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Species Composition, Abundance, and Distribution of Seagrasses along the Coast of Dilasag, Aurora, Philippines

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ABSTRACT

Information on the seagrass meadows along the intertidal areas is crucial for better management. Seagrass meadows in the Municipality of Dilasag, Aurora, Philippines, were mapped to the areas covered by seagrass beds. Species composition, distribution, and density were determined, and potential threats were also identified. Seagrass beds observed in Barangay Masagana, Barangay Diagyan and Barangay Diniog covers an area of at least 8.7 hectares (ha). Only four seagrass species were identified from all the sites: *Enhalus acoroides, Halodule pinifolia, Thalassia hemprichii* and *Syringodium isoetifolium. T. hemprichii* was present at all stations. The average seagrass cover and shoot density were 42.92+4.99 m^{-2} and 154 shoots m^{-2}. The potential threats to adjacent seagrass beds, such as presence of port for fishermen, plastic pollution, recreational areas, gleaners, direct discharge of household wastewater, chemical discharge from boat making, and chemical discharge from farmland, were observed. These findings are important for managing seagrass meadows in the Municipality of Dilasag, the Philippines.

INTRODUCTION

Globally, seagrass meadows are significant to climate, coastal ecosystems, and food security; however, some information regarding their marine conservation is still unknown **(Duarte *et al.*, 2008)**. The seagrass flora of the western tropical Pacific reported ten species for Micronesia by **Tsuda**, **Fosberg**, **and Sachet (1977)**, while **Johnstone (1979)** listed 13 taxa for Papua New Guinea, and **Fortes (2013)** reported 18 species for the Philippines.

Seagrass meadows support the production of about 20% of the world's fisheries by providing a nursery ground for juveniles **(Unsworth *et al.*, 2018b)**. Seagrass meadows serve as a nursery and feeding grounds for shrimp, sea turtles, bottle-nose dolphins, manatees, and a variety of reef fish and invertebrates of these organisms. Aside from providing food and shelter, seagrass meadows hold bottom sediments and provide a good symbiosis among aquatic organisms. Important marine animals like dugongs and turtles depend on seagrass **(Bleakley & Wells, 1995)**. Moreover, about an acre of seagrass beds can support 40,000 fish and 50,000 invertebrates **(Mukhida, 2007)**. Beyond its importance to the aquatic environment, seagrass ecosystems have accelerated their degradation rate in recent years **(Waycott *et al.*, 2009; Unsworth *et al.*, 2018a)**.

Seagrass meadows' presence in the intertidal area of coastal land makes them highly susceptible to disturbances and anthropogenic activities. Moreover, recent studies have shown that overfishing, ocean acidification, sedimentation, increased water temperature, land reclamation, boating, and aquaculture are significant threats to seagrasses worldwide **(Grech *et al.*, 2012; Wilson & Lotze, 2019; Artika *et al.*, 2020; Artika *et al.*, 2021)**.

The Municipality of Dilasag is located in the farthest part of Aurora province, near the Philippine Rise. It is one of the municipalities with rich marine biodiversity, and one of its rich ecosystems is its seagrass meadows. The seagrass meadows in Dilasag serve as a feeding and nursery ground for economically important fishes and macroinvertebrates. It also provides food for the community, as different fish species and invertebrates can be harvested. Despite these services, the seagrass ecosystems' current status in the municipality of Dilasag has not yet been evaluated.

Therefore, this paper aimed to document the seagrass beds, species composition, distribution, and density in Municipality of Dilasag, Philippines.

MATERIALS AND METHODS

Study site

The seagrass ecosystem assessment was conducted in December 2023-June 2024 in the Municipality of Dilasag, Aurora, the Philippines. A reconnaissance survey was conducted to determine the actual extent of the study area.

Seagrass sampling

Seagrass sampling methods by **McKenzie *et al.* (2001)** were used with some modifications. Local interviews and snorkeling were conducted to confirm the presence of seagrass. The boundaries between landward and seaward of seagrass meadows were marked using the Garmin etrex 10 Global Positioning System (GPS). GPS points were recorded while walking in the seagrass meadows. Maps were generated using Aeronautical Reconnaisance Coverage Geographic Information System (ArcGIS 10.8 version). Areas covered by seagrass beds were calculated using the reprojected GPS data and the area function in ArcGIS. Only three barangays in the Municipality of Dilasag have seagrass meadows: Barangay Masagana (16^{o}24’278” N, 122^{o}12’821” E), Barangay Diniog (16^{o}21’355” N, 122^{o}12’975” E), and Barangay Diagyan (16^{o}26’684” N, 122^{o}12’780” E). These also served as the sampling stations during the study. Three transect lines were set in each barangay with intervals of 30 meters. Quadrats measured $0.25m^2$ were laid every five meters along the transect line to serve as the representative samples of assessed seagrass species. The transect line serves as the reference observation point.

