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Assessment of Seagrass Beds and Associated Macro-Invertebrates at Cogtong Bay, Philippines: Basis For Conservation And Management

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ABSTRACT

The seagrass beds in Cogtong Bay were assessed utilizing a set of repeated quarterly assessment. Four representative sites were randomly selected as sampling areas. A 50x50 cm quadrat was used in the assessment along a 50m transect with three replicates per site to determine seagrass % cover, composition and abundance. Commercially important macro-invertebrate associates were assessed using 2m x 50m strip transect. Sediment accretion rate and other environmental parameters were measured. A social component survey was also conducted among seagrass gleaners to corroborate the findings of the actual resource assessment. Results showed that there were only five species of seagrasses in the Bay, *Enhalus acoroides, Cymodocea rotundata, C. serrulata, Thalassia hemprichii* and *Halophila ovalis*. *E. acoroides* was the only species found in sites 1 and 2 (Tabangdio and Calanggaman Islets), while in sites 3 and 4 (North and Northwest sides of Kawasihan Islet) *T. hemprichii* was the dominant among five species. *Diadema setosum* and *Tripneustes gratilla* were the dominant macro-invertebrates. A slight fluctuation of seagrass cover was observed on *E. acoroides* and *T. hemprichii* with highest percent cover during the 3rd quarter with 3.46% to only 1.54% during the 4th, and 20.48% cover during the 4th to only 9.58% in the second quarter, respectively. Abundance of invertebrates also fluctuated in November with only 25 from a high of 42 individuals in May. The sediment load was minimal. The results of the socio-economic survey showed that the seagrass beds had significantly benefited the seagrass gleaners in the area.

Keywords: seagrass, macrofauna, diversity, sediment, gleaners.

INTRODUCTION

The coastal zones of most nations in ASEAN are subjected to increasing population and economic pressures manifested by a variety of coastal activities, notably fishing, coastal aquaculture, waste disposal, salt mining, oil drilling, tanker traffic, rural construction and industrialization. This situation is aggravated by the expanding economic activities attempting to uplift the standard of living of coastal people, the majority of which live below the official poverty line.

The variety of efforts in coastal resource management initiated in some areas of the Philippines are trying to address the problem on the declining productivity of coastal areas brought about by the rising population in the coastal

zones. This rise in coastal population deals some negative impacts thereon such as overfishing to the extent that the resource base has been damaged specially the three most productive coastal ecosystems, the mangroves, seagrasses and coral reefs.

Seagrasses play very important role in the overall productivity of coastal areas. They have been known to serve as food for marine organisms. Seagrass beds serve as nursery, shelter and food for many marine organisms.[1] They also produce sediments and interact with coral reefs and mangroves in reducing wave energy.[2] (Alongi, 1998) and regulating water flow .[3] (UNESCO,1983). Seagrass biomass is a primary factor in determining the organization of marine macrofaunal communities.[4] (Stoner, 1982) as it controls the habitat complexity, species diversity and abundance of associated invertebrates.

At present, there is no specific management program initiated to develop and protect the 3,000 hectares of seagrass beds in Cogtong Bay. This resource is totally ignored or if not, their value and significance are unknown to the stakeholders of the bay. Recently, Eucheuma farming is proliferating in the bay utilizing hundreds of hectares. Eucheuma farmers cleared out their areas of seagrasses to ensure productivity of their plants. If this practice shall not be abated, it will affect the biodiversity of the resources in the bay. In order to come up with seagrass management program and policies, there is a need to assess this seagrass ecosystem as basis for policy direction and setting.

OBJECTIVES OF THE STUDY

This study was conducted to assess the status of seagrass beds in Cogtong Bay.

The specific objectives of the study are:

1. To determine the biodiversity and abundance of seagrasses and seagrass macro-invertebrate associates in Cogtong Bay.
2. To determine the present economic utility of the resource.
3. To measure the sediment accretion rate of the seagrass beds.
4. To find out if seagrass cover and abundance of macro-invertebrate associates fluctuate throughout the year.

