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Seagrass diversity and structure along the coastal area in Paligue, Hagonoy Davao del Sur, Philippines

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Abstract. The seagrass is important for a variety of ecological functions. The study site has no previous assessment on seagrass. The study was employed through a purposive sampling along intertidal coastline of Paligue, Hagonoy, Davao del Sur, Philippines. A total of ten transects (100 meter length each) were installed with an interval of at least 50 meters apart. Each transect consisted of 20 (1 m x 1 m) quadrats. The sampling effort was highly adequate as revealed in species accumulation plot. Seven (7) species of seagrasses were identified as part of inventory. Diversity indices of species richness, abundance, dominance, evenness, Shannon diversity and percent cover of seagrass were determined. The spatial structure showed three major groupings at 60% Bray-Curtis similarity. The three groups were displayed in the cluster dendrogram and plotted in the non-metric multidimensional scaling. The groupings were influenced by dominant species of seagrass. The study is the first attempt to assess and charaterize the spatial structure which may be important in the coastal management of seagrass.
Key Words: seagrass diversity, species accumulation plot, cluster analysis, Bray-Curtis similarity, Hagonoy, Davao del Sur.

Introduction. Seagrasses are diverse ecosystems that support diverse communities in marine waters. It is the only group of highly specialized flowering plants or angiosperms that inhabit the coastal and marine environment of the temperate and tropical region. (Phang 2000; Tanduyan et al 2011). Their presence in ecosystem is important in the trophic structure of marine coastal community. They provide habitats for fishes and larger vertebrate as feeding, breeding and nursery grounds (Alima et al 2014). Their presence in ecosystem gives significant component in trophic and importance for fishes and larger vertebrates as the feeding, breeding and nursery grounds of marine organisms of profitable importance. They supply oxygen, stabilize sand and mud banks and sequestrations of carbon which are essential for the sustainability of the marine ecosystem. One of the features of seagrasses is their ability to reproduce underwater like terrestrial grasses do and live entirely submerged and share numerous convergent morphological and physiological characteristics. Ecologist agreed that studying its reproduction and phonology is significant in understanding the population structure (Walker et al 2010). Seagrasses are attached to all types of substrates but mostly occur on soft ones which are up to 30 meters depth in intertidal region. Seagrass meadows are also important in nutrient cycling, enhancement of coral reef fish productivity, providing habitat of fish and invertebrates, and major food source for many marine animals (Waycott et al 2009). Understanding the connectivity of seagrasses with mangroves and coral reefs is very important. These three components (seagrass, mangroves and coral reef) are usually linked between each other in a stable marine coastal environment. They exert a stabilizing effect resulting in important physical and biological support for the other communities. The instability of one system may greatly affect the others, thus the destruction of seagrass meadow will likely destabilize another system (Worm et al 2006). Currently there are 13 recorded seagrass species in Philippine water representing 27% of the total species reported worldwide (Calumpong & Meñez 1997). In Mindanao Island, Southern Philippines the studies on seagrass diversity were very limited. The sampling area of Hagonoy, Davao del Sur has no scientific study conducted on inventory and assessment according to Environmental Office Division of the local government office.

In a key informant interview, the respondents mentioned that the intertidal area was very rich in species richness and abundance of seagrasses. Consequently, marine molluscs were also rich and were frequently collected as food source by the community. The destructive gleaning practices contributed largely to seagrass destruction. The over exploitation, lack of knowledge and information regarding this ecosystem, and siltation might have caused the declining of habitat condition. It is imperative that inventory and assessment to be conducted to establish baseline information in the area.

The study on seagrass will be a big help to the environmental planners in the management of coastal resources on the site. The objective of the study is to conduct a an assessment of seagrass communities in the intertidal areas in Paligue, Hagonoy, Daval del Sur. Specifically, the study aimed to (1) determine the species composition; (2) compute the biodiversity indices; and (3) describe the communnity structure of seagrasses in the sampling sites.

Material and Method

The study area. The study was conducted on December 2014 to March 2015 at Brgy. Paligue, Hagonoy, Davao del Sur located at Southern Mindanao, which geographically lies between 6°41'7"N 125°18'46"E (Figure 1). One site was selected at the location consisting of two hundred (200) quadrats. The site represents the general area. The actual location of site was determined through the use of Global Positioning System (GPS).

