Assessment of seagrass beds and associated macrobenthic fauna in the intertidal areas of Dasol, Pangasinan, Philippines

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Abstract. Seagrass beds are indispensable components of an aquatic realm. Dasol is among the coastal municipalities of Pangasinan that support the province's need for cheap and sustainable food and livelihood. Recognizing the preponderance of the ecosystem in this municipality, an assessment was conducted to determine the status of the seagrass beds and their associated macrobenthic fauna and to identify further management strategies to sustain their productivity. Sampling sites were established in the barangays of Tambobong (station 1) and Uli (station 2). The transect-quadrat method was employed with triplicates and laid out perpendicular to the shoreline. Meanwhile, economic benefits and disturbances were determined through face-to-face interviews with local government officials. The results revealed that higher seagrass percent cover, shoot density (sd), and relative density (rd) were recorded in Tambobong. Likewise, Tambobong recorded higher estimates of biomass for most seagrass species. In terms of associated macrobenthic fauna, Tambobong harbors a higher number of species belonging to three classes: Porifera (11%); Echinodermata (33%); and Mollusca (56%), with an overall estimated density of 1.400 individual m^{-2}. However, environmental quality did not differ between sampling sites. Economic benefits include gleaning and tourism. These activities may have caused disturbance to seagrass beds, as mentioned by the local officials.

Key Words: biomass, cover, density, gleaning, percent, tourism.

Introduction. Seagrass beds are among the most productive coastal habitats and constantly provide important ecosystem goods and services to the fishing communities of many maritime nations. Ecologically, seagrass beds have high primary productivity that supports numerous diverse grazing and detritus-based food chains and associated ecosystems such as mangal forests and coral reefs, of which seagrass beds are regarded as ecotones (Fortes 2013). The seagrasses have immeasurable ecological functions, such as being an essential breeding ground, nursery, and feeding ground for various economically important fishery species as well as some critically endangered marine reptiles and mammals (Jumawan et al 2015; Vinson et al 2016). Due to the expansion of the direct services and benefits seagrasses provide to people, their significance in Southeast Asia is gaining ground steadily but significantly. However, seagrass communities continue to be put at risk due to industrialization. There was a big gap between seagrass science, policy, and practice. The social and environmental 'crisis' occurring in Southeast Asia is forcing governments to protect, monitor, and manage seagrass ecosystems (Fortes et al 2018).

The Philippines ranked second worldwide in terms of seagrass diversity, with 13 species distributed over an area of approximately 22,000 km based on remote sensing (McKenzie 2007). As a result, destructive activities like dredging, runoff, and oil spills present a threat to seagrass beds. Population growth has contributed to the overexploitation and devastation of resources. Poisoning and blast fishing continue to have a negative impact on the Philippines' coastal resources.

Dasol is a small coastal town in western Pangasinan, situated on a plateau with an area of about 230 km^2. It is bounded on the north by the municipalities of Burgos and Mabini, the mineral-rich Zambales Mountains in the east, the municipality of Infanta on the south, and the West Philippine Sea in the west. Furthermore, Dasol is known for producing commercial salt, 10,000 salt beds across coastal and riverine villages (Alcantara 2017). The town of Dasol produces 37.4% of the salt in the province of Pangasinan, Philippines (Province of Pangasinan 2023). Dasol Bay encompasses the entire Dasol shoreline and is the source of the town's saltwater for traditional salt-making. At present, there is still inadequacy of information about the fisheries resources of the town. Only fishing communities and some of their catches in the coastal waters (part of Dasol Bay) of the town have been documented in previous undertaking (Aban et al 2017). It is often cited that the absence or inadequacy of ecological and biological data is a major constraint in developing appropriate management strategies to ensure the sustainability of marine resources for extractive purposes. Seagrass beds are among the common areas for fishing and serve as important sites to boost tourism, of which both sectors are fueling the town's economic engine. However, studies regarding the status of seagrass beds were not considered at present. It has been identified that unrestricted activities could negatively affect the system. Continuous exploitation without any intervention may lead to the collapse of the resource. Therefore, an assessment must be conducted to establish a reference for future conservation and management.

The primary objective of this study is to provide baseline information on the seagrass beds in the intertidal areas of Dasol. Specifically, it aims to determine the species composition, seagrass cover, relative density, biomass estimate, environmental quality, and the associated microbenthic fauna present in the area. Furthermore, disturbances were assessed from the locals and possible interventions were identified that could serve as significant tools in the management of the intertidal resources.

