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Diversity of mangrove species along panguil bay, Ozamiz city, Mindanao Island, Philippines

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Abstract
Mangroves are plants that grow in saline coastal habitats in the tropics and subtropics. Mangrove species are classified into true mangrove and mangrove associates. Its importance is widely known, being a unique ecosystem that protects the coastal areas, sanctuary of many lifeforms, and as carbon sink. The study along the Panguil Bay in the coastal areas of Ozamiz City seeks to determine the species diversity, distribution, conservation status, and threats of mangrove and mangrove associates. The present study recorded 58 species of plants in the coastal area; it recorded 17 species of true mangroves composed of 12 families and 13 genera. The established sampling plots recorded seven (7) true mangrove tree species comprised of five (5) families of mangroves. The most abundant species is *Rhizophora macrunata*, with the highest importance value of 149.61, while *Xylocarpus granatum* with **0.60**, the lowest of all the species. *Sonneratia alba* species has the highest diversity among the seven species and has high relative dominance. Most of the true mangrove species belonged to less concern based on the IUCN Redlist 2019. Locally identified issues affecting the area include garbage disposal, intermittent cutting of mangrove trees, the encroachment of human settlers, and soil erosion were observed threats to mangrove forest along the Panguil bay. Thus, the recorded species are locally threatened in the area that needed unified protection and conservation measures from concerned agencies and communities to avert the trend locally.

Keywords: diversity, mangrove, Ozamiz City, Panguil Bay, *Rhizophora*species

Introduction

Mangrove species are classified as true mangrove and mangrove associates (Viaga and Joseph 2016; Primavera 2004; Wang *et al* 2001) [1, 2, 3]. Mostly, it thrives and grows at the interface between land and sea in tropical and subtropical latitudes, where they exist in conditions with high salinity, extreme tides, strong winds, high temperature, and muddy and aerobic soil (Dahdouh-Guebas 2021; Poedjirahajoe 2019; Natividad *et al* 2015; Kandasamy and Bingham 2001) [4, 5, 6, 7].

The Philippines is archipelagic of more than seven thousand islands, lined by coral reefs, seagrass meadows, and mangrove forests surrounded by water bodies (Garcia *et al* 2014;Vallejo 2011) [8, 9]. The study of Kandasamy and Bingham, (2001) [7] cited that 65 species of mangroves were reported in the world. Meanwhile, the studies of Primavera (2004) [2] and Sinfuego and Buot Jr (2014) [10] considered the Philippines as the home 39 species of mangrove species. Notably, the Philippines is considered one of the world's biodiversity-rich countries (Barcelona *et al* 2013) [11]. It is a home of about 8000 to 10,000 plants (Barcelona *et al* 2013; Madulid 1995) [11, 12], but also a biodiversity hotspot.

McGowan (2010) [13] and Mendoza (2001) [14] disclosed that among the mangrove services identified include coastal protection, erosion control, sediment stabilization, flood regulation, nutrient supply regeneration, waste treatment, and wildlife habitats. Also, mangroves create a unique ecological environment that hosts an assemblage of species and has an essential function supporting and sustaining life forms in the coastal area, particularly in bay areas. Mangroves support the residents' socio-economic activities in the provinces, especially the coastal residents, whose main livelihood is primarily in the coastal area (Garcia *et al* 2014) [8]. However,despite its ecological importance, their population continues to dwindle (Walters2004) [15]. According to Primavera (2004) [2], the decline of mangroves in the Philippines caused by coastal dwellers' overexploitation and conversion to settlements, aquaculture, salt pans, and industry.

The province of Misamis Occidental is one of the provinces located in the northern part of Mindanao Island, Philippines. With a coastline distance of 27 kilometers and it is blessed with mangroves species stretching in the province's coastal area, and has a total area of about 3,739 hectares of mangrove forest (DENR, 2010) [16]. Ozamiz City along the Panguil Bay is one of the component cities of Misamis Occidental. A portion of its coastal area is part of Bagumbang Malaubang Mangrove Swamp Forest Reserve through the Presidential Proclamation No. 2152 dated December 29, 1981. The protected area is the home of 25 species of true mangroves and 13 mangrove associates, according to (DENR 2017) [17]. This study on the Mangroves' present population and diversity is necessary to determine appropriate, efficient, and effective management intervention to protect and conserve these mangrove resources.

