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Diversity, cover, shoot density, and distribution of seagrasses in the coastal areas of Gingoog City, Misamis Oriental, Philippines

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ABSTRACT

Seagrass is a vital part of the coastal environment because it offers refuge, food, and protection for a variety of animals. Despite its ecological and economic importance, seagrass meadows are under threat globally due to natural and human-caused activities. This study aims to establish baseline data on seagrass diversity, composition, cover, shoot density and distribution in Gingoog City, Misamis Oriental that would serve as a useful reference for future initiatives in management and conservation measures. A total of six species of seagrasses were identified in two sampling stations namely: *Thalassia hemprichii, Halophila ovalis, Enhalus acoroides, Halodule pinifolia, Halodule uninervis,* and *Syringodium isoetifolium*. These two sampling stations exhibited a mixed stand of seagrass community. The result of diversity indices showed that barangay Lunao was more diverse than barangay San Juan (*H'* = 0.99). Shoot density and distribution of seagrass showed preferences in different regions of the seagrass beds where *Thalassia hemprichii* species was widely distributed and dominated in Barangay Lunao while *Halodule pinifolia* has some restrictions in its distribution with high shoot density in the high intertidal region of the seagrass of Barangay San Juan. This high density of seagrass especially on *Halodule pinifolia* in a disturbed area is important in the coastal ecosystem because it maintains the seagrass diversity, actively stabilizes sediment, improves water quality, and supports a vast number of the marine organisms in this disturbed area of the coastal water of barangay San Juan.

Keywords: Disribution, diversity, Gingoog City, *Halodule pinifolia*, shoot density

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INTRODUCTION

Seagrasses are marine angiosperms that grow in shallow marine and brackish habitats ranging from temperate to tropical region. They grow on the seafloor in sediment, with upright, elongated leaves and a hidden network of roots and rhizomes (Short et al., 2001; Short et al., 2007). Seagrasses provide a sheltered, nutrient-rich habitat for a diverse range of flora and fauna from young fish and other small and large invertebrates such as shrimp, crabs, and sea urchins to endangered or critically important animals such as sea turtles and, in some cases, endangered dugongs (Fortes and Santos, 2004). Specifically, seagrass canopy, leaves, and stems are extremely valuable because they provide food and protection from predators (Lee et al., 2001; Ambo-Rappe, 2016). They also provide an immense use to human society since they are a source of food, raw material for home ornaments, jewelry, and medicine (Lumayag et al., 2018)

Despite the ecological and economic benefits they provide, seagrass faces a serious threat worldwide (Waycott et al., 2009) specifically in the Philippines which is home to the second greatest number of taxa of seagrasses with 16 species (Short et al., 2001). Multiple environmental stressor, many of which are attributed to human activities, have contributed to seagrass declines, including water eutrophication, coastal salinity variations, water turbidity in connection to sediment management, port, industry, and coastal development (Short and Coles 2001, 2003). Dredging, beach reclamation, pier construction, and aquaculture activities have a direct impact (Cuenca-Ocay et al., 2019). Indirect effects such as fertilizer, suspended sediments, destruction of coastal vegetation, and shoreline modification resulted in decreased water clarity with an impact on seagrass decline (Bantayan et al., 2023). The decline of seagrass beds has serious consequences for our marine environment (Jumawan et al., 2015). If these issues are not addressed, seagrass habitats may be threatened by stressors that impair and degrade natural productivity and ecological values. Thus, it is important to document seagrass species diversity and distribution to identify regions in need of conservation efforts (Short et al., 2001) and monitoring is essential for determining if the condition of the seagrass is stable, declining, or improving.

The coastal area of Gingoog encompasses a variety of habitats including seagrass but it is understudied and scientific data on the seagrass beds that are needed for the formulation of management measures in future initiatives is still lacking. To address these gaps, this study was conducted to determine theseagrass diversity, composition, cover, density and distribution that would serve as baseline information and a useful tool for future environmental management measures and sustainable development of this important resource.

MATERIALS AND METHOD

Description of the study area

Gingoog is a seaside component City in the northeastern province of Misamis Oriental (Figure 1). The coordinates are 124º57’ east and 8º52’ north. It is bounded by Gingoog Bay to the north, the Municipality of Magsaysay and the province of Agusan del Norte to the east, the municipalities of Claveria and Medina to the west, and Agusan del Sur to the south. Gingoog’s coast is frequently fed by two major rivers: the Odiongan and the Gingoog River, and it is highly influenced by the Northeast Monsoon system, with the wind-driven circulation of Gingoog Bay appearing to be oriented towards the coastline. Lunao, and San Juan are two coastal barangays with many seagrass beds. The coastal area of Barangay San Juan, in particular, contains an undersea spring that lowers the salinity of the water.