Material and Method

Data gathering procedure. Before the actual assessment, a letter requesting permission to conduct the study in waters under their jurisdiction was sent to the Local Government Unit (LGU) of Dasol, Pangasinan, and Barangay Councils. A preliminary evaluation was conducted to assess the location of sampling stations. In addition, a personal interview was conducted with key personnel in order to determine the status and conditions of their coastal resources.

Site. The assessment of seagrass beds and associated macrobenthic fauna was conducted on the coast of Tambobong (15°56'16.08" N, 119°46'48.72" E) and Uli (15°57' 39.6" N, 119°49'9.48" E), the selected coastal barangays of Dasol, Pangasinan, Philippines, on March 2023 (Figure 1).

Data collection. The evaluation and data collection of seagrass and macrobenthic fauna were conducted using the transect-quadrat method, in which three 50-meter (m) transects were set perpendicular to the shoreline with a distance of 100 m between each line in the identified sampling station (according to English et al 1997). A 1 x 1 m^2 plot per quadrat was established every 10 m.

Seagrass percent cover, shoot, and relative density and estimated biomass. Seagrass coverage is the percentage of an area covered by a seagrass canopy. The assessment of the condition and cover of seagrass was based on visual observation and refers to the Standard Criteria for Damage and Guidelines for Determining the Status of Seagrass (Table 1).

Figure 1. The two study areas: Tambobong (Station 1) and Uli (Station 2) Dasol, Pangasinan, Philippines.

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Table 1
The standard criteria for damage and guidelines for determining the status of seagrass

Description	*Condition*	*Coverage*
Good	Healthy	> 60%
Moderate	Less healthy	30-59.9%
Bad	Poor	< 29.9%

Shoot density was measured by counting the shoots per species for each quadrat and the shoot numbers have expressed a density (shoot m^{-2}). The density and relative density were calculated using the formulae below:

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

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

In addition, the study made an attempt to calculate the purported biomass of seagrass species. The following formula was adapted from English et al (1997) and included in Assuyuti et al (2016) to process the data pertaining to the covering of several species of seagrass that were employed in this analysis:

Estimated biomass (EB) = T x 10.000 x Carbon Species Index

where: T = covering of species i (individual).

Assessment of macrobenthic fauna. In each transect line, sampling of macrobenthic fauna was done by counting the organisms present in each square meter quadrat plotted in every 10-meter interval. An in-situ photo documentation of macrofauna was carried out. Identification was done based on their morphological features using available published references (Napata & Andalecio 2011; Leong et al 2013; Olbers et al 2015; Laimeheriwa et al 2018; Fortaleza et al 2020; Arabaca et al 2022; Arriesgado et al 2022) and taxonomical classification of each organism was based according to the World Register of Marine Species (http://www.marinespecies.org/index.php) website.

The density of macrobenthic fauna was estimated following the formula of English et al (1997):

Density = number of individual species (ni) / total area sampled (A)

Water and sediment quality. Important physico-chemical parameters were determined in situ. The dissolved oxygen (DO) and temperature were measured by using DO analyzer D09100, while the ph, salinity, oxygen reduction potential (ORP), and electrical conductivity (EC) were measured using the 7-in-1 water quality tester C-600.

To determine the soil sediment and chemical quality of the study area, one kilogram of soil per line was taken during the sampling. The soil samples were dried for several days, ground, and sieved prior to analysis. The grinding and sieving operations should ensure a homogenous mixture for analysis. The feel method was used to determine the sediments' texture, while the potentiometric, Olsen, and Walkley-Black colorimetric methods were used to determine the soil's pH, phosphorous, and organic matter, respectively.

Identification of ecosystem goods, services, disturbances, and management. This was conducted through personal interviews with the key leaders of the municipality and at the barangay level. A matrix design served as the interview's guide to aid in the discussion. The context is to enlighten how coastal resource management was implemented in the area and impart protection to the seagrass community. The key stakeholders that were interviewed are the barangay captain, municipal/barangay councilor (Committee on Agriculture), barangay councilor (Committee on Infrastructure), Municipal Agriculture Office (MAO), Municipal Environment and Natural Resources Office (MENRO), Administrative Office of the LGU, and Tourism Office. They were chosen because of their direct functions in resource management.