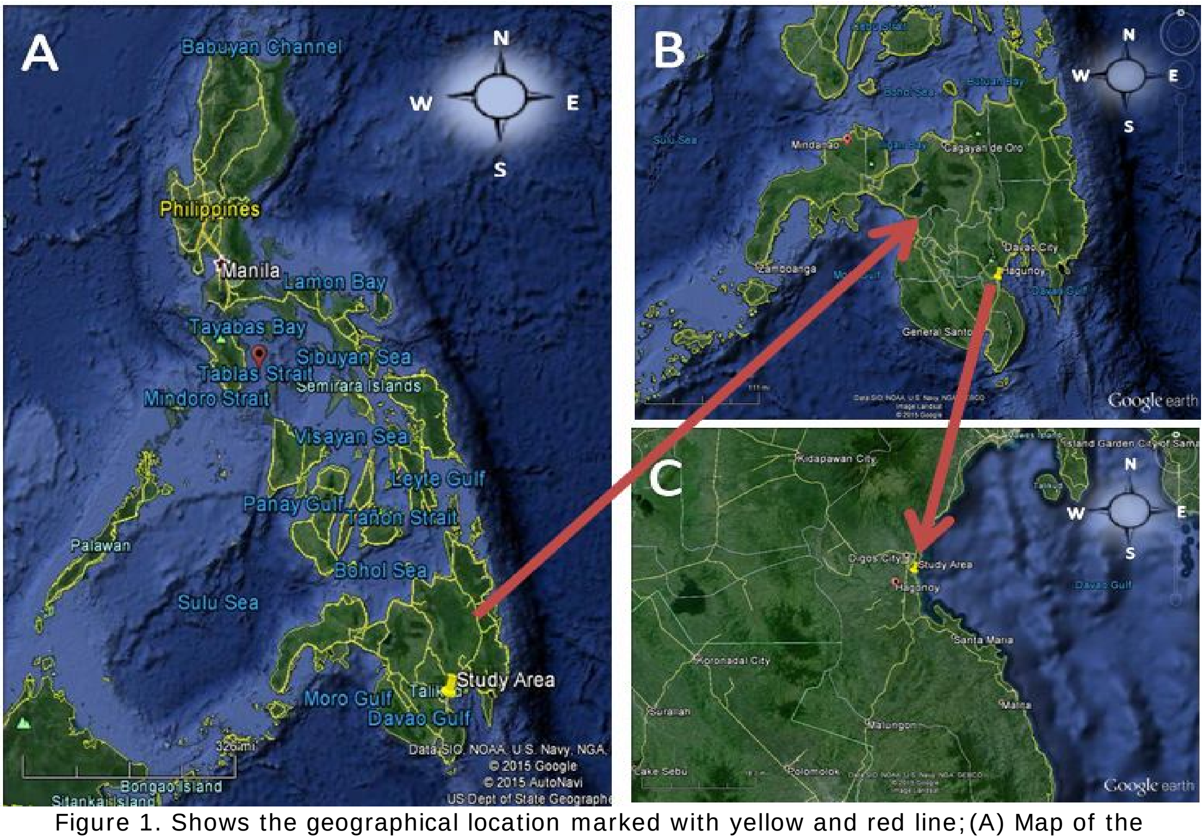

Figure 1. Shows the geographical location marked with yellow and red line;(A) Map of the Philippines; (B) Map of Mindanao, Philippines and; (C) Map of Central Mindanao/Davao Gulf where the sampling site in Paligue, Hagonoy, Davao del Sur is located (http://www.google.com/maps/).

Establishment of sampling stations. The site was surveyed along the intertidal areas with sufficient seagrasses Ten transects, each with a length of 100 meters, were established in the sampling station. The distance between transects was at least 50 meters. In each transect, 20 quadrats (1m X 1m) were laid. Seagrasses were identified, counted and photographed using Cannon DSLR D1200.

