THE NAGISA WORLD CONGRESS: 53-64, 2009

Baseline Assessment of Seagrass Communities of Lubang and Looc Islands, Occidental Mindoro, Philippines

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Abstract The Lubang and Looc Islands in Occidental Mindoro are located west and form part of the Verde Island Passage (VIP), an ecologically important corridor linking the South China Sea and the Philippine internal waters. The VIP has also been labelled as a regional hotspot for tropical marine biodiversity, highlighting the need for management and conservation efforts that are science-based. Thus, this assessment was done to provide baseline data on the seagrass beds of the Lubang and Looc Islands.

Thirteen sites were surveyed around the Lubang and Looc Islands, Occidental Mindoro on April 13 - 17, 2009. The seagrass beds are generally multispecific meadows that are characterized by both continuous and patchy meadows, with cover ranging from 0.62% to 59.49%. Eight seagrass species were observed, with *Thalassia hemprichii and Cymodocea rotundata* the most ubiquitous. Shoot densities observed in the area are generally high (mean = 961 shoots$\cdot$m^{-2}), and composite leaf biomass (mean = 212.70 gDW$\cdot$m^{-2}) is comparable to other seagrass beds surveyed in other sites in the country.

The observed "kaingin" practices in the uplands pose the greatest threat to the seagrass ecosystems of the area because of the long-term domino effect of erosion and sedimentation on the seagrass beds. However, fisheries practices also need to be quantified to determine hierarchy of anthropogenic disturbance that causes habitat fragmentation of the seagrass beds of Lubang and Looc Islands.

Key words: Lubang and Looc Islands, multispecific, shoot density, leaf biomass

Introduction

Seagrasses are a prominent component of Philippine coastal ecosystems (Fortes, 1995). They are biota and habitat in one, as they naturally and simultaneously function both as primary producers and structural species. Consequently, they form ecosystems of great physical, biological, and economic importance (Baron et al., 1993), as they sustain a diversity of fauna, act as nutrient sinks and sedimentation buffers, and generally support important human exploitation (Hirst and Attrill, 2008; van Houte-Howes et al., 2004; Paula et al., 2001). Moreover, precisely because they are ecological constants of shallow coastal areas, they are rendered vulnerable to habitat fragmentation and sediment loading mostly brought about by anthropogenic activities (Hirst and Atrill, 2008; Tanner, 2005; Fortes & Santos, 2004).

The ecological importance of seagrass habitats has long been recognized (Frost et al., 1999). However, their conservation and management in the country are not at par because of gaps in