MATERIALS AND METHODS

Research Design

The study was conducted in 2005. It was done using 50-m line transect method laid perpendicular to the shorelines. Sites were identified through a preliminary survey of 8 representative areas and four were randomly selected as sampling sites within the 3,000 hectares seagrass meadows in the bay where three replicate transects were laid per site. A quadrat measuring 50cm x 50cm was used in the assessment of seagrass composition and percent cover at five meter intervals in each replicate transect. A T-bar of 1meter length at each side was employed to assess the commercially important macro-invertebrates along the transect line. The animals encountered were identified and their sizes and weights were measured in

situ. For sediment accretion rate, the study used plastic gallons with cover attached by three's to wooden posts driven into the substrate to trap sediments. The gallons' bases were removed to serve as sediment entrance. The collector had a diameter of 15 cm at the mouth and strapped to the wooden post up side down. The sediments collected in the collector were blot dried before taking the wet weight and then the sediments were sun dried to get the dry weight. Samplings were done during the middle month of every quarter. Sediment collection was run in 30-days period.

On the socio-economic aspect of the study, composition and quantities of collected commercially-important macro-invertebrates by seagrass gleaners in the area were collected using survey questionnaires and interview guide. The data collected from this survey were compared with the data taken during the actual resource survey by the researchers for comparison.

Physico-chemical parameters such as temperature, salinity and mean water depth were also taken during each sampling.

Samplings were done every quarter throughout the year to ascertain seasonal species fluctuations and composition of both seagrasses and macro-invertebrates.

Data Analysis

Seagrass biodiversity and abundance was assessed using Saito and Atobe (1970) as cited by English et al, (1994).[5] The species composition was determined using the procedure developed by Menez et al, (1988). The relative abundance was determined using Shannon Diversity Index (H'). Seagrass cover fluctuations between sampling months was determined by finding the mean cover per sampling.

Table I. Estimation of seagrass cover adopted from Saito and Atobe (1970)

CLASS	STATUS OF AREA COVERED	AREA COVERED (5)	MID POINT (m)
5	½ to all	50 – 100	75
4	¼ to ½	25 – 50	37.5
3	1/8 to ¼	12.5 – 25	18.75
2	1/16 to 1/8	6.25 – 12.5	9.38
1	Less than 1/16	<6.25	3.13

Species diversity of commercially important macro-invertebrate associates of seagrass per site was analyzed using Shannon Weiner Index and their fluctuation in abundance was determined by finding their means per sampling quarter.

Sediment accretion rate was compared through one-way ANOVA with site and sampling quarters as factors. Data from socio-economic survey was analyzed mainly through non-parametric statistics. Statistical analyses were done using Statistical Package for Social Sciences (SPSS) version 14 (2005).

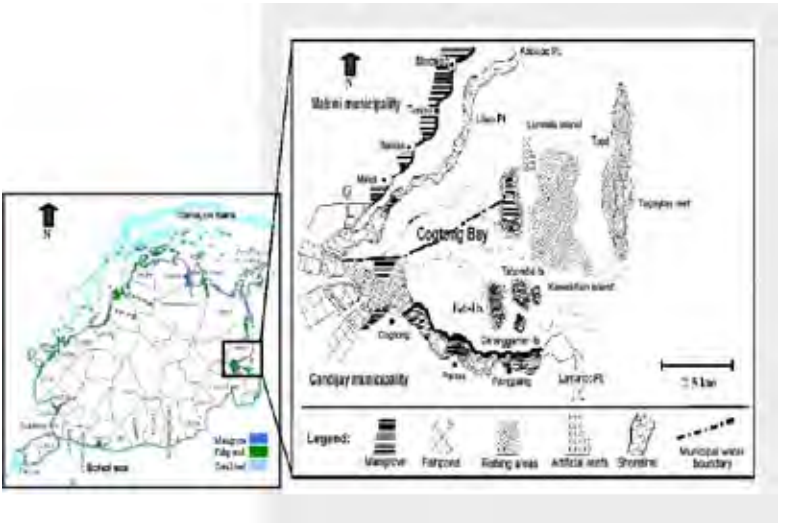

Fig. 1. Map of Cogtong Bay (Source: Katon, Pomeroy, Ring and Garces, 1998)

