Composition of Mangroves and Mangrove Associates in Barangay Ata-Atahon, Nasipit, Agusan del Norte, Philippines

Crescencio C. Cabuga Jr.1*, Aldrin B. Lopez2, Neprissa E. Cuarteron3, Nñeka Jean A. Pangapalan4

1Senior High School Department, Del Pilar National High School, Cabadbaran City, Agusan del Norte, Philippines
2Senior High School Department, University of San Jose Ricoletos, Cebu City, Philippines
3Languages and Social Science Department, North Eastern Mindanao State University (NEMSU), Cantilan Campus, Surigao del Sur, Philippines
4Senior High School, Department of Education, San Jose National High School, Surigao Del Sur, Philippines

*Corresponding Author
Received: 11 March 2022 / Revised: 17 October 2022 / Accepted: 26 October 2022 / Published: 19 November 2022

ABSTRACT

Mangroves are essential components of the coastal biome and have an extremely productive ecosystem. It provides benefits for both the environment and humans. Valuation of the diversity and species composition plays a crucial role in the conservation and protection. This study aimed to assess the composition of mangroves and mangrove associates in Barangay Ata-Atahon, Nasipit, Agusan del Norte, Philippines. Three sampling stations were established with a 50-meter interval in every station. Transect lines of 50 meters were laid perpendicular to the shoreline. The results show that 19 species of mangroves and 5 mangrove associates were recorded. Ceriops decandra was found to be the dominant species with 303 individuals and constituting 36% of the entire mangroves population. While Camptostemon philippinensis, Rhizophora apiculata, Rhizophora mucronata had the lowest number of individuals and made up a combination of 5%. In mangrove associates, Avicennia rumphiana made up 47% of the population and was followed by Avicennia marina (40%). This implied that the study area is less diverse based on the observed species when compared to the 46-mangrove species found in the Philippines alone. Necessarily, reforestation and conservation efforts must be attained to fill the gaps between the community and mangrove sustainability. Thus, determining the species diversity and composition measures ecological status. Mitigations and ecological management must be enacted by the locality to further conserve the mangrove ecosystem.

Keywords: Biodiversity, Mangroves, Caraga Region.

1 Introduction

Mangroves are known as the most productive ecosystems. It is geographically situated in the intertidal zones among tropics and sub-tropics region [1]. Characteristically as woody shrubs or trees found in coastal saline or brackish water. They are called halophytes, or salt-tolerant trees, and are used to harsh coastal conditions. These species are found explicitly on tropical and subtropical coasts of 30 to 50 mangrove species in the Philippines [2]. Globally, mangrove biodiversity is highest in the Indo-Malay Philippine Archipelago, with between 36 and 46 of the 70 known mangrove species occurring in this region [3]. Mangrove forests are highly productive ecosystems with a rate of primary equal to those of tropical humid evergreen forest. It also plays a crucial role in both human and animal sustainability [4]. The mangrove trees are ecologically significant as it offers a home for different species such as phytoplankton, zooplankton, and fish. These invertebrates feed on decomposed leaves, rubble, plankton, and small animals [5]. The trees also produce large amounts of leaf litter and are decomposed by fungi and bacteria. Also serve as a food source for
marine life. Mangroves' habitats are also associated with water purification as it is related to the accumulation of algae, bacteria, and filter-feeding animals. Also, it works as an essential role in removing excess nutrients from the water [6]. Large amounts of carbon are tied up both in mangrove tree forests and in their fertile soils. Hence, mangroves are often critical for the long-term storage of carbon in their biomass and soil [7]. Further, it plays a significant role in protecting shorelines from damaging storms and typhoon winds, waves, and floods. In the natural environment, mangroves are capable of lowering storm surge height and of dampening the waves. The use of mangroves in coastal areas ensures to play a critical role in reducing wind or swell waves, thus reducing erosion [8]. As the mangrove’s ecosystem function, a crucial role in our ecosystem, their diversity in a specific region is essential. Thus, the diversity of the mangroves produces significantly both in humans and the environment. Each species performs an indispensable function regardless as they are a small or large system [9]. Species composition is similarly essential, especially when seeking how an ecosystem works and how different vital organisms are to an environment [10]. A pressing matter continues to arise, the Indo-Malay Philippine Archipelago has one of the highest rates of mangrove area loss globally, with an estimated 30% reduction in mangrove area since 1980. Mangroves in this region were threatened by clearing for the creation of shrimp and fishponds. Approximately half of the 279,000 hectares of mangroves in the Philippines lost from 1951 to 1988 were developed into fish/shrimp culture ponds. The species of C. philippinensis (listed as endangered) has an estimated 1,200 or fewer individuals remaining due to the extensive removal of mangrove areas for both aquaculture and fuelwood within its range [3]. The massive decline of the mangrove areas continues to occur. The International Union for Conservation of Nature (IUCN) Red List of Threatened Species has listed several species of mangroves as vulnerable and endangered. Thus, the study aims to assess the species composition of mangroves in Barangay Ata-Atahon, Nasipit, Agusan del Norte, Philippines. And further, it is vital to conserve and protect the remaining trees in the area. Lastly, this evaluation also targets spreading awareness of the current situation of the mangrove forests in the area and advocating replanting and rehabilitation of the floral community.

