Assessment of mangrove species composition and diversity in selected coastal Barangays in Pangutaran Island, Sulu Province, Philippines

[1]Sandra K. Adam, [1]Patricia A. S. Epan, [1]Frandel L. S. Dagoc, [2]Jhona D. Landong, [3] Mary A. M. Ganzon, [1]Wella Tiu-Tatil

[1] Department of Environmental Science, School of Interdisciplinary Studies, Mindanao State University- Iligan Institute of Technology, Iligan City, Lanao del Norte, Philippines; [2] Sustainable Development Studies, School of Interdisciplinary Studies, Mindanao State University- Iligan Institute of Technology, Iligan City, Lanao del Norte, Philippines; [3] Philippine Science High School Caraga Region Campus in Butuan City, Brgy. Ampayon, Butuan City, Philippines. Corresponding author's email: sandra.adam@g.msuiit.edu.ph.

Abstract. Mangrove forests provide nature-based solutions, serving as crucial coastal defenses against natural disasters and as nurseries for marine organisms. Despite its ecological and economic importance, there is still a lack of baseline information on the species composition and diversity of Pangutaran Island's mangrove forest. It is also often marginalized, largely due to limited community understanding. The absence of localized baseline data makes it difficult to assess its biodiversity status, detect environmental degradation, or implement evidence-based policies for sustainable coastal resource management. Therefore, this study aims to determine the species composition and diversity within three selected barangays, providing the empirical foundation needed for informed conservation and policy strategies. Three 100-m transect lines were established perpendicular to the shoreline with five 10x10m quadrats. The study recorded 6 species across three families. Species diversity at the three sampling sites was low (H′ = 0.65-1.47), dominated by Rhizophoraceae. The evenness values across the three sites range from 0.3837 to 0.8671, indicating a species distribution considered semi-balanced to almost balanced. The low diversity across sites, with a dominance of small, sapling-aged trees, is likely driven by the rampant anthropogenic activity associated with resource extraction. These findings highlight the pressing need for sustainable conservation efforts. As a result, this study provides essential baseline data necessary to design effective coastal management plans aimed at protecting the ecological health of mangrove forests, specifically within the Sulu region.

Keywords: coastal greenbelt, floral survey, mangrove ecosystem, nature-based solution, Rhizophoraceae.

Introduction. Mangrove forests are highly productive and diverse ecosystems found along tropical and subtropical coastlines. These forests provide ecosystem services, including shoreline protection, carbon sequestration, and nursery habitats for marine life, while supporting the livelihoods of coastal communities (Primavera, 2004; Alongi, 2012; Lee et al., 2014). Their role is vital for climate mitigation, disaster risk reduction, and the global preservation of biodiversity (World's Mangrove Report, 2024). However, although mangrove forests are ecologically valuable and economically important, they are threatened globally, nearly half of the world's mangroves are threatened with degradation and a severe risk of collapse driven by human-induced land-use changes, coastal development, pollution, and climate change (Feller et al., 2017; Goldberg et al., 2020; International Union for Conservation of Nature, 2024; Semine et al., 2026).

In the Philippines, these forests represent some of the most diverse coastal environments, yet they are under increasing threat from urbanization and unsustainable resource extraction (Pototan et al., 2021, as cited in Baylon et al., 2025). Despite their national importance, localized ecological data remain insufficient for many regions. These data gaps hinder effective conservation planning and leave vulnerable coastal ecosystems increasingly susceptible to environmental decline.

Pangutaran Island (Sulu Province) is one such island municipality where extensive coastal habitat exists, and where local communities exist along the coastline, highly dependent upon marine and mangrove forest resources for food and livelihoods. Although it is strategically located within the Sulu Archipelago and is ecologically important, the area has been largely excluded from formal scientific assessments and regional development planning. Consequently, no comprehensive biodiversity data currently exists for this region. These assessments produce data that support scientifically based methods of managing coastal resources and assist in developing and implementing local policies related to conserving mangroves and enhance existing efforts to sustain mangrove ecosystems in Pangutaran and other similar island communities. This study aims to determine the mangrove species composition and diversity on Pangutaran Island as well as evaluating its conservation status and existing community management practices.

Material and Method

Description of the study sites. Pangutaran Island is located in the Sulu Sea, Philippines (Figure 1) and has an estimated land area of 611.66 square kilometers (236.16 square miles), constituting 13.45% of Sulu's total area (PhilAtlas, 2020). The study was conducted in the three mangrove areas of the municipality, namely: Barangay Simbahan (6.3017° N, 120.5849° E), with a mangrove area of 53 ha., Barangay Lantong Babag (6.3066° N, 120.5449° E) has approximately 75 ha, and Barangay Kihi Niog (6.3503° N, 120.5674° E) has a mangrove area of 148 ha (Figure 2). The Pangutaran mangrove extent was recorded at 3,520.179 hectares in the Participatory Resource and Socio-Economic Assessment (PRSA, 2021) of the Sulu Sea. The area lacked formal protection, and residents who had established settlements within the mangrove forest held a sense of informal ownership. Through interviews with agency officials and local key informants, it was revealed that as of this writing, there is no national protection listed for Pangutaran Island's mangroves. Therefore, these areas may not formally fall under the National Integrated Protected Area System (NIPAS) of the Philippines.