In 2019, the City Government of Ozamiz, through the City Agriculture Office, in partnership with Misamis University launched a project entitled Ozamiz City Coastal Resource Assessment (OCCRA) project to determine the coastal areas' existing natural resources in Ozamiz City. These are necessary inputs in preparing the Coastal Resource

Management Plan (CRMP) of Ozamiz City, and as basis to enact policies geared towards protecting and conserving these finite resources. Furthermore, various agencies' concerted efforts deem necessary to enhance the mangrove vegetation of the coastal areas of Ozamiz City.

Included in the City Government of Ozamiz and Misamis University OCCRA project was the conduct of the mangrove assessment in the coastal area of Ozamiz City along Panguil Bay. The mangrove assessment aims to determine species diversity, distribution, conservation status, mangrove threats, and mangrove associates in the coastal areas. Finally, the study recommended appropriate management policies for the mangrove and other associated species in the coastal area of Ozamiz City.

Materials and Method

1. Establishment of Sampling Plots

The 10m x 10m sampling plots with a distance of 50 meters were established. Within the sampling plots, all individual species of plants/trees in each sampling plot were identified; the volume was measured of the standing mangroves and associate species to determine which sampling plot has high species diversity, and assess each species' conservation status of the identified species of mangrove and mangrove associated species. The barangays of Sinuza, Tabid, Pulot, Dimaluna, Malaubang, Maningcol, Villa Consuelo, and San Antonio were the sampling barangays shown in *Figure 1*. Fifteen sampling plots were established using GPS by acquiring the four corners of the sampling plots in the eight coastal barangays of Ozamiz City. The study was conducted last June 11, 12 and 13, 2019.

2. Opportunistic Sampling Survey

An opportunistic sampling survey is a floral assessment by listing the number of species collected outside the sampling plots. In this method, opportunistic surveys are significantly greater than those recorded from the quadrants. This method, combined with others, has a higher chance of encountering more species occurring in the area. However, except for the presence or absence of the species, it will not give other qualitative data to determine each species' dominance or importance value.

