Species Composition, Diversity and Stand Structure of Mangroves in Olango Island Wildlife Sanctuary, Cebu, Philippines

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ABSTRACT

The stand structure and species composition of the mangroves in Olango Island Wildlife Sanctuary were assessed using the following parameters: relative frequency, relative dominance, relative density, importance value, crown cover, abundance of trees/hectare, regeneration/m² and constancy. The study recorded the presence of 17 species, 9 of which were considered rare in occurrence. There was a total of 10,309 trees surveyed and O. octodonta registered the highest with 3,739 trees, R. stylosa with 2,827 and A. marina with 1,268 as the third. The area had a very low crown cover with 23.06%. Regenerants were also very few with 1.3 wildling /sq.m². Also, the mangroves in OIWS showed a small basal area of 1.27 m²/hectare indicating there was overharvesting/ overcutting of the trees. To prevent further degradation of the place, there is an urgency to reforest the area, with emphasis on planting the disappearing/lost species observed.

Keywords: Stand structure, species composition, mangroves, composition structure, and Olango Island Wildlife Sanctuary

INTRODUCTION

Olango is a small coralline island located (bet.10°13’ and 10°16’N, bet. 124°02’ and 124°04’E) about 4km east of Mactan Island and 15km east of Cebu City (Mapalo, 1999), Central Philippines (Fig. 1). The island has a total land area of 1,030.2984, and on its southern tip are relatively vast tidal sand flats and mangroves of about 926.50 has (Fig. 2), the Olango Island Wildlife Sanctuary (OIWS). The OIWS was declared in 1992 as one of the seven wetlands listed in the Convention on Wetlands of International Importance Especially as Waterfowl Habitats (RAMSAR Convention) that supports the largest concentration of migratory birds (48 species including the rare Chinese egret, the Asiatic dowitcher and some species of sandpiper and plover) found in the Philippines. It is an important fly away stop over site of 10,000 migrating birds as this is the path of the East Asian Migratory Flyway. Ninety-seven (97) species of birds have been identified in the area, 48 of which are migratory, 42 residents and 7 unidentified. Among the water birds, 32 are waders, 13 are waterfowls, and 9 are sea birds (Barangan, 2004).

Another important resource to the OIWS and its surrounding coastal communities is a natural mangrove forest that covers an area of 327.958 hectares. It is the roosting site for many birds during high tides and provides a habitat for several important marine organisms like crabs, shells and other invertebrates. For the local people, over the years, they have been cutting mangrove trees inside the sanctuary for firewood, posts for their houses, piles for bridges and wharfs and
other construction materials (Bagalihog and Melana, 2003; Bueno, 2006). At times other species of mangroves like the fruits of *R. macronata* are eaten raw and its young shoots cooked while other Rhizophora species are used to treat diabetes and haematuria (Canopy International, 1981).

Ecologically, mangroves protect coastal areas from storm surges, waves, and typhoons. Mapalo in 1999 already warned that the loss of mangroves in Olango Island would mean the loss of a buffer zone against strong waves and storm surges, thus, conserving the remaining mangrove forests in the island is imperative. Another importance of mangrove ecosystem which is only highlighted lately is its being a site for carbon captured and stored in the biosphere system, thus mitigating climate change as shown in the study in Bunaken National Park, North Sulawesi Island by Kimbal et al. (2014).

But inspite the above cited values, globally, mangrove areas are decreasing, with an estimated loss of 30% since 1980. The highest reduction rate occurred in the Indo-Malay region that includes the Philippines, which is also the area with the highest species diversity and most threatened primarily due to clearing for conversion to shrimps and fish ponds. (Polidoro, et al., 2010).