Results and Discussion

Species composition of seagrass. There were six (6) species of seagrass identified in Barangays Tambobong and Uli (Table 2). The common species is *Enhalus acoroides*. The rest of the species are distinct to each site; *Thalassia hemprichii*, *Halodule pinifolia*, and *Syringodium isoetifolium* are the common species in the Tambobong site, except that *Cymodocea rotundata* and *Halophila decipiens* evolved in Uli. There are known complicated environmental factors that affect the seagrass existence in a certain area, including the type of sediment characteristics (substrates), hydrodynamics of the area, human perturbation, nutrients (nitrogen and phosphorous) (Borum et al 2004), and other environmental factors that affect its abundancy and existence.

Table 2

Species composition of seagrass in Tambobong and Uli, Dasol, Pangasinan

Station	*Seagrass species*
Tambobong	*E. acoroides* Royle, 1839 (Guiry & Guiry 2023) *T. hemprichii* (Ehrenberg) Aschenson, 1871 (Tanduyan et al 2013; Guiry & Guiry 2023) *H. pinifolia* (Miki) Hartog (Guiry & Guiry 2023) *S. isoetifolium* (Guiry & Guiry 2023)
Uli	*E. acoroides* Royle, 1839 (Guiry & Guiry 2023) *C. rotundata* Asch. & Schweinf (Guiry & Guiry 2023) *H. decipiens* Ostenfeld, 1902 (Guiry & Guiry 2023)

Seagrass percent cover, density, and estimated biomass. The average percent cover of seagrass at the Tambobong was 71, which indicates that it is in good and healthy condition, while Uli is in bad and poor condition with an average cover of 7%. The conditional description refers to the Standard Criteria for Damage and Guidelines for Determining the Status of Seagrass (Table 3).

Table 3

Seagrass average % cover, shoot density, relative density and estimated biomass in Tambobong and Uli, Dasol, Pangasinan

Site	*Average % cover*	*Identified species*	*Shoot density (m^{-2})*	*Relative density (%)*	*Estimated biomass (gDw m^{-2})*
Tambobong	71	*E. acoroides*	14	22	859.1
		T. hemprichii	31	48	787.16
		H. pinifolia	14	22	93.22
		S. isoetifolium	5	8	37.89
					1,777.37
Uli	7	*E. acoroides*	11	59	550
		C. rotundata	7	37	10.57
		H. decipiens	0.75	4	1.57
					562.14

At the Tambobong site, the shoot density (sd) and relative density (rd) ranged from 5 to 31 shoots m^{-2} and from 8 to 48%, respectively. *T. hemprichii* was the dominant species, with a shoot density of 31 and a relative density of 48%, followed by *E. acoroides* and *H. pinifolia* (14, 22% each), and *S. isoetifolium* (5, 8%). In addition, Uli obtained a lower number of shoots and a lower relative density, with the following results: *E. acoroides* (11, 59%), *C. rotunada* (7, 37%), and *H. decipiens* (0.75, 4%). In most cases, the density of seagrass is directly related to the percentage of its cover. Seagrass biomass analysis showed that *E. acoroides* was the greatest in Tambobong (859.1 gDw m^{-2}) and Uli (550 gDw m^{-2}) compared to other seagrass species in both areas. The result was certainly related to the morphology of the leaves and the closure of each type of seagrass (Dewi & Sukandar 2017). In the Philippines, genus *Enhalus* is one of the most prominent seagrass mixed seagrass beds (McKenzie 2007).

The result shows that Tambobong has a higher percentage of cover, density, and biomass compared to Uli. The existence of river water intrusion in the Uli area, which causes silted sediment, could be the reason for the low percentage of cover, density, and biomass of seagrass. According to Terrados et al (1998) and Halun et al (2002) seagrass species richness and community leaf biomass declined sharply when the silt and clay content of the sediment exceeded 15%.

Species composition of macrobenthic fauna. A total of 11 macrobenthic fauna from three (3) different phyla were identified in Tambobong and Uli, Dasol, Pangasinan (Figure 2).

