March 2008 with location of sampling sites (squares) on transects in November 2008. Blackened sites contained seagrass in

quadrats. Histogram shows percent species cover averaged over the 24 sites with seagrass. (Cr=*Cymodocea rotundata*, Th=*Thalassia hemprichii*, Ho=*Halophila ovalis*)

Seagrass meadows were usually found on the east side of islands where they were sheltered from the southwest monsoon which brings strong storms across the Andaman Sea from May to September. During other times of the year, winds are milder and tend to come from the northeast. The largest seagrass meadows occurred on the east sides of Nyaung Wee (Bada), Bo Cho, and Lampi islands, where there are coral reefs which form a partial barrier to waves from the east. Behind those reefs there are flats that gently slope to sandy beaches, so that the seagrass occurs in an intertidal band between the reef and the beach. On the outer edge of the meadows, toward the reefs, the seagrass is less dense, and is scattered amongst coral rubble, macrophytic algae, and patches of bare sand. Toward the beach, the seagrass becomes denser, and there was often a sharply defined border between the meadow and the bare sand of the beach.

The coastal strip of seagrass on Lampi Island appears to be restricted to its southeast corner. Bays to the north were explored in November 2008, but only isolated patches of seagrass were found. Those bays appear to have some of the same characteristics as bays with seagrass, in that they have extensive well-sheltered intertidal areas. However, they also had very turbid water and soft sediments that were readily suspended by wave action.The largest seagrass meadow occurred along the east coast of Nyaung Wee (Bada) Island, where there is a broad intertidal shelf approximately 3 km long and up to 500 m wide (Fig. 4). The meadow at 'second bay' (Ke Aw) on Lampi Island formed a narrower band 2.5 km long around the inside of the bay. The area of that meadow was estimated to be 28 ha in March 2008. Seagrass cover was estimated at 77 sites in November along transects that crossed the area of the meadow. Of those sites, 24 had seagrass. The occurrence of seagrass at the sites conformed well to the outline of the meadow drawn from the earlier data (Fig. 5).

However, the distribution appeared to be quite patchy in the northern part of the meadow, which also had a slightly higher elevation and greater tidal exposure. The percent seagrass cover, averaged over the three quadrats at each site, varied from <1% to 80%. The average cover over the 24 sites with seagrass was 43%, which included 27% *Cymodocea rotundata*, 11% *Thalassia hemprichii*, and 5% *Halophila ovalis*. The remaining three species known to occur in the bay, *Halodule uninervis*, *Cymodocea serrulata*, and *Halophila beccarii*, did not occur in the quadrats.

Clear evidence of dugong feeding was first seen in March 2008 (Fig. 6) in the meadow at 'second bay' (Ke Aw) Lampi Island. In November 2008, more feeding trails were observed (Fig. 7) and photographed in the meadow on the east side of Nyaung Wee Island and again at 'second bay' (Ke Aw). All trails were in dense patches of *Halophila ovalis* and tended to be high in the intertidal zone.

Fig. 6 Dugong feeding trail through a patch of *Halophila ovalis* at Lampi Island, March 2008

Fig. 7 Dugong feeding trails through a patch of *Halophila ovalis* at Lampi Island, November 2008

DISCUSSION

More seagrass was found in the Myeik Archipelago than had been initially anticipated. Although intertidal seagrass is uncommon along the well-travelled western coast of Lampi and neighbouring islands, it was common on the lesser-known eastern shores. Its absence from the west likely reflects exposure to the southwest monsoon. The large meadows on the east are associated with barrier reefs (Fig. 8) that provide some protection from the milder northeast monsoon.

Most meadows in the Lampi area are characteristic of the 'reef' habitat type that was one of four seagrass habitat types described in northeastern Australia by Carruthers *et al.* (2002). They considered reef associated meadows to be highly biodiverse, and sometimes highly productive, although limited by low nutrient availability. In the Lampi area, meadows are less likely to be as nutrient limited as those on Australian reefs because they are closer to a continental shoreline that receives high annual rainfalls and nutrient inputs from large river systems.

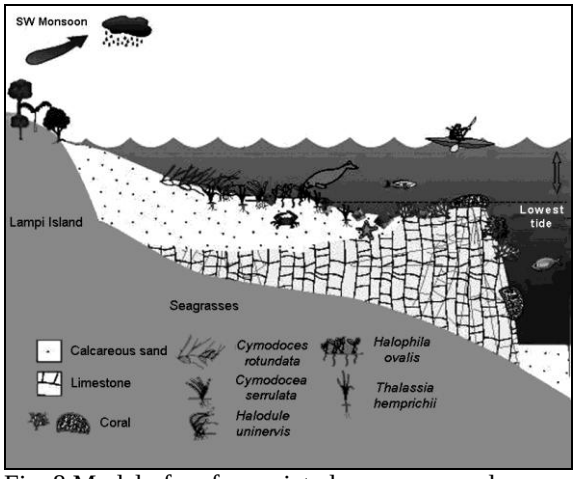

Fig. 8 Model of reef associated seagrass meadow on east coast of Lampi Island. Symbols for diagram courtesy of the Integrated and Application Network (ian.umces.edu/symbols), University of Maryland Center for Environmental Science

Intertidal seagrass meadows in the Myeik Archipelago are dominated by *Cymodocea rotundata* and *Thalassia hemprichii*, species characteristic of reef habitats. In coastal regions of Myanmar, other species can be expected to dominate, although the list of species from those areas will be similar to that found here (Soe-Htun et al. 2001). Ten seagrass species are know from Myanmar, and all of them have been recorded from the Myeik Archipelago, including *Syringodium isoetifolium* (Soe-Htun *et al.*, 2008), which was not recorded in this study.