In the Philippines mangrove forests are relatively well-studied. Among the highly species diverse sites are Guimaras Island with 30 species (Sadaba *et al.*, 2009), Davao Gulf with 30 (Flores, 2003), Bohol with 34 (Mapalo, 1993) and San Remegio, Cebu with 18 (Baconguis, 1994). Yet such diversity has been declining in some parts of the country like inOrmoc Bay, Leyte, Philippines where mangrove species diversity decreased by 50% (Juario and Ontoy, 2005). While in Central Visayas which is composed of Cebu, Negros, Bohol and Siquijor Islands, some mangrove species which are *C. tagal*, *C. decandra*, *B. gymnorrhiza*, *B. sexagula*, *B. cylindrica*, *B. parviflora*, *X. granatum*, *X. moluccensis*, *E. agallocha*, *A. corniculatum*, *A. floridum*, *L. littorea*, *L. racemosa*, *O. octodonta* and *S. hydrophyllacea* already showed signs of rare occurrences two decades ago (Melana *et al.*, 1996). Particularly in Olango Island there have been initial inventories and studies on mangroves of the island (Magsalay and Gonzales, 1989) as cited by Bagalihog (2002) that reported 23 true mangrove species and associates and of Silliman University Marine Laboratory (SUML, 1997 as cited by Sotto *et al.*, 2001) identified 19 true mangrove species and associates with *R. mucronata* present in all mangrove areas in OIWS. However, after almost three decades no updated studies were done on the current status of the mangroves in OIWS which could have been a basis to improve its protection and conservation, hence, this study. Given the significance of OIWS, conservation and reforestation efforts as well as its sustainable use should be aligned to prevent further damage to its mangrove resource.

**METHODOLOGY**

Prior to the study proper, an initial survey was done which showed that the mangrove trees inside the OIWS generally, are highly disturbed as revealed by their small basal areas and
shorter heights as well as the presence of many gaps in the forest, indicative of heavy human exploitation hence, a re-assessment and inventory of the mangrove flora in the area is an urgent issue.

For the actual species inventory and study of the mangrove community structure, specifically it was conducted within the 423.94ha mangrove natural forest of OIWS covering three barangays: Brgy. San Vicente, Brgy. Sabang and Santa Rosa (Fig.1).

Considering that mangrove species are not evenly distributed but follow a distinct zonation pattern as influenced by tidal inundation and substrate type, the transect line-quadrat method was used in this study. A total of five transect lines were distributed as follows; three (3) in Brgy. San Vicente, one (1) in Brgy. Sta. Rosa and one (1) in Brgy. Sabang, respectively were laid perpendicular to the shoreline starting seaward to the inland edge of the mangrove forest within the OIWS (Fig.2) 2. All mangrove trees along the transect lines were identified and counted. Then a series of 10x10 meter quadrats, were established in each of the 5 transect lines laid in the three brangays,110 in transect 2, 140 in transect 3,137 in transect 4 and 90 in transect 5. In each of the 10x10m quadrats three (3) smaller (1x1m) quadrats were also established. These smaller quadrats are intended for the regenerants. The transect lines were laid down using a rope and for a precise location of the sites, a GPS was used. The mangroves species were identified referring to the field guides of Melana and Gonzales (1996) and Calumpong and Meñez (1996). The trunk diameter and
breast height of each stand were measured using a fiberglass tape.

For field data collection, a team of 6 workers coordinated with a team leader who identified the mangrove species and at the same time facilitated the conduct of the entire work, a recorder who documented all the data collected, counted the number, estimated the crown diameter of mature trees per species and counted the wildlings per species.

The equations based on English et al. (1997) that were used to calculate each of these parameters are given below:

\[
\text{Frequency} = \left( \frac{\text{total no. of plots in which species occurred}}{\text{total no. of plots}} \right) \times 100
\]

\[
\text{Relative frequency} = \left( \frac{\text{frequency of species A}}{\text{total frequency of all species}} \right) \times 100
\]

\[
\text{Relative density} = \left( \frac{\text{no. of individuals of species A}}{\text{total number of individual of all species}} \right) \times 100
\]

**Figure 2.** The five transect lines laid within the mangrove forest inside the Olango Island Wildlife Sanctuary, Cebu, Philippines.