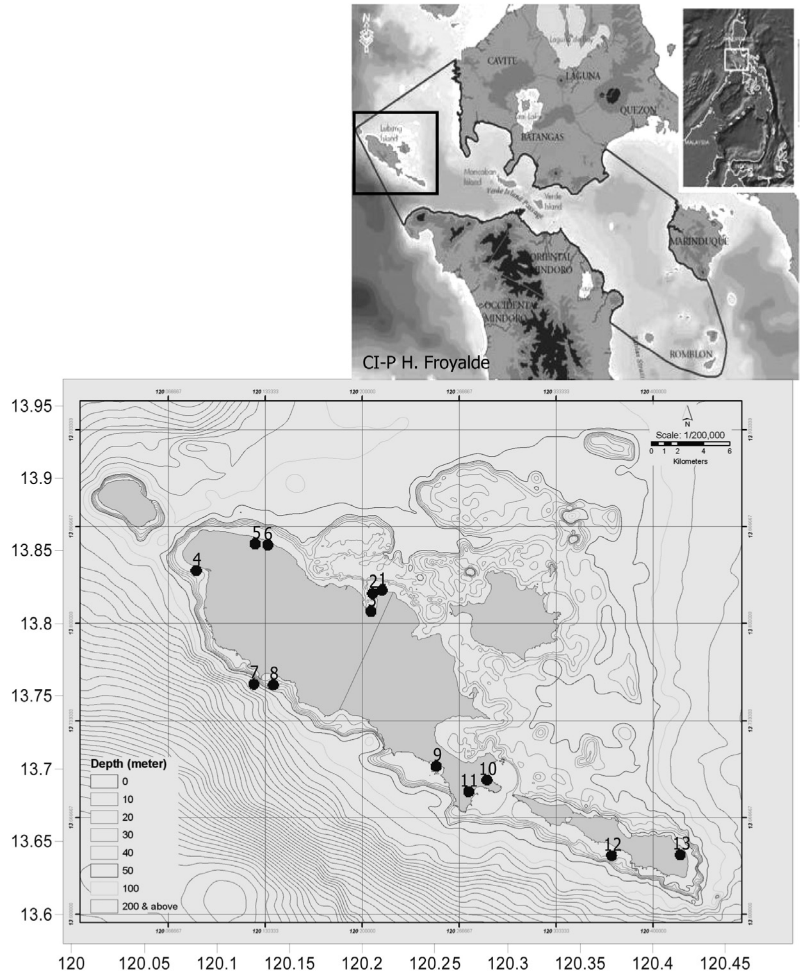

Fig. 1. Map of seagrass sites surveyed in Lubang and Looc Is., Occidental Mindoro, April 2009.

systematic and comprehensive data gathering and clear policy objectives on seagrass communities (BINU, 2005), as well as a lack of appreciation of the resources (Fortes & Santos, 2004).

The objective of this study was to provide baseline assessment of the seagrass beds in Lubang and Looc Islands, Occidental Mindoro, Philippines. These islands are located west and form part of the Verde Island Passage (VIP), which is an ecologically important corridor linking the South China Sea and the Philippine internal waters. The VIP has also been labelled as a regional hotspot for tropical marine biodiversity, thus highlighting the need for management and conservation efforts that are science-based.

Materials and Methods

Study area and sampling

The study was conducted in 13 sites in Lubang and Looc Islands, Occidental Mindoro, Philippines on April 13 - 17, 2009 (Fig. 1). At each seagrass site, transect/s were laid perpendicular to

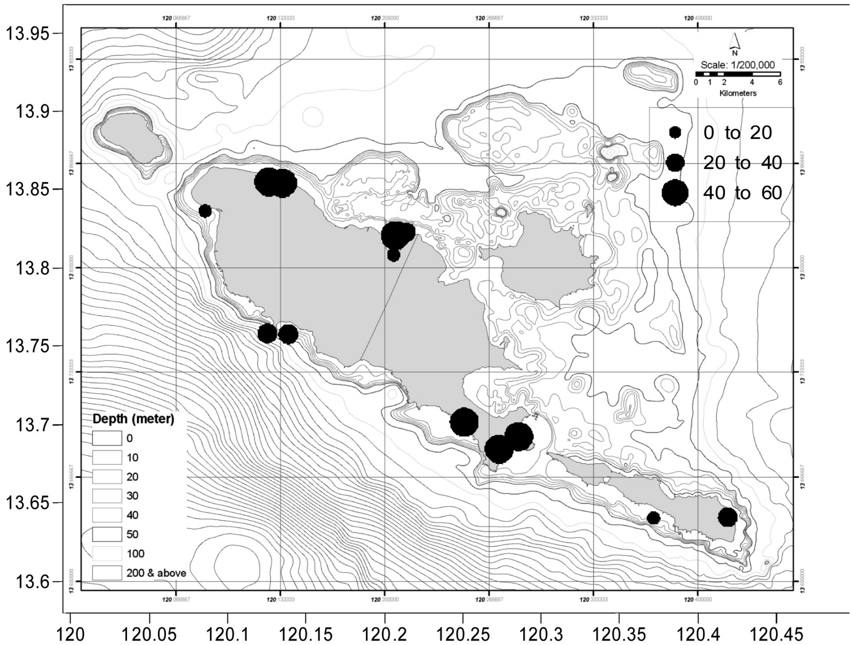

Fig. 2. Distribution of % cover of seagrass in surveyed areas in Lubang and Looc Is., Occidental Mindoro, April 2009.

the shoreline. The length of each transect was dependent on the expanse of the grassbeds, with a maximum transect length of 100m for extensive meadows.

Seagrass cover, shoot density and leaf biomass

Increments of 10m along each transect were used as points for measuring percent cover, assemblage, shoot density, and leaf biomass. Percent cover was measured using the standard Saito - Atobe method (English et al., 1994). At each point, the number of seagrass shoots per species was counted from a $50cm^2$-quadrat to determine shoot density. Three random grids from the quadrat were chosen for harvesting seagrass to be used in biomass measurements.