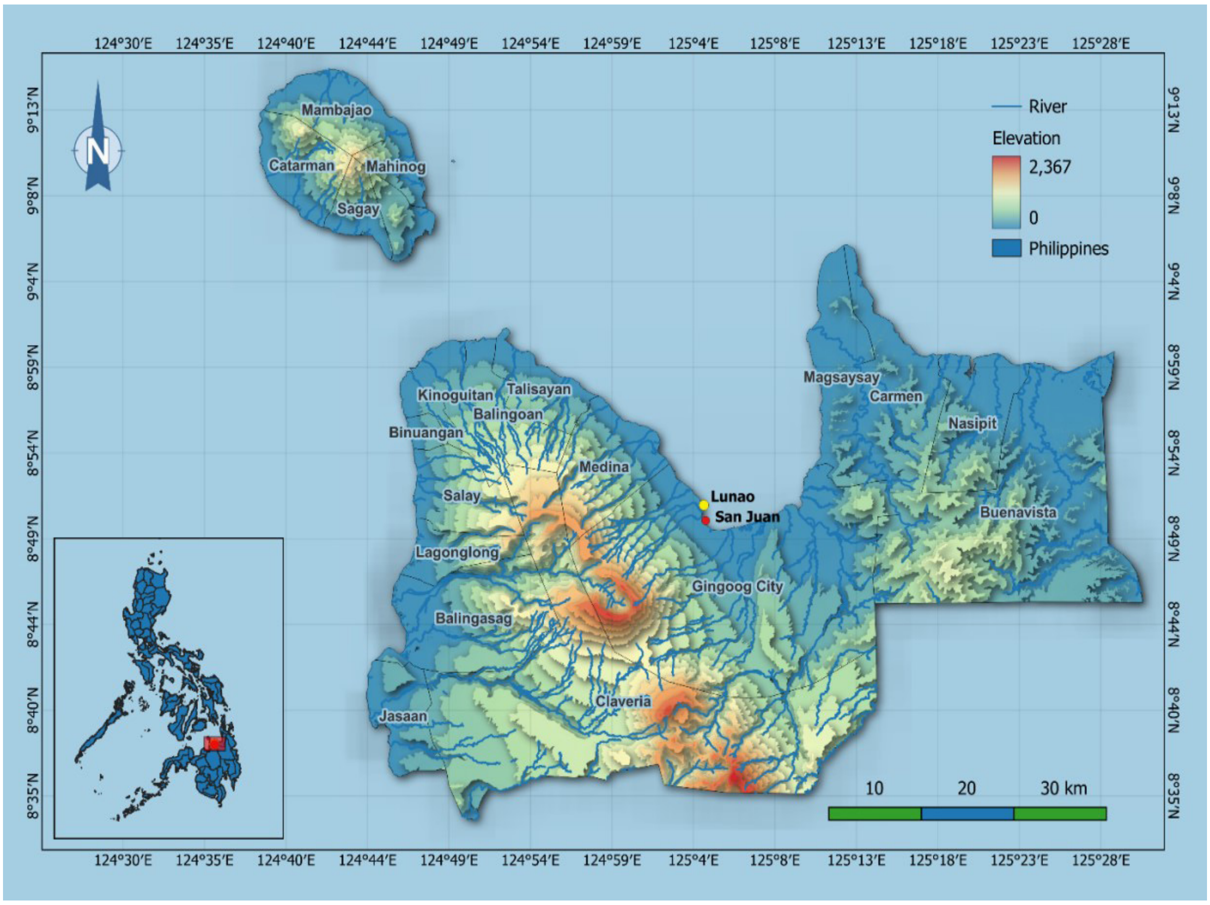

Figure 1. Map showing the study site. The bottom insert on the left is the map of the Philippines with Gingoog Bay marked with a red rectangle.

Data collection of seagrass

Sampling was conducted in the established sampling stations of Gingoog City, Misamis Oriental namely in Barangay San Juan which is geographically located at 8°49'35" North and 125°4'41" East, and in barangay Lunao which is geographically located at 8°51'1" North and 125°3'23" East. Sampling was done in the daytime during low tide using a mask and snorkel. The seagrass beds of the two sampling stations were divided into three regions: high or near the coastline, middle, and low or area where seagrasses are fully submerged with the measured distance of 10 m in each region. For each region, a 50 m transect was laid parallel to the shoreline and a 0.5 x 0.5 m steel quadrat was laid alongside the transect line with an interval of 5 m to record the following parameters: diversity, species composition, shoot density, cover, and distribution. All of the seagrasses inside the quadrats were identified using the taxonomic keys of Calumpong and Menez (1997) and Kuo and den Hartog (2001). The shoot density of the seagrass species was determined by carefully counting the number of shoots per species in each quadrat and expressed as density (shoot/m2). The estimation of seagrass cover was determined using the procedure adapted from Saito and Atobe (1970). Each species in the 25 subsquares of the quadrat was assigned with cover class and the equivalent midpoint percentage (Table 1). The seagrass coverage for each transect was then determined by dividing the sum of the average cover for each quadrat by the number of quadrats utilized. The percentage of seagrass cover of each sampling site was then categorized to determine the condition of seagrass beds of the area using the categories used by Fortes (1989) where poor = 0 – 25 %, fair = 26 – 50 %, good = 51 – 75 %, and excellent = 76 – 100 %.