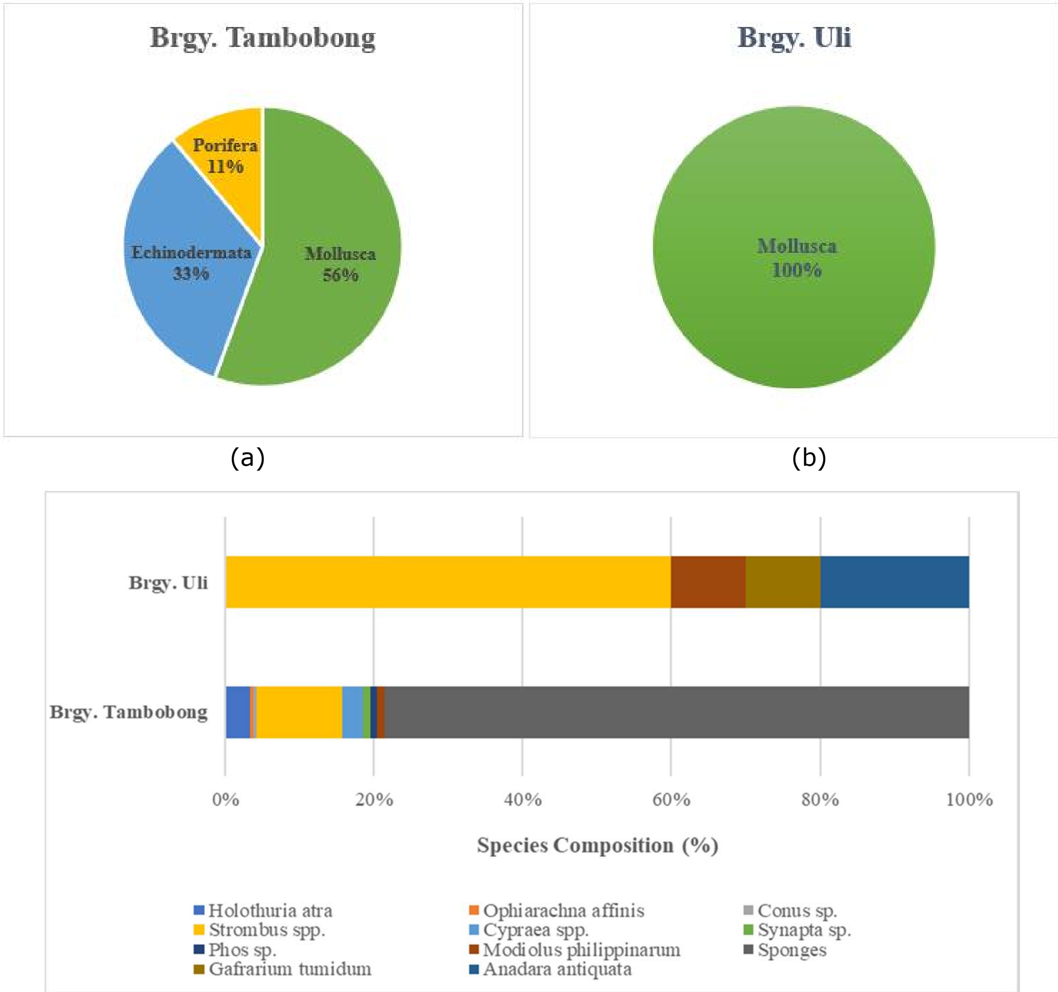

Figure 2. Seagrass-associated macrobenthic fauna of barangays Tambobong and Uli, Dasol, Pangasinan: (a-b) percentage distribution of phyla identified the two sampling sites, and (c) species composition of macrobenthic fauna in Tambobong (N = 210) and Uli (N = 10).

The phylum Mollusca dominates the majority of fauna in Tambobong in terms of identified families (56%), followed by Echinodermata (33%), and Porifera (11%). Only one bivalve (Class Bivalvia) with one species and four gastropods (Class Gastropoda) were identified in the phylum Mollusca in Tambobong. The numerous species under Class Gastropoda in the seagrass environment are comparable with previous research conducted in the Philippines (Walag & Canencia 2016; Lumayag et al 2018). The Phylum Echinodermata, on the other hand, comprised three families (Holothuriidae, Ophiomyxidae, and Synaptidae) with three species, while the Phylum Porifera consisted of unidentified sponges. In Uli, all of the identified species belong to the phylum Mollusca in four different families: Veneridae, Strombridae, Mytilidae, and Arcidae.

