Diversity and species composition of mangroves in Barangay Imelda, Dinagat Island, Philippines

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Abstract. Mangroves are considered as the most important components of the coastal ecosystem and among the most productive and biologically complex ecosystems on the planet. Assessment of mangrove species plays a critical role in the conservation and protection of the mangroves forest. This study aimed to perform a preliminary assessment on the true mangrove species in barangay Imelda, Dinagat Island, Philippines. The results revealed that the area is in low diversity (H'= 1.856) with ten mangrove species belongs to six families. Among the six families, family *Rhizophoraceae* obtains the highest species composition with five species (*Rhizophora mucronata, Rhizophora* stylosa, *Rhizophora apiculata, Bruguiera gymnorrhiza and Bruguiera sexangula)*. *Rhizophora apiculata*, *Bruiguiera gymnorrhiza and Xylocarpus granatum* on the other hand are the top three species of true mangroves recorded of having the highest population density, relative frequency, relative dominance and importance value while *Heritiera littoralis,* is noted of having the lowest value. The habitat assessment of the sampling area revealed that the percent crown cover in the sampling area is in fair category (40.16%) while regeneration per m² (3.6) and the average height of mangroves (5.87) are in an excellent category.

Key Words: true mangrove, population density, frequency, dominance, importance value (IV).

Introduction. The Philippines is an archipelago country made up of 7,107 islands located completely within the tropics of the Southeastern Coast of Asia. The Philippine coastline extends 36,289 km and is surrounded by the waters of the Celebes and Sulu Seas along its southern coast, the South China Sea along the western coast, and the Philippine Sea along its eastern coast (Long & Giri 2011). The Philippine Islands are considered one of the top biodiversity "hot spot" areas of the world, supporting 1.9% of the world's endemic plants and vertebrate species (Myers et al 2000). According to Calumpong & Menez (1996), the Philippines were considered as one of the richest diversity of coastal plants in the world.

One of the most important components of the coastal ecosystem is the mangal community (or mangroves) on the landward side of the coastal zone, usually located within the inter-tidal zone. The Philippines has an estimated of 500,000 hectares of mangrove forest in 1918 (Brown & Fischer 1920), and it decreased to 100,000 hectares in 1994–1995 (Primavera 2000).

Approximately 60 to 70 mangrove and associated mangrove species from 26 families are found in the Philippines. An estimated forty species (from 16) are considered true mangroves (CV-CIRRD 1993; Primavera 2000) which can be defined as those which are restricted to the mangrove community while associated species may also grow in other habitats (Melana & Gonzales 1996). In the Philippines, majority of the common genera are Rhizophora, Avicennia, Bruguiera and Sonneratia (Calumpong & Menez 1996) and at least 14 species have previously been recorded from Negros Island (Calumpong 1994).

Mangroves are dicotyledonous woody shrubs or trees, virtually confined to the tropics. They often form a dense intertidal forest that dominates muddy intertidal shores, frequently consisting of virtually monospecific patches or bands (Hogarth 2015). Mangroves form unique ecological environments which provide an appropriate habitat for a rich assemblage of species. Thereby muddy or sandy sediments of the mangroves offers home for different species of epibenthic, infaunal, and meiofaunal invertebrates, reservoirs within the mangroves support communities of phytoplankton, zooplankton, and fish. Furthermore, the mangroves also play a unique role as hatchery and nursery habitat for juveniles of fish whose adults occupy other habitats (e.g. coral reefs and seagrass beds). The specific landscape with aerial roots, trunks, leaves and branches host a large amount of organisms. This habitat is an ideal home for some crab species which live among the roots, on the trunks or even forage in the canopy. A large amount of organisms like insects, reptiles, amphibians, birds and mammals thrive in this habitat and contribute with its lifestyle to its unique character (Kathiresan & Bingham 2001). In accord to this, Guebas et al (2005) states that mangrove ecosystems are among the most productive and biologically complex ecosystems on the planet. Aside from its ecological function, mangroves representatives such as Rhizophora spp. function as a physical barrier against tidal and ocean influences using their large aboveground aerial root systems and standing crop.

