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Tree Species Inventory and Diversity Assessment in Sitio Sak-Sak, Buanoy, Balamban, Cebu, Philippines: A Baseline Study

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SUMMARY

This study evaluated the composition and diversity of tree species in Sitio Sak-Sak, Buanoy, Balamban, Cebu, to establish baseline data regarding the ecological status of the region. We identified a total of five tree species across five families in three sampling quadrats using standard biodiversity assessment protocols. The computed Shannon–Wiener Diversity Index (H' = 1.461) indicated very low diversity, while the Simpson's Index of Diversity ($1-\lambda = 0.792$) showed relatively low dominance. The Evenness Index (E = 0.908) reflected a relatively even distribution of individuals among the recorded species. These conditions are primarily attributed to historical reforestation and past land disturbances, as evidenced by the dominance of the introduced species *Swietenia macrophylla* and *Gmelina arborea*. Most species recorded were categorized as Least Concern by the IUCN (2025), excluding *S. macrophylla* and *Artocarpus altilis*, which were listed as Endangered and Data Deficient, respectively. The prevalence of exotic species suggests potential ecological risks, such as competition with native flora and reduced biodiversity. These findings emphasize the need for management interventions that promote native species restoration and continuous monitoring to maintain ecological stability in the area.

Keywords: Balamban, Cebu Island, tree diversity, tree species inventory

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INTRODUCTION

Forests are among the most vital terrestrial ecosystems, serving as reservoirs of biodiversity and providers of critical ecological services such as carbon sequestration, air purification, water regulation, and soil stabilization. Globally, forests cover about 31% of the total land area and provide habitats for various terrestrial species (FAO, 2022). The Philippines, recognized as one of the world's biodiversity hotspots (Myers et al., 2000), hosts numerous endemic and threatened species that contribute significantly to global biodiversity (Oliver and Heaney, 1996; Malabrigo et al., 2022). Beyond their ecological role, forests also underpin the country's economy and resilience by supporting local livelihoods, preventing erosion, and mitigating the impacts of climate change (FAO, 2022). However, the combined pressures of rapid urbanization, agricultural expansion, and resource exploitation have led to severe

deforestation and forest degradation across the archipelago, threatening biodiversity and ecosystem stability (Agduma et al., 2023; Climate Change Commission, 2024).

Among the islands of the Philippines, Cebu stands out as an ecologically essential yet heavily disturbed area (Lillo et al., 2019). Its remaining forest cover has been significantly reduced by human activities, including illegal logging, settlement expansion, tourism, and infrastructure development (Lillo et al., 2019, 2020, 2024; OECD, 2017). Despite this, several patches of natural vegetation persist, particularly in the upland and mountainous regions of the island, which may still harbor diverse native tree species vital for ecological restoration and conservation planning (Lillo et al., 2020, 2021). While these remnant forests may appear limited in extent, they are ecologically important. Assuming that all species contribute equally to ecosystem health overlooks the fact that some possess greater ecological or conservation value. Particular species are endemic or rare, while others are endangered or threatened, and a few serve as keystone species that play crucial roles in maintaining ecosystem balance and resilience (Ontoy and Padua, 2014). Recognizing these distinctions underscores the importance of conducting comprehensive diversity assessments to document and protect these species in the remaining forested areas of Cebu.

Assessing tree diversity in these remaining habitats is crucial to address environmental degradation and better understand species composition, ecological stability, and forest health. Tree assessment and diversity studies were conducted in various locations in Cebu such as Cebu City (Flores et al., 2020; Jumonong et al., 2022; Pansit, 2019), Lapu-Lapu City (Ballesteros, 2023), Carcar City (Lillo et al., 2024), Toledo City (Rosales et al., 2018) and other provincial municipalities like Minglanilla (Alvarico et al., 2019), Catmon (Lillo et al., 2021; Rosales et al., 2018), Alcoy (Lillo et al., 2020; Rosales et al., 2018), Sibonga (Lillo et al., 2024), and Argao (Chavez and Lillo, 2022; Replan and Malaki, 2017). However, research in the municipality of Balamban remains limited, with available studies mainly focusing on ethnobotanical uses (Calangi et al., 2019; De La Torre et al., 2016), the diversity of tree-like species within the order Arecales (De La Torre et al., 2016), and the spread of invasive alien species influenced by human activities (Garces and Genterolizo, 2018), particularly in Mount Manunggal.

This lack of comprehensive data limits understanding of ecological status and potential role in biodiversity conservation in Balamban. Therefore, this study aims to assess the diversity and composition of tree species in Sitio Sak-Sak, Barangay Buanoy, Balamban, Cebu. The findings will serve as baseline information for future conservation initiatives, reforestation programs, and ecological research.