In terms of counts per individual, 78.57% of the species encountered in the seagrass beds of Tambobong belong to the phylum Porifera. In the phylum Mollusca, *Strombus* spp. were predominantly present in both sampling stations, with 11.43% in Tambobong and 60% in Uli. The *Holoturia atra* had the highest count (3.33%) of individuals among the species identified under Phylum Echinodermata in Tambobong but was absent in Uli.

Among the species identified in the two sampling sites, *Strombus* spp. and *Modiolus philippinarum* were found present in both stations.

The number of species in the present study is lower compared to the reports in the Central Philippines with 12 species (Wagey et al 2017), in Eastern Bohol with 19 species (Libres 2015), in Misamis Occidental with 45 species (Leopardas et al 2014) and in Bolinao, northwestern Philippines, with 81 species (Leopardas et al 2016). This might be attributed to the fact that the study is carried out only at one sampling and only daytime in each station.

The density of macrobenthic fauna. The estimated density (individuals m^{-2}) of macrobenthic fauna in the seagrass beds in Tambobong and Uli, Dasol, Pangasinan is shown in Table 4. The sponges had the highest density (1.1 individual m^{-2}) in Tambobong. The *Strombus* spp. was the most abundant in the phylum Mollusca and occurred in both stations. In Phylum Echinodermata, *H. atra* had a higher population density (0.047 individual m^{-2}) in Tambobong. There are no species of echinoderms identified in Uli.

Table 4

Estimated density (individuals m^{-2}) of macrobenthic fauna in the seagrass beds in Tambobong and Uli, Dasol, Pangasinan

Macrobenthic fauna	*Tambobong*	*Uli*
Echinodermata		
Holothuria atra	0.047	-
Ophiarachna affinis	0.007	-
Synapta sp.	0.013	-
Mollusca		
Gastropoda		
Conus sp.	0.007	-
Cypraea spp.	0.040	-
Phos sp.	0.013	-
Strombus spp.	0.160	0.040
Bivalvia		
Anadara antiquata	-	0.013
Gafrarium tumidum	-	0.007
Modiolus philippinarum	0.013	0.007
Porifera		
Sponges	1.100	-
Overall density	1.400	0.067

Under the phylum Echinodermata, *H. atra* was the most abundant, while *O. affinis* had the lowest count. The abundance of *H. atra* in seagrass beds is parallel with the report elsewhere in the Philippines, such as in Panglao, Bohol (Vito 2019), and Mindanao (Arriesgado et al 2022). The fast-reproducing ability of *H. atra* via asexual reproduction by fission was linked to its abundance (Vito 2019; Arriesgado et al 2022). Further, its high density may also be associated with the time of sampling, which is also reflected in the study of Arriesgado et al (2022), where this species has been found abundant during the daytime. The low density of *O. affinis* may be attributed to its fast mobility and also to its habitat preference, which is found under *Porites* colonies, boulders, and coral rubbles (Olbers et al 2015), making it difficult to identify their presence. The presence of *Synapta* sp. in the seagrass areas is also reported in Honda Bay, Palawan, and Mindanao and occurs actively and abundantly during the daytime (Jontila et al 2017; Arriesgado et al 2022).

Among the two classes of Mollusca, Gastropoda obtained the highest density in both stations and it is comparable with the findings in the previous works done in the Philippines (Segumalian et al 2016). The abundance of macrobenthic gastropods in Tambobong may be attributed to the light-textured sediment, which is characterized by a lower concentration of clay-sized particles where sand and clay particles are evenly distributed (Ritchey & McGrath 2015). Based on Segumalian et al (2016), gastropods are less abundant in silty or clay types of sediments. In terms of species, *Strombus* spp. has a relatively high density compared to other gastropods. This may associate with the presence of favorable habitat for the *Strombus* population, having a combination of sandy-rocky substrate and the presence of seagrass beds in the area (Ciasico et al 2006).

The distribution of sponges in the seagrass beds may likewise associate with the proportion of coarse particles in the sediment and/or may also with the conjunctive influence of seagrass shoot density and sedimentation/resuspension rate as observed in the estuarine environment by Avila et al (2014). Sponges, therefore, were only present in the coastal waters of Tambobong.