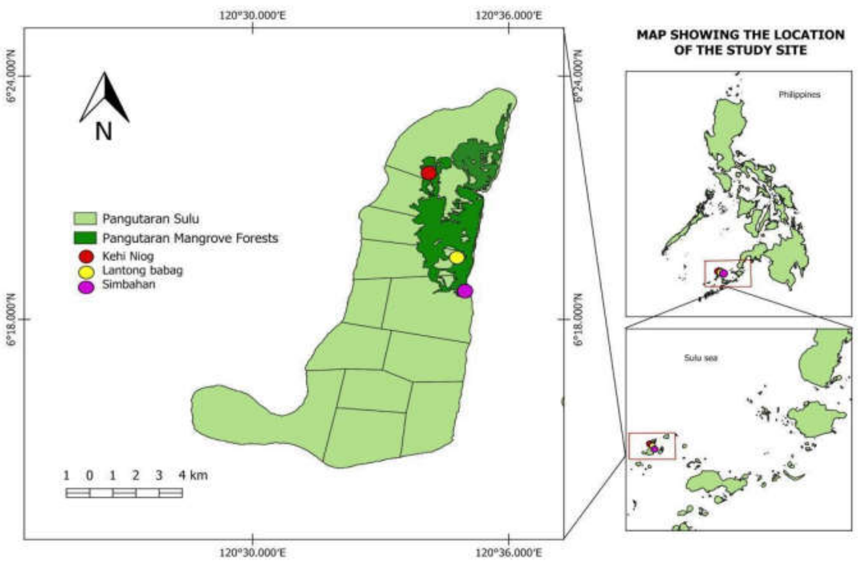


Figure 1. Location of the sampling sites of Pangutaran Island, Sulu, Province, Philippines (Generated with QGIS Software Version 3.40.4).

Figure 2. Photos showing mangrove forests of the selected study sites: (A) Simbahan, (B) Lantong Babag, (C) Kehi Niog.

Entry protocol. Before data collection, the researcher obtained research ethics clearance from the Mindanao State University - Iligan Institute of Technology in Iligan City. A formal request letter was then submitted to the LGU of Pangutaran, Sulu, outlining the purpose, significance, and procedures of the study. Coordination with barangay officials was also established to facilitate the selection of mangrove areas.

Field sampling and collection. Data were collected from July to August 2025 using standard methods outlined in the Manual on the Biodiversity Assessment and Monitoring System for Terrestrial Ecosystems (Department of Environment and Natural Resources, 2016). At each sampling site, three 100m transect lines were established perpendicular to the shoreline, with a 100m interval maintained between each line. Along each transect, five 10m × 10m quadrats were systematically placed at 10 intervals to assess tree components. A handheld GPS was used to record geographic coordinates to map all sampling locations. Species identification was based on the morphological features of leaves, fruits, trunks, roots, and flowers, using the field guides by Primavera et al. (2008).

Species composition and diversity. To determine the structural characteristics of the stands, mangrove Diameter at Breast Height (DBH) was measured at 1.3 meters above ground level, following the protocol established by Philip (1994), as cited in the study by Avery and Bukhart (2002).
Basal area indicates how much space the tree trunks occupy within a given area. To determine this, the diameter or circumference of all recorded trees was measured. The formula used follows the method cited in the study by Komiyama et al. (2005).

$$Basal\ Area = \frac{\Pi\ DBH2}{4} m2$$

Where:
DBH - diameter at breast height
π(Pi) - 3.14

The following formula is a standard measure in forest ecology for determining the relationship between species. These formulas were adapted from the Manual on the Biodiversity Assessment and Monitoring System for Terrestrial Ecosystems (Department of Environment and Natural Resources, 2016). It allows for the calculation of the importance value of species, interpreted as the ecological influence of the species in the forest community.

$$\text{Relative Density} = \frac{Density\ for\ all\ species}{Total\ density\ for\ all\ species} \times 100$$

$$\text{Relative Frequency} = \frac{Species\ frequency\ value}{Total\ frequency\ for\ all\ species} \times 100$$

$$\text{Relative abundance} = \frac{total\ individual\ count\ of\ species}{total\ number\ of\ all\ individual\ count\ of\ all\ species} \times 100$$

$$\text{Relative Dominance} = \frac{Species\ dominance}{Total\ dominance\ for\ all\ species} \times 100$$

Importance Value Index = Relative Density + Relative Frequency + Relative Dominance

The Simpson's Dominance Index(D) is a measure used to determine the degree to which a single species dominates an ecological community (Simpson, 1949).

Simpson Dominance Index (D) formula:

$$D = \sum \frac{n(n-1)}{N(N-1)}$$

Where:
n - number of individuals of a particular species
N - total number of individuals of all species
Σ - summation across all species

The Shannon-Wiener Index (Shannon & Wiener, 1963) was utilized to provide a quantitative assessment of mangrove habitats based on species richness and evenness. This diversity index is a standard metric used in several studies (Gevaña & Pampolina, 2009; Sharma et al., 2010; Lumbres et al., 2012) and was calculated using the formula:

$$H' = \sum_{i=1}^{s} (p_i \ ln\, p_i)$$

Where:
H - Shannon-Wiener diversity index;
s - number of species;
Pi - fraction of the entire population made of species.