To examine in the surveyed areas the continuum and persistence of seagrass growth against algal associations and non-vegetated patches, the LIT method (English et al., 1994) was applied. The method was also applied to examine possible zonation patterns in seagrass species distribution along a depth gradient.

Results

The surveyed seagrass communities were characterized by both continuous and patchy meadows, with cover ranging from 0.62% to 59.49% (sd: 16.75%). The continuous and extensive meadows occurred mostly in the north side of the islands, while south of the islands were more patchy seagrass beds but with higher species heterogeneity. Survey results showed that 6 of the 13 sites have a generally moderate (40%-60%) cover, located along the northern coast (Transects 2, 5 & 6) and in the southeastern portion (Transects 9, 10 & 11) (Fig. 2). Moreover, results from the LIT showed that 10 out of 13 transects have a ground cover of more than 85%, with a low percentage of algae and/or

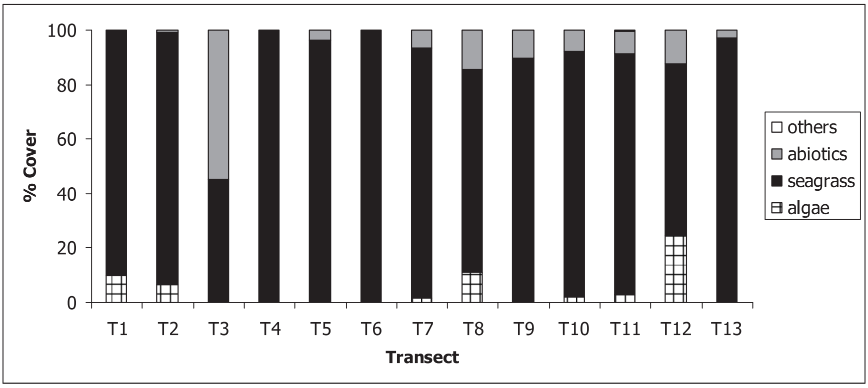

Fig. 3. LIT-based % cover of habitat structural components of seagrass beds in surveyed areas in Lubang and Looc Is., Occidental Mindoro, April 2009.

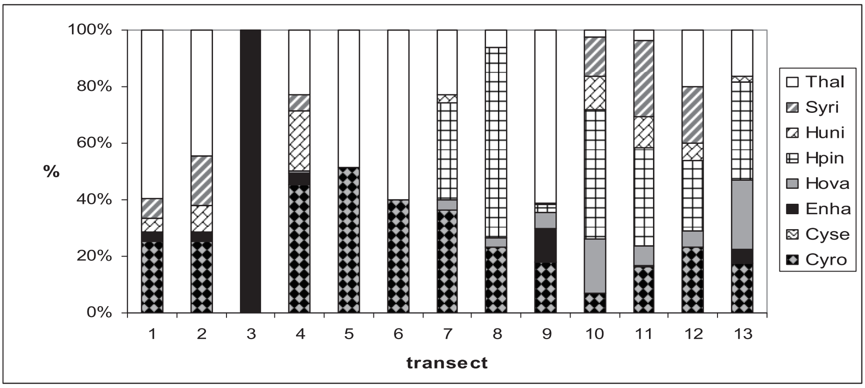

Fig. 4. Relative densities (%) of the 8 seagrass species observed in the surveyed areas in Lubang and Looc Is, Occidental Mindoro, April 2009.

abiotic components (Fig. 3). Lowest seagrass ground cover was observed in Transect 3, where patches of bare sand are dominant (54.58%).

Eight species of seagrass were found in the area, namely *Cymodocea rotundata, Cymodocea serrulata, Enhalus acoroides, Halodule pinifolia, Halodule uninervis, Halophila ovalis, Syringodium isoetifolium*, and *Thalassia hemprichii* (Table 1, Fig. 4). The occurrence of species ranged from a monospecific *E. acoroides* bed to a maximum of 7 species in mixed communities. Populations of *T. hemprichii* and *C. rotundata* provide consistent coverage with generally more species co-occurring in the eastern side.

Shoot density ranged from 16 to 2,010 shoots$\cdot$m^{-2} (mean = 961 shoots$\cdot$m^{-2}), with the highest value in Transect 10 (Fig. 5), contributed mostly by *H. pinifolia* (45.83%). Lowest density was observed in Transect 3, where the matrix of monospecific *E. acoroides* growth and bare sand patches span a vertical length of 48m, bordering the reef edge that has occasional submassive and massive coral heads (e.g. *Porites*).