Table 1. Classes of dominance of the seagrass cover (Saito and Atobe, 1970).

Class	Area covered	Substratum covered %	Midpoint % (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
0	Absent	0	0

Data analysis

Calculation of seagrass cover

Seagrass percent cover (C) of each species in every 0.5 m x 0.5 m quadrat was computed following the equation of English et al. (1997).

$$C = \frac{\Sigma(M_i \times f_i)}{\Sigma f}$$

Where:

M_i = mid-point percentage of class i.

f = frequency number of subsquares with the same class of dominance (i)

Calculation of density, relative density and diversity index

The shoot density and relative shoot density were calculated using the formula:

$$\text{Density} = \frac{\text{Number of shoots per species}}{\text{Total area of the quadrat (m}^2)}$$

$$\text{Relative density} = \frac{\text{Density of the species}}{\text{Total density of all species}} \times 100$$

Seagrass shoot density was used to determine the species diversity indices for each of the stations. Shannon-Weiner diversity index, index of evenness, and dominance were computed using the following formula:

a. Shannon-Weiner Index of General Diversity (H')

$$H' = -\sum\left(\frac{P_i}{N}\right)\log P_i / N$$

Where:

P_i = is the importance values of each species

N = is the total number of individual species per unit area

b. Index of Evenness (e)

$$e = \left(\frac{H'}{\log S}\right)$$

Where:

H' = is the Index of general diversity

S = is the total number of species

c. Index of *Dominance* (*D*)

$$D = \sum(N_i/N)^2$$

Where:

N_i = is the importance values of each species

N = is the total number of individual identified per unit area

Statistical analysis

Statistical t-test was used to test for significant differences at the alpha (α = 0.05) level of confidence in the shoot density of two sampling stations.

RESULTS

Seagrass cover and diversity

A total of six (6) species of seagrasses were identified in two sampling stations namely: *Thalassia hemprichii, Halophila ovalis, Enhalus acoroides, Halodule pinifolia, Halodule uninervis,* and *Syringodium isoetifolium* (Table 2). A total of four species of seagrasses were recorded in Barangay San Juan where was dominated by *Halodule pinifolia* (Figure 2) with a percent cover of 23.89% while *Halophila ovalis* had the lowest percent cover of 0.40%. On the other hand, five species of seagrass were found in Barangay Lunao where *Thalassia hemprichii* had the highest cover of 60.10 % while *Enhalus acoroides* had the least one (1.60%) (Figure 3). Based on the seagrass cover criteria set by Fortes (1989), the seagrass bed of Barangay San Juan and Lunao were considered fair (42.39%) and in good condition (68.08%) respectively.

The result of the Shannon-Weiner diversity index showed that Barangay Lunao has the higher value of *H'* = 1.21 compared to Brgy San Juan with a diversity value of *H'* = 0.99. Index of evenness and index of dominance showed that both of the stations have a high value of uniformity (E = 0.68), and no seagrass species were dominating (D < 1), respectively (Table 3).

Shoot density and distribution of seagrass

The distribution of seagrass species in three regions of the intertidal flat (high, mid, low) relative to the shoot density of each species was shown in Figures 4 and 5. Statistical analysis showed significant difference ($p<0.05$) in the shoot densities of seagrasses between Barangay Lunao and Barangay San Juan. Species of *Halodule pinifolia* in Barangay San Juan was distributed and dominated in the high intertidal region with a relative density of 97.06% and only a small portion in the mid-region (13.82%) while other species of seagrasses such as *Thalassia hemprichii* and *Halodule uninervis* were restricted in the mid and low region. In addition, *Halophila ovalis* was

Table 2. Species composition of seagrasses in two sampling stations of Gingoog City, Misamis Oriental.

Family	Genus and Species	Common Name	Gingoog City	
			San Juan	Lunao
Hydrocharitaceae	*Thalassia hemprichii*	Sickle-grass	✓	✓
	Halophila ovalis	Paddle weed	✓	✓
	Enhalus acoroides	Tape grass	-	✓
Cymodoceaceae	*Halodule pinifolia*	Needle-grass	✓	-
	Halodule uninervis	Manatee-grass	✓	✓
	Syringodium isoetifolium	Syringe grass	-	✓