Despite its great importance, mangrove forest faces a serious problem, the mangrove deforestation and the major driving force of mangrove forest loss in Southeast Asia and the Philippines are the rapid expansion of aquaculture development (Dodd & Ong 2008). In the Philippines, 50% of estimated mangrove deforestation can directly account for brackish-water pond development (Primavera 1995). Despite greater conservation and localized replanting efforts, mangrove degradation in the Philippines is still anticipated to (Samson & Rollon 2008). Thus, the assessment of the remaining mangrove forest is essential in preserving and protecting the remaining mangrove forest in the Philippines.

Material and Method. This study was conducted on January 14-17, 2016 at Brgy. Imelda, Dinagat Island, Philippines.

Study area. Imelda is one of the barangay in the Municipality of Tubajon, province of Dinagat Islands in Caraga, which is part of the Mindanao group of islands with a population of about 7,815. Figure 1 shows the location of the two transect lines established in Brgy. Imelda, Dinagat Island, Philippines.

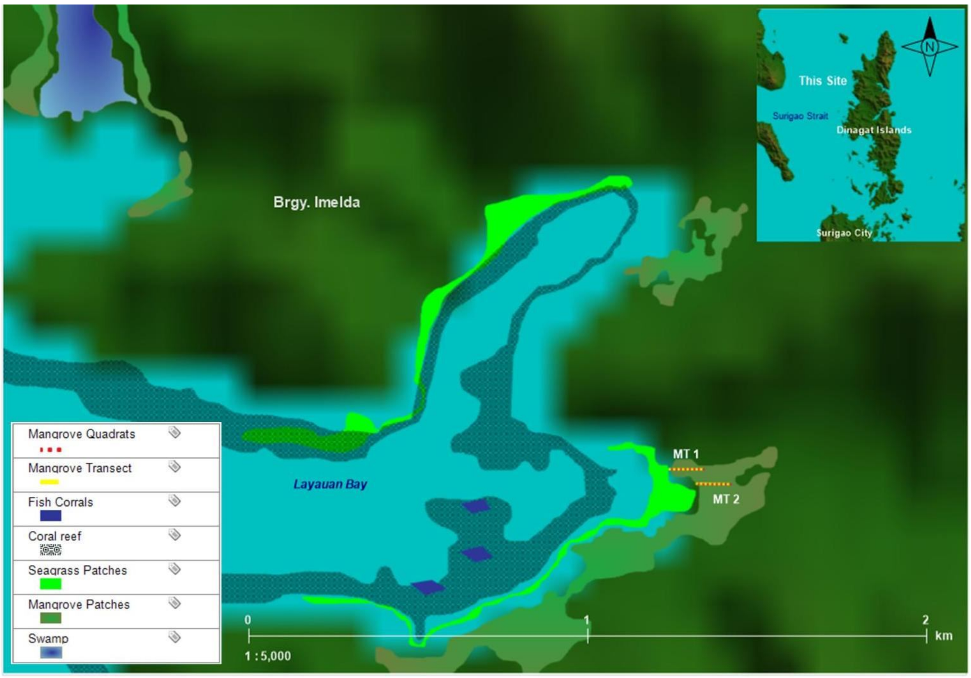

Figure 1. Map showing the location of the mangrove forest in Brgy. Imelda, Dinagat Island, Philippines.

Line transects plot sampling and basal diameter measurement of mangrove trees. Two sampling stations were established in the area. For each station, transect lines range 150 meters was laid perpendicular to the shoreline. Within, the transect line 10x10 m plots for the sampling of mangrove trees (mangrove with a basal stem diameter of 4 cm and higher with more than 1 m height) were set up with an interval of twenty meters in every plot. In every station, five 10x10 m plots were laid. The mangrove inside the plot was identified and counted, the diameter at breast height (dbh) in cm, basal area in meter and density was measured. The measurement of diameter at breast height (dbh) was based on the book of English et al (1997). For the regeneration of mangroves, three 1x1 m sub plot was established. All the seedlings and saplings of mangroves inside the 1x1 m were counted. Each mangrove within the plots was characterized as seedling, sapling and mature tree based on the definition of Deguit et al (2004).