Pielou's Evenness Index measures how evenly individuals are distributed across the species present and was calculated using the evenness index described by Pielou (1996) as follows.

$$J' = \frac{H'}{InS}$$

Where:
J' - evenness index;
H - The observed Shannon-Wiener Diversity Index for the community;
In - is the natural logarithm
S -the total number of species in the community

Species diversity and evenness were calculated using PAST software (v.4.03). The classification scheme developed by Fernando et al. (1998) was used to interpret the ecological indices, as shown in Table 1.

Table 1

Descriptive values for interpreting mangrove diversity and evenness indices

Ecological index	*Value*	*Description*
Shannon-Wiener Diversity (*H′*)	≥ 3.50	Very high
	3.00-3.49	High
	2.50-2.99	Moderate
	2.00-2.49	Low
	≤ 1.99	Very low
Simpsons Dominance (*D*)	1.00	Absolute
	0.81-0.99	High
	0.61-0.80	Moderate high
	0.41-0.60	Moderate
	0.01-0.40	Low
Evenness (*J′)*	> 0.8-0.9	Balanced
	> 0.5-0.8	Semi-balanced
	≤ 0.5	Unbalanced

Source: Fernando et al.,1988.

***Data analysis**.* Descriptive statistics, including counts and mean values, were calculated using Microsoft Excel. Paleontological Statistics Software (PAST) Version 4.03 was used for further ecological data analysis. The Shannon-Wiener Diversity Index (H') was computed to assess species diversity, while the Evenness Index (*J′*) was calculated to evaluate the distribution of individuals among species Pielou (1996).

Results and Discussion

Species composition and richness. The study recorded six mangrove species representing three distinct families: Rhizophoraceae, Meliaceae, and Sonneratiaceae (Table 2, Figure 3). Across all study sites, *Rhizophora apiculata* Blum (Figure 4), *Rhizophora mucronata* Lam (Figure 5), and *Rhizophora stylosa* (Figure 6) were the dominant species. Specifically, Barangay Simbahan recorded a high density with 204 individuals, more than half of which were *R. apiculata* (n = 109). In contrast, Lantong Babag showed a lower density of 115 individuals, with dominance divided between *R. mucronata* (n = 35) and *R. apiculata* (n = 33). These species were predominantly found in the middle and seaward zones, a spatial distribution likely driven by their specific physiological niches. As noted by Hong et al. (2018) and corroborated by Herison et al. (2026), members of the genus *Rhizophora* are highly adapted to high-salinity environments, utilizing specialized prop-root systems to withstand high wave energy.

Barangay Kehi Niog exhibited the highest overall abundance with 265 individuals, a population predominantly composed of *Ceriops tagal (Perr.) C.B.Rob.* (Figure 7). This species was concentrated within landward zones, the areas furthest from the shoreline. The prevalence of *C. tagal* in these zones is attributed to its specialized physiological capacity to thrive in highly saline soils (Patel, 2010; Alongi, 2012). Other species recorded were *Sonneratia alba* (Figure 8), which is only present in one site (Simbahan) and *Xylocarpus granatum* J.Koenig (Figure 9), present in Lantong Babag and Kehi Niog. Overall, the mangrove forests of Pangutaran Island exhibit moderate species richness but are heavily dominated by *Rhizophoracea* species, specifically *R. apiculata*, *R. mucronata*, and *R. stylosa*. These taxa play a fundamental role in defining the forest's physical structure, maintaining ecological balance, and delivering vital ecosystem services (Duke et al., 2007). Although other families are less abundant, their presence enhances the island's coastal environment by increasing its biodiversity and ecological complexity (Cuenca-Ocay et al., 2019).

Table 2

Species composition, richness, and abundance in three selected barangays in Pangutaran, Sulu, Province, Philippines

Family	*Species*	*Common name*	*Abundance per site*			*Conservation status*	
			Simbahan	*Lantong Babag*	*Kehi Niog*	*DAO 2026-20*	*IUCN Red List (2024)*
Rhizophoraceae	*Ceriops tagal*	Tangal	2	11	216	OWS	LC
	Rhizophora apiculata	Bakawan lalaki	109	33	4	OWS	LC
	Rhizophora mucronata	Bakawan Babae	70	35	35	OWS	LC
	Rhizophora stylosa	Bakawan Bato	18	30	7	OWS	LC
Sonneratiaceae	*Sonneratia alba*	Pagatpat	5	0	0	OWS	LC
Meliaceae	*Xylocarpus granatum*	Tabigi	0	6	3	OWS	LC
Total			204	115	265		

Note*:* Conservation Status: LC: least concern; OWS- other wildlife species (plant species that are native to the Philippines) DAO No. 2026-20; IUCN categories are based on the IUCN Red List of Threatened Species Version 2026-1 from the official website of International Union for Conservation of Nature (2026).