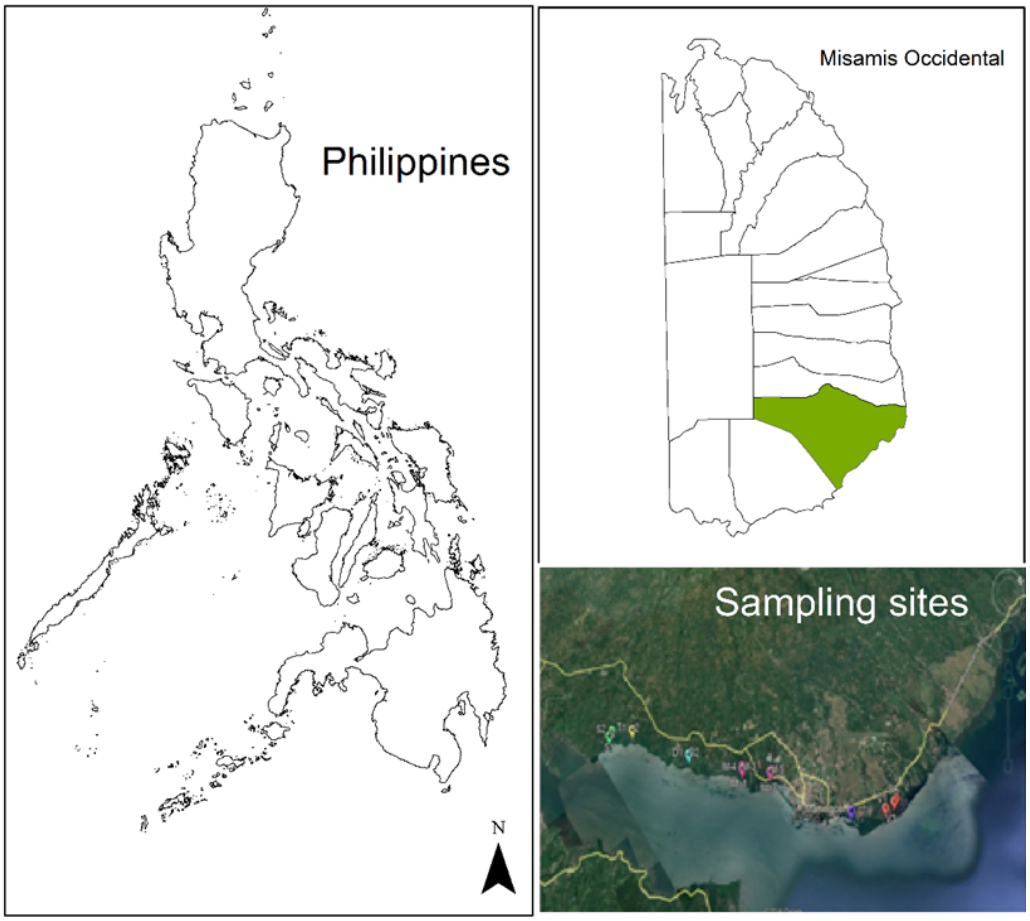

Fig 1: Map showing the study area in barangays of Ozamiz City, Misamis Occidental, Mindanao, Philippines

B. Data Analysis

Data/information gathered from the study area were encoded/tabulated in excel worksheets. It computed the basal area and volume of the individual trees. Data were calculated and analyzed using bio Pro software.

The endemism and ecological or conservation status of the different species were assessed to determine the vegetation's ecological importance in the area using DENR Administrative Order No. 2017-11, IUCN (2018) Red list, and CITES.

Results and Discussion

The present study found a total of 17 species, 12 families, and 13 genera of true mangroves were recorded during the study's conduct in the coastal area of Ozamiz City along the Panguil Bay, Mindanao, Philippines, as shown in Table 1. It accounts for 43% of the recorded mangrove species in the Philippines in the studies of Primavera (2004)[2]and Sinfuego, and Buot Jr. (2014) [10]. While the study of DENR 2017 recorded 25 true mangrove species and 13 mangrove associates in the Malaubang Bagumbang Mangrove Swamp

Forest Reserve, it accounts 68% of the recorded true mangrove species. However, in the established sampling areas, seven mangrove tree species were documented in all the sampling areas in each barangays. Most of the mangrove species were found in mouths of rivers, abandoned fishponds, fishpond dikes, coastal line, and usually found in patches occupying small areas from the highest tide in the coastal region. Accordingly, some of the mangroves species that thrives in the coastal area were the result of the tree planting activities conducted by the national government agencies, LGUs, academe, and private sectors in Ozamiz City. Among the eight (8) barangays, Pulot and Malaubang have more abundant mangrove species compared to other barangays, with more species of mangrove present in their respective coastal area.

Table 1: True mangrove species in the coastal area of Ozamiz City, Misamis Occidental, Philippines

Family Name	***Scientific Name***	Common Name
Acanthaceae	*Acanthus ebracteatus* Vahl.	Lagiwliw, Ragoyroy
	*Acanthus ilicifolius*L.	Lagiwliw, Ragoyroy
Arecaceae	*Nypa fruitican* (Thunb.) Wurmb.	Nipa
Avicenniaceae	*Avicennia alba* Blume	Piapi, api-api
	Avicennia officinalis L.	Bungalon, api-api
Bombacaceae	*Camptostemon philippinensis* (Vidal) Becc	Gapas-gapas
Combretaceae	*Lumnitzera littorea* (Jack) Voigt.	Libato, Tabao
	Lumnitzera racemosa Willd	Libato, Tabao
Euphorbiaceae	*Excoecaria agallocha* L.	Buta-buta
Meliaceae	*Xylocarpus granatum* Koen	Tabigi
	Xylocarpus rumphii (Kostel.) Mabb.	Piagao
Myrsinaceae	*Aegiceras corniculatum* (L.) Blanco	Tinduk-tindukan
Rhizophoraceae	*Bruguiera gymnorrhiza* (L.) Lam.	Pototan, busain
	Rhizophora mucronata Lam.	Bakaw babae
Sonneratiaceae	*Sonneratia alba* J. Smith	Pagatpat
Sonneratiaceae	*Sonneratia caseolaris* (L.) Engl.	Pedada
Sterculiaceae	*Heritiera littoralis* Dryand. Ex W. Ait.	Dungon, Dungon-late