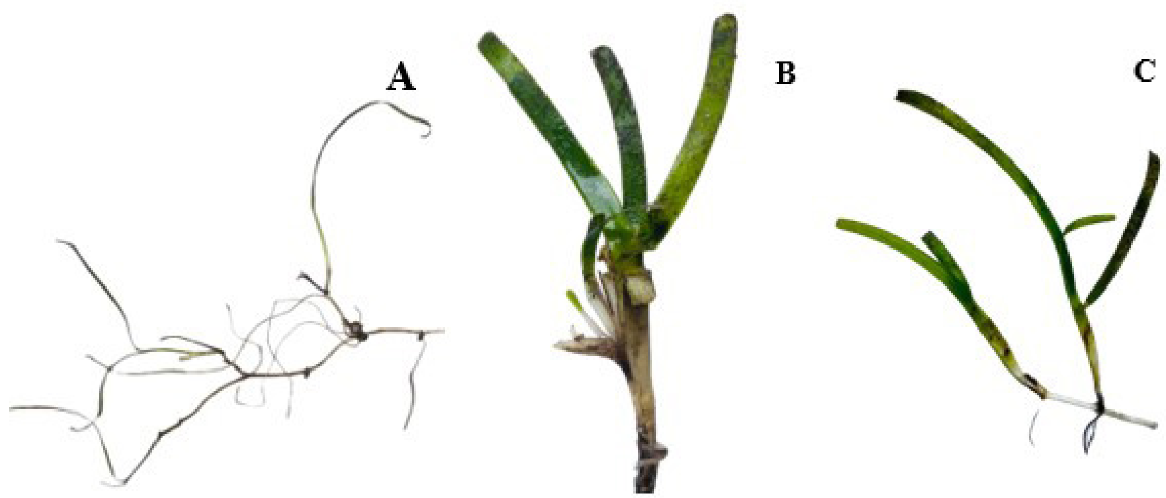

Figure 2. Images of the dominant seagrass species found in the seagrass beds of Gingoog City. Misamis Oriental. Left most side of the image is the *Halodule pinifolia* (A); Center part of the image is the *Thalassia hemprichii* (B); Right most side of the image is the *Halodule uninervis* (C).

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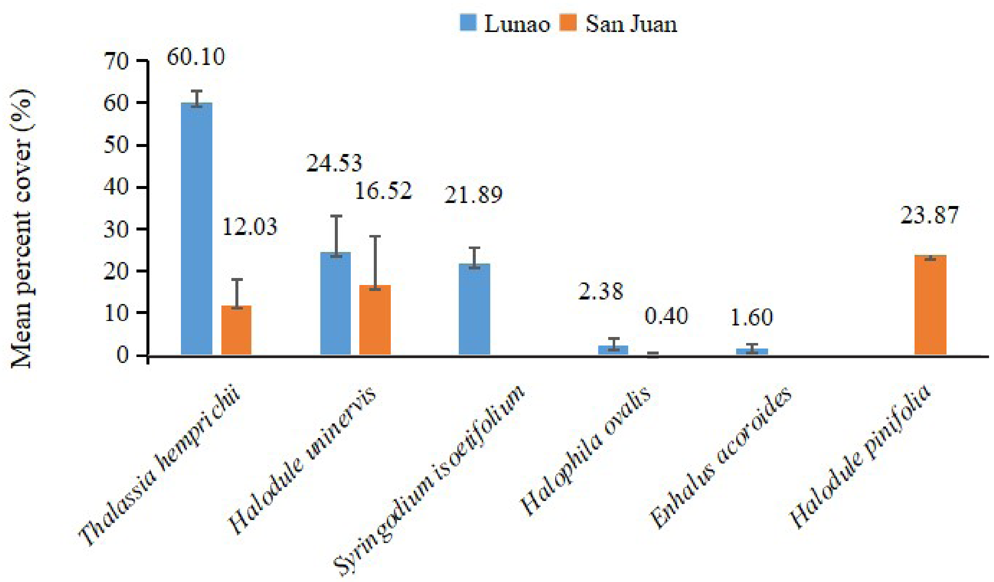

Figure 3. Mean percent cover of seagrass species with standard error of mean in Barangay San Juan and Barangay Lunao, Gingoog City, Misamis Oriental.

Table 3. Diversity profile in two sampling stations of Gingoog City, Misamis Oriental.

Stations	Ecological Index			Total number of shoots
	H'	**Even**	**Domain**	
Brgy. San Juan	0.99	0.68	0.45	4,554
Brgy. Lunao	1.21	0.68	0.33	6,471

distributed only in high intertidal and mid-region with a relative density of 2.94% and 2.40 % respectively (Figure 4). On the other hand, in Barangay Lunao, the three (3) species of seagrasses namely: *Thalassia hemprichii, Halodule uninervis,* and *Syringodium isoetifolium* were widely distributed with high densities in three regions except for *Halophila ovalis* that was only presentin the mid and low intertidal region with a relative density of 6.15% and 6.22% respectively. Moreover, *Enhalus acoroides* was restricted only in the high region with a relative shoot density of 2.78% (Figure 5).

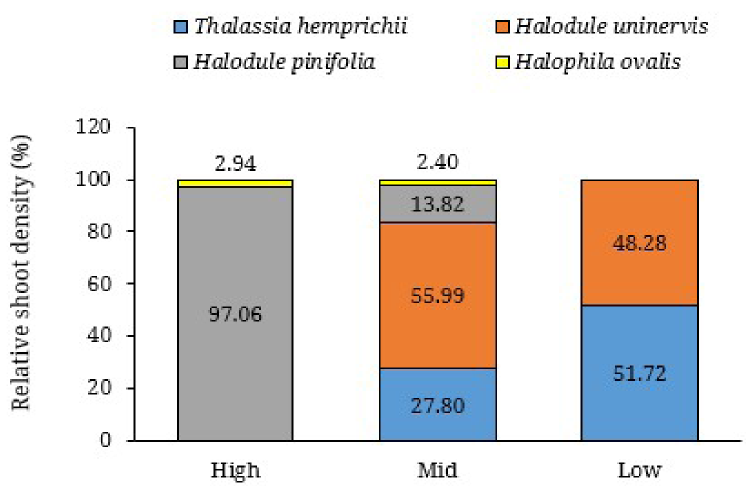

Figure 4. Distribution of seagrass species in three region: high, mid and low of Barangay San Juan, Gingoog City, Misamis Oriental.