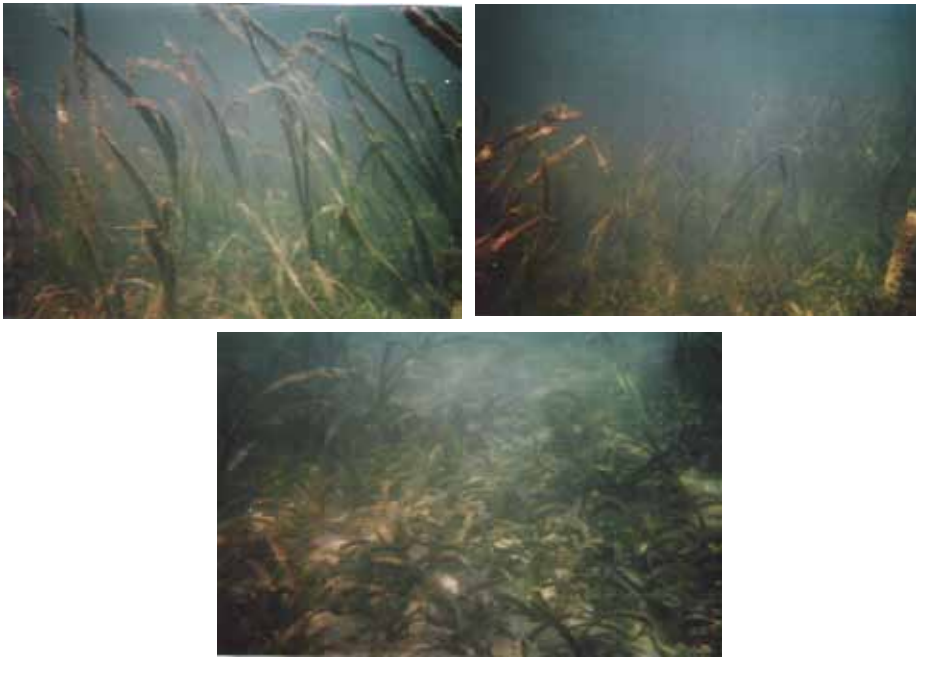

Figure 2. *Enhalus* (top 2 photos) and *Thalassia* (bottom) are the most dominant seagrass species in the bay. (Photo: T. Tuyogon)

RESULTS

Table 1. Geographical location of sampling areas

		COORDINATES	
SITES	LOCATION	Latitude (N)	Longitude (E)
1	SW of Tabangdio Is.	09° 50′07″	124° 34′ 12″
2	Calanggaman Is.	09° 51′ 01″	124° 34′ 03″
3	North of Kawasihan Is.	09° 49′ 79″	124° 34′ 17″
4	NW of Kawasihan Is.	09° 48′ 39″	124° 33′ 56″

Table 2. Mean environmental parameters of sampling sites

SITE	TEMP (°C)	SALINITY (ppt)	MEAN DEPTH (M)
1	29.5°C	34‰	2.00
2	30°C	33.5‰	2.50
3	30°C	37‰	1.80
4	30°C	37‰	1.12

Table 3. Seagrass Percent Cover Per Quarter

	Mean Percent Cover Per Sampling Quarter			
Species	1st	2nd	3rd	4th
Enhalus Acoroides	1.98	1.62	3.46	1.54
Cymodocea rotundata	0.10	0.30	0.22	0.53
C. serrulata	0.12	0.26	0.12	0.80
Thalassia hemprichii	12.93	9.58	18.06	20.48
Total Cover	15.13	11.75	21.85	23.34
Total No. of Species	4	4	4	4

Table 4. Seagrass Composition and Percentage Cover of Sampling Sites

	Percentage Cover					
Seagrass Species	Site 1	Site 2	Site 3	Site 4	Mean	RA (%)
Enhalus acoroides	4.04	4.31	0.10	0.15	2.15	11.93
Cymodocea rotundata	0	0	0.96	0.18	0.28	1.58
Cymodocea serrulata	0	0	0.76	0.54	0.32	1.80

Thalassia hemprichii	0	0	31.07	29.98	15.26	84.68
Total cover (%)	4.04	4.31	32.89	30.85	18.02	100
Total No. of Species	1	1	4	4		
Shannon Diversity Index (H')	0.20	0.18	0.36	0.36		