*Note: The transect lengths varied according to the shoreline topography.*

mangrove forest within the OISW, the basal area, relative density, relative dominance, importance value (IV) and the Shannon Index of Diversity (H’) were calculated for each species recorded in each plot/quadrat. Stand counts for each were done.
Relative dominance (RD) = \( \frac{\text{total basal area of species A}}{\text{total basal area of ALL species}} \) \times 100

Importance value (IV) = relative frequency + relative density + relative dominance

Shannon Index = \( \sum \left( \frac{\text{importance value of each species}}{\text{total importance value}} \right) \times \text{Natural Log} \left( \frac{\text{importance value of each species}}{\text{total importance value}} \right) \)

Average Basal Area per ha = \( \frac{\text{total basal area (m}^2\text{)}}{\text{total area sampled}} \)

Regeneration = \( \frac{\text{total regeneration count/speciesA}}{\text{total no. of regeneration plots}} \)

RESULTS AND DISCUSSION

Species Composition and Diversity

Of the 423.94 hectares mangrove forest within the Olango Island Wildlife Sanctuary, about 5.06 were covered and assessed. A total of 17 mangrove species were recorded belonging to nine (9) families in 11 genera (Table 1). Of the 17 species identified, the first six species of high importance value (IV) are; R. stylosa at 73.26% followed by Osbornia octodonta (57.62%) then, A. marina at 46.64%, A. lanata (30.79%) and the last two, S. alba (26.48%) and L. racemosa at 25.68% respectively (Table 2). The number of species identified in this study is lower than the 23 species and associates reported by Magsalay and Gonzales in 1989.

As to the dominant mangrove species, R. stylosa still dominated the mangrove forest inside the OIWS, as what had been reported by RBI in 1998 in which at that time had an importance value of 26.59%, followed by Osbornia octodonta and Avicennia marina. The relative dominance of R. stylosa could be attributed to the easy collection and planting of its propagules. The propagules are simply inserted into the mud or sandy substra to a depth of 1/3 or ¼. With suitable environmental conditions these grow. According to Walters (2000) this species is also the most easily dispersed naturally because of its propagules which are buoyant, and has the tendency to grow and reproduce rapidly. Hence, most of the government agencies, local governments, non-government organizations and even individuals engaged in mangrove tree planting in the sanctuary re-planted R. stylosa, thus the reason why it dominates the mangrove population in OIWS.
Table 1. Species composition and mangrove stand structure of the remaining mangrove forest in Olango Island Wildlife Sanctuary, Barangay San Vicente, Lapu-Lapu City, Cebu, Philippines.