Identification of mangroves. The mangroves were identified in situ and classify taxonomically. The mangrove species were determined using the field guide manual to Philippine Mangroves by Primavera et al (2004).

Diversity indices. The diversity indices such as species richness, relative abundance, Shannon-Weiner diversity index and evenness were calculated using the Paleontological Statistical Software Package (PAST) developed by Hammer et al (2001).The diversity values for Shannon-Weiner were classified based on a scale developed by Fernando (1998).

Vegetation analysis. The vegetation analysis was analyzed by using the parameters: population density, frequency, dominance, relative density, relative frequency, relative dominance and the importance value. This kind of analysis provides a better index than density alone regarding the importance or function of a species in its habitat. It also gives rank or order for a particular species within the forest community.

Mangrove habitat assessment. For the habitat assessment of mangroves, percent crown cover, regeneration per m^2 and average height were calculated.

Crown diameter (m^2) = the average crown width at the widest point and second with the measurement of 90° to the diameter at the widest point. The crown cover was calculated by using the $\pi/d.^2$

$$\text{Percent crown cover} = \frac{\text{Total crown cover of all trees}}{\text{Total numbers of trees recorded}}$$

$$\text{Regeneration per m}^2 = \frac{\text{Total regeneration count}}{\text{Total of regeneration plots}}$$

$$\text{Average height} = \frac{\text{Total heights of trees recorded}}{\text{Total number of trees recorded}}$$

Results and Discussion. A total of 10 mangrove species were identified and belonged to 6 different families. Family Rhizophoraceae obtain the highest species composition with five mangrove species these were: *Rhizophora mucronata, Rhizophora stylosa, Rhizophora apiculata, Bruguiera gymnorrhiza* and *Bruguiera sexangula.* Regarding the conservation status out of ten species of mangroves, eight species were assessed by the IUCN with the least concern status. The list of observed mangrove species was shown in Table 1. Figure 2 represent the percent composition of mangrove family and conservation status.

Table 1
Species composition and conservation status of mangroves in Barangay Imelda, Dinagat, Island

No	*Family*	*Mangrove species*	*Local name*	*Conservation status (IUCN*)*
1	*Rhizophoraceae*	*Rhizophora mucronata*	Bakhaw-babae	*Least concern*
2	*Rhizophoraceae*	*Rhizophora stylosa*	Bakhaw-bato	*Least concern*
3	*Rhizophoraceae*	*Rhizophora apiculata*	Bakhaw-lalake	*Least concern*
4	*Rhizophoraceae*	*Bruiguiera gymnorrhiza*	Busain	*Not assessed*
5	*Rhizophoraceae*	*Bruiguiera sexanguela*	Pototan	*Not assessed*
6	*Combritaceae*	*Lumnitzera racemosa*	Tabao	*Least concern*
7	*Sterculiaceae*	*Heritiera littoralis*	Dunga	*Least concern*
8	*Ebenaceae*	*Excoecaria agallocha*	Buta buta	*Least concern*
9	*Meliaceae*	*Xylocarpus granatum*	Tabigi	*Least concern*
10	*Avicineacea*	*Avicennia rumphiana*	Pototan Lalaki	*Least concern*

* www.iucnredlist.org

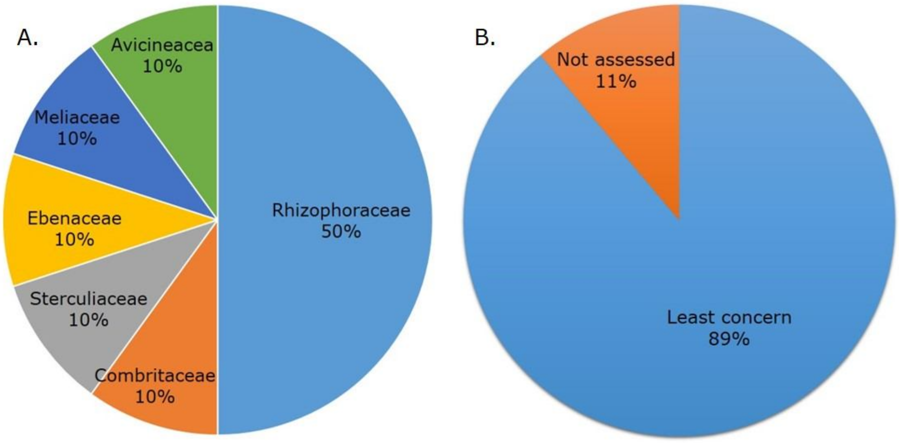

Figure 2. Percent composition of mangrove families (A) and conservation status (B) in barangay, Imelda, Dinagat Island, Philippines.