Table 5. Macro-invertebrate Associates Collected Per Sampling

No.	Species	1st Sampling		2nd Sampling		3rd Sampling		4th Sampling	
		Ave size (cm)	Ave. Wt. (g)	Ave size (cm)	Ave. Wt. (g)	Ave size (cm)	Ave Wt. (g)	Ave. size (cm)	Ave. Wt. (g)
1	*Tripneustis gratilla*	7.42	90.83	6.16	86.20	7.35	83.12	5.85	85.50
2	*Malleus malleus*	14.73	174.66	13.20	198.00	16.15	193.50	0	0
3	*Pinna muricata*	14.20	110.80	0	0	9.90	31.00	0	0
4	*Anadara scapharca*	2.97	11.17	2.97	36.67	3.20	13.00	0	0
5	*Diadema setosum*	4.63	74.17	3.78	30.89	4.71	77.28	3.64	17.78
6	*Applysia sp.*	10.30	224.67	0	0	9.70	230.00	0	0
7	*Sea tangle*	4.28	43.25	3.95	10.50	3.98	17.43	3.60	10.50
8	*Conus daucus*	5.10	17.00	4.40	17.00	0	0	0	0
9	*Holuthuria sp.*	8.80	202.00	6.13	86.17	6.95	189.00	6.33	77.50
10	*Mastigias papua*	7.40	39.00	5.90	30.00	6.67	31.33	6.43	30.00
11	*Cerithedea sp.*	0	0	2.60	18.00	0	0	0	0
	Totals		987.55		513.43		865.66		221.28

Table 6. Differences of Macro-invertebrate Associates Per Sampling

Sampling	No. of Individuals	Weight (g)
1st	32	3,021.5
2nd	42	1,937.9
3rd	35	2,934.0
4th	25	841.0
Average	33.5	2,183.6

Table 7. Diversity Index of Seagrass Macro-invertebrate Associates

	count	pi	((pi * LN pi))
Species			
T. gratilla	20.0	0.14815	-0.282896
M. malleus	6.0	0.04444	-0.138369
P. muricata	6.0	0.04444	-0.138369
A. scapharca	8.0	0.05926	-0.167458
D. setosum	45.0	0.33333	-0.138369
Applysia sp.	6.0	0.04444	-0.138369
Sea tangle	15.0	0.11111	-0.244134
C. daucus	2.0	0.01481	-0.623860
Holuthuria sp.	14.0	0.10370	-0.235010
M. papua	12.0	0.08889	-0.215145
Cerithedea sp.	1.0	0.00741	-0.036345
Total	135.0		-2.358324

SWI = 2.358324

Table 8. Comparison on sediment accretion rate per sampling

Sampling	Average Accretion Rate (g/mo.)		Average Accretion Rate ($g/cm^3/day$)	
	Wet	Dry	Wet	Dry
1	5,241.4	3,246.9	11.65	7.21
2	5,220.2	3,207.6	11.60	7.13
3	4,978.0	2,328.4	11.06	5.17
4	5,062.7	2,320.9	11.39	5.16
Averages	5,125.56	2775.9	11.43	6.167

Table 9. Sediment Accretion Rate Per Site Per Sampling

	Average Dry Wt. Per Day (gm/cm^3/day)				
Site	Feb	May	Aug	Nov	Average
1	7.75	7.34	3.66	3.82	5.64
2	24.80	24.70	18.10	18.47	21.52
3	20.72	20.70	14.28	14.50	17.44
4	19.29	18.87	14.59	14.67	16.85

Table 10. Box Plot on Testing for Variance of Sediment Accretion by Sampling Months