Seagrass species composition, abundance and cover

Seagrass species identification was verified using the field guide and monograph by Seagrass-Watch **(McKenzie *et al.*, 2001)**. Two parameters were used to describe abundance: % cover and density; this is to lessen disturbances in the seagrass meadows. Seagrass cover was determined by estimating the percent cover using the photo standards in the field guide. To measure the seagrass density, shoot per species was determined by counting the number of shoots inside the quadrats laid and dividing it by the total number of quadrats for the transect.

Identification of seagrass ecosystem threats

Researcher identified the potential threats to seagrass beds during the reconnaissance and mapping surveys. This was also done through the interviews with the community in the areas.

Data analysis

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 the photo standards from Seagrass-Watch: Manual for Mapping & Monitoring Seagrass Resources by Community (citizen) volunteers **(McKenzie *et al.*, 2001)**. Calculations for the seagrass cover (C) of each species in each 50 × 50cm quadrat were as follows:

$$\mathbf{C} = \frac{\sum(\text{Mi x f})}{\sum \text{f}}$$

Where:
Mi = midpoint percentage of class
f = frequency (number of sectors with the same class of dominance)

Seagrass coverage for each station transect was determined by dividing the sum of the mean coverage for each quadrat by the number of quadrats utilized. The percentage cover per sampling station was determined by adding the percentage cover of transects divided by the number of transects laid for each sampling station. The seagrass cover for each sampling sampling station was categorized using the criteria of **Fortes (1989)** where poor = 0-25%, fair = 26-50%, good = 51-75% and excellent = 76-100%.

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

$$\text{Density} = \frac{\text{Total no. of individuals in a species (i)}}{\text{Total sampling area } (m^{-2})}$$

RESULTS AND DISCUSSION

Seagrass distribution

Seagrass meadows were observed in Barangay Masagana, Barangay Diniog and Barangay Diagyan. A total of 42 GPS coordinates were collected, marking the seagrass meadows. These beds cover a total area of 8.7 ha (Fig. 1). Seagrass covered the largest area 7.4 ha in Branagay Masagana. This was followed by Barangay Diagyan with 0.9 ha. The area with the least seagrass cover was recorded in Barangay Diniog with 0.24 ha .

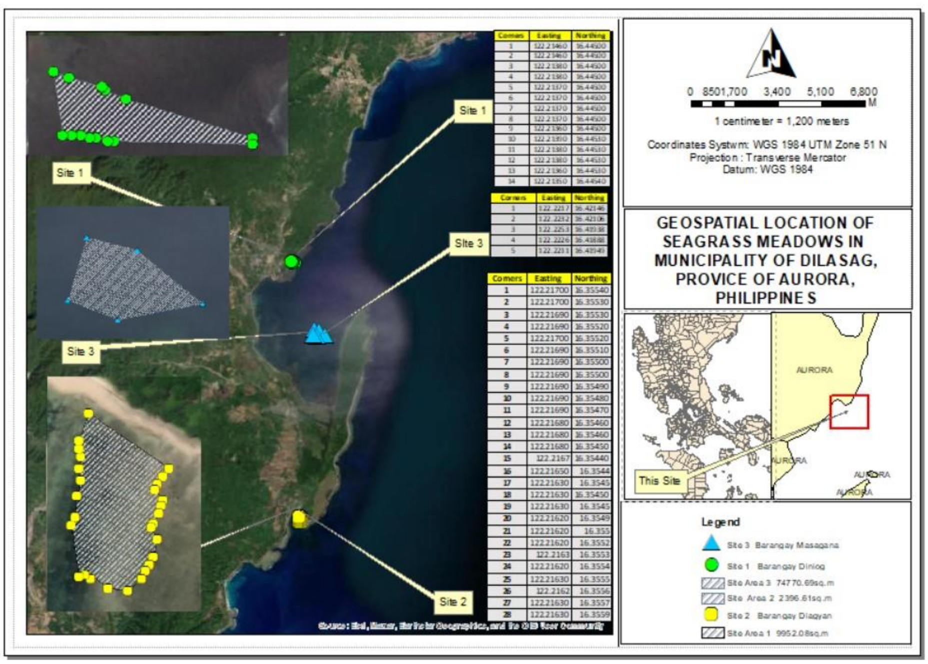

Fig. 1. Total area covered by seagrass meadows in Municipality of Dilasag, Philippines

No recent estimates of the total area covered by seagrass meadows in the Philippines exist. However, several reports show that the Philippines' seagrass meadows occupy around 22,000 -35,289km of the country's coastline **(McKenzie 2007; Fortes 2013; Fortes *et al.*, 2018)**. The Biodiversity Management Bureau-Department of Environment and Natural Resources also estimated that the Philippines had 2.73 million hectares of seagrass in 2009 **(BMB-DENR, 2016)**. The current study provided the first estimate of seagrass beds in the Municipality of Dilasag, with a total area of 8.7 ha. However, the value may be larger as some intertidal areas could not be mapped due to siltation in the water column of Barangay Masagana.

