Journal of Sustainability Science and Management
Volume 20 Number 8, August 2025: 1681-1694
eISSN: 2672-7226

COMPOSITION, DIVERSITY, AND VEGETATIVE STRUCTURE OF MANGROVES IN SAMAR, PHILIPPINES

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http://doi.org/10.46754/jssm.2025.08.009
Submitted: 7 September 2024 Revised: 23 December 2024 Accepted: 10 February 2025 Published: 15 August 2025

Abstract: Samar is one of the Philippines' provinces with extensive mangrove cover, which could be a potential biological hotspot. However, information on its status is scarce, and this study seeks to gather information on developing conservation strategies applicable to Samar. Hence, this study investigates the composition and diversity of mangrove species in the province. Accordingly, 69 10 m × 10 m plots were assessed using the Transect Line Plot (TLP) method to obtain the data on the forest structure, and diversity indices were used for the mangrove biodiversity. In particular, 20 mangrove species were identified. *Avicennia marina*, *Rhizophora apiculata*, and *Sonneratia alba* were the most widespread and ecologically dominant species based on their high Importance Value Index (IVI) and basal area. Meanwhile, the Shannon Diversity Index only ranged from 0.87 to 1.56, indicating a low level of mangrove diversity. Furthermore, the results revealed that although the mangroves of Samar fall short on the diversity scale, the dominance of the few species offers information for identifying suitable species that can be utilised as planting materials. Nevertheless, the environmental factors influencing species dominance should be investigated, and long-term monitoring should be explored to assess the success of mangrove restoration initiatives in Samar.

Keywords: *Avicennia marina*, Eastern Visayas, mangrove biodiversity, mangrove conservation, stand structure.

Introduction

Mangrove forests are coastal ecosystems home to various salt-tolerant tree, palm, fern, and shrub species that are found worldwide, mostly between latitudes 25 degrees north and 25 degrees south, along tropical and subtropical coastlines (Tomlinson, 1986; Spalding *et al*., 2010). Typically, this ecosystem is found in coastal intertidal zones or brackish water habitats, where freshwater from rivers and saltwater from the sea mix. Correspondingly, they thrive in areas with high rainfall and warm temperatures (Giri *et al*., 2011).

Mangrove forests perform various ecological functions crucial for maintaining coastal ecosystems' stability. These services include coastal protection, biodiversity support, nutrient cycling, and water quality improvement (Bagarinao & Primavera, 2005). In addition, due to their dense vegetation and the slow decomposition rate of soils, these coastal ecosystems can absorb and retain carbon, thus significantly functioning in carbon sequestration (Nellemann *et al*., 2009; Kauffman & Donato, 2012). On top of that, this ecosystem sustains the livelihoods of many coastal communities by providing a wide range of economic benefits (e.g., ecotourism, timber, edible products) (Hutchison *et al*., 2014). Overall, mangrove forests' ecological benefits and economic potential highlight their importance to coastal areas worldwide (UNEP, 2014).

The Philippines is known for its diverse and rich mangrove ecosystems, with approximately 42 identified true mangroves belonging to 18 families. This is about 70% of the globally recognised mangrove species (Polidoro *et al*., 2010; Samson & Rollon, 2011). In terms of mangrove cover, the country had approximately 400,000 to 500,000 ha in the 1920s (Primavera, 2000; Long & Giri, 2011). However, it declined significantly to 260,000 ha in 2000 due to the combined effect of natural disasters and anthropogenic disturbances (Siikamaki *et al*., 2012).

In recent years, converting this natural habitat into residential, industrial, tourism, and aquaculture areas has caused severe mangrove forest deforestation (Alongi, 2002; Buot, 2020). Furthermore, the pollution caused by agricultural runoff and industrial waste exacerbates the adverse effects on mangroves (Ahmed *et al*., 2021). Climate change also poses additional risks by causing rising sea levels and intensifying storms, which can alter mangrove habitats and disrupt their growth (Abino *et al*., 2014a). Due to these threats, much research has been conducted on mangroves in the Philippines. Regrettably, there is a lack of comprehensive data and research on mangroves in Samar despite it constituting 7% of the total mangrove area of the country (FMB, 2011). According to the 2007 Coastal Resources Assessment report prepared by the Provincial Agriculture Office, the estimated area of the mangrove forest in the province is approximately 10,170 ha (Salmo *et al*., 2019). Despite the vastness of this mangrove cover, little is known about the diversity, composition, and stand structure of the mangroves in Samar. While two coastal municipalities of the province were previously investigated based on published papers, the status of mangroves in other parts of the province is still lacking. Therefore, the objectives of this study are to assess species diversity, stand composition, and structural characteristics of the mangrove forests in Samar and determine the ecological health and status of the ecosystem. In addition, this study will provide baseline information such as the inventory of mangrove species present in the area necessary for policy development, sustainable management practices, and long-term monitoring. This, ultimately, contributes significantly to the sustainable development goals and regional conservation strategies applicable to the mangrove forests in the Province of Samar.