Table 1. Species composition and relative frequency per transect of seagrass in the surveyed areas in Lubang and Looc Is., Occidental Mindoro, April 2009.

Species	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13
Cymodocea rotundata	6+	6+	-	6+	6+	6+	6+	6+	6+	6+	6+	6+	6+
Cymodocea serrulata	-	-	-	-	-	-	-	-	-	-	2+	-	-
Enhalus acoroides	6+	6+	6+	6+	-	-	-	-	6+	-	-	-	6+
Halophila ovalis	-	-	-	3+	-	-	2+	4+	6+	6+	6+	6+	6+
Halodule pinifolia	-	-	-	-	-	-	6+	6+	3+	6+	6+	3+	6+
Halodule uninervis	6+	6+	-	5+	-	-	2+	-	2+	6+	6+	3+	4+
Syringodium isoetifolium	3+	6+	-	3+	-	-	-	-	-	6+	6+	6+	-
Thalassia hemprichii	6+	6+	-	6+	6+	6+	6+	6+	6+	6+	6+	6+	6+
total number of species	**5**	**5**	**1**	**6**	**2**	**2**	**5**	**4**	**6**	**6**	**7**	**6**	**6**

- : absent in all quadrats
1+ : present in 1-9% of all of the quadrats sampled
2+ : present in 10-19% of all of the quadrats sampled
3+ : present in 20-29% of all of the quadrats sampled
4+ : present in 30-39% of all of the quadrats sampled
5+ : present in 40-49% of all of the quadrats sampled
6+ : present in more than 50% of all of the quadrats sampled

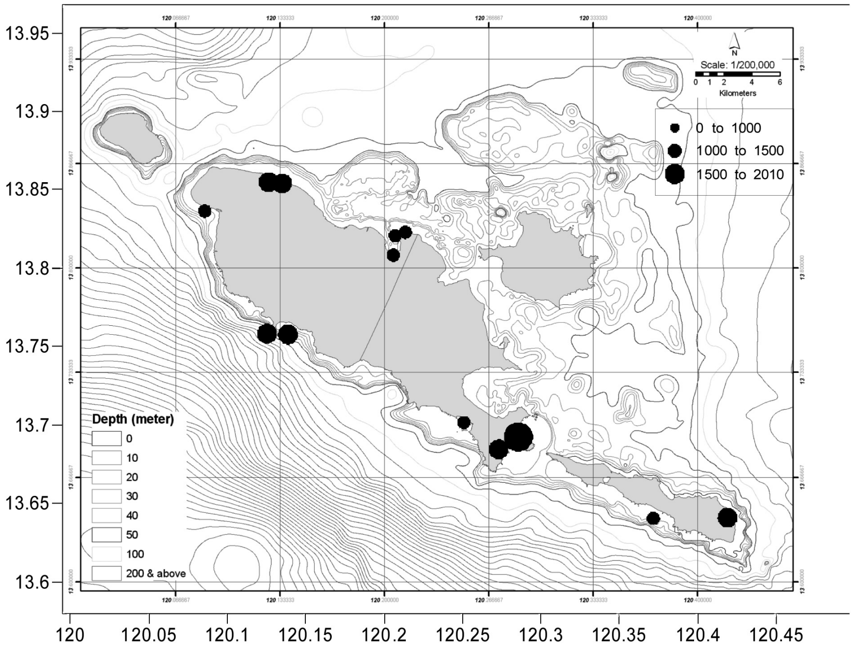

Fig. 5. Distribution of shoot density (shoots・m^{-2}) of seagrass in surveyed areas in Lubang and Looc Is., Occidental Mindoro, April 2009.

