Original Research Article

Bioaccumulation Potential of Seagrass *(Halophila sp.)* for Mercury in the Selected Coastal Areas in Malita,Davao Occidental

ABSTRACT

Aims: To determine the potential of seagrass *Halophila sp.* in absorbing mercury in the selected coastal barangays in Malita, Davao Occidental.

Study design: The study employs a quantitative type of research where strategies focus on quantifying the collection and analysis of data.

Place and Duration of Study: Brgy.Culaman, Brgy. New Argao and Brgy. Tingolo in Malita Davao Occidental, Philippines from October 2020 to December 2021.

Methodology: The researchers used the transect line quadrat approach to determine the percent cover and shoot density of sea grass. Using this method, the researcher determined the location of seagrass up to the point at which it vanished. There were three (3) stations and three (3) transect lines were laid for each station with an interval of 50m. The researchers next set five (5) quadrats on the seagrasses along a 50-meter transect line parallel to the shoreline. Temperature, pH and salinity were also determined in the study. Moreover, seagrasses were collected in each quadrat and the samples were transported to Davao Analytical Laboratories, Inc. for mercury analysis.

Results: The highest mean percent cover (10.27%), shoot density (128.91 shoots/m^2) and Hg accumulation (572.9ppb) recorded was Brgy. Tingolo, Malita, Davao Occidental while the lowest results were obtained by Brgy. Culaman, Malita, Davao Occidental.

Conclusion: *Halophila sp.* has the capability to accumulate mercury content and exceeds the standard level of 20 ppb. There were no significant differences in the percent cover and Hg accumulation of seagrass *Halophila sp.* while significant difference is observed in the shoot density. However, there is a positive relationship (.664) between the shoot density and mercury concentration of *Halophila sp.*

(recast and form a continuous writing while writing abstract) use an improved English here

Keywords: Bioaccumulation, seagrass, mercury, Malita

1. INTRODUCTION

Seagrasses are vascular flowering monocotyledonous plants that live in the world's coastal and estuarine habitats. They are unique and are usually immersed in water. They have a root system with stems buried in a soft substrate; they reproduce vegetatively and sexually; and water fertilizes their blossoms (Phillips et al., 1992). There are 12 genera and 58 species of these plants, which flourish in saltwater. Many species have long, thin leaves that grow from rhizomes and thrive in vast meadows that mimic grassland underwater (Den Hartog, 1970).

Because of its ecological and economic worth, factors affecting sea grass distribution and condition are of growing interest to the scientific community (Duarte, 1999). Sea grasses are significant in global carbon and nutrient cycling because they sustain important grazing and detrital food webs, stabilize sediment, and play an important role in global carbon and nutrient cycling. Moreover, hundreds of planktonic, epibenthic, and infaunal species rely on grass beds for life (Virnstein & Howard, 1987; Jackson et al., 2006). These aquatic plants have the ability to capture and store a significant quantity of carbon from the atmosphere. Sea grasses collect carbon from the water to create their leaves and roots in the same way as trees receive carbon from the air to construct their trunks. Parts of the sea grass plants and accompanying creatures are buried and trapped in the sediments when they die and degrade. It is projected that the world's sea grass meadows may trap up to 83 million metric tons of carbon per year in this manner (Reynolds et al., 2017).

Sea grasses have an unique metal bioaccumulation capability because they interact directly with both water column and pore water as ionic absorption; hence, the study's findings can represent the entire health of coastal water (Llagostera et al. 2011). Sea grasses, like marine angiosperms, interact with sediments via their roots and rhizomes, as well as with the water column via their leaves (Romero et al., 2005). As a result, heavy metal accumulation and dispersion were discovered not only on the roots, but also on the rhizomes and leaves. Malita, Davao Occidental, features some of the most extensive sea grass meadows in the country, which sustain populations of dugong, turtles, and commercially and historically significant fisheries. However, once pollution levels approach fatal levels, the sea grasses will die off, and this intertidal environment will be gone for good because there is little potential for the ecosystem itself to relocate (Hadley, 2009). The purpose of this research is to find out how effective sea grass is in absorbing mercury in the sea grass meadows of Malita, Davao Occidental.

2. MATERIAL AND METHODS

2.1 Study Site

This research was conducted in Malita, Davao Occidental. Malita is the capital of Davao Occidental, Philippines, and a first-class municipality. It is divided into 30 barangays. It is the main economic hub of Davao Occidental, with agriculture and fishing being the primary industries. Specifically, Brgy. Brgy. Culaman (6°24'4"N 125°36'25"E), The towns of New Argao (6°22'33"N 125°36'38"E) and Brgy. Tingolo (6°21'37"N 125°37'25"E) are coastal barangays notable for dugong, sea turtles, and other marine life due to the richness of sea grass ecosystems and coral reefs. Furthermore, livestock and agricultural crops like as banana, coconut, and durian might be found in these coastal areas. The Davao San Miguel power station, commonly known as the Malita power station, is a 628-megawatt (MW) coal-fired power plant located in Brgy. Culaman (Fig 1).