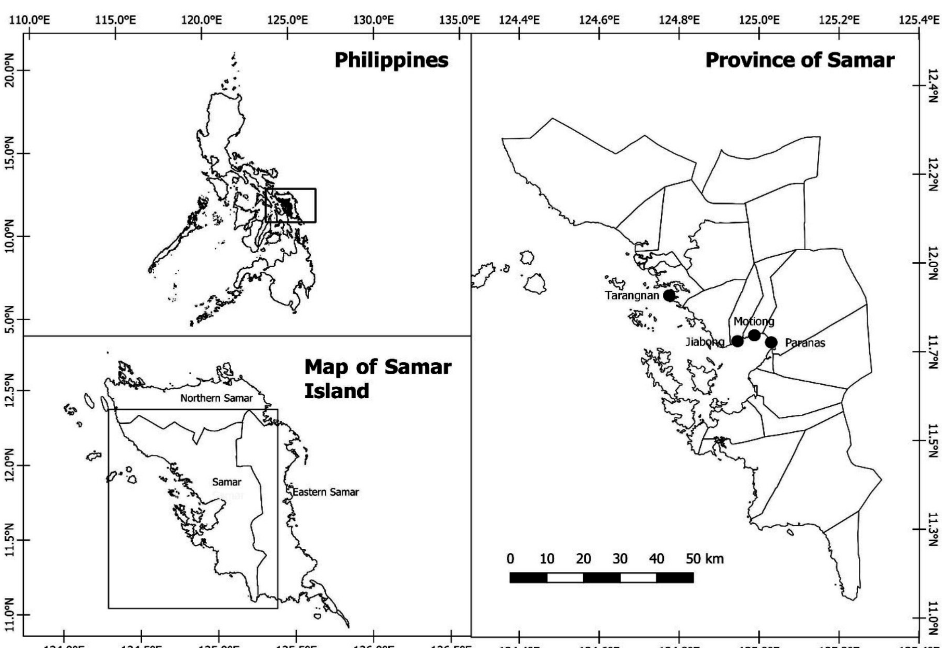

Figure 1: Location map of the sampling sites in Samar, Philippines

Materials and Methods

Description of the Study Site

This study was conducted in four coastal municipalities of Samar, namely Tarangnan, Jiabong, Motiong, and Paranas (Figure 1). In particular, two sampling sites were established in every municipality except Paranas, with only one sampling area. The survey sites were selected as these areas have extensive mangrove coverage, providing valuable information on the status of the mangrove vegetation. Accordingly, assessing these sites allows the researchers to document vital flora and fauna, including the endangered species. Note that many local communities in these study sites depend on mangroves for their livelihoods directly or indirectly. Nevertheless, these mangrove forests also face pressures such as logging and aquaculture developments. Hence, conducting assessments can provide insights into the extent of these threats and further identify priority areas for restoration and protection. Accessibility and safety were also considered prior to the study's being conducted. On that note, most of the sampling sites are involved in mangrove reforestation initiatives overseen by fisherfolk organisations with the support of the Local Government Unit (LGU). The fieldwork was conducted during low tide from August to November 2023 during the rainy season. In addition, prior to field assessments, an ocular survey of the area was conducted to ensure the safety of the sampling stations.

Data Collection

At each sampling site, 100 m linear transects were laid perpendicular to the waterline, with at least 50 m between adjacent transects. Data on the vegetative structure of mangroves was obtained using the Transect Line Plot (TLP) method. The plots measuring 10 m x 10 m were placed along line transects (Yap *et al*., 2018). As such, a total of 25 line transects were established. Plots within each transect were surveyed at distances of 0, 50, and 100 m, representing the landward, middleward, and seaward zones. A total of 69 plots were assessed from all sampling sites.