MATERIALS AND METHODS

STUDY SITE

The field study was conducted at Sitio “Sak-sak”, Barangay Buanoy, Balamban, Cebu, on October 25, 2025 (Fig. 1). Barangay Buanoy is one of the barangays in the Municipality of Balamban. It is geographically bounded by Barangay Cantibas to the east, Tañon Strait to the west, Barangay Abucayan to the north, and Barangay Arpili to the south. It has an estimated elevation of 15.3 meters above sea level (m.a.s.l.). The total area is 1,050 ha, with most land classified as agricultural, agro-industrial, and residential, housing around 14,000 residents. Urban projects are concentrated

along the highway, but as density increases in the sitios, land is increasingly used for commercial and institutional purposes. It is also considered an urban and coastal barangay (Municipality of Balamban, 2022). The tree vegetation in Sitio "Sak-sak" is relatively aggregated yet fragmented. Although numerous trees are present, the area is predominantly occupied by other plant species, including herbs, shrubs, ferns, and mushrooms.

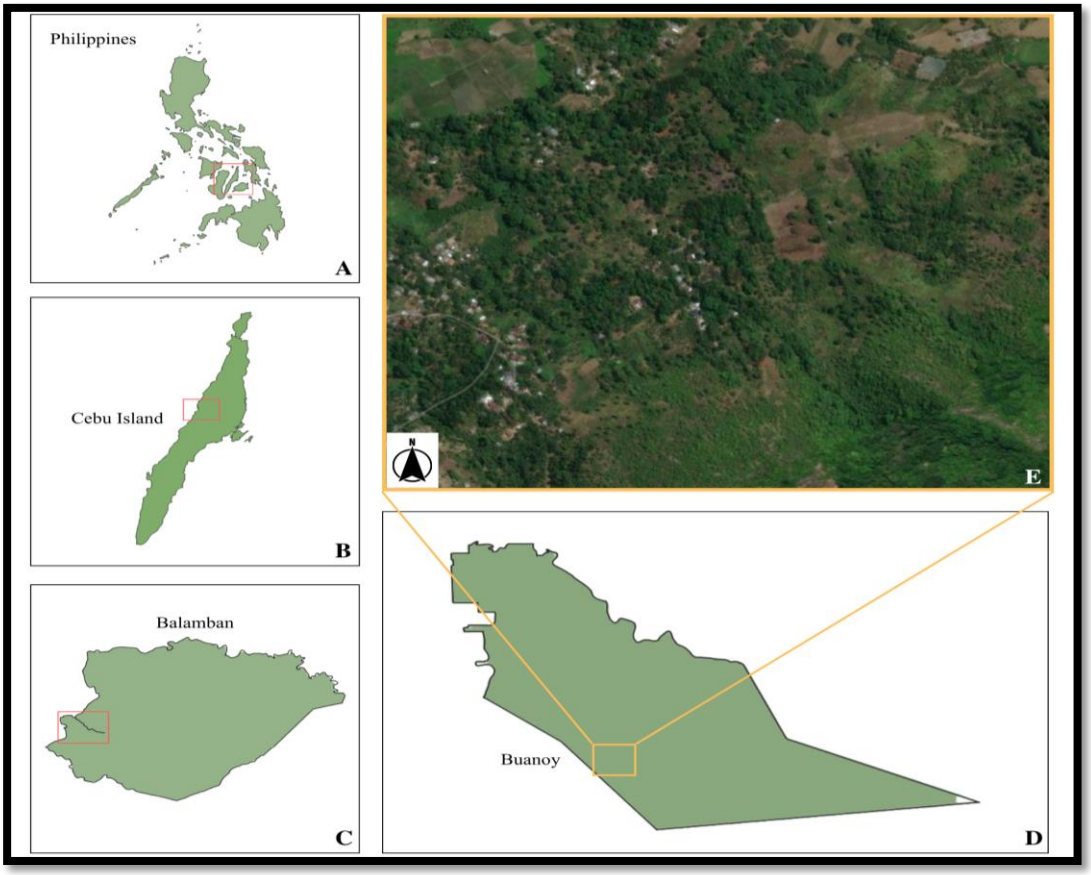

Figure 1: Map of the Philippines, Cebu Island, Municipality of Balamban, Barangay Buanoy, and satellite view of the study site in Sitio Sak-sak. Maps were generated using QGIS 3.44 and ArcGIS Online.