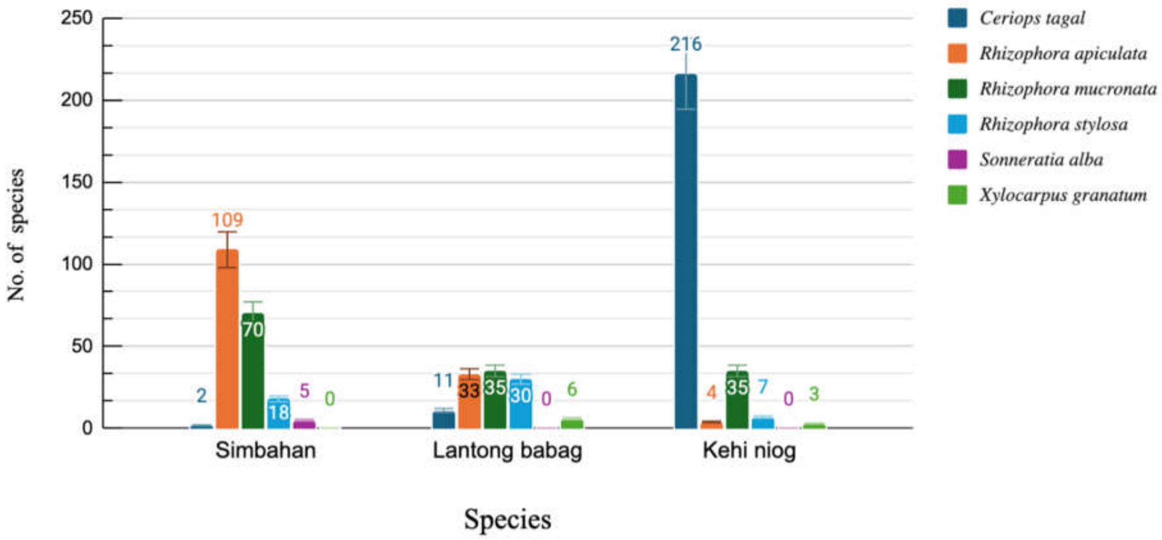
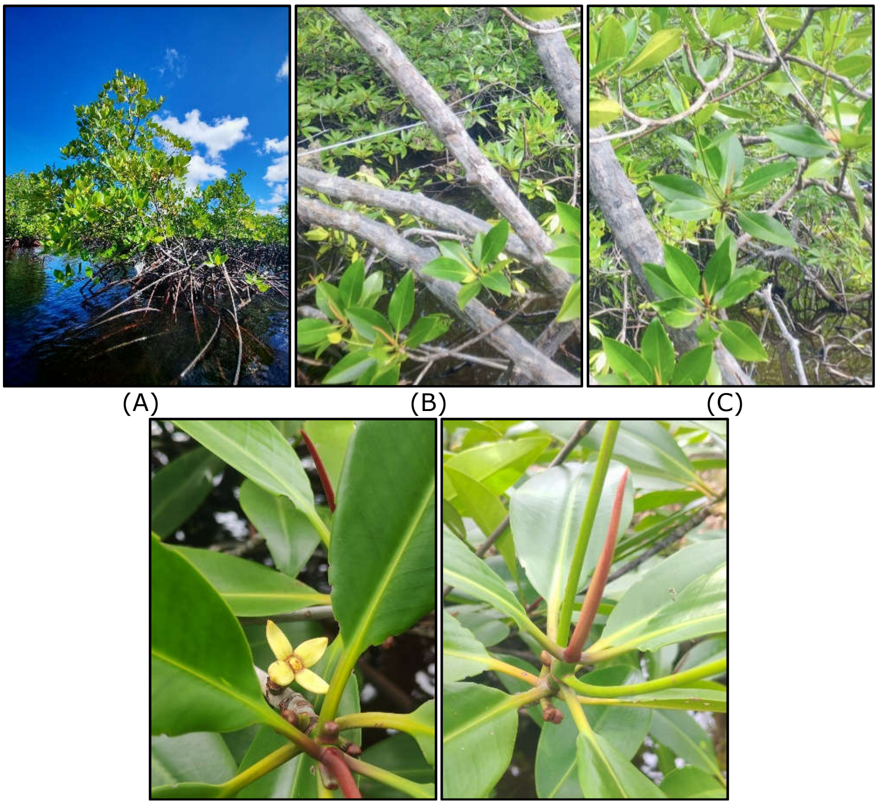


Figure 3. Mangrove species count in three selected sites.

Furthermore, the identified species are categorized as Other Wildlife Species (OWS) under Philippine regulations and classified as "Least Concern" by the International Union for Conservation of Nature (IUCN) Red List. However, this status as a common species does not diminish their ecological importance; these mangroves remain high-priority targets for conservation and sustainable management. On coral islands like Pangutaran, Sulu these species provide protection to coastal communities from erosion and storm surges. While this survey was limited to three target sites, previous assessments by Hanani et al. (2021) indicate that Pangutaran Island, which comprises eight barangays, hosts up to 13 true mangrove species, with the family Rhizophoraceae distributed widely along its coastline.

(A) (B) (C) (D)

Figure 4. *Rhizophora apiculata* (whole tree), (B) flower, (C) leaves, (D) Propagule.



(A) (B) (C)

(D) (E)

Figure 5. *Rhizophora mucronata* (A) whole tree,(B) trunk, (C) leaves, (D) Propagule.

(A) (B) (C) (D)

Figure 6. *Rhizophora stylosa* (A) whole tree, (B) trunk of the tree, (C) leaves, (D) inflorescence bud.


(A) (B) (C) (D)
Figure 7. *Ceriops tagal* (A) whole tree, (B) trunks, (C) flower, (D) stems and leaves.


(A) (B) (C) (D)
Figure 8. *Sonneratia alba* (A)whole tree, (B) trunk, (C) leaves, (D) flower.


(A) (B) (C) (D)
Figure 9. *Xylocarpus granatum* (A) whole tree, (B) trunk, (C) leaves, (D) fruit.