All trees with a Diameter at Breast Height (DBH) of ≥ 5 cm were measured, identified, and counted within each sampling plot. A diameter tape was employed to measure the diameter at DBH, while the total heights of the trees were estimated visually. Specifically, the DBH of *Bruguiera* and *Rhizophora* species were measured by determining the trunk diameter at a height of 30 cm above the buttress and above the highest prop root, respectively. The DBH was measured 130 cm above the ground for the remaining species (Quitain, 2023).

The mangrove species were identified using established field guides of Primavera *et al*. (2004) and Primavera (2009). Photographs were taken to establish the presence of flowers, fruits, and mangrove propagules. In addition, mangrove trees were classified based on three maturity categories, as defined by Deguit *et al*. (2004): mature trees (Height > 4 m), saplings (Height > 1 m to < 4 m), and seedlings (plants with Height ≤ 1 m). Since the DBH of mangrove saplings and seedlings is less than 4 cm, they were only considered for biodiversity assessment.

Data Analysis

Species Diversity

The calculation and interpretation of species diversity for each site were performed using the Shannon-Wiener Diversity Index (H'), Margalef's Index (D), and Pielou's Evenness Index (J') (Shannon & Wiener, 1963; Pielou, 1966; Margalef, 1972) formula:

$$H' = \sum_{i=1}^{S} \left(\frac{n_i}{n}\right) \ln\left(\frac{n_i}{n}\right), \quad (1)$$

$$D = \frac{S-1}{\ln(n)}, \quad (2)$$

$$J' = \frac{H}{\ln S}, \quad (3)$$

where H' is the diversity index, S is the total number of species or the species richness, n_i is the total number of individuals for each species, n is the total number of individuals for all species, and ln is the natural logarithm.

Structural Characteristics

Structural variables like abundance, basal area, relative density, dominance, relative dominance, frequency, and relative frequency were calculated following the formula from Cintron and Schaffer-Novelli (1984). The Importance Value Index (IVI) was computed by summing relative density, frequency, and dominance values. Note that the vegetation analysis only includes the true mangrove trees. *Nypa fruticans*, *Acanthus ebracteatus*, and *Acanthus volubilis* were excluded from the study of the vegetation ecology of woody plants since they are palms and herbs. These species do not have a stem that can be measured, preventing the application of the same scientific approach used for woody plants.

The data was recorded in a Microsoft Excel database and examined quantitatively using statistical functions in Microsoft Excel.

Results and Discussion

Species Composition and Distribution

A total of 20 true mangrove species belonging to seven families and ten genera were documented in the 69 plots studied (Table 1). Of the 20 species, 15 were recorded in Tarangnan, 13 in Jiabong, seven in Paranas, and five in Motiong. Specifically, Rhizophoracea was the most dominant family with seven species, and *Avicennia* was the most dominant genus with four species. At the same time, *Avicennia marina*, *Rhizophora apiculata*, and *Sonneratia alba* appeared in all the sampling sites, meaning these species are common in the area. Meanwhile, *A. ebracteatus*, *A. volubilis*, *Avicennia rumphiana*, *Aegiceras floridum*, *Bruguiera cylindrica*, *Bruguiera parviflora*, *Bruguiera sexangula*, and *Rhizophora stylosa* appeared only in one sampling site revealing the rarity of these species.

When comparing the data collected in this study to the total number of true mangroves documented by Polidoro *et al*. (2010) worldwide and known to occur in the Philippines (Spalding *et al*., 2010), it is observed that approximately 35% of all known mangrove species in the world and 45% of identified species in the country are discovered in the survey sites. This makes the study one of the highest number of mangrove species identified in the Philippines. Other studies with high mangrove species are in Camotes, Cebu, with 30 species (Lillo *et al*., 2022). Puerto Princesa, Palawan, has 28 species (Dangan-Galon *et al*., 2016) and Argao, Cebu, has 22 species (Lillo & Buot, 2016). Relatively, the total number of species reported in the present study was also higher compared to the previous studies of Pototan *et al*. (2017) in Davao del Norte and Goloron *et al*. (2020) in Butuan Bay, Agusan Del Norte, of which both areas identified only 12 species.

In ecology, a species that can thrive in various environmental conditions is considered a generalist and a specialist if the species can flourish only in a narrow range of ecological conditions (Pielou, 1972). In this study, *A. marina*, *R. apiculata*, and *S. alba* appeared in all sampling sites, which suggests that the physiology of these plant species adapted well to the current environmental conditions of the area, hence their presence. In contrast, those species restricted to one study site have a specific physiological requirement. Therefore, their distribution is limited.