<table>
<thead>
<tr>
<th>Family/Scientific name</th>
<th>Species</th>
<th>Local name</th>
<th>No. of segments of occurrence</th>
<th>Total no. of trees</th>
<th>Total basal area (m²)</th>
<th>F</th>
<th>Rf</th>
<th>Rden</th>
<th>Rdom</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avicenniaceae</td>
<td>Avicennia lanata</td>
<td>Piapi</td>
<td>135</td>
<td>387</td>
<td>1.0798</td>
<td>2.70</td>
<td>10.34</td>
<td>3.75</td>
<td>16.69</td>
<td>30.79</td>
</tr>
<tr>
<td></td>
<td>Avicennia marina</td>
<td>Bungalow</td>
<td>201</td>
<td>1268</td>
<td>1.2255</td>
<td>4.02</td>
<td>15.39</td>
<td>12.30</td>
<td>18.95</td>
<td>46.64</td>
</tr>
<tr>
<td>Rhizophoraceae</td>
<td>Bruguiera cylindrica</td>
<td>Pototan-lalaki</td>
<td>10</td>
<td>31</td>
<td>0.0313</td>
<td>0.20</td>
<td>0.77</td>
<td>0.30</td>
<td>0.48</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>Bruguiera gymnorrhiza</td>
<td>Busain</td>
<td>23</td>
<td>80</td>
<td>0.1419</td>
<td>0.46</td>
<td>1.76</td>
<td>0.78</td>
<td>2.19</td>
<td>4.73</td>
</tr>
<tr>
<td></td>
<td>Ceriops decandra</td>
<td>Malatangal</td>
<td>9</td>
<td>55</td>
<td>0.0078</td>
<td>0.18</td>
<td>0.69</td>
<td>0.53</td>
<td>0.12</td>
<td>1.34</td>
</tr>
<tr>
<td></td>
<td>Ceriops tagal</td>
<td>Tangal</td>
<td>43</td>
<td>208</td>
<td>0.2842</td>
<td>0.86</td>
<td>3.29</td>
<td>2.02</td>
<td>4.39</td>
<td>9.70</td>
</tr>
<tr>
<td>Euphorbiaceae</td>
<td>Excoecaria ogallocha</td>
<td>Buta-buta</td>
<td>1</td>
<td>9</td>
<td>0.0251</td>
<td>0.02</td>
<td>0.08</td>
<td>0.09</td>
<td>0.39</td>
<td>0.55</td>
</tr>
<tr>
<td>Combraceae</td>
<td>Lamnitzera littorea</td>
<td>Tabau</td>
<td>29</td>
<td>163</td>
<td>0.1574</td>
<td>0.58</td>
<td>2.22</td>
<td>1.58</td>
<td>2.43</td>
<td>6.24</td>
</tr>
<tr>
<td></td>
<td>Lamnitzera racemosa</td>
<td>Kulasi</td>
<td>161</td>
<td>106</td>
<td>0.1977</td>
<td>3.22</td>
<td>12.33</td>
<td>10.29</td>
<td>3.06</td>
<td>25.68</td>
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<tr>
<td>Myrtaceae</td>
<td>Osbornia octodonta</td>
<td>Taulis</td>
<td>230</td>
<td>3739</td>
<td>0.2419</td>
<td>4.60</td>
<td>17.61</td>
<td>36.27</td>
<td>3.74</td>
<td>57.62</td>
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<tr>
<td>Lythraceae</td>
<td>Pemphis acidula</td>
<td>Bantigue</td>
<td>21</td>
<td>195</td>
<td>0.2692</td>
<td>0.42</td>
<td>1.61</td>
<td>1.89</td>
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<td>7.66</td>
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<tr>
<td>Rhizophoraceae</td>
<td>Rhizophora apiculata</td>
<td>Bakaun-lalaki</td>
<td>57</td>
<td>106</td>
<td>0.0960</td>
<td>1.14</td>
<td>4.36</td>
<td>1.03</td>
<td>1.48</td>
<td>6.88</td>
</tr>
<tr>
<td></td>
<td>Rhizophora mucronata</td>
<td>Bakaun-babae</td>
<td>2</td>
<td>2</td>
<td>0.0024</td>
<td>0.04</td>
<td>0.15</td>
<td>0.02</td>
<td>0.04</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>Rhizophora stylosa</td>
<td>Bankau-bankau</td>
<td>321</td>
<td>2827</td>
<td>1.3811</td>
<td>6.42</td>
<td>24.58</td>
<td>27.42</td>
<td>21.35</td>
<td>73.36</td>
</tr>
<tr>
<td>Rubiaceae</td>
<td>Scyphiophora</td>
<td>Nilad</td>
<td>2</td>
<td>27</td>
<td>0.0029</td>
<td>0.04</td>
<td>0.15</td>
<td>0.26</td>
<td>0.04</td>
<td>0.46</td>
</tr>
<tr>
<td></td>
<td>hydrophyllacea</td>
<td>Pagat-pat</td>
<td>60</td>
<td>150</td>
<td>1.3213</td>
<td>1.20</td>
<td>4.59</td>
<td>1.46</td>
<td>20.43</td>
<td>26.48</td>
</tr>
<tr>
<td>Sonneratiaceae</td>
<td>Sonneratia alba</td>
<td>Piagau</td>
<td>1</td>
<td>1</td>
<td>0.0023</td>
<td>0.02</td>
<td>0.08</td>
<td>0.01</td>
<td>0.04</td>
<td>0.12</td>
</tr>
<tr>
<td>Meliaceae</td>
<td>Xylocarpus moluccensis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TOTAL: 10309 6.4678 26.12 100.00 100.00 100.00 300.00