Structural characteristics of the mangrove forest. In Barangay Lantong Babag, the forest structure was dominated by *R. stylosa* exerting the greatest influence with a mean DBH of 58.49 cm and a substantial stand basal area of 180.54 m² ha^{-1} (Table 3). The wide DBH range, reaching up to 158.11cm, indicates the presence of mature, old-growth stands with an uneven size-class distribution. *R. mucronata* followed in dominance, while *C. tagal* and *X. granatum* contributed the least, with basal areas ranging from 3.71 to 7.01 m² ha^{-1}. These structural attributes support rich marine nurseries for crabs, shrimps, and fish, implying that the sites are less disturbed by anthropogenic pressures (Primavera, 2004; Alongi, 2012).

While Kehi Niog showed a unique structural dynamic. Although *C. tagal* was the most abundant species, *R. stylosa* recorded the highest mean DBH at 17.83 cm. The superior growth is attributed to its placement in the middle and low intertidal zones, where frequent tidal inundation and increased availability facilitate higher growth rates (Rout et al., 2015; Pramudji & Dharmawan, 2016). While the broad DBH range of *C. tagal* (5.20 to 52.73 cm) suggests continuous recruitment, consequently exhibiting a simplified forest structure of this site, with one species occupying the majority of available resources (Asadi et al., 2024). Despite its abundance in one site, *C. tagal* provided a lower overall structural contribution compared to *R. apiculata* and *R. stylosa*, which exert the most significant influence with a combined stand basal area of 48.15 and 183.56 m², respectively. However, increasing anthropogenic pressures pose a threat to these sites, as human disturbance can gradually affect stunt growth, leading to reduced DBH and lower overall stand basal area.

Table 3

Structural characteristics of the mangrove forest across study sites

Species	*Mean DBH (cm)*	*DBH range*	*Basal area (m²)*	*TotalStand Basal Area (m² ha⁻¹)*
Simbahan				
Ceriops tagal	0.01	7.96-9.32	0.07	0.05
Rhizophora apiculata	12.38	5.04-24.39	2.19	14.57
Rhizophora mucronata	16.76	5.04-56.10	8.35	55.69
Rhizophora stylosa	9.98	5.26-23.36	0.21	1.42
Sonneratia alba	72.86	20.17-162.46	2.95	19.65
Lantong Babag				
Ceriops tagal	22.51	5.48-78.55	1.05	7.01
Rhizophora apiculata	35.49	5.04-102.21	4.93	32.86
Rhizophora mucronata	11.84	5.10-48.66	0.64	4.23
Rhizophora stylosa	58.49	6.32-48.66	27.08	180.54
Xylocarpus granatum	21.74	8.26-158.11	371.11	3.71
Kehi Niog				
Ceriops tagal	17.56	5.20-52.73	6.53	43.51
Rhizophora apiculata	15.22	6.78-33.04	0.11	0.72
Rhizophora mucronata	9.71	5.04-19.05	0.31	2.07
Rhizophora stylosa	17.83	10.10-43.22	0.24	1.60
Xylocarpus granatum	9.39	6.51-12.87	0.02	0.15

The percent composition of seedlings and saplings are shown in Figure 10, which provides an overview of the regeneration rate across sampling sites. The numbers found between parentheses indicate how many seedlings and saplings were counted for each species at each of the three sampling sites. The percentages are based on the total number of seedlings or saplings counted for that species and represent the relative contribution of that species to the overall regeneration community. *R. apiculata* comprises the largest proportion of total regeneration (37.26%), followed by *R. mucronata* (29.72%) and *C. tagal* (27.83%). In contrast, *R. stylosa*, *S. alba,* and *X. granatum* contribute significantly smaller percentages, at 2.36%, 1.42%, and 1.42%, respectively. This suggests a relatively few dominant species predominantly completing the recruitment process at all three sampling sites. The high proportion of *R. apiculata* and *R. mucronata* could be attributed to their ability to establish successfully in the natural conditions of the forest, particularly within the muddy, tidally influenced areas. This also indicates that current environmental conditions favor the establishment and survival of these two species (Unger et al., 2025). The relatively high proportion of *C. tagal* is primarily attributed to a high sapling count in Kehi Niog.

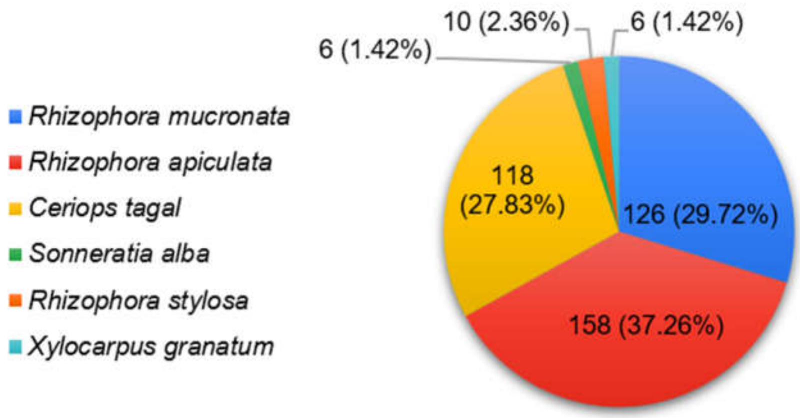


Figure 10. Percentage composition of saplings and seedlings across three sites.