Along the Andaman coast of Thailand, seagrasses are sometimes associated with mangroves (Poovachiranon and Chansang, 1994). Around Lampi, mangroves areas have been fully explored
and there was little evidence of their co-occurrence with seagrasses. In Thailand, the dominant seagrass in meadows associated with mangroves was *Enhalus acoroides*, the largest tropical seagrass species. It is also associated with estuarine habitats (Carruthers *et al.*, 2002), and seems particularly tolerant of turbid habitats. At Lampi a small patch of *E. acoroides* occurred in the muddy bay (Bulet Aw) north of 'second bay' (Ke Aw), and in a muddy channel draining a mangrove area at Ko Phawt. Terrados *et al.* (1998) studied seagrass species diversity and biomass along gradients of siltation in Southeast Asia and found that they declined sharply with increased silt and clay content in the sediments. They considered *E. acoroides* to be most tolerant of siltation, while *Cymodocea rotundata* was amongst the least tolerant. The absence of seagrass in somebays on the east coast of Lampi Island is possibly the result of siltation. The occurrence of seagrasses along the coast of Myanmar is likely limited by high rates of siltation from coastal rivers. They are absent from the Ayeyawady delta region (Soe-Htun *et al.*, 2001).

Although intertidal seagrass was restricted to the east coasts of islands, the species *Halophila decipiens* was found in subtidal waters on the west coast of Nyaung Wee Island. It is a species usually found in clear deep waters (Durako *et al.*, 2003), and has been found at >50 m deep in Australia (Lee Long *et al.*, 1996). Deepwater seagrass meadows of mixed *Halophila* spp. have been described elsewhere in the world (Kenworthy, 2000; Lee Long *et al.*, 1996), but have received little attention in southeast Asia. Chansang and Poovachiranon (1994) described three meadow types occurring in Thailand: mangrove associated, reef associated, and those on shallow sandy bottoms. However, they did not mention deepwater meadows. That may reflect the low occurrence of such meadows because of poor water transparency and siltation, or the difficulties of observing and studying deep habitats. If extensive meadows exist in deeper waters on the western side of the Myeik Archipelago, they may have significance as feeding areas for dugongs.

Seagrass biomass in the Lampi area meadows appears to be low near the reef edge and to increase up the slope of the flat until it became too exposed. That pattern may be the result of feeding by animals that take shelter in the reef. In the Caribbean patches of reef that are surrounded by seagrass develop 'halos' of bare sand around the edge that are the result of feeding by reef associated fishes, such as parrot fish (Randall, 1965), and urchins (Ogden *et al.*, 1973). In the Lampi area, high densities of the black needle-spined urchin, *Diadema setosum*, can be easily observed in subtidal areas. Urchins are important grazers of seagrass in some tropical waters (Klumpp *et al.*, 1993; Valentine *et al.*, 2000), and high densities are thought to be related to over-fishing of their natural predators (Carreiro-Silva and McClanahan, 2001; McClanahan *et al.*, 1994). In the Lampi area, urchins are a potentially important limiting factor for seagrass development in subtidal areas.

The observation and photographing of dugong feeding trails during this study is the first concrete evidence that the Myeik Archipelago supports a resident population of dugongs. Feeding trails were found in two different meadows at two times of year. They occurred in dense turf-like growth of *Halophila ovalis*. Although dugongs feed on all other tropical seagrasses (Lanyon *et al.*, 1989), that species is its preferred food (Preen, 1995). It feeds on the whole plant of *H. ovalis*, including roots, and so produces distinctive feeding scars in the meadow where that species grows densely.

One of us, Tint Tun, also heard evidence of the existence of dugongs from local people during interviews. Dugongs are known to occur on the Rakhine coast (Ilangakoon and Tun, 2007), and in neighbouring areas of Thailand (Hines *et al.*, 2005), but are rare and endangered throughout the region. The number and size of the meadows we observed in the Myeik Archipelago suggests that there is enough seagrass in the area to support a small population. Individual meadows are small however, as they occupy thin coastal strips behind coral barrier reefs. In contrast, the coastal meadows that support the largest dugong populations in Thailand are several square kilometers (Chansang and Poovachiranon, 1994). The meadows of the Myeik Archipelago are also likely to be important food for green turtles, especially given the abundance in the meadows of *Thalassia hemprichii*, their preferred food.

CONCLUSIONS

The Myeik Archipelago has a rich seagrass flora which forms significant meadows in sheltered areas on the east coasts of the larger islands. The distribution of seagrass is limited by the availability of sites sheltered from monsoons. However, seagrasses are also limited by human mediated factors, such as the siltation of some bays on the east coast of Lampi Island, and over-fishing which enhances urchin populations that are major grazers of seagrasses. The meadows of the Myeik Archipelago are a unique reef associated habitat that differs from meadows in coastal habitats. Reef associated habitats have high biodiversity. Feeding trails of dugongs were observed and photographed for the first time, demonstrating the existence of a resident dugong population. The meadows are also likely sites for feeding by green turtles. Some of the meadows are in an area already designated as a national park, and so there may be an opportunity to actively conserve and protect them from future exploitation.

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