A. Rarefaction of mangrove trees species within the sampling plots

Results of the15 sampling plots established in the coastal area of Ozamiz City revealed plot no. 5 is the most abundant plot with high rarefaction value. Dominant mangrove tree species belonged to Rhizoporaceaeand Avicenniaceae which are the mangrove families that dominated in this plot located Barangay Pulot, Ozamiz City, Misamis Occidental in Table 2. Plot 1 and Plot 11 ranked second, while plot 3 Plot 6, 7, 8 dominated by *Avicenia* species.

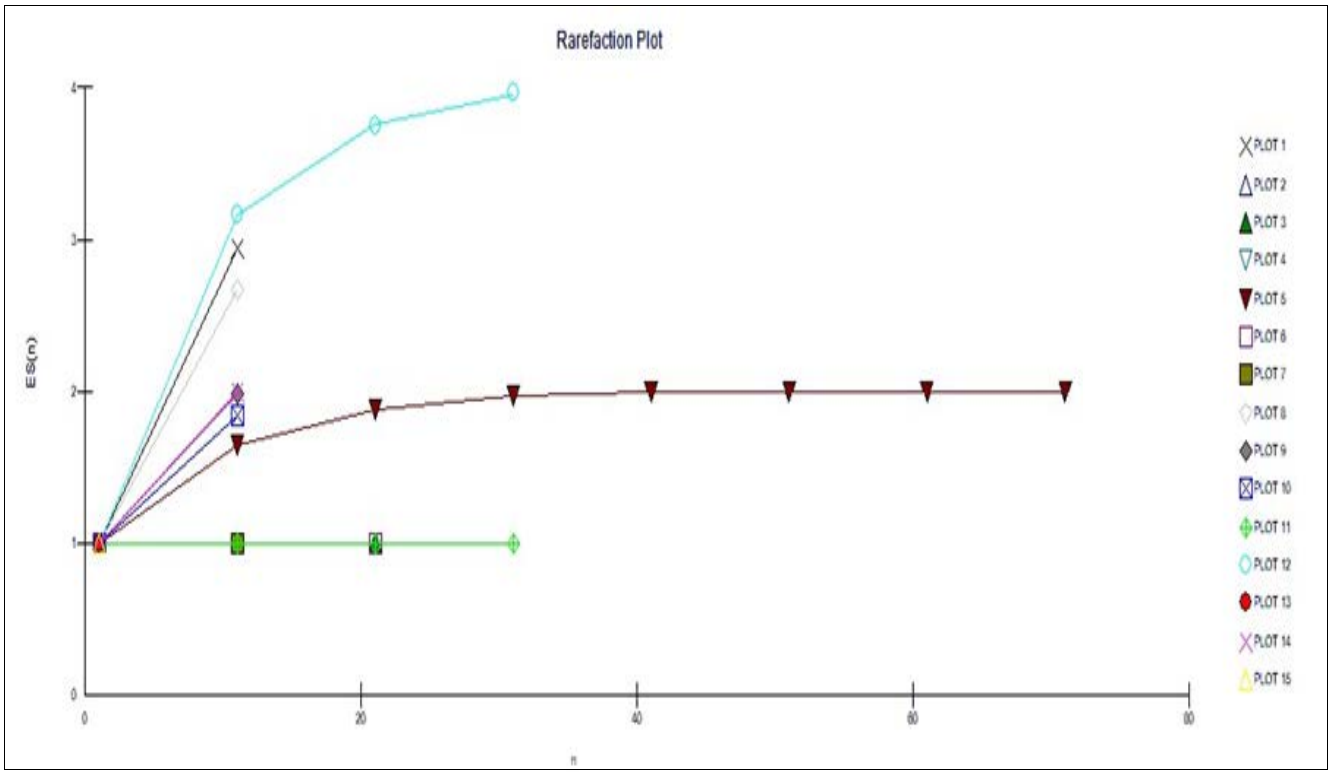

Fig 2: Rarefaction the true mangrove tree species within the sampling plots in the coastal area of Ozamiz City, Mindanao Philippines.