2 Research Methodology

2.1 Description of the Area

The study was conducted in April 2021 in Barangay Ata-Atahon, in the town of Nasipit, in the province of Agusan del Norte, Caraga Region in Mindanao, Philippines (Fig. 1). It is located (8°59′N 125°20′E). Accordingly, 1,232 hectares of Mangrove forests are found in the province of Agusan del Norte [11].

Figure 1: Map of the study area, Barangay Ata-Atahon, Nasipit, Agusan Del Norte, Philippines.
2.2 Species Identification
The mangroves and mangrove associates were identified as on-site and classified taxonomically. A digital camera was used to document the plant samples. The field guide manual obtained from the Philippine Mangroves was used to determine the mangrove species [12].

2.3 Establishment of Line Transects and Plot Sampling
Three sampling sites (S1, S2, and S3) were established in the area with a 50-meter interval in every station. The corresponding transects lines ranging 50 meters were laid perpendicular to the shoreline. Inside, the area was divided into two sides, the mangroves inside each division were then identified and counted.

2.4 Status Determination of Mangrove and Mangrove Associates
The IUCN Red List of Threatened Species by IUCN, 2019 [13] was used to determine the status of the species of mangroves and its associates. It is the comprehensive and globally used for the inventory of the conservation status among of the plant and animal species. The IUCN Red List is recognized as the most authoritative guide to the rank of biological diversity. The IUCN Red List Categories (Table 1) define the extinction risk of species assessed. Nine categories extend from NE (Not Evaluated) to EX (Extinct).

Table 1: Categories of the IUCN Red List of Threatened Species of the status of plant and animal species (2019).

<table>
<thead>
<tr>
<th>Categories</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Evaluated (NE)</td>
<td>Has not yet been evaluated against the criteria</td>
</tr>
<tr>
<td>Data Deficient (DD)</td>
<td>There is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status</td>
</tr>
<tr>
<td>Least Concern (LC)</td>
<td>Evaluated against the criteria and does not qualify for Critically Endangered, endangered, Vulnerable or Near Threatened</td>
</tr>
<tr>
<td>Near Threatened (NT)</td>
<td>Evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.</td>
</tr>
<tr>
<td>Vulnerable (VU)</td>
<td>30% extinction risk based on exceeding a threshold of population decline</td>
</tr>
<tr>
<td>Endangered (EN)</td>
<td>50% extinction risk based on exceeding a threshold of population decline</td>
</tr>
<tr>
<td>Critically Endangered (CR)</td>
<td>80% extinction risk based on exceeding a threshold of population decline</td>
</tr>
<tr>
<td>Extinct in the Wild (EW)</td>
<td>Known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range</td>
</tr>
<tr>
<td>Extinct (EX)</td>
<td>no reasonable doubt that the last individual has died</td>
</tr>
</tbody>
</table>