Identification of species. The species were identified *in situ* using reliable identification manuals (McKenzie et al 2009; Calumpong & Meñez 2009). For species with difficulty in identification, some samples were observed using magnifying glass and dissecting microscope to determine the leaf structure variation which were helpful in identifying the species.

Biodiversity measurements. The data on abundance was used to compute for biodiversity values. These include species richness, abundance, dominance, evenness, and Shannon's diversity. The software PAST (Hummer et al 2001) was used to compute for the diversity values. Percent cover was also evaluated in seagrasses (McKenzie et al 2009).

Seagrass community structure. The data on abundance was square root transformed so that rare species might exert their influence in the analysis of data. Similarity matrix was constructed using Bray-Curtis index of similarity. The resulting matrix was used to analyze the community structure of seagrass such as cluster analysis and non-metric multidimensional scaling.

Statistical analysis. The data on abundance was used to compute for the species accumulation curve. The observed species count was compared to the species richness estimators which were Michaelis-Menten (MM), the UGE, and bootsrap estimator with 999 permutations. Biodiversity indices was computed using species richness, abundance, dominance, evenness, and Shannon diversity. Percent cover of the seagrass was also determined. The data was square root transformed and similarity matrix (Bray-Curtis index) was constructed. Cluster analysis and non-metric muultidimensional scaling were employed in the comparison of similarities of sampling data points (Clarke & Gorley 2006; Clarke & Warwick 2001). The PRIMER software was used in the computation.

Results and Discussion

Species accumulation curve. The collection of seagrass was sufficiently covered based on species accumulation plot (Figure 2). The plot showed to be asymptotic to the species richness estimators (UGE and bootsrap of 999 permutations) which implied that the sampling effort was adequate.

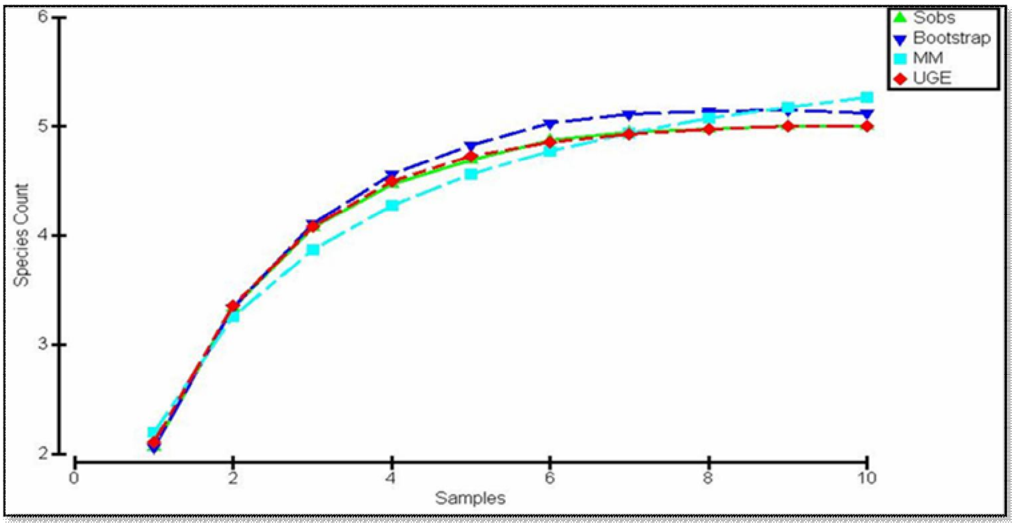

Figure 2.The species accumulation curve showing the adequacy of sampling.

Inventory of species. A total of 7 species were collected and identified in the sampling site of Paligue, Hagonoy, Davao del Sur as part of species inventory (Table 1). The intertidal seagrasses belong to two families namely Cymodoceaceae and Hydrocharitaceae. There were 5 species found along the transects (*Cymodocea rotundata, Halodule pinifolia, Thalassia hemprichii, Enhalus acoroides,* and *Halophila spinulosa)* and two species were observed outside (*Halodule uninervis* and *Syringodium isoetifolium*). The species composition *in situ* comprised more than 50% of Philippine seagrasses. This observation is high considering that samples were only collected along intertidal areas. The data suggested high species diversity in the area sampled.