Note: Total no. of segments sampled: 506
Total area sampled: 5.06 ha
Shannon Index of Species Diversity (H'): 0.9239
Evenness Index (e): 0.7509

Stand Structure and Characteristics

Species Density

A total of 2,038 stands/ha were counted with O. octodonta having the highest number at 739 stands/ha or 36.26%, followed by R. stylosa (559 stands/ha) or 27.42% and A. marina at 12.31% (251 stands/ha). In terms of density per hectare, these three species composed (75.99%) of the trees in the stand.

Zonation Pattern and Frequency of Occurrence

The mangrove fringes in the Philippines generally are naturally-lined with a band of frontline species such as A. marina and or S. alba with R. stylosa and R. apiculata behind (Primavera et al., 2012). Per observations, the mangroves in the OIWS showed no distinct zonation pattern in which Rhizophora species (R. apiculata, R. mucronata, R. stylosa) and particularly R. stylosa dominated the mangrove community which could be a result of the previous reforestation projects done in the area using only one species. Also Rhizophora species can easily grow in any substratum types (RIB, 1998) and have the potential to be invasive (Duke, 2016).
In terms of frequency of occurrence, the ranking is as follows: First is *R. stylosa* followed by *O. octodonta* with 17.61% next *A. marina* (15.39%), *L. racemosa* recorded 12.33% while *A. lanata* ranked last with (10.34%). However, it was observed that there were some species that were least represented in the sampling sites. Of the total 10,309 individual mangrove stands counted, there were only 2 individual trees of *R. mucronata*, 9 trees of *E. agallocha*, and 1 stand of *X. moluccensis*. It followed that these species were of lesser importance in terms of: frequency, density, and dominance and importance value. *E. agallocha* and *X. moluccensis* were species requiring low salinity and their displacement could be due to overharvesting of the plant for firewood and for other wood needs in the place. Overharvesting and gleaning of the propagules for commercial purposes could be another reason.

**Basal Area, Tree Height and Crown Cover**

The mangrove forest of OIWS was composed of relatively small-sized trees with an average basal area per tree of 4.88cm² and average total basal area (TBA) of 1.278m²/ha for the average total number of trees counted at 2,038 trees/ha. Among species, *R. stylosa* had the highest basal area at 0.272m²/ha, indicative of heavy harvesting by the local people as fuelwood and construction materials. Although *O. octodonta* had higher density of trees (739 trees/ha), its basal area per tree was only 0.6cm² which showed that its individual trees in the study area have relatively small trunks. According to the local islanders they do not consider *O. octodonta* as mangrove species to be protected, so they overharvest it for construction needs and domestic cooking in which upon harvest they simply removed the bark and right away used it for cooking, unlike other species like *R. stylosa* which requires drying under the sun before it could be used as fuelwood. As for *S. alba* compared to *O. octodonta*, its basal area/tree of 87cm² was bigger which could be attributed to the stands in which majority are remnants of the old mangrove forest.

On the other hand, majority of the stands within the mangrove areas studied have inferior growth due to the overharvesting by the locals who until now relied heavily on the mangrove trees for their fuelwood, housing materials and other related needs.

**Crown Cover**

The percent crown cover of the mangroves in the OIWS was relatively low at 23.058% in which 7.91% was of *L. littorea*. Such low percent crown cover could mean desertification will be forthcoming. Likewise, the regeneration capacity of the mangroves obtained in the area studied was inadequate with only one wildling/m². Majority of the regenerants were that of *R. stylosa* 5,810/ha followed by *A. marina* 3,008/ha and *A. lanata* 2,411/ha. It is interesting to note that the species *P. acidula*, *E. agallocha*, *B. cylindrica*, *S. hydrophylacea*, *X. moluccensis*, and *R. apiculata* have no regenerants. The above findings suggest a course of action to replant mangroves within the OIWS otherwise a considerable decrease of the mangrove cover and species decline are foreseen.