Of the 20 mangrove species, one is considered Vulnerable (VU), two are marked as Near Threatened (NT) species, and the rest are Least Concerned (LC). Among the mangrove species identified, *A. rumphiana* was classified as VU in the International Union for Conservation of Nature (IUCN) Red List (IUCN, 2024). This rare species faces a high risk of extinction or collapse in the wild in the medium-term future due to significant population losses of 30% to over 50% in the past ten years. This designation also indicates that this species faces substantial threats that could lead to its decline or loss. Note that *A. rumphiana*, locally known in Samar as “miyapi,” is native to Southeast Asia (Giesen *et al*., 2007). In this current study, only one *A. rumphiana* tree was counted, growing in the landward zone of Jiabong, Samar. In addition,

Table 1: Distribution, red list, and national category of mangrove species in the sampling sites

Family	Species	Name of Sampling Sites				Red List Category	DENR DAO No. 2017-11
		Tarangnan	Jiabong	Motiong	Paranas		
Acanthaceae	*Acanthus ebracteatus*	-	·	-	-	LC	-
	Acanthus volubilis	·	-	-	-	LC	-
	Avicennia alba	-	·	·	-	LC	-
	Avicennia marina	·	·	·	·	LC	-
	Avicennia officinalis	·	·	-	·	LC	-
	Avicennia rumphiana	-	·	-	-	VU	-
Arecacea	*Nypa fruticans*	-	·	-	·	LC	-
Combretaceae	*Lumnitzera racemosa*	·	·	-	-	LC	-
Lythracea	*Sonneratia alba*	·	·	·	·	LC	-
	Sonneratia caseolaris	·	·	-	-	LC	-
Meliaceae	*Xylocarpus granatum*	·	-	-	·	LC	-
Myrsinaceae	*Aegiceras corniculatum*	·	·	-	-	LC	-
	Aegiceras floridum	·	-	-	-	NT	-
Rhizophoraceae	*Bruguiera cylindrica*	·	-	-	-	LC	-
	Bruguiera parviflora	·	-	-	-	LC	-
	Bruguiera sexangula	·	-	-	-	LC	-
	Ceriops decandra	·	·	-	·	NT	-
	Rhizophora apiculata	·	·	·	·	LC	-
	Rhizophora mucronata	-	·	·	-	LC	-
	Rhizophora stylosa	·	-	-	-	LC	-
	**Camptostemon philippinense*	-	·	-	-	EN	EN
Total Number		**15**	**13**	**5**	**7**		

Red List Categories refer to IUCN (2024); National Categories refer to DENR (2017); LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered
*Found outside the plot and not included in the tally

the species described here is one of the largest trees in the sampling sites, with a circumference of more than 3 m.

Meanwhile, *C. decandra* and *A. floridum* were categorised as NT species. This implies that these species are not considered endangered or VU but are close to meeting the criteria for a threatened category (IUCN, 2024). For NT mangroves, this designation indicates that these species face threats that could push them toward a more severe conservation status if they are not addressed. While not yet in immediate danger of collapse, these mangroves require monitoring and proactive conservation measures to prevent their status from worsening. In addition, some anthropogenic activities observed in the sampling sites, although minimal, that could affect the *C. decandra* and *A. floridum* populations were cutting of tree branches and improper garbage disposal. These species are also observed in the studies of Abino *et al*. (2014a) in Pinabacdao and Calipayan *et al*. (2024) in Zumarraga, Samar.

Furthermore, it is also essential to note the presence of an endangered mangrove species, C. philippinense, observed in Jiabong, although observed outside the plot (Figure 2P). This proves that Samar is home to rare and endangered mangrove species. Hence, the preservation of this landscape should be addressed.

Species Diversity

Diversity indices can be employed to describe the relationship between species abundance in a community and are presented in Table 2. Correspondingly, the highest value of the Shannon Diversity Index was recorded in Paranas (H' = 1.56), while the lowest was in Motiong (H' = 0.87). Meanwhile, the Pielous Index of Evenness was still highest in Paranas (J = 0.80) and very low in Jiabong (J = 0.41). At the same time, the highest value of Margalef's Index was noted in Jiabong (R = 3.01), and the lowest value was recorded in Motiong (R = 0.62). Overall, diversity results suggest that all sampling sites have < 1.99 values, which can be categorised as having very low diversity based on the scale by Gevaña and Pampolina (2009). Relatively, this number is slightly higher in diversity (H' = 1.027) in Davao del Norte (Alimbon & Manseguiao, 2021) and also reported by Abino *et al*. (2014b) (H' = 0.9918) in Bahile, Puerto Princesa, Palawan. However, the species diversity calculated in this whole study area was lower than that of Pototan *et al*. (2021) in Banaybanay, Davao Oriental, with H' = 3.15, and Lillo *et al*. (2022) in Camotes Island, Cebu (H' = 3.01).