The low recruitment rates for *R. stylosa* and *S. alba* suggest limited regeneration potential for these taxa under present conditions. Despite some recovery, most stands remain early-stage. This pattern suggests a potential shift toward a more homogenized *Rhizophora*-dominated forest structure, which may lead to reduced future species diversity. While the ecosystem shows signs of gradual recovery, the majority of the stands remain in early developmental stages. This condition may be attributed to continuous anthropogenic activities, as local residents are primarily dependent on mangrove resources for their livelihoods. Although mangroves provide immediate economic benefits to the community, there is still limited local awareness regarding their long-term ecological importance in Pangutaran Island. The major local activities that negatively impact mangrove forests, including cutting trees for timber or firewood, bark collection, and removal of mangroves for other land uses (settlements), increase the community's vulnerability to hazards such as storm surges, erosion, and flooding. This continued degradation could reduce the forests' capacity to sequester carbon, thereby indirectly exacerbating climate change impacts. This situation highlights the gap between immediate survival needs and the long-term requirement for coastal protection; without intervention, the ecosystem may not remain viable over the next decade (Baring & Cadiz, 2024).

Structural composition of mangrove forest. The structural composition of the mangrove forests across the three study sites is summarized in Table 4. In Simbahan, the stand is clearly dominated by *R. mucronata*, which recorded the highest Importance Value Index (IVI) of 120.27%. This high IVI is primarily driven by its strong relative dominance (60.95%), indicating that the species occupies a large proportion of the basal area and defines the canopy structure. Such dominance patterns are often indicative of mature, well-established stands in mid-intertidal zones (Martin et al., 2013). *Rhizophora apiculata* also exhibited high ecological significance (IVI = 101.52%), supported by its high relative density (53.43%) and frequency (32.14%). While *S. alba* showed moderate relative dominance (21.50%), its lower frequency resulted in a lower IVI, and *C. tagal* made a minimal structural contribution.

In Lantong Babag, a different dominance pattern emerged. *R. stylosa* exerted the greatest structural control, possessing the highest relative dominance (75.26%) and IVI (119.53%). This indicates that *R. stylosa* largely dictates the canopy structure and basal area of the forest. Although *R. apiculata* showed a high relative frequency (40.91%), suggesting a wide distribution across the site, it was not structurally dominant in terms of biomass. The minor structural roles of *C. tagal* and *X. granatum* showed an uneven stand where *R. stylosa* effectively competes for space and resources, influencing the survival of seedlings.

Kehi Niog displayed a markedly different structural composition, as it is dominated by *C. tagal*. This species recorded a high relative density (81.51%), relative dominance (97.33%), and frequency (53.57%), resulting in a high IVI of 232.40%. This result indicates that *C. tagal* controls both the horizontal and vertical forest structure, likely due to environmental drivers such as elevated salinity or substrate composition (Ulqodry et al., 2025a). This single most influential species in the area led to low level of species evenness and therefore low structural complexity of this site. Consequently, this reduced structural diversity may diminish the stand's resilience to environmental stressors (Caballero et al., 2025).

Table 4

Relative density, dominance, frequency, and importance value of mangrove species across three barangays

Species	*Density*	*Relative density*	*Relative dominance(%)*	*Relative frequency(%)*	*Importance value(%)*
Simbahan					
Ceriops tagal	6.67	0.49	0.05	3.57	4.11
Rhizophora apiculata	726.67	53.43	53.43	32.14	101.52
Rhizophora mucronata	466.67	34.31	60.95	25	120.27
Rhizophora stylosa	120.00	8.82	1.55	14.29	28.23
Sonneratia alba	33.33	2.45	21.50	7.14	31.09
Lantong Babag					
Ceriops tagal	6.67	9.57	2.92	9.09	21.58
Rhizophora apiculata	220	28.70	13.70	40.91	83.30
Rhizophora mucronata	233.33	30.43	1.76	18.18	50.38
Rhizophora stylosa	200	26.09	75.26	18.18	119.53
Xylocarpus granatum	40	5.22	6.35	13.64	25.21
Kehi Niog					
Ceriops tagal	1440.00	81.51	97.33	53.57	232.40
Rhizophora apiculata	26.67	1.51	0.42	17.89	19.82
Rhizophora mucronata	233.33	13.21	1.22	17.86	32.29
Rhizophora stylosa	46.67	2.64	0.94	7.14	10.72
Xylocarpus granatum	20.00	1.13	0.09	3.57	4.79

Overall, the variations across the three sites reflect differing environmental and anthropogenic conditions. Simbahan and Lantong Babag have more balanced *Rhizophora* populations, supporting species coexistence (Fitri et al., 2025). In contrast, the imbalanced structure in Kehi Niog is likely influenced by environmental stress and localized anthropogenic pressures, such as selective cutting for charcoal production. This uneven distribution implies ecological pressure and limited regeneration of non-dominant species (Ulqodry et al., 2025b).

Mangrove forest diversity. As shown in Figure 11, the diversity indices across the three sites reveal a community structure with relatively low complexity. Based on the Shannon diversity index, the three sampling sites exhibit very low community complexity, with Kehi Niog (H' = 0.55) indicating the lowest species. While Lantong Babag showed a relatively balanced species distribution (Evenness = 0.82), its overall diversity remains low as reflected by Simpson's dominance index. Conversely, Simbahan and Kehi Niog recorded lower evenness values, indicating skewed distributions and high dominance by single species, with Simpson's values of 0.27 and 0.49, respectively.