Relative abundance percent. Figure 3 shows the relative abundance of each mangrove species recorded in the sampling area. Among the 10 species of mangroves, *R. apiculata* obtain the highest percent relative abundance (29.9%), followed by *B. gymnorrhiza* (27.83 %) and *X. granatum* (15.46 %). On the other hand, three species were noted for having the lowest value; these are; *Avicennia rumphiana, Excoecaria agallocha*, and *Heritiera littoralis* having a percent relative abundance of 2.06%.

R. apiculata belong to family Rhizophoracea, this species of mangrove is an indicator of the intermediate estuarine zone. *R. apiculata* can withstand high currents and tides, can tolerate a maximum salinity up to 65 ports and a salinity of optimal growth of 8-10 ppt (Robertson & Alongi 1992) while *B. gymnorrhiza* is a large-leafed mangrove and one of the most important and widespread mangrove species in the Pacific. It is found in intertidal areas of the tropical Pacific region from Southeast Asia to the Ryukyu Islands of southern Japan in Micronesia and Polynesia (Samoa), and southward to subtropical Australia. Large-leafed mangrove thrives under a broad range of intertidal conditions, including salinity levels from near freshwater to full-strength seawater, and tolerates a range of flooding and other soil types. Typically, it is most prevalent in the middle and upper intertidal zones, rather than in the lower intertidal zone or along the seaward edge of mangrove stand.

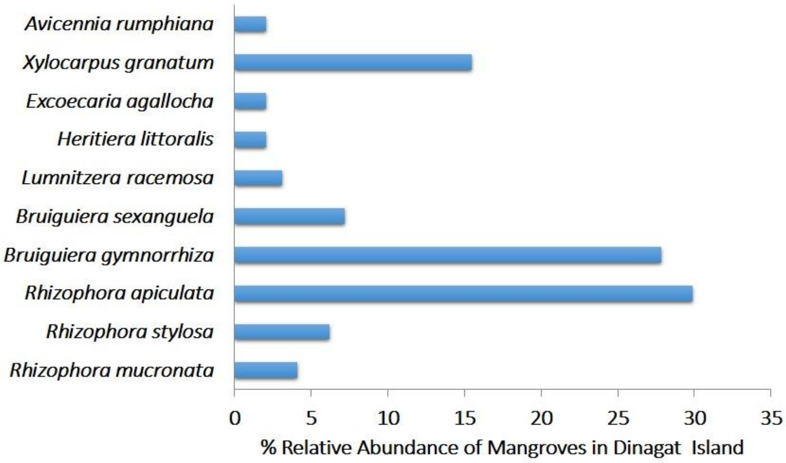

Figure 3. The percent relative abundance of mangroves noted in Brgy. Imelda, Dinagat Island, Philippines.

Mangroves diversity indices. The sampling site has species richness of 10 which means 10 species of mangroves were noted in the area. The dominance has a value of 0.2014 while evenness has 0.6399. Shannon diversity obtained 1.856 and based on the classification given by Fernando (1998), the area falls under very low diversity category (Figure 4). In two sampling stations, station one (1) recorded of having the highest value of species richness (9 species), evenness (0.80) and Shannon (1.97) while in dominance (0.25) station two (2) obtain the highest value for the two sampling stations (Figure 5).