Characterization of seagrass ecosystems

Species composition

Four seagrass species belonging to two families (*Cymodoceacea* and *Hydroritaceacea*) were identified from all the barangays surveyed, namely *Enhalus acoroides, Halodule pinifolia, Syringodium isoetifolium,* and *Thalassia hemprichii.* Barangay Masagana harbored all four species and was the most species-rich of all the stations sampled. *T. hemprichii* was the widely distributed species and appeared on all barangays surveyed (Table 1). In Barangay Diagyan, *T. hemprichii* was found to co-occur with *E. acoroides.* While in Barangay Diniog, it was found to co-occur with *H. pinifolia.*

Table 1. Seagrass species composition

Species	Barangay Masagana	Barangay Diagyan	Barangay Diniog
Syringodium isoetifolium	✓	✗	✗
Thalassia hemprichii	✓	✓	✓
Halodule pinifolia	✓	✗	✓
Enhalos acoroides	✓	✓	✗

Legend: . ✓ **= present**

✗ **= absent**

Only four species of seagrass were observed during the study period in December 2023-June 2024, compared to the 18 species **(Fortes, 2013)** reported for the Philippines. However, almost similar result has been observed in many coastal areas in the western seaboard of Luzon Island **(Paz-Alberto *et al.*, 2015; Ilac, 2017; Reyes *et al*., 2023)**. The low diversity may be due to the environmental conditions in the area. One of the factors is the suspended sediments and unidentified materials on the water's surface reducing the penetration of light for the plants to grow; this was observed in Barangay Masagana, where there is frequent docking of boats that affects the turbidity of the water. These have also been reported in Cape Bolinao (Philippines), where it observed a declining seagrass species diversity with increasing suspended materials **(Bach *et al.*, 1998)**. In 2019, there was a reported seagrass species of *Halophila ovalis* in Barangay Masagana (unpublished thesis) **(Huertas *et al.*, 2019)**; however, during the reconnaissance survey, it was not observed. This may be attributed to the fact that there were species of seagrass that germinate and occur in a period of favorable growth **(Orth *et al.*, 2000; Qiu *et al.*, 2017)**. Thus, it is important to have long-term monitoring to evaluate the species of seagrass in the area fully.

Species abundance

The average seagrass cover of the surveyed sites is 42.92%+4.99m^{-2}. Moreover, the largest seagrass cover of 47.58%m^{-2} was observed in Barangay Diniog (Fig. 2), with 66% *T. hemprichii*, and 34% *H. pinifolia*. Barangay Masagana followed it with a total seagrass cover of 43.55% m^{-2}, with 57% *T. hemprichii* followed by *E. acoroides* with 29% and *S. isoetifolium* and *H. pinifolia* with both 7%. In barangay Diagyan, a much lower cover was recorded, with 37.65% m^{-2}. It comprises only two species dominated by *T. hemprichii* and only 1% of *E. acoroides*.

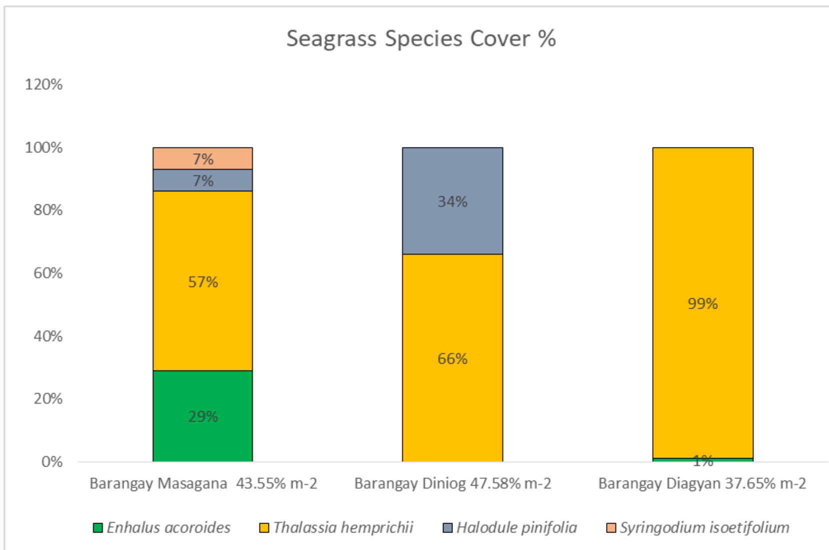

Fig. 2. Seagrass species cover (%m^{-2}) at different sites in Municipality of Dilasag, Philippines