A. Ranks of the Importance Value of Mangrove tree species within the sampling plots in the coastal area of Ozamiz City, Misamis Occidental, and Philippines

As shown in Figure 3 these are the rank of the importance values from highest to lowest of mangrove inside the samplingplots in the coastal areas of Ozamiz City. The true mangrove tree species that has high importance values was the *Rhizophora mucronata.* This was directly influenced by its high relative frequency and relative density despite of being rank 2 in terms of relative dominance among the species found in the sampling plot. *Sonneratia alba* ranked 2, *Avicenia oficinalis* ranked 3. While *Bruguiera gyr*mnorhiza ranked 4 and ranked 5 *Sonneratia caseolaris* and *Xylocarpus granatum* ranked 6 as supported by the study of Mchenga *et al*. (2014) [18], the vegetation characteristics of the species is different in site and species.

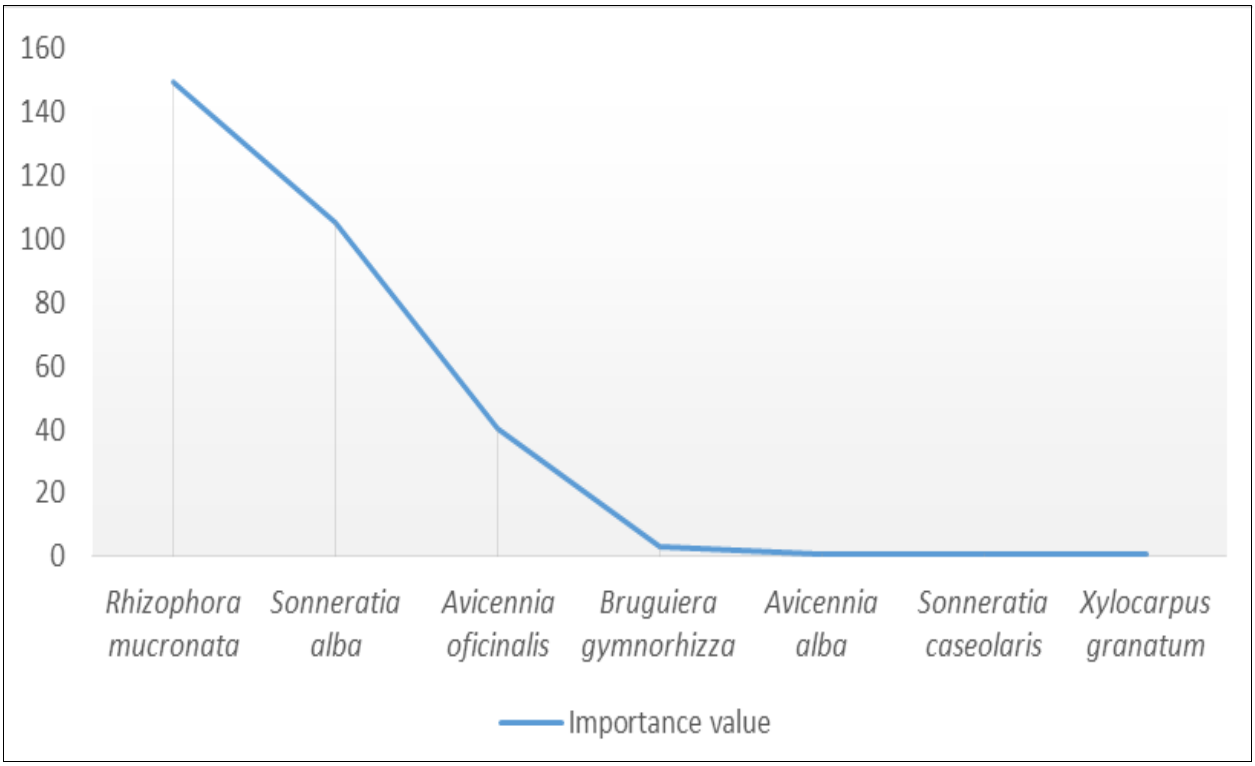

Fig 3: Importance valueof true mangrove tree species found inside the sampling plots in the coastal areas of Ozamiz City, Misamis Occidental, Philippines

Regenerants of Mangroves

In terms of regenerants, the presence of propagules fruits of Rhizophora species were found in the eight (8) barangays. Regenerants were abundant in the coastal areas of Ozamiz City. It was also recorded in the eight barangays of Ozamiz City. This is an indication that mangrove species have high possibility to regenerate, if proper and sound management of the mangrove resources will be put in place.