The low density of macrobenthic fauna in both stations compared to other published studies (Ciasico et al 2006; Segumalian et al 2016; Jontila et al 2017; Arriesgado et al 2022) may be mainly influenced by local anthropogenic activities. This could be associated with the gleaning access across the sampling areas and recreational activities such as swimming and boating. For instance, *Strombus* spp. are gleaned for its meat for local consumption, and its shell is sold for the manufacturing of costume jewelry, shell crafts, and furniture (Ciasico et al 2006). Further, all of the identified bivalves were exploited as human food and as feed for high-valued aquaculture species like mud crabs (Napata & Andalecio 2011; Mendoza et al 2020). The *H. atra* is also a commercially important sea cucumber (Minguito 2023), but it is considered a low-market value (Arriesgado et al 2022).

Environmental condition. The Table 5 displays the water quality parameters observed in the areas of Tambobong and Uli as part of the study. The result shows that the average DO ranges from 7.13 to 11.87 mg L^{-1} and the temperature ranges from 28.42 to 31.13^{o}C indicating an acceptable water quality parameter in the study area (PHILMINAQ 2010; DAO 2016). Furthermore, the pH measured in this study ranged from 6.30 to 7.15, indicating that it is generally acidic in Uli and neutral in Tambobong, owing to the effluent carried by the tributaries connected in Uli, whereas Tambobong has rich in seagrass beds that may absorb carbon dioxide, reducing acidification (Yates et al 2016). The average salinity was between 39.41 to 40.00 ppm in the two study locations. In addition, the ability of various types of seagrass to tolerate salinity can affect the number of shoots (Oscar et al 2018). The optimal range of ORP for aquaculture is 300-500 mv according to Goldman & Horne (1994). Tambobong is within its optimal ORP level of 311.53 mv, indicating that it has a more diverse species than in Uli. Conductivity ranges from 1,000 to 10,000 specifies that the water is saline. It is also a direct measurement of pollutants and contaminants in water (Card et al 2023). The conductance values in Tambobong were greater than in Uli indicating that the area was more polluted from human factors such as impervious surface runoff, septic leachate, and other human waste considering that the area is one of the tourist destinations of Dasol, Pangasinan. The quality standard on the phosphorous level in the Philippines is from nil (as organophosphate) to 0.20 mg L^{-1} for marine water. It shows that the two locations were outside their optimum level of phosphates. The Philippines has just freshwater NO_3 criterion. Freshwater and marine NH_3 and NH_4 criteria are lacking, however, these requirements are crucial for industrial sustainability and output maximization (PHILMINAQ 2010).

Table 5

The water quality parameters in Tambobong and Uli, Dasol, Pangasinan

Parameters	*Tambobong*	*Uli*
DO (mg L^{-1})	11.87	7.13
pH	7.15	6.30
Salinity (ppm)	40.00	39.41
Temperature (^{o}C)	31.13	28.42
Oxygen reduction potential (ORP) (millivolts (mv))	311.53	186.00
Electrical conductivity (EC) (micro siemens per centimeter (μs cm^{-1})	8346	7623
Phosphate (ppm)	0.30	0.75

According to Schwarz et al (2004), sediment is playing a crucial role in keeping the seagrass beds in optimal condition. Hence, some of the important parameters were assessed in this study and the result was indicated in Table 6.

Table 6

Sediment quality in the seagrass beds of the two sampling sites

Parameter	*Site*	*Mean±S.E.*
Texture	Tambobong	Light
	Uli	Medium
pH	Tambobong	8.28±0.046
	Uli	8.21±0.022
Phosphorus (mg L^{-1})	Tambobong	7.42±1.05
	Uli	4.68±1.21
Organic matter (%)	Tambobong	0.92±0.053
	Uli	1.03±0.113