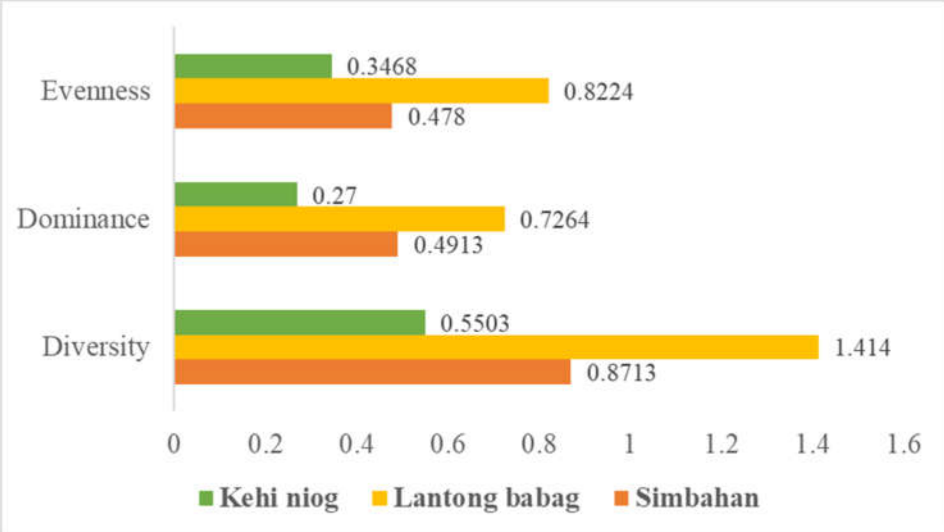


Figure 11. Mangrove diversity indices across the three sites.

This low diversity in Simbahan and Kehi Niog is closely linked to anthropogenic pressures, specifically the harvesting of mangroves for fuelwood, charcoal production (Walters, 2005; de Lacerda et al., 2022, as cited in Akram et al., 2023). Residents in Barangay Simbahan recall a historically lush landscape and abundant fisheries; however, ecological decline was triggered by the conversion of these areas into fishponds and the introduction of tilapia. As the population grew, mangroves were cleared for residential construction, as well as for fuelwood and charcoal production and energy needs. This cumulative deforestation led to habitat loss and a subsequent decline in fish stocks, which have been largely replaced by domestic waste, a trend consistent with Primavera's (1995) identification of aquaculture and wood harvesting as primary drivers of mangrove degradation.

In contrast, Lantong Babag possesses a more balanced species distribution, suggesting a stable ecological community. This stability is likely due to its sheltered location and relative isolation from anthropogenic disturbance, indicating it is the least disturbed site in the study. In this area, *R. apiculata* is the dominant species (n = 33). Meanwhile, *Ceriops tagal* is the most abundant in Kehi Niog (n = 216), where it plays a crucial role in coastal stabilization and provides significant ecological benefits (Hogarth, 2015). The prevalence of *C. tagal* in Kehi Niog is likely due to the favorable combination of rocky and muddy substrates at the site.

Comparison of mangrove forests in the region. The taxonomic diversity documented on Pangutaran Island shows a relatively low species richness compared to regional data (Table 5). Previous assessments of Sulu province identified a total of 28 mangrove species across its various municipalities. In a study by Hanani et al. (2021), 11 mangrove species were identified in Pangutaran Island across five target areas, a figure that remains lower than neighboring provinces. While in Basilan, they documented 24 mangrove species representing 11 distinct families.

In comparison, studies in Zamboanga del Sur identified 7 true mangrove species (Mariano et al., 2019). While this count appears low relative to the broader Sulu Archipelago, it is important to note that the Zamboanga assessment was limited to only two barangays, whereas studies in Sulu (Hanani et al., 2021) typically cover more extensive geographical areas. The present study, which surveyed three barangays in Pangutaran, Sulu, identified only six species. This finding underscores a localized trend of low species richness within the sampled areas compared to the higher diversity documented elsewhere in the region.

Table 5

Comparison of mangrove forest species richness with the neighboring provinces

Location	*No. of species*	*Source*
Sulu	28	Hanani et al., 2021
Basilan	24	Hanani et al., 2021
Tawi-tawi	21	Maruji, 2025
Zamboanga del Sur	7	Mariano et al., 2019
Pangutaran Island, Sulu	6	This study

Species recorded outside transect lines. Beyond the established transect lines, three additional species belonging to three families: Myrsinaceae, Euphorbiaceae, and Combretaceae, were documented (Table 6). These opportunistic observations provide a more comprehensive view of the island's floral diversity. *Aegiceras floridum Roem.& Schult,* commonly called the northern river mangrove, is a small mangrove tree/shrub species found in equatorial Asia. It typically thrives on high salinity sandy or rocky substrates and is currently listed as Near threatened on the IUCN Red List due to its habitat loss and coastal developments (International Union for Conservation of Nature, 2024). *Excoecaria agallocha L*., commonly known as the blind-your-eye mangrove, is a medium-sized tree from the family Euphorbiaceae that flourishes in estuarine and high intertidal zones (Banerjee et al., 2016). Finally, *Lumnitzera racemosa* Willd, a member of the family Combretaceae*,* is a small to medium-sized tree commonly known as white-flowered black mangrove that occurs along the landward fringe on sandy soils (Shu, 2007).