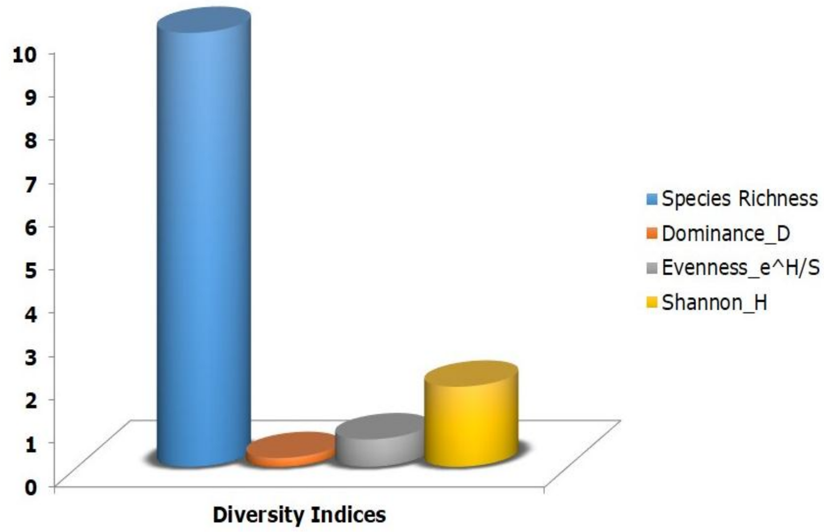

Figure 4. Diversity indices of mangroves in Brgy. Imelda, Dinagat Island, Philippines.

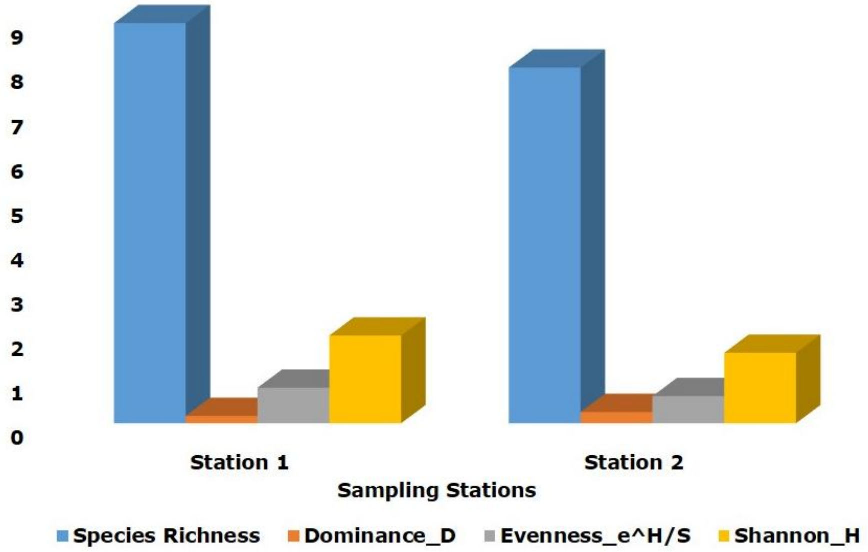

Figure 5. Diversity indices of mangroves in two sampling stations of Brgy. Imelda, Dinagat Island, Philippines.

Mangrove vegetation structure. The community structure of the mangroves was evaluated by using the values of relative population density, frequency and dominance. The summations of these values were added to attain species importance value (SIV) in the entire sampling area.

The species *R. apiculata* was noted of having the highest population density indicating that this specie has the highest count per unit area, followed by *B. gymnorrhiza* and *X. granatum* (Figure 6). In terms of relative frequency, similar mangroves species with high relative frequency were observed, however *B. sexanguela* was included having a relative frequency value of 12.12% the same value obtain by *X. granatum* (Figure 7). Relative dominance and population density on the other hand were noted of having the same species with the highest relative dominance value (Figure 8). Thus the top three species with the highest importance value were *R. apiculat*a (81.02%), followed by *B. gymnorrhiza* (75.47%) and *X. granatum* (40.05%). Among the ten species of mangroves *H. littoralis* got the lowest importance value (Figure 9).