Low diversity in Samar could be attributed to the uneven distribution of trees and a high abundance of some species in the area. Species like *A. marina* and *R. apiculata* have reached more than 500 individuals, while *A. rumphiana*, *B. cylindrica*, *B. sexangula*, and *R. stylosa* have less than five individuals. In addition, the species diversity of mangroves in a particular area could also be influenced by a combination of environmental, ecological, and geographical factors. Some key factors include salinity, tidal fluctuations, sediment type, temperature, and nutrient availability (Barrientos & Apolonio, 2017; Lillo *et al*., 2017). Such assumptions, however, need further assessment to identify which environmental factors likely affect the mangrove diversity of Samar. Furthermore, unlike tropical lowland rainforests, mangroves have generally low biodiversity due to their unique adaptations to harsh coastal environments and distinct stand formation (Gevaña & Pampolina, 2009; Rashquinha & Mitra, 2021).

Forest Structure and Features

A total of 1,709 individual mature trees in a 6,900 m^2 area were counted in this study, while 1,848 seedlings and saplings were enumerated (Table 3). The basal area of a tree is a measure of the cross-sectional area of the trunk at breast height (typically 1.3 m or about 4.5 feet above the ground) and expressed per unit area. Among the species identified, the highest basal area was obtained for *A. marina* with 14.71 m^2 ha^{-1}, followed by *R. apiculata* with 11.50 m^2 $ha^{-1,}$ and the lowest basal area was *B. sexangula* with only 0.03 m^2 ha^{-1}. From the result, the high basal area