Table 2: List of Mangrove tree species with conservation status in the sampling plots of the coastal barangays of Ozamiz City, Mindanao, Philippines.

Common Name/Local Name	Scientific Name	Family Name	Distribution Status	Conservation Status		
				IUCN Status	DAO 2017-11	CITES
Piapi	*Avicennia oficinalis*	Avicenniaceae	Non Endemic	Least Concern	OWS	N/A
Pagatpat	*Sonneratia alba*	Sonneratiaceae	Non Endemic	Least Concern	OWS	N/A
Bakauan babae	*Rhizophora mucronata*	Rhizophoraceae	Non Endemic	Least Concern	OWS	N/A
Tabigi	*Cordia subcordata*	Meliaceae	Non Endemic	Least Concern	OWS	N/A
Pedada	*Sonneratia caseolaris*	Sonneratiaceae	Non Endemic	Least Concern	OWS	N/A
Bakauan Busaing	*Bruguiera gymnorhizza*	Rhizophoraceae	Non Endemic	Least Concern	OWS	N/A
Bungalon	*Avicennia alba*	Avicenniaceae	Non Endemic	Least Concern	OWS	N/A

Mostly, all of the mangrove tree species identified in the coastal areas in Ozamiz City are considered least concern, based on the 2019 IUCN Redlist and DAO 2017-11. It still locally abundant, however locally, there is a need for immediate action, particularly for the protection and conservation of this unique species of mangroves. Mangroves play an essential role in the existence of other faunal species in Panguil Bay. Panguil Bay supports the fisherfolk's local economy, and their livelihood activities of the bay's abundant resources. Its ecological services of mangrove include carbon sink, the sanctuary of juvenile fauna, wind protection, and filter sedimentation from upstream. It supports the existence of mangroves in the coastal areas. Must make utmost priority before these natural resources will go.

Rhizopora macrunata also known as "Bakhaw"

Sonneratia alba

Nypa frutican

*Cordia subcordata (*Sea trumpet*)*

Fig 4: Some photographs of mangrove and associated species in the coastal area along Panguil Bay of Ozamiz City, Mindanao, Philippines.

Table 3: List of mangrove and mangrove associated species outside the sampling plots in the coastal area of Ozamiz City, Mindanao, Philippines.

Common Name	Scientific Name	Family Name	A1	A2	A3	A4	A5	A6	A7	A8	Remarks
1 Alagaw	*Premna serratifolia* L.	Lamiaceae	-	-	-	-	-	+	-	-	
2.. Alim	*Melanolepis multiglandulosa* (Reinw. Ex Blume) Rchb. & Zoll.	Euphorbiaceae	-	+	-	-	+	+	+	+	Philippine Endemic
3. Antipolo	*Artocarpus blancoi* (Elmer) Merr.	Moraceae	+	+	-	-	-	-	-	-	Philippine Endemic
4. Anonang	*Cordia dichotoma* G. Frost.	Boraginaceae	-	+	-	-	-	-	-		
5. Apatot/Noni	*Morinda citrifolia* L.	Rubiaceae	+	-	-	-	-	+	+	-	
6. Aroma	*Prosopis juliflora* (Sw.) DC.	Fabaceae	-	-	-	-		+	-	-	
7. Asin-asin	*Derris trifoliate* Lour.	Fabaceae	-	-	-		-	+	-	-	
8.Atis	*Anona squamosal* L.	Annonaceae	-	-	+	-	-	-	-		
9.Bagalunga	*Melia dubia* Cav.	Meliaceae	+	-	-	-	-	-	-	-	Philippine Endemic
10. Balak-balak (Octopus bush)	*Heliatropium foertherianum* Diane & Hilger	Boringinaceae	-	-	-	+	-	-	+	-	
11.Balite	*Ficus balite*Merr.	Moraceae	-	+	-	-	-	-	-	-	Philippine Endemic
12. Balok-Balok	*Milletia pinnata* (L.) Panigrahi	Fabaceae	-	-	+	+	-	-	-	-	
13. Bayabas	*Psidium guajava*L.	Myrtaceae	+	-	-	-	-	-	-	-	
14. Binunga	*Macaranga tanarius* (L.) Mull.Arg.	Euphorbiaceae	-	+	-	+	-	-	-	-	
15. Bitaog	*Callophylum inophylum* L.	Clusiaceae	-	-	+	-	-	-	-	-	
16. Bulu			+	-	-	-	-	-	-	-	
17.Buta-Buta	*Excoecaria agallocha* L.	Euphorbiaceae	+	-	-	-	-	-	-	-	
18.Caimito	*Chrysophyllum cainito*L.	Myrtaceae	-	+	-	-	-	-	-	-	
19. Dampalit	*Sesuvium portulacastrum* (L.) L.	Aizoaceae	-	-	-	-	-	+	-	-	