Table 1

Species Composition of sea grass in Paligue, Hagunoy, Davao Del Sur

Family	*Species*
Cymodoceaceae	*Cymodocea rotundata*
	Halodule pinifolia
	*Halodule uninervis**
	*Syringodium isoetifolium**
Hydrocharitaceae	*Enhalus acoroides*
	Halophila spinulosa
	Thalassia hemprichii

* species observed outside the transects.

Seagrass diversity. Species richness was highest in transect 8 consisting of 4 species (Table 2). *T. hemprichii* was the most abundant species. This was followed by *C. rotundata.* Seagrasses which have the least number of individuals were *E. acoroides, H. pinifolia, and H. spinulosa.* Dominance was the highest in transect 6 and lowest in evenness. Shannon diversity was very high in quadrats 8, 1 and 2. The percent cover of seagrass was relatively similar but highest values were observed on transects 1, 6 and 2 (Table 2 and Figure 3). The observed variation of diversity values might be explained by the variation of substrates and the distance of seagrasses from the shore.

Table 2

Diversity Values of Seagrass Species Richness, Abundance, Dominance, Shannon, Evenness and Simpson in Paligue, Hagunoy, Davao Del Sur

	Richness	*Abundance*	*Dominance*	*Evenness*	*Shannon*	*Cover*
Transect 1	2	13.05	0.5071	0.993	0.6861	28.50 %
Transect 2	2	19.6	0.5133	0.9867	0.6798	25.65 %
Transect 3	1	30.4	1	1	0	25.05 %
Transect 4	1	25.35	1	1	0	23.75 %
Transect 5	2	15.4	0.7936	0.7171	0.3607	15.55 %
Transect 6	3	27.75	0.954	0.3779	0.1255	26.50 %
Transect 7	1	14.15	1	1	0	18.65 %
Transect 8	4	26.25	0.5958	0.5018	0.6968	17.00 %
Transect 9	2	48.05	0.8847	0.6298	0.2308	55.25 %
Transect 10	3	29.75	0.8605	0.4555	0.3122	56.25 %
Average	2.1	24.975	0.8109	0.76618	0.30919	29.215%

Spatial structure of seagrass. To characterize the spatial structure of seagrass community in the area, cluster analysis and non-metric multidimensional scaling (nMDS) were used. Bray-Curtis similarity index was used in the proximate similarity of sample points. The cluster analysis (Figure 4A) revealed that 3 major groups were formed at 60% similarity. Group 1 consisted of transects 3, 4, 5, and 6. Group 2 were transects 1 and 2. While group 3 belong to transects 7, 8, 9, and 10. The seagrass in group 1 were dominated by the species *C. rotundata*. Group 2 were influenced by the species *T. hemprichii* and *E. acoroides*. The species *T. hemprichii* was dominant in group 3 as shown in Figure 4B. The resulting similarity figures were displayed in the two dimensional plot in the nMDS. The result in the nMDS showed similarity of groupings formed in cluster dendogram at 60% Bray-Curtis similarity. Groups 2 and 3 were more similar in terms of spatial structure of the seagrass community. They were influenced by the species *T. hemprichii* being dominant in both sample groups. In contrast, group 1 was more distinct in comparison with other groupings. The result indicated variation in the spatial structure of seagrass in the sampling area. The variation was influenced by species composition and structure as indicated in the results. However, composition of the substrates and other edaphic factors might have affected the variation as well.