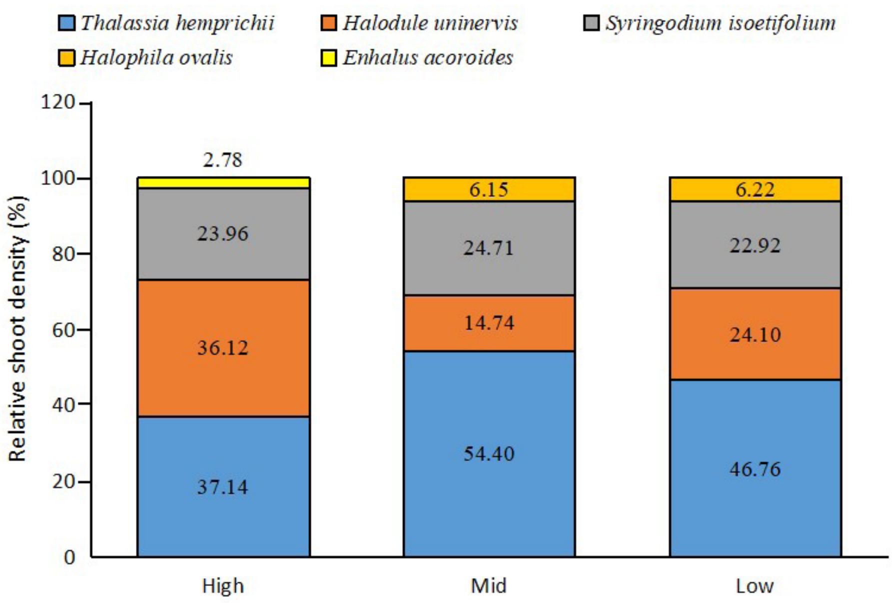

Figure 5. Distribution of seagrass species in three regions: high, mid and low of Barangay Lunao Gingoog City, Misamis Oriental.

DISCUSSION

A total of six species of seagrasses were identified in the seagrass beds of Barangay Lunao and Barangay San Juan namely: *Thalassia hemprichii, Halophila ovalis, Enhalus acoroides, Halodule pinifolia, Halodule uninervis, and Syringodium isoetifolium.* These represents about 40% of the total seagrass found in the Philippines (Short and Coles, 2001; Short et al., 2007). The seagrass beds of Gingoog City exhibited a mixed seagrass meadow from smaller size species (*Halophila ovalis*) to larger size (*Enhalus acoroides*) seagrass species. The present findings are similar to the results reported that showed seagrass meadows are generally mixed in Balingoan, Misamis Oriental (Hamisain et al., 2020), in Hagonoy, Davao del Sur (Jumawan et al., 2015), in the Southwest coast of Davao Oriental (Capin et al., 2020), in Kauswagan, Lanao del Norte (Redondo et al., 2017), in Iligan City (Orbita and Gumban, 2013), in Bongao, Tawi-Tawi (Abubakar and Echem, 2018), in Calatagan Batangas (Brazas and Lagat, 2022), and Maribojoc, Bohol Philippines (Mascarinas and Otadoy, 2022). The seagrass diversity index obtained in Barangay Lunao with *H'* = 1.21 was higher compared to Barangay San Juan with *H'* = 0.99. These diversity values were comparably higher to seagrass beds in Hagonoy, Davao del Sur with *H'* = 0.31 (Jumawan et al., 2015), and in Lupon, Davao Oriental (*H'* = 0.84) (Capin et al. 2020) but lower in Panglao (*H'* = 1.33) and in Dauis, Maribojoc Bay Bohol (*H'* = 1.31) (Mascarinas and Otadoy 2022), in Candelaria Zambales with *H'* = 1.61 (Paz-Alberto et al., 2015), in Calatagan, Batangas with *H'* = 1.82 (Brazas and Lagat, 2022). The low species diversity found in barangay San Juan can be attributed to the location of the area which was affected by various environmental conditions. The seagrass beds of barangay San Juan are characterized by prolonged exposure to sunlight during low tide and are directly influenced by the input of underwater spring. This physicochemical setting in Barangay San Juan might also explain the fair condition of the seagrass bed in the area. Duarte (2002) pointed out that seagrass diversity is higher in places with moderate degrees of disturbance, which include physical, chemical, natural, and human anthropogenic activities (Mckenzie and Campbell, 2002; Dewi et al., 2020). Thus, seagrass exposed to low tide, wave action, and low salinity from freshwater inflow affects seagrass species survivability in shallow waters (Mckenzie and Campbell 2002).