20.Dungon-late	*Heritiera littoralis* Dryand. Ex W. Ait.	Sterculiaceae	-	-	+	-	-	-	-	-	
21. Hagiwi	*Dodonea 585iscose* (L.) Jacq.	Sapindaceae	+	-	-	-	-	+	-	-	
22.Ipil-ipil	*Leucaena leucocephala*(Lam.) de Wit	Fabaceae	-	-	+		-	-	-	-	
23. Igyo	*Dysoxylum gaudichaudianum*(Juss.) Miq.	Meliaceae	-	+	-	-	-	-	-	-	
24.Gapas-Gapas	*Camptostemon philippinensis* (Vidal) Becc	Bombaceae	+	-	-	-	+	+	-	-	
25.Gmelina	*Gmelina arborea*Roxb. Ex Sm.	Meliaceae	-	+	-	-	-	-	-	-	
26. Guyabano	*Anona muricata*L.	Annonaceae	+	-	-	-	-	-	-	-	
27.Kakawate	*Glericidia sepium* (Jacq.) Steud.	Leguminasae	+	-	-	-	-	-	-	-	
28. Lagiwliw	*Acanthus ebracteatus* M. Vahl	Acantahaceae	+	-	-	-	-	+	-	-	
29.Lagiwliw	*Acanthus ilicifolius*L.	Acanthaceae	+	-	-	-	-	-	+	-	
30.Lansones	*Lansium domesticum*Jack	Meliaceae	-	+	-	-	-	-	-	-	
31.Libato	*Lumnitzera littorea* (Jack) Voigt	Combretaceae	+	_	_	_	_	_	_	_	
32.Libato	*Lumnitzera racemosa* Willd	Combretaceae	-	-	-	+	-	-	-	-	
33. Lubi	*Cocos nucifera* L.	Arecaceae	+	+	+	-	-	-	-	-	
34.Mangga	*Mangifera indica*L.	Moraceae	+	+	-	-	-	-	-	-	
35.Marang	*Artocarpus odoratissimus*Blanco	Moraceae	-	-	+	-	-	-	-	-	
36.Malapapaya	*Polyscias nodusa* (Blume) Seem.	Moraceae	-	+	-	-	-	-	-	-	Philippine Endemic
37.Malabago	*Talipariti tiliaceum*(L.) Fryxell	Malvaceae	+	-	-	+	-	-	+	+	
38. Narra	*Pterucarpus indicus*Willd.	Fabaceae	+	-	-	-	-	-	-	-	Philippine Endemic/Endangered Species
39.Nangka	*Artocarpus heterophyllus*Lam.	Moraceae	-	-	+	-	-	-	-	-	
40.Nipa	*Nypa frutican*Wurmb	Arecaceae	+	+	+		+	+	+	+	
41. Palang-palang	*Ipomoea pes-caprae* (L.) Sw.	Convolvulaceae	-	-	-	-	-	+	-	-	
42.Piagao	*Xylocarpus rumphii* (Kostel.) Mabb.	Meliaceae	+	-	-	+	+	+	-	-	
43.Putat/Red Barringtonia	*Barringtonia acutangula* (L.) Gaertn.	Lecythidaceae	-	+	-	-	-	-	-	-	
44.Talisay	*Terminalia catappa* L.	Combretaceae	+	+	-	+	-	-	+	+	
45.Tinduk-tindukan	*Aegiceras corniculatum* (L.) Blanco	Myrsinaceae	-	-	-	-	-	+	-	-	
46Tiwi (Mangrove Trumpet Tree)	*Dolichandrone spathaceae* (L.fil.) K.Schum.	Bignoniaceae	+	-	-	-	-	-	-	-	
47.Santol	*Sanduricum koetjape*Merr.	Meliaceae	-	+	-	-	-	-	-	-	
48.Sea trumpet	*Cordia subcordata*Lam.	Boraginanceae	-	-	-	-	-	+	-	-	
49. Suha	*Citrus maxima*(Burm.) Merr.	Rutaceae	+	-	-	-	-	-	-	-	
50. Hoya sp.		Apocynaceae	-	-	-	-	-	+	-	-	