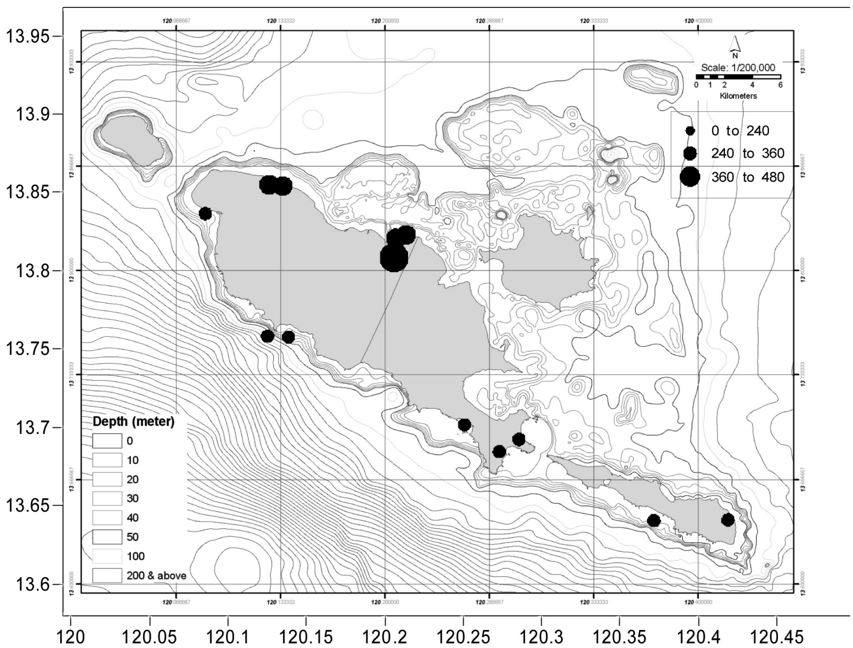

Fig. 6. Distribution of leaf biomass (gDW・m^{-2}) of seagrass in surveyed areas in Lubang and Looc Is., Occidental Mindoro, April 2009.

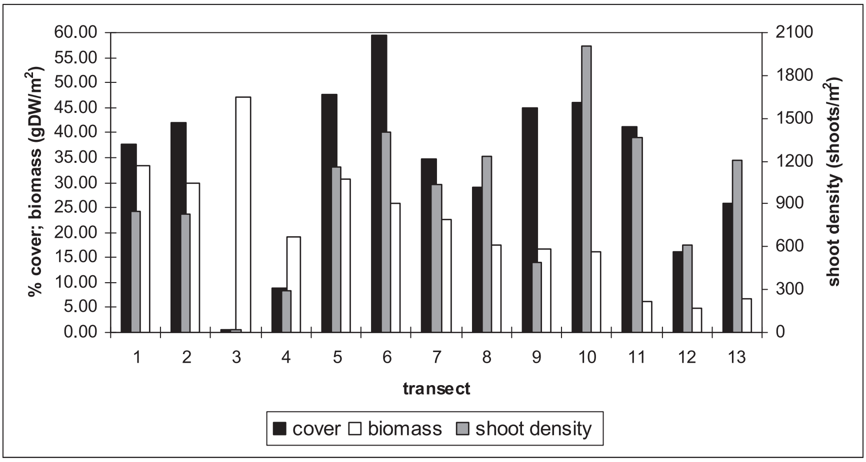

Fig. 7. Comparison of measured parameters of seagrass in surveyed areas in Lubang and Looc Is., Occidental Mindoro, April 2009. Note: Actual values of biomass were divided by 10.

While seagrass cover and shoot density were generally high in the northwest and eastern portions, leaf biomass was high only in the northern part (Figs. 6 & 7). These areas are predominantly *Thalassia-Cymodocea* association (Fig. 3). Meanwhile, mean leaf biomass across all transects was 212.70 gDW・m^{-2} (sd: 121.56 gDW・m^{-2}), with a range of 49.67 gDW・m^{-2} (Transect 12) to 471.25 gDW ・m^{-2} (Transect 3).

As aforementioned, the LIT method was applied in the survey to examine possible zonation patterns in seagrass species distribution along a depth gradient as represented by the transect line. Overall seagrass density was generally high nearshore. Detailed observation on each species shows that *C. rotundata* occurs densely nearshore, while *H. ovalis* and *H. pinifolia* occur in midwaters and *H. uninervis* and *S. isoetifolium* in deeper portions. Moreover, *T. hemprichii* and *E. acoroides* are indiscriminate species in relation to depth.