Thangaradjou & Kannan (2007) cited that areas with sandy as well as muddy substrate with thin layers of sand are suitable substrata for the growth and establishment of seagrasses. In the present study, the two sampling sites varied in terms of sediment texture. This could be an important factor that influences the percent cover, density, biomass, and diversity of seagrass species in the two areas. As observed, seagrasses are denser and more diverse in Tambobong with light-textured sediment/soil. This may suggest that the area is more suitable for seagrasses than Uli. Light-textured sediments have a lower concentration of clay-sized particles compared with medium-textured sediments, of which there is an even distribution of sand and clay particles (Ritchey & McGrath 2015). In terms of pH, both areas have almost the same level, indicating that the effect of this parameter is nil. However, phosphorus is slightly higher in Tambobong. Although there was no statistical significance ($p > 0.05$), this difference could have some degree of influence on seagrasses between sampling sites. Phosphorus is considered one of the key-limiting nutrients in tropical habitats, including seagrass beds. As stated by Brodersen et al (2017), deficiency in this type of nutrient can negatively affect several biological processes. In the study of Armitage & Fourqurean (2016), the addition of phosphorous increased the carbon stock in above-ground biomass by 300% and 50-100% in belowground biomass. Earlier studies also showed an increase in seagrass biomass with phosphorous enrichment (Short et al 1990). As to organic matter content, the analysis also showed no significant difference ($p > 0.05$). The value obtained is within the optimum range in which seagrass tends to grow in sediments with an organic matter content of below 6% (Schwarz et al 2004). Fraser et al (2016) disclosed that derived organic matter may assist the seeding survival of seagrass by enhancing root branching and stability in sediments. However, it is surprising that there is still variation in terms of density and biomass between the sampling sites despite similarity in the levels of pH and organic matter. Although phosphorus has no significant variation, the numerical difference could still have a remarkable effect, but a variation in seagrass bed quality could not be attributed to this parameter alone.

Ecosystem goods and services of seagrass beds. Seagrasses provide ecological services for biodiversity, water quality control, and shoreline protection. These are known as food sources, filtering media, and secondary buffer zone, and support the productivity of 20% of the world's biggest fisheries (Borum et al 2004; Terrados & Borum 2004; Unsworth et al 2018, 2019).

The seagrass community in barangay Tambobong and Uli provided an abundant resource for the gleaning activities of the marginalized fisherfolk as their food source, as well as a refuge for sea turtles. Additionally, there is another economic benefit derived from the resources in the area it encouraged the fisherfolk to venture into other livelihood activities, turned into tourists' guide, and their fishing boats were used as service boats instead of fishing. Another aspect is that the utilization of the washed ashore seagrass (*Sargassum*) was utilized in organic fertilizer, it generates profits for local entrepreneurs, and the product is distributed locally. Hence, averted the usual fishing activities of the fisherfolks, this facilitate the natural resource to recuperate and regain its diversity.

Identified disturbances and management intervention. There are numerous disturbances observed in the coastal barangay of Tambobong and Uli, Dasol, Pangasinan, these are identified by the key leaders of the area. The identified issues are encroachment of beach areas (shoreline management), excessive siltation, blast fishing, no seagrass assessment, no proper plan of resource use, localized legislation, no available coastal resource management (CRM) plan, empowerment of Fisheries and Aquatic Resources Management Councils (FARMCs), advocacy to promote resource conservation and water quality monitoring. These issues identified in these barangays were considered common among the coastal municipalities in the country (Batungbakal 2001; Philippine Coastal Management Guidebook Series No. 8 of DENR series of 2001).

In barangay Uli, illegal fishing activity was observed, but the enforcers were technically handicapped to enforce the law. Evident also in Tambobong is the massive development in tourism activities, from January to April 2023 alone there were 73,490 guests arrived in the area. This bulk of guests that stayed in the area is an unimaginable environmental stress coupled with active gleaning and fishing in the area.

The LGU has a broad spectrum of power and responsibilities based on various laws, making them the primary unit to implement the CRM (Republic Act (RA) 7160, RA 8550), and Philippine Coastal Management Guidebook Series No. 7-8 of DENR (DENR 2001). However, smaller LGUs have difficulty in providing funding for the sustainability of resource management, as well as limitations in research capacity and political issues. These factors limit the sustainability of the implementation of CRM activities, as well as weakness in community organizing to generate collective participation and empower the community (Alcala 1998).

Conclusions. The study showed that there were six (6) identified seagrass species in the study area. In station 1 Tambobong has a greater seagrass percentage cover (71%), shoot density (5-31 shoots m^{-2}), relative density (up to 48%), estimated biomass of 1,777.37 gDw m^{-2} compared to station 2 Uli. In addition, 11 species of seagrass-associated macrobenthic fauna from three (3) distinct phyla Mollusca, Echinodermata, and Porifera were identified, with Mollusca dominating the phyla. However, Tambobong was found to be more polluted than Uli due to human factors, as the area is one of Dasol, Pangasinan's tourist destinations. In addition, the local government has underdeveloped Coastal Resource Management plan to support the sustainability of the aquatic resources.

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Conflict of interest. The authors declare that there is no conflict of interest.

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