**Table 2. Characteristics of individual species and the stand of the mangrove forest of Lozano and Bueno: Species Composition, Diversity and Stand Structure of Mangroves**
Olango Island Wildlife Sanctuary, Lapu-Lapu City, Cebu, Philippines.

<table>
<thead>
<tr>
<th>Family Avicenniaceae</th>
<th>Crown cover (ha)</th>
<th>Density/species (trees/ha)</th>
<th>Basal area (m²/ha)</th>
<th>Regeneration (per m²)</th>
<th>Constancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avicennia lanata</td>
<td>0.1970</td>
<td>3.894</td>
<td>76</td>
<td>0.2134</td>
<td>26.68</td>
</tr>
<tr>
<td>Avicennia marina</td>
<td>0.1725</td>
<td>3.409</td>
<td>251</td>
<td>0.0005</td>
<td>0.20</td>
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<tr>
<td>Family Rhizophoraceae</td>
<td>0.0019</td>
<td>0.038</td>
<td>6</td>
<td>0.0062</td>
<td>1.98</td>
</tr>
<tr>
<td>Bruguiera cylindrica</td>
<td>0.0012</td>
<td>0.025</td>
<td>16</td>
<td>0.0280</td>
<td>4.55</td>
</tr>
<tr>
<td>Bruguiera gymnorrhiza</td>
<td>0.0153</td>
<td>0.302</td>
<td>11</td>
<td>0.0015</td>
<td>1.78</td>
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<tr>
<td>Ceriops decandra</td>
<td>0.0025</td>
<td>0.049</td>
<td>41</td>
<td>0.0562</td>
<td>8.50</td>
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<td>0.4003</td>
<td>7.911</td>
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<td>0.0050</td>
<td>0.20</td>
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<tr>
<td>Family Euphorbiaceae</td>
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<td>1.027</td>
<td>32</td>
<td>0.0311</td>
<td>5.73</td>
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<tr>
<td>Excoecaria agallocha</td>
<td>0.0756</td>
<td>1.494</td>
<td>210</td>
<td>0.0391</td>
<td>31.82</td>
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<tr>
<td>Family Combraeae</td>
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<td>0.214</td>
<td>739</td>
<td>0.0478</td>
<td>45.45</td>
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<tr>
<td>Lumnitzera l obtura</td>
<td>0.0164</td>
<td>0.324</td>
<td>39</td>
<td>0.0532</td>
<td>4.15</td>
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<tr>
<td>Lumnitzera racemosa</td>
<td>0.1478</td>
<td>2.920</td>
<td>21</td>
<td>0.0190</td>
<td>11.26</td>
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<tr>
<td>Family Myrtaceae</td>
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<td>0.012</td>
<td>0</td>
<td>0.0005</td>
<td>0.40</td>
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<tr>
<td>Osbornea octodonta</td>
<td>0.0568</td>
<td>1.123</td>
<td>559</td>
<td>0.2729</td>
<td>63.44</td>
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<td>0.012</td>
<td>5</td>
<td>0.0006</td>
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<td>Pemphis acidula</td>
<td>1.123</td>
<td>30</td>
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<td>0.00593</td>
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<tr>
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<td>0</td>
<td>0.2422</td>
<td></td>
<td>39.72</td>
</tr>
</tbody>
</table>

| Note: Total mangrove area inventoried | 50.6 ha |
| Total area sampled               | 5.06 ha  |
| Ave. length of strip             | 1,012 m (range: 400m-1340m) |

<table>
<thead>
<tr>
<th>1-20% - rare species</th>
<th>21-40% - low constancy</th>
<th>41-60% - intermediate constancy</th>
<th>61-80% - moderately high constancy</th>
<th>81-100% - high constancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constancy</td>
<td></td>
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</tbody>
</table>