Figure 1. Map of study areas in Malita, Davao Occidental

2.2 Collection of Sea Grass Samples

The samples were taken in the subtidal zone of coastal barangays in Malita, Davao Occidental, especially in Bgry. Brgy. Culaman Brgy Tingolo and New Argao. Seagrass species were taken in their whole, including roots, rhizomes, and leaves. The samples were washed with saltwater to remove silt from the roots and rhizomes, as described by Sanchiz et al., (2000). The samples were then placed in clean plastic bags, sealed, and frozen at -20oC (use correct Symbol and format) before being analyzed. The samples were then delivered to Davao Analytical Laboratories, Inc. in Matina, Davao City, for analysis. Species of sea grass identification The identification of sea grass species was done in the lab. Images and a dichotomous key to the species of Philippines Sea grass (Calumpong & Meñez, 1997) were employed.

2.3 Determination of Sea Grass Percent Cover

The transect line quadrat technique was employed by the researchers to assess the percent cover of sea grass (Cite a reference or quote one). Using this approach, the researcher calculated the place of existence of sea grass up to the outer limit when seagrass vanished. Second, the researchers placed quadrats on the sea grasses along a 50-meter transect line parallel to the coastline. The % (use word here is better) cover of the sea grass species per quadrat was recorded using the categories proposed by Saito and Atobe (1970). The procedure was repeated for each of the quadrat's species. The dominance classes used to record percentage cover of sea grass species at the three sample stations are shown in Table 1.

$$C = \frac{\sum(M_1\ x\ F_1)}{\sum f}$$

(Use math type to write equations, this is a picture copied and paste)

Where:
M1 = midpoint percentage of class (i)
F1 = Frequency (number of sectors with the class dominance)
f = number of frequency of the class

Table 1. Criteria in categorizing the percent cover of seagrass

CLASS	AMOUNT OF PERCENTAGE COVERED	COVERED	MEAN
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

2.4 Determination of Shoot Density in *Halophila sp*.

The researchers used the transect line quadrat approach to determine the percent cover of sea grass. (Cite a reference or quote one), (this is a repeated statement) Using this method, the researcher computed the location of sea grass up to the point at which it vanished. (this is a repeated statement) The researchers next set quadrats on the sea grasses along a 50-meter transect line parallel to the shoreline. Using the classifications suggested by Saito and Atobe (year of cited work), the percent cover of sea grass species per quadrat was calculated (1970). The method was repeated for each type of quadrat. The table below shows (where is the table put table number) the dominance classes used to record the percentage cover of sea grass species at the three sample locations. Where,

$$Density = \frac{number\ of\ shoots\ of\ a\ species}{area(m^2)}$$

2.5 Mercury Analysis in Seagrass Sample

As to mercury accumulation analysis, the samples will be (have you carried the research) delivered at Davao Analytical Laboratories, Inc. Matina, Davao City. Cold vapor atomic absorption spectroscopy will be used to analyse mercury.

2.6 Physico – Chemical Parameters

Physico – chemical parameters were determined in each sampling sites. Water temperature, salinity and pH were the selected parameters to be monitored in each station.

2.7 Statistical Analyses

The (remove) Analysis of Variance (ANOVA) will be used to (have you carried the research) determine the significant difference of the percent cover, shoot density and mercury accumulation level of seagrasses in the three sampling stations. Tukey's test will also (have you carried the research) employ to find out which specific groups' means compared with each other are different. Pearson's correlation coefficients of mercury concentration to the shoot density of seagrass and mercury concentration will be determined (have you carried the research) using Statistical Package for the Social Science (SPSS version 17).

3. RESULTS AND DISCUSSION

3.1 Percent Cover of Seagrass *Halophila sp*

Seagrass *Halophila sp.* showed the highest mean percent cover of sea grass (10.27.%) (how by what procedure and technique) in Brgy. Tingolo while Brgy. Culaman had the lowest mean percent cover of 5.46% (Fig 2). The substrate of the area could be the reason of its low percent cover since *Halophila sp.* (how by what procedure and technique you just jump to conclusion) requires wide variety of substrate, such as mud, living corals or coral rubble and sand where the plant could occasionally almost completely buried. According to Kou and Den Hartog (2001), *Halophila sp.* is an abundant seagrass in tropical and warm temperate areas, occasionally found in pure stands. There was no significant difference (P = .165) in the mean percent cover of *Halophila sp.* among sampling stations (Table 2). Furthermore, the dominating seagrass species discovered was *Halophila ovalis* which had the greatest percent frequency of occurrence with 64%, and could be found in all sections of the Davao Gulf (Noel et. al., 2013).