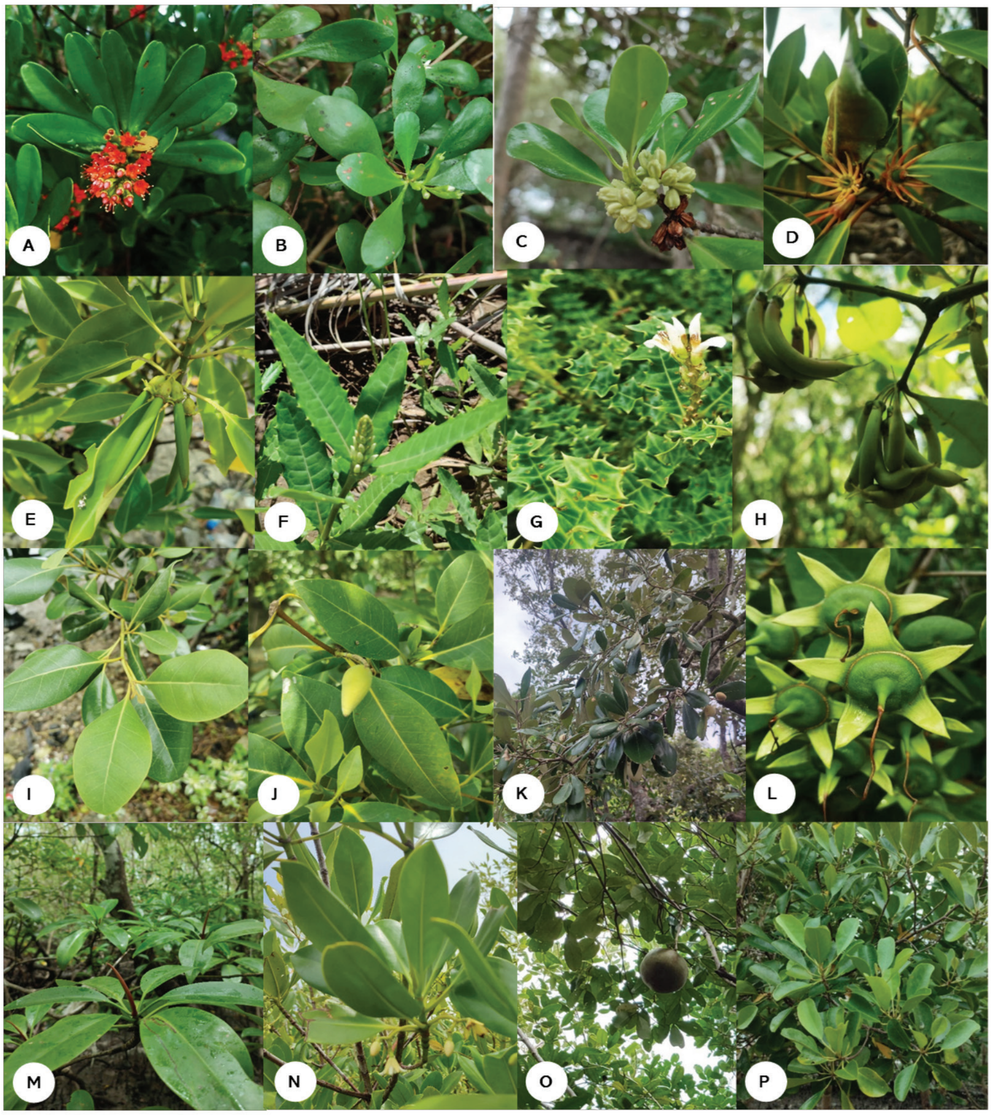

Figure 2: Mangrove species found in Samar: A: *Lumnitzera littorea*, B: *Lumnitzera racemosa*, C: *Scyphiphora hydrophyllacea*, D: *Bruguiera sexangula*, E: *Bruguiera cylindrica*, F: *Acanthus volubilis* G: *Acanthus ebracteatus*, H: *Aegiceras conrniculatum*, I: *Avicennia marina*, J: *Avicennia alba* K: *Avicennia rumphiana*, L: *Sonneratia alba*, M: *Rhizophora apiculata*, N: *Rhizophora stylosa*, O: *Xylocarpus granatum* and P: *Camptostemon philippinense*

Table 2: Diversity indices of mangroves in the sampling sites

Diversity Analysis	**Sampling Sites**			
	Tarangnan	**Jiabong**	**Motiong**	**Paranas**
Shannon-Wiener Index (H’)	1.54	1.05	0.87	1.56
Margalef’s Index (R)	2.19	3.01	0.62	1.28
Pielou’s Index of Evenness (J)	0.58	0.41	0.54	0.80

of *A. marina* implies that this mangrove species has a more significant number of trees per unit area, suggesting a denser mangrove stand. This could also be attributed to the broader DBH of each tree, which indicates that they are large and potentially older. Additionally, the presence of a larger tree may indicate its ability to store a larger amount of carbon, making a substantial contribution to carbon sequestration and enhancing the potential ecosystem services in the area. Moreover, the same result was observed in the Eastern Mangrove Lagoon National Park in Abu Dhabi and the Panabo Mangrove Park, resulting from its high salt tolerance and growth adaptability, strong regenerative capacity, and great biomass contribution due to having larger trunk diameters compared to other species (Alsumaiti, 2014).

The IVI measures a species' dominance and ecological success based on its overall contribution to the mangrove community. Several research studies have indicated that species with a greater IVI contribute more significantly to forest ecosystems, especially regarding forest productivity (Turkis & Elmas, 2018). In the current study, *A. marina* appears to be the most important and dominant species (113.76%), closely followed by *R. apiculata* (81.03%), *S. alba* (43.93%), and *B. sexangula* (0.62%) demonstrated the lowest value revealing its sporadic distribution.

A. marina presented high significance and appeared in all sampling sites, implying that this species significantly contributes to the mangrove ecosystem's overall community structure. Also referred to as the grey mangrove, *A. marina* has strong adaptability to the area's present environmental conditions, hence its dominance. According to the studies of Almahasheer *et al.* (2016), one of the unique characteristics of this