SAMPLING PROCEDURE

The study employed a quadrat sampling method to assess the tree diversity within the study area. A total of 3 quadrats (Malayao and Mendoza, 2013), measuring 10 x 10 m, were established in the study area. This quadrat size was adapted based on the dimensions used for native tree assessments (Lillo et al., 2021, 2024) and aligns with the recommended quadrat size for tree/forest studies (Alder, 1980). The sampling of tree species followed a selective sampling method, especially when populations (e.g., tree communities) are aggregated, to ensure the inclusion of representative species (Flores et al., 2020). Tree species within each quadrat with a DBH (diameter at breast height) of more than or equal to 10 cm (≥10 cm) were only included in the inventory of trees. Measuring the DBH of the tree species will follow the standard methods

used in the American Forests Tree-Measuring Guidelines (e.g., how to get the DBH of a multi-stemmed tree) (Leverett and Bertolette, 2014).

Plant Species Identification and Conservation Status

All tree species encountered in the sampling quadrats were initially identified using the iNaturalist application. Species identification was then verified using established botanical references such as A Pictorial Encyclopedia of Philippine Ornamental Plants by Dr. Domingo Madulid and Revised Lexicon of Philippine Trees by Justo Rojo, and digital databases like Co's Digital Flora of the Philippines (https://www.philippineplants.org/) and Plant Systematics (http://www.plantsystematics.org/) (DENR-FMB, 2019; Flores et al., 2020; Lillo et al., 2019). Morphological traits, including reproductive features (flowers and fruits, if applicable), leaf characteristics (arrangement, shape, margin, and venation), and bark and trunk features (texture and color), were examined to ensure accurate species identification. The conservation status of each identified tree species (latest issue) was determined using the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. It was supplemented by local classifications from the Department of Environment and Natural Resources (DENR) Department Administrative Order (DAO) No. 17-11 (DENR, 2017). The origin or native status of each tree was determined using Co's Digital Flora of the Philippines and Rojo's Revised Lexicon of Philippine Trees.

Data Analysis

All the recorded data were stored in a Microsoft (MS) Excel database and analyzed quantitatively using MS Excel statistics. The collected data from the sampling quadrats were analyzed to determine species richness, abundance, and diversity in the study area. For each identified tree species, frequency of occurrence, relative density, relative dominance, and importance value (IV) (DENR-FMB, 2019; Lozano and Bueno, 2015) were computed as follows:

$$Relative\ frequency\ (RF)\ =\ \frac{frequency\ of\ species}{total\ frequency\ of\ all\ species}\ x\ 100 \quad (1)$$

$$Relative\ density\ (Rd) = \frac{no.of\ individuals\ of\ species\ A}{total\ number\ of\ individual\ of\ all\ species}\ x\ 100 \quad (2)$$

$$Relative\ dominance\ (RD) = \frac{total\ basal\ area\ of\ species\ A}{total\ basal\ areas\ of\ all\ species}\ x\ 100 \quad (3)$$

$$\text{Importance value (IV)} = RF\ + Rd\ + RD \quad (4)$$

Biodiversity will be evaluated using standard ecological indices such as the Shannon-Wiener Diversity Index (H'), Shannon's Evenness Index (*E*), Simpson's

Index of dominance (λ), and Simpson's Index of diversity (*D*) (De La Torre et al., 2016; DENR-FMB, 2019). The indices were calculated as follows:

$$H' = -\Sigma_{i=1}^{s} p_i \times \ln(p_i) \quad (5)$$

$$E = \frac{H'}{lnS} \quad (6)$$

Where H' is the Shannon-Wiener diversity index, *E* is the Shannon's Evenness Index, *S* is the total number of species, p_i is the proportion of individuals belonging to the i^{th} species, and *ln* is the natural log.

$$\lambda = \left(\frac{\Sigma\, n(n-1)}{N(N-1)}\right) \quad (7)$$

$$D = 1 - \left(\frac{\Sigma\, n(n-1)}{N(N-1)}\right) \quad (8)$$

Where λ is the Simpson's Index of dominance, D is the Simpson's Index of Diversity, "n" is the number of individuals of a particular species, and N is the total number of individuals across all species.

RESULTS

TREE COMPOSITION AND SPECIES INVENTORY

Five tree species from five different families were recorded across the three sampling quadrats in Sitio "Sak-sak", Buanoy, Balamban, Cebu (Table 1). These include *Artocarpus altilis* (Moraceae), *Gmelina arborea* (Lamiaceae), *Swietenia macrophylla* (Meliaceae), *Terminalia catappa* (Combretaceae), and *Macaranga tanarius* (Euphorbiaceae). Among these tree species, *S. macrophylla* has the highest Importance Value (98.43%), followed by *A. altilis* (92.85%) and *G. arborea* (61.75%). Meanwhile, the least dominant species was the *M. tanarius* (18.15%). The total number of individual trees across all quadrats was 16, with *S. macrophylla* having the greatest frequency and density.

Table 1: Importance value components of recorded tree species in Sitio Sak-Sak, Buanoy, Balamban, Cebu.