Discussion

The estimated percent cover of the seagrass beds in Lubang and Looc Islands, Occidental Mindoro, varies from low to moderate cover with 46% of the surveyed transects showing moderate cover, but mostly on the low-end values of the range. If to be treated on a larger scale, the overall mean estimate for the entire area is 33.37%, which implies sparse (20-40%) coverage, similar to Guimaras, which had a mean cover of 25.93% (range: 11.50% - 48.10%) in 1995 (Babaran & Ingles, 1996) and 25.31% (range: 0.40% - 73.60%) in 2006, immediately after an oil spill incident that hit the province (Nievales, submitted) (Table 2). In the Philippines, data for 26 different sites reported seagrass cover to be generally low, usually not exceeding 20%, indicating that most of the seagrass beds in these areas have patchy cover (BINU, 2005).

The habitat structure of the surveyed seagrass beds is generally of multispecies composition, comparable to other seagrass beds surveyed in Palawan, Bolinao, Guimaras, and Negros Oriental, and even more diverse than southwestern Thailand and South Sulawesi, Indonesia (Table 2). Of the 8

Table 2. Seagrass parameters reported for some areas in the Philippines and other SE Asian countries.

study area	# of species	% cover	density (shoots·m^{-2})	leaf biomass (gDW·m^{-2})	source
Lubang Is., Occidental Mindoro	**8**	**33.37**	**1259**	**212.7**	**this study**
Bacuit Bay, El Nido, Palawan	7			87.9	Terrados et al., 1998
Sibaltan, El Nido, Palawan	4		1418	64.0	PCSDS, 2006
New Quezon, Busuanga, Palawan	8		1295	383.4	PCSDS, 2006
Tinitian, Roxas, Palawan	8		1235	219.0	Albasin, 2005
Ulugan Bay, Palawan	8		786		UNESCO, 2002
Bolinao, Pangasinan	7			282.2	Terrados et al., 1998
Bolinao, Pangasinan	7		132	345.6*	Vermaat et al., 1995
Guimaras Is.	7	25.93	199		Babaran & Ingles, 1996
Guimaras Is.	9	25.31	571	647.1*	Nievales, submitted
Negros Oriental	8			125 - 250*	Tomasko et al., 1993
Pto. Galera, Oriental Mindoro	5			81.6	Terrados et al., 1998
Bang Rong, Ko Phuket, SW Thailand	5			10.3	Terrados et al., 1998
Ko Talibong Is., Southern Thailand	6			47.5	Terrados et al., 1998
Spermonde Archipelago, South Sulawesi, Indonesia	5		3130	82.0	Vonk et al., 2008

*above-ground biomass (leaves + vertical internode) species found in the surveyed areas, *T. hemprichii* and *C. rotundata* both occurred in 12 of the 13 transects (Table 1, Fig. 3). In Bolinao, both species were also found to be the most proliferate (Vermaat et al., 1995), and in Guimaras (Nievales, submitted, Babaran & Ingles, 1996) and Pto. Galera (Terrados et al., 1998), *T. hemprichii* was also the most ubiquitous seagrass species.

The ubiquitous co-occurrence of these two seagrass species compliments each other in such a way that *T. hemprichii* is a climax species, while *C. rotundata* is pioneering. The former occupy space more permanently, and accumulate and retain resources for extended periods of time, while the latter is best equipped to colonize new areas through rhizome expansion, or to wander from gap to gap within established beds (Vermaat et al., 1995). Thus, this balance ensures the maintenance of seagrass ground cover of the area.

Meanwhile, patchy monospecific *E. acoroides* bed was observed in Transect 3. It is highly likely that this homogeneity is a result of, or at least promoted by a relatively high sedimentation in the area, brought about by allochthonous inputs from the adjacent mangrove community as well as from the two small creeks opening up directly to the seagrass bed. The large, slow-growing *E. acoroides* is a climax species (Duarte, 1991) that has been demonstrated to be resilient to light reduction and enhanced sedimentation (Vermaat et al., 1995). In addition, the area is a locally important fishing ground, particularly drive-in gill net fishing for siganids. Moreover, it is located east of a high use embayment that serves as a docking port, and coastal settlement.