Table 3: Structural characteristics of mangrove species in the sampling sites

Mangrove Species	Stand Structure				
	No. of Mature Individuals	**Basal Area (m^2 ha^{-1})**	**Average Height (m)**	**IVI (%)**	**Rank**
Avicennia marina	610	14.71	8.07	113.76	1
Rhizophora apiculata	763	11.50	12.25	81.03	2
Sonneratia alba	100	8.82	11.41	43.93	3
Rhizophora mucronata	26	0.30	9.44	10.19	4
Ceriops decandra	45	0.69	6.76	8.11	5
Avicennia alba	24	2.05	11.41	7.87	6
Xylocarpus granatum	26	1.12	5.85	7.04	7
Aegiceras corniculatum	33	0.74	3.16	6.30	8
Avicennia officinalis	12	1.20	8.76	5.43	9
Lumnitzera racemosa	35	0.45	4.60	5.06	10
Sonneratia caseolaris	9	1.98	7.86	5.01	11
Avicennia rumphiana	1	0.74	12.60	1.63	12
Rhizophora stylosa	4	0.06	4.25	1.29	13
Aegiceras floridum	8	0.11	3.32	1.09	14
Bruguiera parviflora	8	0.10	4.08	0.97	15
Bruguiera cylindrica	4	0.06	3.75	0.76	16
Bruguiera sexangula	1	0.03	3.39	0.62	17
Total	**1709**	**44.65**		**100**	

plant is its high salt tolerance. Therefore, it can thrive in saline or brackish water. In addition, this plant is also resistant to environmental stress and can succeed even in contaminated areas (Usman *et al*., 2013). Based on field observation, *A*. *marina* thrives well in the seaward portion of the mangrove forest, indicating that this plant has adapted to regularly inundated places with high salinity. In line with this, *A*. *marina* has been consistently identified as the most prevalent species in many studies, such as those conducted by Pototan *et al*. (2017) and Alimbon and Manseguiao (2021) in Davao del Norte. Moreover, the dominance of *A*. *marina* across various sites highlights its critical role in maintaining mangrove ecosystem structure and resilience, particularly in areas exposed to high salinity and environmental stress. Nevertheless, adapting to saline and moderately disturbed environments underscores the species' ecological importance and suitability for conservation and rehabilitation projects in challenging coastal habitats.

R. *apiculata* is also abundant since this plant is commonly preferred in the mangrove regeneration program in the country. Notably, this species has been frequently planted due to its various ecological and physiological traits, making it highly suitable for these initiatives. Furthermore, this species' seedlings demonstrate relatively fast growth rates, facilitating quicker establishment in the soil (Primavera, 2005; Amaliyah *et al*., 2018). Moreover, *R*. *apiculata* can withstand and adapt to many environmental challenges frequently encountered in coastal areas, including drought, flooding, and sedimentation. The capacity of the species to endure these pressures improves its competitive edge and enables it to flourish in various mangrove habitats (Dissanayake *et al*., 2014; Md Isa & Suratman, 2021). In many cases, *R*. *apiculata* is commonly discovered in coastal areas, making it readily available for propagation and planting (Usman *et al*., 2022). *R*. *apiculata* is preferred for the rehabilitation and reforestation of mangrove vegetation in the assessed areas, considering that it is planted in its natural mangrove species zonation. Note that *Rhizophora* species thrive best in mid to low intertidal zones and are often misplanted in inappropriate zones, such as seaward areas. It often leads to poor growth or stunted development and high mortality rates due to stress from wave action, erosion, or unsuitable soil conditions (Samson & Rollon, 2008).

Data per sampling sites indicates that Motiong obtained the highest abundance, accounting for 37.43% of the total number of trees encountered, followed by Tarangnan at 34.07%, Jiabong at 21.96%, and Paranas at 5.56%, respectively (Table 4). In Jiabong, the population of mangrove species consisted predominantly of *A*. *marina*, accounting for about 75% of the total tree count. At the same time, *R*. *apiculata* exhibited the highest percentage count in Motiong and Tarangnan, with 73% and 40%, respectively. Meanwhile, Paranas, primarily made up of *S*. *alba*, account for 33% of the total number of trees recorded.

The abundance of *R*. *apiculata* in Motiong results from the tree-planting activity implemented by the municipality decades ago. Correspondingly, the environmental conditions (soil texture, nutrients, tidal flooding, salinity,

Table 4: Comparison of structural characteristics based on sampling sites

Sampling Sites	No. of Seedlings and Saplings	Abundance (%)	Basal Area (m^2 ha^{-1})	Average Height (m)
Jiabong	1080	21.96	17.03	8.10
Motiong	429	37.43	9.98	16.42
Paranas	76	5.56	5.37	10.43
Tarangnan	327	34.07	12.27	4.33
Total	**1848**	**100**		

and temperature, to name a few) of Jiabong and Paranas may have provided a favourable environment for the rapid spread of *A. marina* and *S. alba* compared to other mangrove species. Comparable outcomes were observed in the research conducted by Raganas *et al*. (2020), where *A. marina* and *R. apiculata* dominated the mangrove stands in Oriental Mindoro due to the development of morphoanatomical characteristics, such as its superficial rooting systems for adaptation in the mangrove environment. In contrast, Lillo *et al*. (2022) and Irwansah *et al*. (2017), *S. alba*. *A. marina*, *A. rumphiana*, and *R. apiculata* were noted to be dominant in Camotes, Cebu and the Gulf of Lombok Island in Indonesia, respectively. This is due to the prevailing environmental condition particularly the substrate type, soil salinity and tidal inundation which favours the growth of these dominant species.