3 Results and Discussion
A total of 1,175 individuals composed of 19 species of mangroves and 5 species of mangrove associates were documented (Table 2). Specifically, 848 individuals of mangroves were observed, and these are classified into 13 families namely: Acanthaceae, Pteridaceae, Myrsinaceae, Avicenniaceae, Rhizophoraceae, Bombacaceae, Euphorbiaceae, Combretaceae, Myrtaceae, Rubiaceae, Sterculiaceae, Arecaceae, and Sonneratiaceae. Indeed, C. decandra, from the family Rhizophoraceae, was noted to have the highest number recorded, thus examined having 303 individuals and accounting for 36% of the overall mangroves’ population. The plant species is currently classified as Near Threatened on the IUCN Red List of Threatened Species (2019), suggesting that this species is decreasing in number despite it having the highest number of individuals in this area. Subsequently, mangroves associates were also recorded and A. rumphiana has the highest individuals (152) followed by A. marina (132), N. fruticans (33), A. alba (9) and S. alba (1) and accounting to 327 individuals.
Table 2: Mangroves and mangrove associates recorded in Barangay Ata-Atahon, Nasipit, Agusan del Norte.

<table>
<thead>
<tr>
<th>Mangrove Species</th>
<th>Family</th>
<th>Local Name</th>
<th>No. of Individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acanthus ilicifolius</td>
<td>Acanthaceae</td>
<td>Lagiwliw, Ragoyroy</td>
<td>156</td>
</tr>
<tr>
<td>Aegiceras corniculatum</td>
<td>Myrsinaceae</td>
<td>Saging-Saging</td>
<td>3</td>
</tr>
<tr>
<td>Aegiceras floridum</td>
<td>Myrsinaceae</td>
<td>Tinduk-tindukan</td>
<td>67</td>
</tr>
<tr>
<td>Acrostichum aureum</td>
<td>Pteridaceae</td>
<td>*Unavailable</td>
<td>5</td>
</tr>
<tr>
<td>Acrostichum speciosum</td>
<td>*Unavailable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camptostemon philippinensis</td>
<td>Bombacaceae</td>
<td>Gapas-Gapas</td>
<td>1</td>
</tr>
<tr>
<td>Avicennia officinalis</td>
<td>Avicenniaceae</td>
<td>Miapi, Api-Apia, Bungalow</td>
<td>51</td>
</tr>
<tr>
<td>Bruguiera sexangula</td>
<td>Avicenniaceae</td>
<td>Pototan</td>
<td>3</td>
</tr>
<tr>
<td>Ceriops decandra</td>
<td>Rhizophoraceae</td>
<td>Baras-Baras</td>
<td>303</td>
</tr>
<tr>
<td>Kandelia candel</td>
<td>*Unavailable</td>
<td></td>
<td>109</td>
</tr>
<tr>
<td>Ceriops tagal</td>
<td>*Unavailable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhizophora apiculata</td>
<td>Bakhaw lalaki</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Rhizophora macrostyla</td>
<td>Bakhaw babae</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Excoecaria agallocha</td>
<td>Euphorbiaceae</td>
<td>Lipata, Buta-Buta</td>
<td>2</td>
</tr>
<tr>
<td>Heritiera littoralis</td>
<td>Sterculiaceae</td>
<td>Dungan</td>
<td>8</td>
</tr>
<tr>
<td>Lumnitzera littorea</td>
<td>Combretaceae</td>
<td>Tabao, Culasi</td>
<td>4</td>
</tr>
<tr>
<td>Lumnitzera racemosa</td>
<td>*Unavailable</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Osbornia octodonta</td>
<td>Myrtaceae</td>
<td>Tawalis, Bunot-Bunot</td>
<td>3</td>
</tr>
<tr>
<td>Scyphiphora hydropyllumae</td>
<td>Rubiaceae</td>
<td>Nilad</td>
<td>8</td>
</tr>
<tr>
<td>Avicennia alba</td>
<td>Avicenniaceae</td>
<td>Ani-Ani</td>
<td>9</td>
</tr>
<tr>
<td>Avicennia marina</td>
<td>*Unavailable</td>
<td></td>
<td>132</td>
</tr>
<tr>
<td>Avicennia rumphiana</td>
<td>*Unavailable</td>
<td></td>
<td>152</td>
</tr>
<tr>
<td>Nypa fruticans</td>
<td>Arecaceae</td>
<td>Nipa, Sasa</td>
<td>33</td>
</tr>
<tr>
<td>Sonneratia alba</td>
<td>Sonneratiaceae</td>
<td>Pagatpat</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>1,175</strong></td>
</tr>
</tbody>
</table>