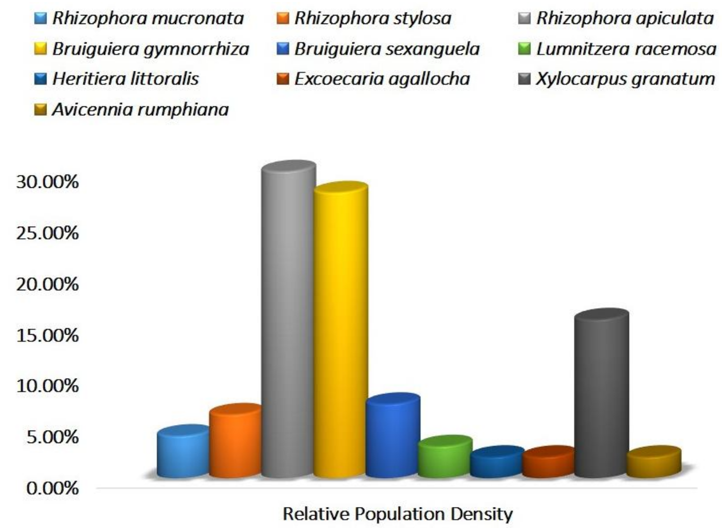

Figure 6. Relative population density of mangroves recorded in Brgy. Imelda, Dinagat Island, Philippines.

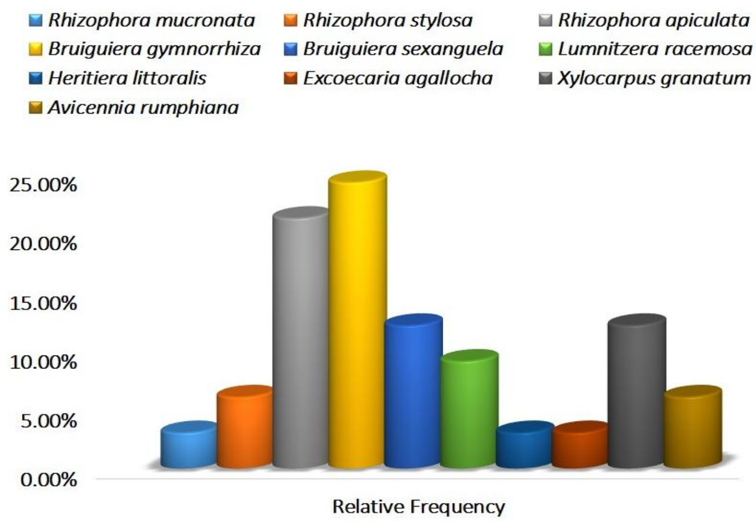

Figure 7. Relative frequency of mangroves noted in Brgy. Imelda, Dinagat Island, Philippines.

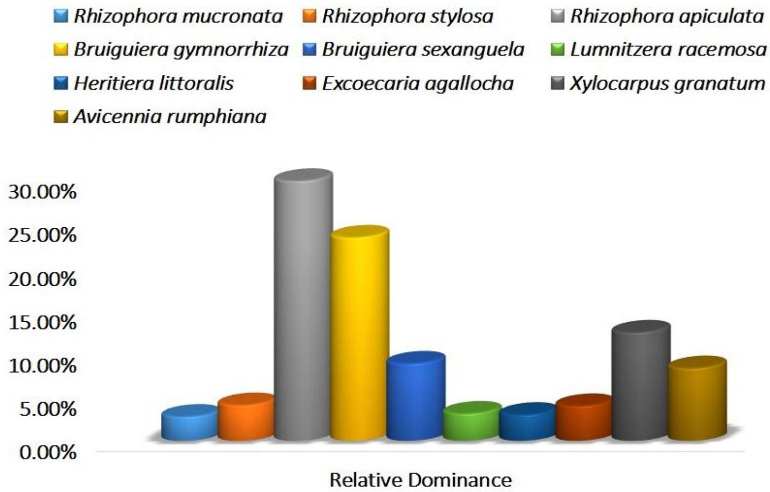

Figure 8. Relative dominance of mangrove recorded in Brgy. Imelda, Dinagat Island, Philippines.