Legend: (+) present, (-) absent

Legend: Area1-Sinuza, Area2-Tabid, Area3-Dimaluna, Area4-Pulot, Area5-Malaubang Area6-Maningcol, Area7-Villaconsuelo and Area-8 San Antonio

During the assessment in the eight (8) coastal barangays of Ozamiz City, a total of fifty one (51) species were observed, identified and listed. Among the 57 species, 50 were identified as incidental species observed, comprising 25 families of plantsthat constitute of about 87.71% of the observed and documented plant species in the coastal areas. The majority of the trees/plant species belong to family Fabaceae formerly Leguminosae, with salient characteristics of its roots that has nodules stem is erect, and leaves are alternate, pinnately compound geographically distributed in the Philippines. Followed by Meliaceae family, Third,belongs to Euphorbiacea, Boraginaceae families while the remaining families of trees/plant species are Moraceae, Combretaceae, Bignoniaceae, Lecythidaea, Malvaceae, Clusiacea, Rubiaceae, Sapindanceae Concluviaceae and Apocynaceae.

Among the 44listed incidental species among the mangrove associated species, one (1) is considered endangered specieswhich is the *Pterocarpus indicus*based on DAO 2017-11 and vulnerable based on the IUCN Red list 2019. Based on endemism, there were five (5) species of trees found in the coastal areas of Ozamiz City, which are considered as Philippine Endemic. These species were found only in the Philippines and nowhere else in the world. Locally not threatened, but protection and conservation of this tree species is still needed to protect this species. These were *Melanolepis multiglandulosa*, *Artocarpus blancoi*, *Melia dubia*, *Pterocarpus indicus*, and *Policias nodusa*.

Human Interaction

Human access to mangrove areas is prevalent to the coastal areas of Ozamiz City, Panguil bay. The identified resulting threats includes encroachment of settlements, dumping of wastes, cutting of mangroves trees, conversion of mangrove areas and soil erosion. These results coincide with study of Dangan-Galon *et al*. (2016) [19] and Primavera and Esteban (2008) [20] and Walters, (2004) [15].

Conclusion

The coastal area of Ozamiz City along Panguil Bay is a home of mangrove and mangrove associates species. A total of 58 species of plants with 29 families with 17 species are true mangrove species. Most of the mangrove species belonged to less concern based on the 2019 IUCN Redlist, while one species belongs to Endangered Status which is the *Pterocarpus indicus*or commonly known as Narra. However, the recorded species are locally threatened in the area due to aforementioned issues and problems, thus, unified protection and conservation measures of concerned agencies and communities must be implemented to avert the trend locally. Identified issues inthe area include improper garbage disposal, infrequent cutting of mangrove trees, encroachment of human settlers, and soil erosion were identified as potential threats to the mangrove forest of the City of Ozamiz coastal areas along the Panguil bay. Concerted efforts of all stakeholders must be intensified and combined to avert the issue to protect and conserve

mangrove resources in the coastal areas of Ozamiz City, Philippines, specially these are considered carbon sink and nature based climate resilient species.

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