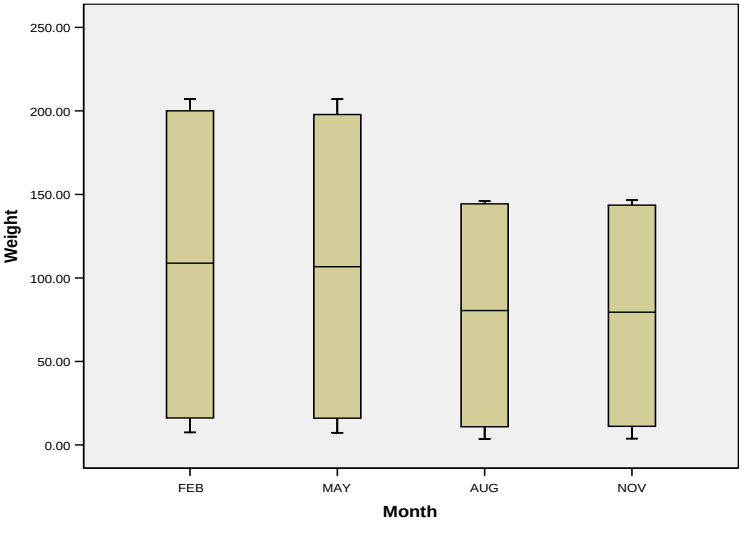

Table 11. Personal Profile of seagrass gleaners (N=98)

Mean Age	Male	Female	Single	Married
46.2	55	43	13	85

Table 12. Seagrass gleaning profile

A. Distribution of respondents as to no. of years in seagrass gleaning

No. of years	Frequency	Percent
1 - 5 years	30	30.61
6 - 10 years	17	17.35
11 - 15 yrs	13	13.26
16 - 20 yrs	16	16.33
21- 25 yrs	22	22.45
26 - up	0	0
Total	98	100.00

Mean = 11.51

B. Distribution of respondents as to frequency of gleaning operation

No. of gleaning	Frequency	Percent
Once/week	2	2.04
2x/week	34	34.69
3x/week	13	13.26
4x/week	3	3.06
5x/week	2	2.04
daily	41	41.84
Total	98	100.00

Mean = 4.45

C. Distribution of respondents as to type of gears used in gleaning

Uses/Gear Types	Frequency	Percent
Use of bare hands	36	36.73
Use of hand tools	55	56.12
Other	7	7.14
Total	98	100.00

D. Distribution of respondents as to the number of hours in seagrass gleaning

No. of Hours	Frequency	Percent
1 - 3 hrs	29	29.59
4 - 6 hrs	41	41.84
7 - 9 hrs	18	18.37
10 - 12 hrs	10	10.20
Total	98	100.00

Mean = 3.77

E. Distribution of Respondents as to volume of harvest per gleaning

Volume	Frequency	Percent
1 - 3 kg	40	40.82
4 - 6 kg	34	34.69
7 - 9 kg	7	7.14
10 - 12 kg	8	8.16

13 - 15 kg	9	9.18
Total	98	100.00

Mean = 2.45

F. Distribution of respondents as to their average income per gleaning

Amount	Frequency	Percent
P25 and below	9	9.18
P26 - P50	14	14.28
P51 - P75	12	12.24
P76 - P100	20	20.41
P101- P125	43	43.87
Total	98	100.00

DISCUSSIONS

There were four sampling sites chosen: Site 1 was at Southwest Tabangdio, site 2 in Calanggaman Islet where both had muddy bottoms and the mean water depths were comparatively deeper. Sites 3 and 4 were near Kawasihan Islet where the bottom was sandy and almost bare during low tide (Table 1). Environmental parameters of sites 1 and 2 were almost identical and so were those in sites 3 and 4 (Table 2).

Table 3 shows that the species composition of seagrass did not vary throughout the year but abundance in *E. acoroides* and *T. hemprichii* fluctuated during the months of November and May, respectively. The former had its highest percent cover during the 3rd quarter of 3.46% and had its lowest during the 4th quarter of only 1.54%. The latter however, saw its highest percent cover during the 4th quarter with 20.48% and had its lowest during the second quarter with only 9.58%. The species fluctuation was attributed to changes in weather condition affecting the species abundance.

Table 4 shows that *E. acoroides* was the only species found in sites 1 and 2 with low percent cover of only 4.04 and 4.31, respectively. Sites 3 and 4, where the four species *C. Cymodocea, C. serrulata, T. hemprichii* and *E. acoroides* were noted had percent cover of 32.89 and 30.85, respectively. *T. hemprichii* was the most abundant with 84.68% cover in sites 3 and 4. *Halophila ovalis* the 5th species found in site 3 was not measured since they occur outside the quadrates.