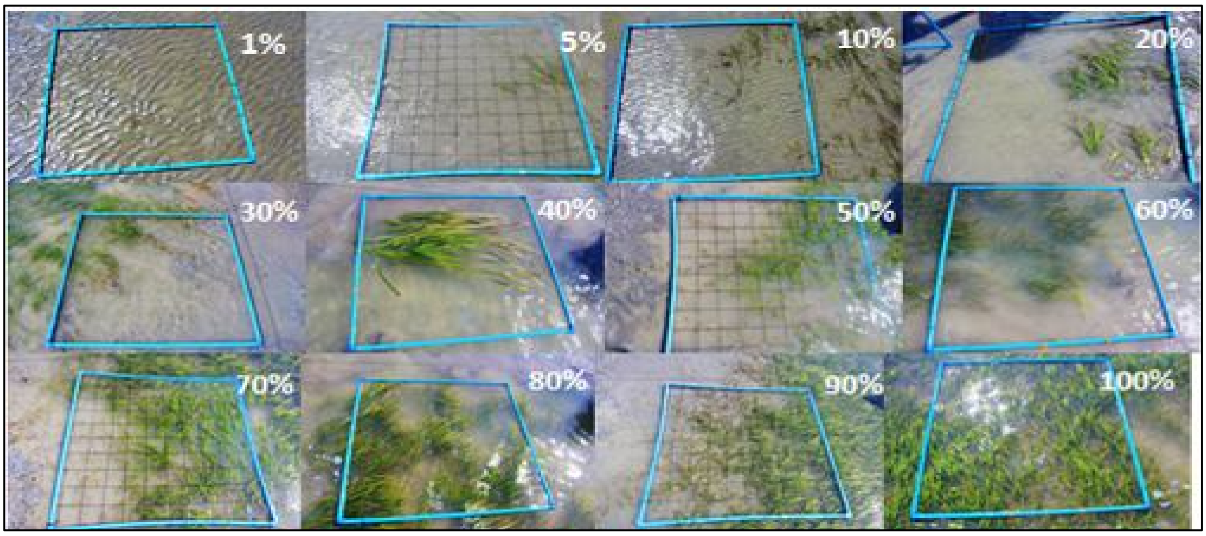

Figure 3. Shows the percent cover of seagrass in Paligue, Hagonoy, Davao del Sur.

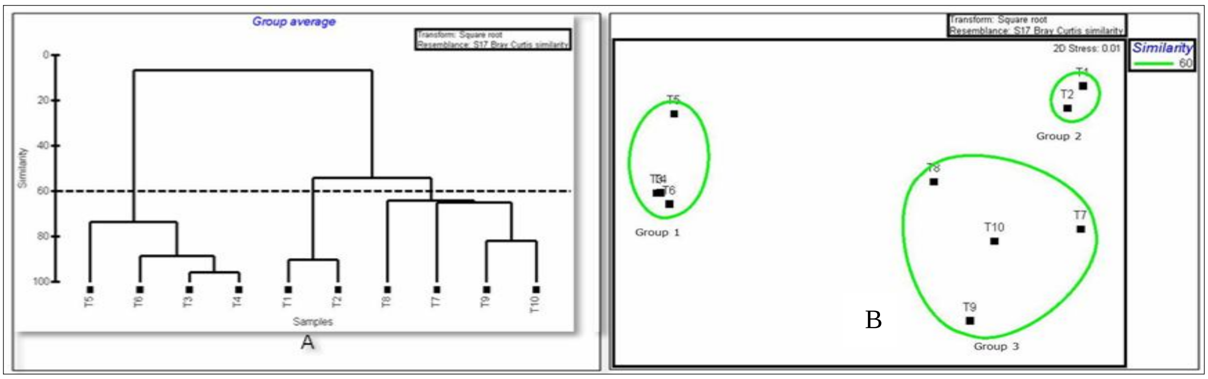

Figure 4. Cluster dendrogram and data ordination. The data formed 3 groups in the cluster analysis (A) and the proximity of samples indicated higher similarity in non-metric multidimensional scaling (B).

Conclusions. The study conlcuded that there were 7 species of seagrass found in Paligue, Hagonoy, Davao del Sur as species inventory. The species belong to two families (*Cymodoceaceae* and *Hydrocharitaceae*) observed using a purposive samping sampling in the intertidal coast of Davao gulf (Paligue, Hagonoy). *T. hemprichii and C. rotundata* were the species with highest number of individuals and the other species were low in dominance. The spatial structure also had variations. Three (3) major groups were formed as evident in cluster analysis and ordination of data using non-metric multidimensional scaling. The variation were influenced by seagrass species and possibly edaphic factors in the sediments as observed *in situ*. The data is important in coastal management of seagrasses in the study area.

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