Table 6

Mangrove species identified outside the transect line

Family	*Species*	*Conservation status*	*Descriptors*
Myrsinaceae	*Aegiceras floridum*	NT	Scattered individuals outside sampling plots
Euphorbiaceae	*Excoecaria agallocha*	LC	Commonly found along mangrove edges
Combretaceae	*Lumnitzera racemosa*	LC	Commonly found along mangrove edges.

Note: NT - near threatened; LC - least concern. Conservation status based on the IUCN Red List of Threatened Species (2024).

Community-based management assessment. Mangrove ecosystems continue to decline globally due to aquaculture expansion, coastal development, pollution, and climate change (Barbier et al., 2011; Donato et al., 2011). In response, community-based forest management (CBFM) has emerged as a vital strategy for sustainable conservation, emphasizing local participation and decentralized governance (Walters et al., 2005). These approaches are grounded in the principle that local stakeholders can effectively manage common-pool resources when provided with institutional support (Macamo et al., 2024). In Pangutaran, Sulu, assessing community awareness is essential to ensuring that local participation fosters long-term ecological sustainability.

Focus Group Discussions (FGDs) conducted across three barangays (Simbahan, Lantong Babag, and Kehi Niyog) captured the community's perceptions regarding management challenges. Participants, including fisherfolk, youth, and barangay employees, consistently identified the ineffective enforcement of environmental regulations as a primary concern. A significant gap exists where Local Government Units (LGUs) are often excluded from conservation activities and awareness campaigns. Furthermore, while environmental policies including Republic Act No. 7161 (Revised Forestry Code of the Philippines) exist, prohibiting illegal mangrove cutting, enforcement to this at the local level remained low and perceived ineffective. Community members said that at the local government level there has been minimal observable activity or services designed to control cutting of mangrove trees or other unsustainable practices. This shows that there is a gap between the existence of environmental protection laws and actual enforcement of those laws at the ground. The FGDs also revealed that timber poaching and charcoal production persist due to inadequate monitoring and a limited presence of the officials of the Ministry of Environment, Natural Resources, and Energy (MENRE) office. Because violators rarely face legal consequences, a perception has emerged that mangrove forests are considered unregulated "open-access resources", leading to conservation efforts being undermined by economic necessity.

Key Informant Interviews (KIIs) further reveal a consensus that the environmental conditions of the study areas are in persistent decline. Interviewees identified a systemic lack of institutional support and weak policy implementation by agencies such as Local Government Units, Department of Environment and Natural Resources, MFAR, and MENRE, as the primary drivers of mangrove loss. These findings indicate an ecological imbalance and long-term vulnerability of the stands, requiring immediate intervention. Ultimately, while awareness exists among community members and government representatives, effective coastal resource management is hindered by poor enforcement mechanisms and limited institutional support. Similar conclusions are drawn from the work of Camacho et al. (2020), who stressed that mangrove restoration and management efforts would not be successful unless there was active participation by communities, ongoing institutional support, and effective policy enforcement.

Conclusions. This study assessed the mangrove species composition and diversity of selected coastal barangays in Pangutaran Island, Sulu Province. Six true mangrove species representing three distinct families were recorded, with Rhizophoraceae being the most dominant across all sites. The prevalence of only a few dominant species suggests that these ecosystems in Pangutaran Island are under significant ecological stress. This condition is primarily driven by anthropogenic pressures (e.g., cutting for charcoal, bark pouching, firewood, timber for house construction) and the harsh physical conditions of the coastal environment. The selective extraction of mangrove species by these poorly regulated consumptive practices contributes to the reduction of the overall diversity of their forests. And while the identified species are currently listed as least concern, their continued disturbance may further reduce ecosystem stability. These findings provide a baseline for mangrove conservation and sustainable management in the Sulu region.

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Authors:
Sandra K. Adam (SKA), Department of Environmental Science, School of Interdisciplinary Studies, Mindanao State University- Iligan Institute of Technology, Andres Bonifacio, Tibanga, 9200 Iligan City, Lanao del Norte, Philippines, e-mail: sandra.adam@g.msuiit.edu.ph
Patricia Angela Solis Epan (PASE), Department of Environmental Science, School of Interdisciplinary Studies, Mindanao State University- Iligan Institute of Technology, Andres Bonifacio, Tibanga, 9200 Iligan City, Lanao del Norte, Philippines, e-mail: patriciaepan96@gmail.com
Frandel Louis Sudaria Dagoc(FLSD), Department of Environmental Science, School of Interdisciplinary Studies, Mindanao State University- Iligan Institute of Technology, Andres Bonifacio, Tibanga, 9200 Iligan City, Lanao del Norte, Philippines, e-mail: frandellouis@g.msuiit.edu.ph
Jhona Damanon Landong(JDL), Sustainable Development Studies, School of Interdisciplinary Studies, Mindanao State University- Iligan Institute of Technology, Andres Bonifacio, Tibanga, 9200 Iligan City, Lanao del Norte, Philippines, e-mail: jhona.landong@g.msuiit.edu.ph
Mary Ann Marapao Ganzon(MAMG), Philippine Science High School Caraga Region Campus in Butuan City, Brgy. Ampayon, Butuan City, Philippines, e-mail: mmganzon@crc.pshs.edu.ph
Wella Tiu Tatil(WTT), Department of Environmental Science, School of Interdisciplinary Studies, Mindanao State University- Iligan Institute of Technology, Andres Bonifacio, Tibanga, 9200 Iligan City, Lanao del Norte, Philippines, e-mail: wella.Tatil@g.msuiit.edu.ph

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