Macro-invertebrates diversity and abundance

Macro-invertebrates associating the seagrasses were less diverse and less abundant in the fourth quarter (Table 5). The highest number of individuals found in the sampling sites was only 42 weighing 1,937.9 grams, consisted of ten species. Highest volume collected in four samplings was on the month of February with

3,021.5 grams consisted of 32 species and the lowest volume of collection was observed in the month of November with 841 grams consisted of only 25 species. Average volume collected during the resource survey in all sites was only 2,183.6 grams (Table 6). When the data on macro-invertebrate associates was subjected to Shannon-Weiner Diversity Index it resulted to a value of 2.358 diversity index (Table 7).

Sediment accretion

Sites 1 with muddy bottoms had the least sediment accretion rates of 5.64 gm/cm^3/day, site 2 with muddy substrates had the highest accretion rate in all sites of 21.52 gm/cm3 daily average. Sites 3 and 4 with sandy bottoms had almost identical accretion rates of 17.44 gm/cm3 and 16.85 gm/cm3 per day.

Table 10 shows the analysis of variance on sediment accretion between quarters per site. It shows that there was significant difference in the rate of accretion in each site between quarters. All sites registered high accretion means during the 1st and 2nd quarters and low during the 3rd and 4th quarters. Overall, the rate in accretion had a significant value of 0.934.

Economic utility of seagrass beds

After the socio-economic survey was conducted on 98 respondents around the bay data revealed (Table 12) that gleaners had a frequency of 4.45 times gleaning operation per week most of them using hand tools. The mean number of hours per gleaning was 3.77 hours or a total of 16.78 hours a week spent in gleaning. The mean volume of harvest per hour was 2.45 kgs. or a total of 41.10 kilograms of seagrass associated products harvested per week per gleaner. This volume corroborated with the actual resource assessment average collected volume of 2,183.6 grams in 3 hours shown in Table 6. The actual resource assessment had lower volume because only the non-burying animals were assessed. Economically, survey showed that majority of the gleaners (43.87%) had an average income of between P101.00 to P125.00 per day taken from the seagrass beds.

Picking up the broad spectrum of the study, the researcher had these findings:

- There were only five species of seagrasses in Cogtong Bay namely; *Enhalus acoroides, Cymodocea rotundata, C. serrulata, Thalassia hemprichii and H. ovalis.*
- *E. acoroides* was dominant in muddy areas with comparatively deeper waters while *T. hemprichii* was abundant dominating in sandy bottom with shallow water areas.
- The species diversity did not vary throughout the year round; seagrass percent cover however insignificantly fluctuates in certain months or seasons depending upon the species.
- Abundance of invertebrate associates was low during November based on the results of the actual assessment.
- Sediment accretion rates were higher in deeper areas with muddy substrate near the river mouths than in shallow, sandy bottom areas.
- The seagrass beds in Cogtong Bay had a significant economic value to the surrounding communities.

CONCLUSION

We conclude that seagrasses thrive mostly in muddy, sandy-muddy and sandy flat areas along the intertidal to subtidal zones of Cogtong Bay consisted of five (5) species; *Enhalus acoroides*, *Cymodocea rotundata, C. serrulata* and *Thalassia hemprichii* and *Halophila ovalis*. Deeper areas with muddy bottoms, tropical eelgrass *(Enhalus acoroides)* was the only species found. Seagrass diversity did not significantly vary throughout the year, however slight fluctuation in abundance was observed in *E. acoroides* and *T. hemprichii*. The former had its highest percent cover during the 3rd quarter and had its lowest during the 4th quarter. The latter however, saw its highest percent cover during the 4th quarter and had its lowest during the second quarter.

Commercially important seagrass macro-invertebrate associates in the sites were less diverse during the fourth quarter than in the first, second and third quarters. Their abundance also fluctuated in the area especially during the month of November.

Sediment accretion rates in all sites significantly vary between quarters. Test of variance revealed a t-value of 0.934, which denotes significant level. Significant level value was set at 0.05.

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