Note: *Local name unavailable

Nevertheless, A. ilicifolius from the family Acanthaceae followed with 156 individuals, nearly half of the population of the species C. decandra. Besides, C. candel with (109), A. speciosum (94), A. floridum (67), and A. officinalis (51). The abundance of these mangrove species often associated with the soil type in the area (Fig. 2). These types of mangroves usually grow on muddy freshwater in which salinity never exceeds that of normal seawater. The species were recognized to acclimate to oxygen-poor environments and nutrient-rich muddy substrates that endure salinity variations [14, 15]. As evidence, soil sampling techniques have come to the most efficient way to investigate its correlation among species growth and development [16, 17]. Also, geographic settings such as climate, substrate type, and nutrients availability have a significant role in the distribution of mangroves community. Nonetheless, among of soil pH, salinity, and organic matter cause substantial differences of mangrove forests. Indeed, study shows that diversification of soil contents changes the species composition, vegetation, and structure of mangrove forests [18]. Moreover, the Philippines had known to be covered by 400,000–500,000 hectares of mangroves in 1920 but it dropped to 120,000 hectares in 1994 [19, 20, 21]. The declined forests were associated to conversion to agriculture, salt ponds, industry, settlements, and overexploitation by coastal dwellers [12].
On the other hand, *C. philippinensis*, *R. apiculata*, and *R. mucronata* were listed as having only one individual per species. This is very alarming, especially in the case of *C. philippinensis* as it is currently classified as ‘Endangered’ in the IUCN Red List of Threatened Species (2019). Aside from lumber logging of residents, another reason is pointed by Ricklefs [22] to be an invasion of other species in the mangrove habitats causing the decline of mangroves in these areas. The diversity of the mangroves in this area is relatively high compared to other parts of this region due to its geographical location and the soil type, which is favorable to mangroves. Accordingly, the Philippines is considered as one of the top 15 most mangrove-rich countries in the world [23]. Also, it holds at least 50% of the world’s approximately 65 mangrove species [12, 24].

Mangrove diversity is a massive help to the food chain as more diverse mangroves means the variety of home for different organisms [25]. Moreover, it was observed that *A. rumphiana* had the highest number of mangrove associates accounting (47%) of the species recorded (Fig. 3). Accordingly, this type of flora is mainly found in sandy or firm silt substrate of the mid to high water mark. It is considered among the largest of Acanthaceae family and is endemic to Southeast Asia [25]. Additionally, there is often a lack of baseline
information on the status of mangrove forests, which is essential for better conservation planning and mangrove management [26, 27]. This highlights the need for comprehensive assessments and research [28]. In relation, mangroves ecological resources form a vast array from food (59.7%), fuel (51.9%), and fishing materials and construction supplies (44.8%). Recognition that mangroves deliver one or all of these advantages was reported in numerous studies [29, 30, 31, 32, 33]. Among the stated benefits of this ecosystem, locals around the world are known to understand its importance and its impact on their livelihood [34,35].