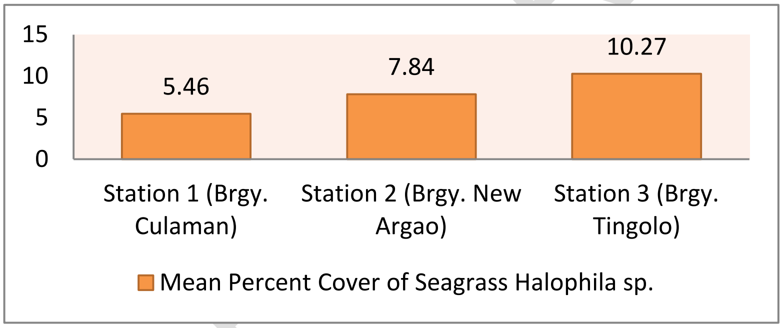

Figure 2. Mean Percent cover of Seagrass *Halophila sp.*

3.2 Shoot Density of *Halophila sp.*

Figure 3 shows that Brgy. Tingolo also got the highest mean shoot density of *Halophila sp.* with the number of 128.91 shoots/m^2 while the least value obtained by Brgy. Culaman with 45.13 shoots/m^2. There was significant difference in the shoot density of *Halophila sp.* (Table 2) between sampling stations (P = .006). *Halophila sp.* density is also influenced by the type of substrate conditions, seasons, tides, wave energy strength, the content of organic matter in the sediment and other environmental factors same with other seagrass species (Short and Coles, 2001).

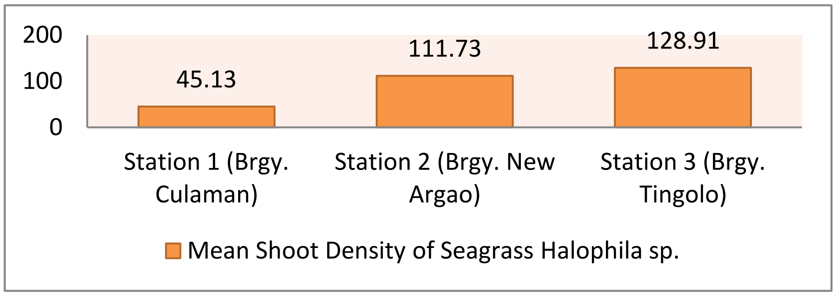

Figure 3. Mean Shoot Density of *Halophila sp.*

3.3 Mercury Analysis

Mercury poisoning has become a present concern as a result of worldwide environmental contamination, and its concentrations in plant stems and leaves are always higher when the metal is introduced in organic form (Patra et. al., 2000). The amount of mercury in the plants should not exceed 20 ng/g .%) (how by which result). Figure 4 shows the mercury accumulation in *Halophila sp.* where the concentration is high in Brgy. Tingolo having the amount of 572.9ppb than the rest of the stations. It is hereby recorded that Brgy. Culaman obtained the lowest concentration of mercury and there were no significant differences in the levels of mercury (Table 2) between sampling stations (P = 0.566). Moreover, there was a positive large uphill relationship (.664) between mercury accumulation and shoot density of seagrass *Halophila sp.* (Table 3).

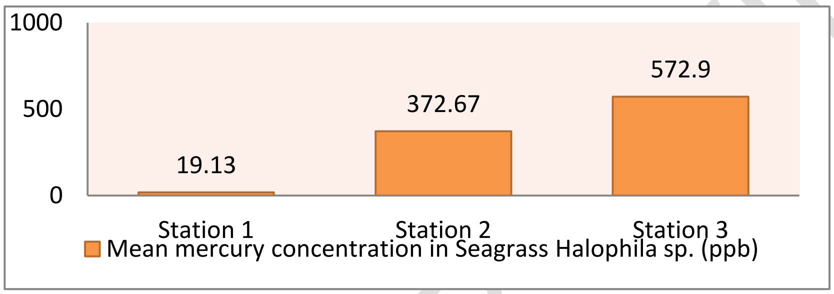

Figure 4. Mean Hg concentration in seagrass Halophila sp.

Table 2. Analysis of Variance for percent cover, mean shoot density and Hg concentration

Particulars		Sum of Squares	df	Mean Square	F	Sig.
Pcover	Between Groups	34.695	2	17.348	2.172	.195
	Within Groups	47.917	6	7.986		
	Total	82.612	8			
SDensity	Between Groups	12084.939	2	6042.470	13.314	.006
	Within Groups	2723.074	6	453.846		
	Total	14808.013	8			
HgCon	Between Groups	55854.082	2	27927.041	.627	.566
	Within Groups	267364.600	6	44560.767		

Total	323218.682	8

Table 3. Pearson's r Correlation Test

Particulars		SDensity	HgCon
SDensity	Pearson Correlation	1	.644
	Sig. (2-tailed)		.061
	N	9	9
HgCon	Pearson Correlation	.644	1
	Sig. (2-tailed)	.061	
	N	9	9

3.4 Physico-chemical Parameters

Temperature, pH and salinity were the following physico – chemical parameters that were determined in the study. (recast) Table 4 shows the results of the physico – chemical parameters of each station.