The average seagrass cover in the Municipality of Dilasag is 42.92%+4.99 m^{-2}, the condition equivalent based on the criteria of **Fortes (1989)** is fair, and it is lower compared to other areas in the country (Cape Bolinao 75%, Puerto Galera 95%, Ulugan Bay 90%, Pag-asa Island, KIG 89.9% and Honda Bay 90%) **(UNEP 2004; Gonzales *et al.*, 2008)**. The low seagrass cover in the area may be due to anthropogenic activities (swimming and port for fishermen); it was observed during the assessment that the fishermen anchor scrape the seagrass meadows, uprooting the seagrasses in the area. Recent reports also showed that anthropogenic activities affect seagrass percentage cover **(Waycott *et al.*, 2009; Short *et al.*, 2011; Arriesgado *et al.*, 2024)**. Therefore, it is imperative to consider strategies to mitigate those anthropogenic activities for the seagrass to recover.

The average seagrass density of the surveyed barangays is 154 shoots m^{-2}. Barangay Diniog and Diagyan obtained the highest average seagrass density at 261 shoots m^{-2} and 200.05 shoots m^{-2}, respectively (Table 2). Barangay Masagana recorded the lowest density at 79 shoots m^{-2}. Seagrass meadows serve as nurseries for small fishes. **Ambo-Rappe (2013)** reported that small seagrass species' meadows harbor juvenile fishes and move afterward to larger seagrass species when they grow. Coastal planning of local government units should also prioritize seagrass meadows due to their biological importance in the environment.

Table 2. Seagrass species shoot density (shoots m^{-2})

Species	Barangay Masagana	Barangay Diagyan	Barangay Diniog
Syringodium isoetifolium	36	-	-
Thalassia hemprichii	184	396.7	438
Halodule pinifolia	9	-	84
Enhalos acoroides	87	3.39	-
Average	79	261	200.05

Seagrass ecosystem threats

Potential threats to the seagrass ecosystems were noted during the survey and interviews with the community. These included direct discharge of household wastewater, the presence of a port for fishermen, plastic pollution, gleaners, chemical discharge from boat making, recreational areas, and chemical discharge from farmland. These threats were observable along the entire coast. The presence of a port for fishermen was observed on all of the sites. During the assessment, tourists swimming along the seagrass areas were also observed in Barangay Diniog. In a study conducted on the coast of Tacloban, similar potential threats adjacent to seagrass beds were also identified, including direct discharge of untreated wastewater, presence of fish pens, plastic pollution, human dwellings, docking areas for pumpboats, recreational areas, man-made intertidal structures, sedimentation, oil pollution and destructive shellfish gleaning **(Payo *et al.,* 2018)**.

No seagrass meadows can be considered pristine **(Fortes, 1991)** as intertidal areas if directly affected by anthropogenic activities. Most of the threats observed in the area can cause the direct dissolution of seagrass meadows. The local government unit imposes mandates and conducts routine seminar awareness in the community. However, despite the increased awareness, environmental health declined as its challenges remained unaddressed, and the global seagrass aerial cover declined (**Fortes & Santos 2004; Waycott *et al.,* 2009)**. This implies the need to increase the participation and cooperation of the community in the coastal areas by getting them involved firsthand in the coastal planning up to the implementation of mandates, which will increase a sense of urgency in managing the coastal environment.

CONCLUSION

Seagrass meadows are among the essential aquatic environments in the Municipality of Dilasag. The study showed that there were four identified seagrass species in the area. It has an estimated total area of 8.7 hectares, and although the average seagrass cover is quite low, with 42.92%+4.99m^{-2}, the condition is in fair condition. In addition, numerous potential threats to the seagrass ecosystems have been identified. It is, therefore, important to consider strategies to mitigate those anthropogenic activities that could increase the degradation. It is also recommended that a study on the real-time effect of those human activities and a time series analysis or more complex techniques be conducted to quantify its impact on the seagrass biological variables. Hence, continuous monitoring of seagrass meadows and other aquatic organisms should be done to manage these coastal environments better.

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