Information on the total basal area of trees per sampling sites revealed that Jiabong had the highest basal area (17.03 m^2 ha^{-1}), followed by Tarangnan (12.27 m^2 ha^{-1}), Motiong (9.98 m^2 ha^{-1}), while Paranas (5.37 m^2 ha^{-1}) obtained the lowest value. According to the studies conducted by Kauffman *et al*. (2011) and Komiyama *et al*. (2008), pristine mangrove forests with minimal impacts have a basal area of > 25 m^2 ha^{-1}. Conversely, secondary forests have a basal area of about 15 m^2 $ha^{-1,}$ and disturbed forests have less than 10 m^2 ha^{-1} (Komiyama *et al*., 2008). Based on this category, Jiabong and Tarangan are considered secondary forests, suggesting that although this mangrove forest may have experienced disturbances, it can regenerate and return to its original vegetation.

The presence of saplings and seedlings in all sampling sites indicates a good regeneration potential. It can replace what might have been lost due to natural and anthropogenic causes. Based on the collected data, all the sampling sites are more likely to sustain the mangrove population, as the number of seedlings and saplings exceeds 50% of mature trees. Among the mangrove species, *A. marina* and *R. apiculata* have the highest seedlings and samplings count. At the same time, the abundance of *R. apiculata* in Jiabong is attributed to the continuous mangrove reforestation project. Meanwhile, the abundance of young trees of *A. marina* can be explained by the tall canopy of the adult mangrove trees in the sampling sites, as the seedlings are well-suited for growing in shady areas beneath the larger trees (Farnsworth & Ellison, 1996).

Conclusions

A total of 20 mangrove species, seven families, and ten genera were identified in Samar. However, they are not evenly distributed. The most common species were *A. marina*, *R. apiculata*, and *S. alba*, which appeared in all sampling sites. This suggests their high adaptive abilities compared to other mangrove species. In particular, Rhizophoracea was the most dominant family with seven species, while *Avicennia* was the most dominant genus with four species. The findings also revealed the presence of VU and endangered species, such as *A. rumphiana* and *C. philippinense*, underscoring the urgent need for conservation measures.

The Shannon Diversity Index values ranged from 0.87 to 1.57, indicating that the mangrove ecosystem of Samar has a relatively low diversity, which can be attributed to the dominance of a few species like *A. marina*, which also exhibited the highest IVI of 113.76%. Its dominance is due to its strong adaptability to the current environmental conditions of the area. *R. apiculata* also demonstrates high abundance, attributed to the monoculture planting activities conducted as part of the reforestation efforts of various sectors of society. Moreover, the high basal area of the pioneer species *A. marina* (14.71 m^2 ha^{-1}) and *R. apiculata* (11.50 m^2 ha^{-1}) demonstrated their significant contribution to mangrove biomass and overall community structure.

The low overall species diversity could affect the ecosystem's resilience to environmental changes and anthropogenic pressures. Thus, while Samar's mangroves demonstrate potential for regeneration due to the abundance of seedlings, conservation strategies must prioritise protecting rare species and enhancing species diversity. This study further recommends the implementation of site-specific conservation and reforestation programs. Additionally, efforts should be made to plant native and locally adapted species in appropriate zones to enhance survival rates and biodiversity.

Monitoring of these mangrove sites is also necessary to ensure their success. Since mangrove planting is still being conducted continuously in some areas of Samar, it is advisable to conduct a preliminary survey first to determine the most suitable sites for planting. Furthermore, additional research should be undertaken to better understand the current condition of mangroves in Samar. This may include evaluating the ecosystem services, other flora and fauna, and physico-chemical aspects of the mangrove forest.

Acknowledgements

The authors deeply appreciate the LGU and coastal residents of Tarangnan, Jiabong, Motiong, and Paranas, Samar, for allowing us to conduct this study. Likewise, we are grateful to the Office of the Research and Extension Services (ORDES) of Samar State University for approving and funding this research project.

Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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