The result of seagrass percent cover showed high coverage of *Halodule pinifolia* in the seagrass beds of Barangay San Juan. This high cover of *Halodule pinifolia* was also reported by various literature (Hamasain et al., 2020: Japar Sidik et al., 2010; Udagedara et al., 2017). The *Halodule pinifolia* seagrass species thrives in lagoons, sheltered bays, and pools in mangrove swamps and can survive and even grow in disturbed areas (Japar Sidik et al., 2010). On the other hand, the lower coverage of other seagrasses in Barangay San Juan could be attributed to the long exposure of seagrass during low tide. This finding was also pointed out by Aboud and Kannah (2017) that exposure of seagrasses to sunlight in shallow lagoons can cause desiccation and stress to the seagrass species resulting in low seagrass coverage. Seagrass beds in Barangay Lunao were dominated by *Thalassia hemprichii* species. This is seen also in other studies conducted in the Philippines (Orbita and Gumban, 2013; Redondo et al, 2017; Paz-Alberto et al., 2015; Abubakar and Echem, 2018; Capin et al., 2020; Mascarinas and Otadoy, 2022) and in other countries (Dewi et al., 2020; Aboud and Kannah, 2017; Hantanirina and Benbow, 2013). The minimal exposure to sunlight during low tide and the sandy-muddy substrate in the area may be attributed to the high cover of *Thalassia hemprichii.* Thus, the ability of *Thalassia hemprichii* to hinder the growth of other species, allowing them to dominate in the seagrass beds (Capin et al., 2020; Abubakar and Echem, 2018). In general, the low coverage of *Halophila ovalis* was attributed to its size and capability to compete with other species in mixed seagrass meadows. Japar Sidik et al., (2010) stated that in mixed seagrass meadows, competition for light, nutrients, and space is evident resulting in a low abundance of small-size *Halophila* plants. The low coverage of *Enhalus acoroides* was attributed to its large size as mentioned by Duarte (1991) that bigger seagrasses like *Enhalus acoroides* grow slowly and have a limited colonizing capacity. In addition, Capin et al., (2020) reported that *Enhalus acoroides* grow in murky waters and muddy substrates, which are typically found at the mouth of rivers.

The seagrass beds of Gingoog City, Misamis Oriental showed habitat preference of their distribution, and only seagrass species that have high adaptability and flexibility to varying environmental circumstances are allowed to thrive effectively in a variety of habitats (Hemminga and Duarte, 2000). The physicochemical characteristics and human anthropogenic activities influence seagrass distribution where some species of seagrass can only be found in one region or either be present in two or three regions of the intertidal flat (Mckenzie and Campbell, 2002; Short et al., 2001). In Barangay Lunao, *Thalassia hemprichii, Syringodium isoetifolium* and *Halodule uninervis* were distributed in all regions with high shoot density indicating habitat suitability in different parts of the intertidal area. On the other hand, *Thalassia hemprichii* and *Halodule uninervis* in Barangay San Juan can only be found in mid and low regions with high density in the low regions. This result shows that the input of underwater springs that makes water less saline affects the distribution and shoot density of seagrass species. Vinson et al., (2016) pointed out that fluctuating salinity can harm seagrasses. Thus, the ability of seagrasses to adapt to environmental conditions varies from one species to another (Wahab et al., 2017). Nonetheless, the presence in high densities of *Halodule pinifolia* and its ability to thrive in fluctuating salinity and high exposure to sunlight in the high intertidal regions compared to other species of seagrasses in Barangay San Juan is an indication of its tolerance to various disturbances. This result was further highlighted by a study conducted by Lamit and Tanaka (2019), which found that the presence of *Halodule pinifolia* is known for its tolerance and flexibility in a variety of water and sediment conditions. Thus, this high density of *Halodule pinifolia* that can thrive in disturbed areas has clearimplications in Barangay San Juan for its importance particularly in coastal ecosystems to preserve seagrass habitat, stabilize coasts and to improve water quality (Hamisain et al., 2020). This finding suggests that seagrasses in Gingoog City flourish and grow depending on the physical and chemical conditions of the area, with some species showing restrictions in their distribution and only robust and tolerant species growing in disturbed areas.

CONCLUSION

A total of six (6) species of seagrasses were identified in two sampling stations of the coastal waters of Gingoog City Misamis Oriental namely; *Thalassia hemprichii, Halophila ovalis, Enhalus acoroides, Halodule pinifolia, Halodule uninervis,* and *Syringodium isoetifolium.* The seagrass percent cover and diversity were higher in Barangay Lunao than in Barangay San Juan. The presence of underwater springs may be attributed to this low species diversity andcover of Barangay San Juan. Species of seagrasses such as *Thalassia hemprichii, Halodule uninervis and Syringodium isoetifolium* occurs in high shoot densities in the three regions of the intertidal area of Barangay Lunao. On the other hand, *Halodule pinifolia* species occurs in high shoot density in the high regions while *Thalassia hemprichii and Halodule uninervis* only occurs in high densities in the mid and low regions in the intertidal area of Barangay San Juan. This indicates that seagrass species showed specific preference in their distribution with some species showing restrictions in their distribution in the intertidal area and only robust and tolerant species growing in disturbed areas. Overall, this study suggests that there is a need for management and conservation measures to be taken to preserve and sustain this valuable resource.