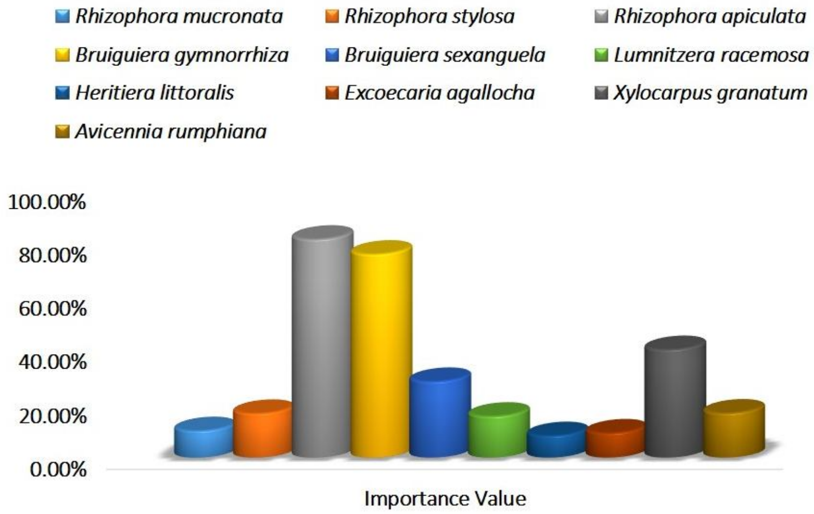

Figure 9. Calculated importance value of mangrove species noted in Brgy. Imelda, Dinagat Island, Philippines.

Mangrove habitat assessment. The mangrove habitat assessment involves the determination of percent crown cover, regeneration per m^2 and an average height of the mangroves. Figure 10, revealed the value of percent crown cover (40.16%), regeneration per m^2 (3.6) and the average height of mangroves (5.87). Based on the classification given in Deguit et al (2004), percent crown cover fall under the fair category, regeneration per m^2 under the excellent category as well as the average height of mangroves. Excellent means undisturbed to negligible disturbance during a fair means moderate disturbance.

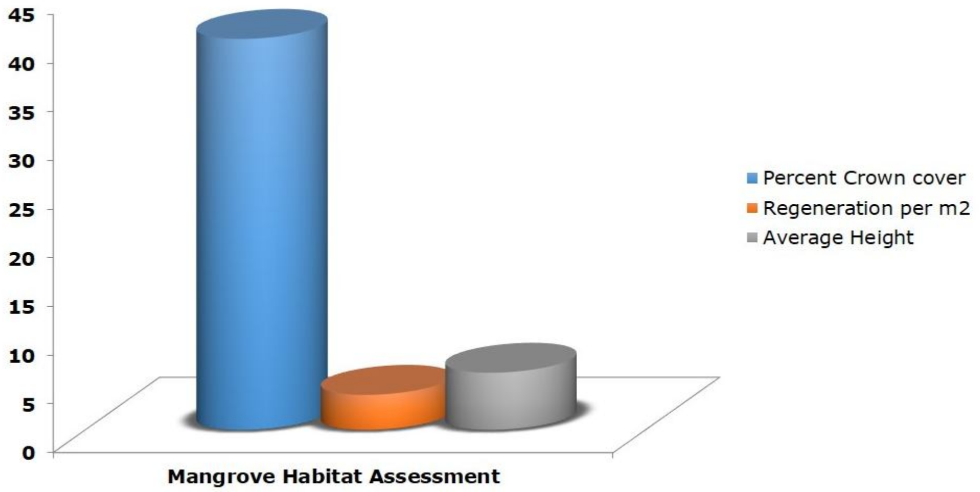

Figure 10. Mangrove habitat assessment in species noted in Brgy. Imelda, Dinagat Island, Philippines.

Conclusions. Based on the findings of the study, it was concluded that Barangay Imelda, Dinagat Island falls under very low diversity (H category with ten true mangrove species, belongs to six families. Among the 10 species of mangroves, *R. apiculata* got the highest species importance value (81.02%). Habitat assessment, on the other hand, shows that the sampling area regarding habitat assessment, percent crown cover fall under the fair category (40.16%) while regeneration per m^2 (3.6) and an average height of mangroves (5.87) are in an excellent category. *R. apiculata* have the highest species importance value (81.02%). Habitat assessment, on the other hand, shows that the sampling area regarding habitat assessment, percent crown cover fall under the fair category (40.16%) while regeneration per m^2 (3.6) and the average height of mangroves (5.87) are in the excellent category. *R. apiculata* have the highest population density, related frequency, and relative dominance thus obtains the highest species importance value (81.02).

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