The overall mean shoot density of seagrass in the surveyed areas is comparable to those reported in other areas in the country, but lower by 40% as compared to South Sulawesi, Indonesia (Vonk et al., 2008) (Table 2). Seagrasses are usually considered to be dense if they exceed 400 shoots·m^{-2} (Fortes, 1990). Thus, Lubang and Looc Islands appear to have a generally good seagrass density, with only two transects (Transects 3 & 4) falling from this criterion. The patchy monospecific *E. acoroides* bed in Transect 3 and the mixed meadow in Transect 4 have densities of 39 shoots·m^{-2} and 296 shoots·m^{-2} respectively. Both areas are high-use beachfronts, i.e. swimming area and docking port. *C. rotundata* accounts for 45.47% of the composite density of seagrass in Transect 4.

Shoot density of the different species present across all sites surveyed ranged from 0.15 (*C. serrulata*) to 365.30 shoots·m^{-2} (*H. pinifolia*). Density of the latter is due to its dominance in Transects 8 & 10 where they contribute 67.39% and 45.83% respectively to the composite shoot densities of the areas. *H. pinifolia* also has the highest density (534.40 shoots·m^{-2}) in surveyed areas in Guimaras Is. (Babaran & Ingles, 1996). Moreover, Transect 10 also harbors the highest densities of *H. ovalis*, as well as *H. uninervis* and *S. isoetifolium*. The higher density of *H. ovalis* (636.67 shoots·m^{-2}) in the area, which is relatively deeper (>2m) than the other sites, is a reflection of its low light requirement adaptive mechanism (Vermaat et al., 1995). Moreover, the area could be a possible dugong feeding ground, as what seem to be feeding tracks were observed, complemented by anecdotal accounts of fishermen of dugong sightings in their waters.

The total dry leaf biomass of the surveyed areas is relatively lower but comparable to that of Bolinao, Pangasinan (Terrados et al., 1998, Vermaat et al., 1995), Negros Oriental (Tomasko et al., 1993), and Roxas and Busuanga, Palawan (Albasin, 2005; PCSDS, 2006). At the same time, it is higher than reported values for Bacuit Bay, Palawan and Pto. Galera, Oriental Mindoro, as well as those observed in other Southeast Asian countries (Table 2). Highest leaf biomass (471.25 gDW·m^{-2}) was observed in the monospecific *E. acoroides* bed in Transect 3, while the lowest value (49.67 gDW·m^{-2}) was recorded in Transect 12. This area is a fragmented habitat, with a heterogeneous array of sand and coral rubble patches interspersed with algae (*Padina* sp.) and 6 species of seagrass that contribute 62.80% to the entire habitat structure of the area (Fig. 3). Furthermore, the dominants are the pioneering species (*H. pinifolia, C. rotundata*) that are smaller (UNESCO, 2002, Vermaat et al., 1995; Duarte, 1991) (i.e. unit area measures of biomass is a function of plant size (Fortes, 1990)). On the other hand, while Transect 3 has the lowest cover and density values, its high biomass could be a reflection of its aforementioned species composition.

The zonation of seagrass species with respect to depth is most likely driven by their competitive requirements for light and nutrients. The ubiquitous presence of climax species such as *E. acoroides* and *T. hemprichii* along the depth gradient is probably an indication, not only of the stability of the seagrass beds, but of their morphological advantage to thrive without significant interference from the other seagrass species. Meanwhile, *C. rotundata*, which is similarly sized, is best adapted nearshore, as compensation for its relatively lower elongation rates (Vermaat et al., 1995) which is otherwise a disadvantage in deeper waters, vertical elongation being an important factor in the competition for light. On the other hand, the other pioneering species are able to inhabit relatively deeper waters by having low light requirements, and faster and continuous rhizome growth (Vermaat et al., 1995).

Summary, Conclusions and Recommendations

The seagrass beds in Lubang and Looc Is., Occidental Mindoro, are generally multispecific meadows that are sparse to moderate in cover. Shoot densities of the 8 species observed in the area are generally high, and composite leaf biomass is comparable to other seagrass beds surveyed in other sites in the country.

In general, the observed "kaingin" practices in the uplands pose the greatest threat to the seagrass ecosystems of the area because of the long-term domino effect of erosion and sedimentation on the seagrass beds. However, fisheries practices also need to be quantified to determine hierarchy of anthropogenic disturbance that causes habitat fragmentation of the seagrass beds of Lubang and Looc Islands.

Acknowledgments

This study was funded by the Sulu-Sulawesi Seascape Program of the Conservation International-Philippines. Special thanks to Dr. Wilfredo L. Campos and Dr. Annabelle G. C. del Norte-Campos for their invaluable help and support.

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