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REFERENCES

Aboud, S. A., and Kannah, J. F. (2017). Abundance, Distribution, and Diversity of Seagrass Species in Lagoonal Reefs on the Kenyan Coast. *American Scientific Research Journal for Engineering, Technology and Science* (ASRJETS), 37(1), 52–67.

Abubakar and Echem, R. T. (2018). Distribution and Abundance of Seagrass in Bongao, Tawi-Tawi. *World Journal of Pharmaceutical and Life Sciences*, 4(7), 17–21.

Ambo-Rappe, R. (2016). Differences in richness and abundance of species assemblages in tropical seagrass beds of different structural complexity. *Journal of Environmental Science and Technology*, 9(3), 246–256.

Bantayan, J. M., Lomoljo-Bantayan, N. A., & Villegas, J. (2023). Community structure of macroinvertebrates in protected and exploited areas of Baganga, Davao Oriental, Philippines. *Davao Research Journal*, 14(1), 17-31.

Brazas Jr., F., and Lagat, R. (2022). Diversity, distribution, and habitat association of seagrass in Calatagan, Batangas, Philippines. *Journal of Ecosystem Science and Eco-Governance*, 4(SI), 23–32.

Calumpong, H. P., West, J., Meñez, E. G., and Menez, E. G. (1998). Field Guide to the Common Mangroves, Seagrasses, and Algae of the Philippines. *Taxon*, 47(1), 203.

Capin, N. C., Pototan, B. L., Delima, A. G. D., and Novero, A. U. (2021). Distribution and Abundance of Seagrasses in the Southwest Coastof Davao Oriental, Philippines. *Philippine Journal of Science,* 150(S1), 383–394.

Coles, R. and Kuo, J. (1995). Seagrasses. Chapter3. pp. 39-57. In: JE Maragos, MNA Peterson, LG Eldredge, JE Bardach, HF Takeuchi (eds.) Marine/Coastal Biodiversity in the Tropical Island Pacific Region: Vol 1. Species Systematics and Information Management Priorities. *East-West Center, Honolulu*.

Cuenca-Ocay, G., Bualan, Y. N., & Macusi, E. (2019). Philippine mangroves: species composition, characteristics, diversity,and present status. *Davao Research Journal*, 12(2), 6-29.

Dewi, C. S. U., Yona, D., Samuel, P. D., Maulidiyah, R. A., Syahrir, A., Putri, Y. E., and Fikri, M. (2020). Distribution and healthy status of seagrass bed in Lamongan coastal area. *In E3S Web of Conferences (Vol. 153). EDP Sciences.*

Duarte, C. M. (1991). Allometric scaling of seagrass form and productivity. *Marine Ecology Progress Series,* 77(2–3), 289–300.

Duarte, C. M. (2002). The future of seagrass meadows. *Environmental Conservation,* 29(2), 192–206.

English, S., Wilkinson, C., and Baker, V. (1997). Survey manual for tropical marine resources. (S. English, C. Wilkinson, & V. Baker, Eds.), Townsville *Australian Institute of Marine Science* (Vol. 390, p. 390).

Fortes M.D.F. (1989). Seagrasses: a resource unknown in the ASEAN region. ICLARM education series 5. *International Center for Living Aquatic Resources Management, Manila* 46 p.

Fortes, M.D., and Santos, K.F. (2004). Seagrass ecosystem of the Philippines: Status, problems and management directions. 90-95. In DA-BFAR (Department of Agriculture-Bureau of Fisheries and Aquatic Resources). In Turbulent Seas: The status of Philippine marine fisheries. Coastal Resource Management Project, Cebu City, Philippines, 378.

Freeman, A. S., Short, F. T., Isnain, I., Razak, F. A., and Coles, R. G. (2008). Seagrass on the edge: Land-use practices threaten coastal seagrass communities in Sabah, Malaysia. *Biological Conservation*, 141(12), 2993–3005.

Greve, T. M., and Binzer, T. (2004). Which factors regulate seagrass growth and distribution? European Seagrasses: An Introduction to Monitoring and Management, 19–23.

Hamisain, R.D., Sama, L.D., Lacuna,M.L.D., Orbita, R.R., and Orbita, M.L.S. (2020). Species composition, abundance and distribution of seagrasses in the brackish waters of Balingoan, Misamis Oriental in relation to environmental parameters. *Internatioal Journal of Biosciences (IJB).*

Hantanirina, J., and Benbow, S. (2013). Diversity and coverage of seagrass ecosystems in south-west Madagascar. *African Journal of Marine Science,* 35(2), 291–297.

Hemminga, M.A. and Duarte, C.M.. (2000). Seagrass Ecology. *Cambridge: Cambridge University Press.*

Jumawan, J., Bitalas M., Ramos, J.J., Garcia, A.R., Landero, R., Cordero, J., Matela, M.N., Apostol, M.A., and Cataluna, R (2015). Seagrass diversity and structure along the coastal area in Paligue, Hagonoy Davao del Sur, Philippines. *AES Bioflux Society,* 7(3), 351-356.