**Family Avicenniaceae**

- *Avicennia lanata*
- *Avicennia marina*

**Family Rhizophoraceae**

- *Bruguiera cylindrica*
- *Bruguiera gymnorrhiza*
- *Ceriops decandra*
- *Ceriops tagal*

**Family Euphorbiaceae**

- *Excoecaria agallocha*

**Family Combraeae**

- *Lumnitzera obturata*
- *Lumnitzera racemosa*

**Family Myrtaceae**

- *Osbornea octodonta*

**Family Lythraceae**

- *Pemphis acidula*

**Family Rhizophoraceae**

- *Rhizophora apiculata*
- *Rhizophora mucronata*
- *Rhizophora stylosa*

**Family Rubiaceae**

- *Scrophularia hydrophyllacea*

**Family Sonneratiaceae**

- *Sonneratia alba*

**Family Melliaceae**

- *Xylocarpus moluccensis*

<table>
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<tr>
<th>TOTAL</th>
<th>2.038</th>
<th>1.2783</th>
<th>1.38884</th>
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</table>

**CONSTANCY**

Moderately high constancy was registered by *R. stylosa* 63.44 and intermediate constancy by *O. octodonta*. The mangrove species considered rare in the area were, *O. octodonta*, *P. acidula*, *B. cylindrica*, *C. decandra*, *B. gymnorrhiza*, *L. littorea*, *A. marina*, *R. mucronata*, and *C. tagal*. Melana et al. (1996) reported that the above mentioned species were also rare in occurrence in the provinces of Bohol, Cebu, Negros and Siquijor. The rareness of these species was due to the destruction of the middle and the back mangrove zones where people usually inhabited. *Ceriops decandra* according to IUCN is a near threatened species so there is a need for continued monitoring and research is recommended as part of its conservation action. (Duke, et al., 2010)

**CONCLUSION**

The results of the study, showed that the mangrove community in Olango Island Wildlife Sanctuary (OIWS) is dominated by a single species, *Rhizophora stylosa*, indicative of an area going into monospecific stands which could eventually affect its species diversity. Of the 17 mangrove species recorded, nine (9) are considered rare in terms of constancy. As to the crown cover, it was only 23.06% which means there is a gap of about 76.04% hence, the need to replant. Despite the protected status of the area studied, there were only
few regenerants, with an average of 2 stands/m², a sign that the mangrove vegetation in OIWS is highly disturbed largely by human activities as observed such as gleaning, trampling and harvesting of mangrove seeds and propagules for commercial purposes.

RECOMMENDATIONS

1. The present mangrove vegetation canopy of the area studied was only 23.06% which is too low and is dominated by only *R. stylosa*. To increase the present canopy cover and improve the species diversity, re-planting more mangrove trees of varied species is imperative.

2. As the mandated government agency, DENR-7 should be pro-active in the management of mangrove replanting program in the OIWS by implementing the re-planting of other species aside from *Rhizopora stylosa* and ensure that the propagules and samplings are planted in their proper zones/locations/sites. For example the species of *Rhizophora* do not grow well in sea fronts zones hence, should not be relied upon for mangrove rehabilitation in greenbelts.

3. In order to improve the regenerative potential of the mangrove community studied, DENR-7 should spearhead the harvesting of propagules and wildlings.

4. Intensify and sustain the protection of mangrove from all illegal activities and destruction by fully implementing the existing laws and regulations while providing fuelwood alternatives to the locals by planting ipil- ipil or biatilis (*Leucena leucocephala*) and madre de cacao (*Gliricida sepium*) on unused lots in the island.

The results of this study is aimed to compliment the already existing knowledge on which a successful mangrove reforestation program is anchored. It is hoped that the results will provide possible extension work for a collaborative and integrative reforestation program among academic institutions, the community and the Department of Environment and Natural Resources (DENR).

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