3.4.1 Temperature

In this study, water temperature from different sampling sites ranged from 30 ˚C – 35 ˚C.

3.4.2 pH

The highest mean pH level was obtained in station 3 (7.86 ppm) followed by 7.04 ppm in station 1 whereas the lowest values was observed in station 2 of 7.02 ppm.

3.4.3 Salinity

The salinity of the seawater is normally 35 parts per thousand in most marine areas. In the study sites, water salinity varies from 34-35 ppt.

Table 4. Physico-chemical parameters in the study area

Parameters	**Station 1**	**Station 2**	**Station 3**
Temperature	35 ˚C	34 ˚C	30 ˚C
pH	7.02 ppm	7.04 ppm	7.86 ppm
Salinity	35ppt	34ppt	35ppt

4. CONCLUSION

The highest mean percent cover (10.27%), shoot density (128.91 shoots/m2) and Hg accumulation (572.9ppb) was obtained by Brgy. Tingolo, Malita, Davao Occidental. These signify that *Halophila sp.* has the capability to accumulate mercury content and exceeds the standard level of 20 ppb. There were no significant differences in the percent cover and Hg accumulation of seagrass *Halophila sp.* while significant difference is observed in the shoot density. However, there is a positive relationship between the shoot density and mercury concentration of *Halophila sp.* Physico-chemical parameter results were in normal condition.

REFERENCES

1. Phillips RC. The sea grass ecosystem and resources in Latin America. In: Seeliger, U. (Ed.), Coastal Plant Communities of Latin America. Academic Press, San Diego, California. 1992
2. Den Hartog C. *The sea grasses of the world.* North Holland Publishing Co., Amsterdam. 1970
3. Duarte C. M, Chiscano C.L. Sea grass biomass and production: A re- assessment. *Aquatic Botany* 1999 *65*: 159-174.
4. Virstein R, Howard R. Sea grass-associated invertebrate communities of the Southeastern USA: a review, *Florida Marine Research Publications 42*, 1987 89-116.
5. Jackson E.L, Attrill M.J, Rowden A.A, Jones, M. B. Sea grass complexity hierarchies: Influence on fish groups around the coast of Jersey (English Channel). *Journal of Experimental Marine Biology and Ecology,*2006 *330*: 38-54.
6. Reynolds P. Sea grass and sea grass beds. Ocean Portal Smithsonian 2017
7. Llagostera I, Perz M, and Romero J, Trace metal content in the sea grass Cymodocea nodosa : Differential accumulation in plant organs. *Aquatic Botany 95*: 2011 124-128.
8. Romero J, Alcoverro T, Creco BM, and Peres M. The sea grass Posidonia oceanica as a quality element under the Water Framework Directive: POMI, a multivariate method to assess ecological status of Catalan coastal waters. Working document of the POMI group, University of Barcelona and Centre d'Estudis Avancats de Blanes (CSIC), 2005 15 pp.
9. Hadley D. *Land use and the coastal zone*. Land Use Policy 26 (Supplement 1) 2009 S198-S203.
10. Sanchiz C, Garcia-Carrascosa A. M, and Pastor A. Relationships between sediment physico-chemical characteristics and heavy metalbioaccumulation in Mediterranean soft-bottom macrophytes. *Aquatic Botany,* 2001 *69*: 63-73.
11. Calumpong H, Phillips R, Menez E. *Field guide the common mangroves sea grass, algae of the Philippines*. Makati City. Bookmark, Inc. 1997 C.199 pp. 59.
12. Saito Y, Atobe S. Phytosociological study of inter-tidal marine algae. I. Ursjiri Benten-Jima, *Hokkaido Bulletin of the faculty of fisheries, Hokkaido University,* 1970 *21*: 37-69
13. Noel H, Lucero R, Parcasio S, Labis P, Lucero M. Productivity and distribution of sea grass communities in Davao Gulf. Proceedings of the 7th International Symposium on SEASTAR2000 and Asian Bio-logging Science (The 11th SEASTAR2000 workshop) 2012 p.59-63.
14. Short FT, Coles RG. Global sea grass research methods. Elsevier Science BV. Amsterdam 2001
15. Patra M, Sharma A. Mercury toxicity in plants. The botanical review, New York Botanical Garden 66:3 PRANGE, J. A. and W. C. DENNISON, W.C. 2000 Physiological responses of five sea grass species to trace metals. *Marine Pollution Bulletin 41*: 327-336.