Kuo, J., and den Hartog, C. (2001). Seagrass taxonomy and identification key. *In Global Seagrass Research Methods* (pp. 31–58). Elsevier.

Lamit, N., and Tanaka, Y. (2019). Species-specific distribution of intertidal seagrasses along environmental gradients in a tropical estuary (Brunei Bay, Borneo). *Regional Studies in Marine Science*, 29.

Lee, S. Y., Fong, C. W., and Wu, R. S. S. (2001). The effects of seagrass (Zostera japonica) canopy structure on associated fauna: A study using artificial seagrass units and sampling of natural beds. *Journal of Experimental Marine Biology and Ecology,* 259(1), 23–50.

Lumayag, K.J, Ronaldo, R., Orbita, M.L.S., and Lacuna, M.L.D. (2018). Benthic mollusks in seagrass beds of Barangay Liangan East and barangay Esperanza, Bacolod, Lanao del Norte, Northern Mindanao, Philippines. *International Journal of Biosciences,* 13(3), 121-131.

Mascarinas, H. J., and Julie B, O. (2022). Seagrass Diversity and Distribution in Maribojoc Bay, Bohol, Philippines. *American Journal of Environment and Climate*, 1(1), 12–19.

McKenzie, L. J., and Campbell, S. J. (2002). "Manual for Community (citizen) Monitoring of Seagrass Habitat Western Pacific Edition.

Menez, E. G., Phillips, R. C., and Calumpong, H. P. (2013). Seagrasses from the Philippines. *Smithsonian Contributions to the Marine Sciences,* 21, 40.

Paz-Alberto, A., Hechanova, M., and Sigua, G. C. (2015). Assessing Diversity and Phytoremediation Potential of Seagrass in Tropical Region. *International Journal of Plant, Animal and Environmental Sciences*, (4), 24–36.

Saito, Y., and Atobe, S. (1970). Phytosociologi cal Study of Intertidal Marine Algae: I. Usujiri Benten-Jima, Hokkaido. *Bulletin of the Faculty of Fisheries Hokkaido University,* 21(2), 37–69.

Japar Sidik B, Harah Z.M., and Arshad A. (2010). Morphological characteristics, shoot density and biomass variability of *Halophila* sp. in a coastal lagoon of the east coast of Malaysia. *Coastal Marine Science,* 34(1), 108-112.

Short F.T., and Coles RG. (2001). Global Seagrass Research Methods. *Elsevier, Amsterdam.* 482 pp.

Short, F.T., Coles, R.G., and Pergent-Martini, C. (2001). Global Seagrass Distribution. Chapter 1, pp. 5-30. In: FT Short, RG Coles (eds.) Global Seagrass Research Methods. *Elsevier Science B.V., Amsterdm.*

Short F.T.and Coles, R.G., (eds) (2003). Global Seagrass Research Methods. *Amsterdam: Elsevier Science BV.*

Short, F., Carruthers, T., Dennison, W., and Waycott, M. (2007). Global seagrass distribution and diversity: A bioregional model. *Journal of Experimental Marine Biology and Ecology,* 350(1–2), 3–20.

Redondo, A.F., Dagoc, K.M., Ignacio, K.M., Sanchez, R.R and Tampus, A. (2017). Seagrass mapping and assessment using remote sensing in the Municipality of Kauswagan, Lanao del Norte, Philippines. *Journal of Biodiversity and Environmental Sciences*, 11(4), 74-88.

Wahab, I., Madduppa, H., and Kawaroe, M. (2017). Seagrass species distribution, density and coverage at Panggang Island, Jakarta. In IOP Conference Series: Earth and Environmental Science (Vol. 54). *Institute of Physics Publishing.*

Waycott, M., Duarte, C. M., Carruthers, T. J. B., Orth, R. J., Dennison, W. C., Olyarnik, S., and Williams, S. L. (2009). Accelerating loss of seagrasses across the globe threatens coastal ecosystems. *Proceedings of the National Academy of Sciences of the United States of America,* 106(30), 12377–12381.

Udagedara, S., Fernando, D., Perera, N., Tanna, A., and Bown, R. (2017). Short Communication A first record of *Halodule pinifolia* Miki den Hartog, and new locality of nationally endangered *Halophila beccarii* Asch, from the eastern coast of Sri Lanka. *Int. J. Aquat. Biol,* 5(5), 328–335.

Unsworth, R. K. F., Nordlund, L. M., and Cullen-Unsworth, L. C. (2019). Seagrass meadows support global fisheries production. *Conservation Letters*, 12(1).

Vinson, N. S., Ante, S. C., Jean, R., Roxas, F. S., Marie, S., Salvio, C., and Requieron, E. A. (2016). Correlation between water quality and seagrass distribution along intertidal zone in Sarangani Province. Philippines. *Journal of Biodiversity and Environmental Sciences,* 8(5), 30–35.