Also, the environmental ability of the mangroves supports sustainability towards habitat, feeding, and nursery grounds of numerous aquatic animals. It also acts as a buffer for coastal communities against tsunamis and typhoons [36, 37, 38, 39, 40]. Importantly, this flora community offers food and livelihood among communities where residents are located and support as a sink for carbon absorption [41, 42, 43, 44]. Additionally, this environment adapts and responds to coastal alteration between natural and human-induced activities of changing temporal and spatial season [45]. Residents inhabited the mangrove ecosystem depending on mangrove loggers and timber processors. While collecting fish, invertebrates and shellfish is a form of living [46, 47]. They are the most affected groups by the loss of mangroves. On the other hand, skilled workers and public servants who have low consumption of mangrove ecological services are less affected [48]. Lastly, mitigation and policies shall be enacted to prevent the loss and destruction of this important ecosystem while continuous education among the locals on how to protect and conserve the latter.

Figure 4: Mangroves species recorded in Barangay Ata Atahon, Nasipit, Agusan del Norte, Philippines
A. Ceriops decandra  B. Aegiceras floridum  C. Heritiera littoralis  D. Rhizophora apiculate  E. Kandelia candel
F. Lumnitzera liitorea  G. Lumnitzera racemose  H. Osbornia octodonta  I. Scyphiphora hydrophyllacea
J. Acanthus ilicifolius  K. Ceriops tagal  L. Acrostichum speciosum
(Note: Image not available: Aegiceras corniculatum, Acrostichum speciosum, Camptostemon philippinensis, Avicennia officinalis, Bruguiera sexangula, Excoecaria agallocha, Rhizophora mucronate)
Nevertheless, 20 species were listed as Least Concern in the IUCN Red List of Threatened Species (2019) implies that these species are not yet subjected to a massive decline in population over the years. Two species namely *A. floridum* and *C. decandra* were classified as Near Threatened, suggesting that these mangroves are declining in number but not in an alarming rate (Fig.4). At the same time, *C. philippinensis* was classified as Endangered and has a 50% extinction risk based on exceeding a threshold of population decline. At the same time, *A. rumphiana* was classified as vulnerable, signifying that this species has a 30% extinction risk based on exceeding a brink of a population drop (Fig. 5). Thus, the present study showed the ecological status of mangroves and mangrove associates. Therefore, the assessment is essential in the effort of conserving and mitigating the mangrove forests.

4 Conclusions

The composition of mangroves and mangrove associates in Barangay Ata-Atahon, Nasipit, Agusan del Norte, Philippines was determined. The result shows a low diversity recorded with only 19 species of mangroves and 5 species of mangrove associates constituting to 1,107 individuals. *C. decandra*, with the local name “Baras-Baras” was the dominant species with an overall number of 303 individuals while listed as nearly threatened. *C. philippinensis* is currently classified as endangered with only one individual recorded and had the same cause of the decline in population as the latter species. *A. rumphiana* and *A. marina* of mangrove associates found the most dominant. The low diversity and the presence of endangered and nearly threatened species in Barangay Ata-Atahon, Nasipit imply the high-risk extinction of some mangrove species if not conserved and managed. Even with the current efforts of restoring and conserving mangrove forests. Planting of seedlings and spreading awareness, mangroves continue to have a high decrease in their population. Thus, pointing out that the cause of the decline of the number is due to habitat shifting and land alteration, logging & wood harvesting.

5 Declarations

5.1 Acknowledgements

Authors are grateful for the support of CENRO-Department of Environment and Natural Resources, Nasipit, Agusan Del Norte for the previous data provided in the study.

5.2 Competing Interests

The authors have no conflicts of interest to declare.
5.3 Publisher's Note

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How to Cite the Article

Will be updated in final version.

References