Species	Total no. of trees	RF (%)	Rd (%)	RD (%)	IV (%)
Artocarpus altilis (Parkinson) Fosberg	3	18.75	11.11	62.99	92.85
Gmelina arborea Roxb. ex Sm.	4	25.00	33.33	3.42	61.75
Swietenia macrophylla King	6	37.50	33.33	27.60	98.43
Terminalia catappa L.	2	12.50	11.11	5.19	28.8
Macaranga tanarius (L.) Müll.Arg.	1	6.25	11.11	0.79	18.15
TOTAL	16	100.00	99.99	99.99	299.98

SPECIES DIVERSITY AND EVENNESS

The computed diversity indices of tree species across the three quadrats in Sitio Sak-Sak, Buanoy, Balamban, Cebu are presented in Table 2. The Shannon-Wiener Diversity (H') ranged from 0.868 to 1.055, with the highest value recorded in Quadrat 2 (Q2) and the lowest in Quadrat (Q3). The overall Shannon index for the site was 1.461, indicating a very low level of species diversity (Fernando et al., 1998, as cited in Coracero et al., 2021). The Shannon's Evenness Index (E) values ranged from 0.790 to 0.960, suggesting a relatively uniform distribution of individuals among the recorded species across quadrats. The computed Simpson's Index of Dominance (λ) values ranged from 0.200 to 0.400, with the highest value observed in Q3 and the lowest in Q2. The overall λ value was 0.208. The Simpson's Index of Dominance (1-λ) ranged from 0.600 to 0.800, with an overall value of 0.792. These values indicate variation in dominance and diversity among quadrats, with Q2 exhibiting the highest diversity and Q3 the lowest.

Table 2: Computed diversity indices of tree species across three quadrats in Sitio Sak-Sak, Buanoy, Balamban, Cebu.

Index	Q1	Q2	Q3	Overall
Shannon-Wiener Diversity Index (H')	0.950	1.055	0.868	1.461
Shannon's Evenness Index (E)	0.865	0.960	0.790	0.908
Simpson's Index of Dominance (λ)	0.300	0.200	0.400	0.208
Simpson's Index of Diversity (1-λ=D)	0.700	0.800	0.600	0.792

Note: Q refers to quadrat; Overall refers to all the sampling quadrats as a whole

CONSERVATION AND NATIVE STATUS OF RECORDED SPECIES

Based on the International Union for Conservation of Nature (IUCN) Red list of Threatened Species (2025), the conservation assessment (Table 3) revealed that most of the recorded tree samples such as *G. arborea*, *T. catappa*, and *M. tanarius*, fall under the Least Concern (LC) category, except for the *S. macrophylla* and *A. altilis*, which fall under the Endangered (EN) and Data Deficient (DD) categories, respectively.

Table 3: Conservation and native status of recorded tree species in Sitio Sak-Sak, Buanoy, Balamban, Cebu.

Species Name	Family	Common Name*	Conservation Status		Origin/ Native Status**
			IUCN (2025)	DENR (2017)	
Artocarpus altilis (Parkinson) Fosberg	Moraceae	Kulo	DD	NA	Naturalized
Gmelina arborea Roxb. ex Sm.	Lamiaceae	Gmelina	LC	NA	Introduced (Exotic)
Swietenia macrophylla King	Meliaceae	Mahogany	EN	NA	Introduced (Exotic)
Terminalia catappa L.	Combretaceae	Talisay	LC	NA	Naturalized
Macaranga tanarius (L.) Müll.Arg.	Euphorbiaceae	Binunga	LC	NA	Native

Note: DD = data deficient, LC = least concern, EN = endangered, NA = not assessed/available in the DAO No. 2017-11; *species' common names used in the Philippines; **based on Co's Digital Flora of the Philippines or Rojo's Revised Lexicon of Philippine Trees

None of the recorded species is included in the DAO No. 2017-11; thus, they are not assessed under the Department of Environment and Natural Resources

(DENR) categories. Additionally, according to Co's Digital Flora of the Philippines and Rojo's Revised Lexicon of Philippine Trees (Rojo, 1999), two species, *G. arborea* and *S. macrophylla*, are introduced to the Philippines. *A. altilis* and *T. catappa* are naturalized, while *M. tanarius* is native to the Philippines.

OBSERVED DISTURBANCES AND THREATS

Several human-related disturbances were documented within and around the established quadrats in Sitio Sak-Sak, Buanoy, Balamban, Cebu (Fig. 2). The most evident of these was the proximity of residential structures to the sampling sites. Some houses were located only a few meters away (Fig. 2A), with visible footpaths leading toward the sampling quadrats, suggesting a regular pathway by residents. Improperly disposed of solid waste, including plastic bottles, glass bottles, and plastic table mats (Fig. 2B-C), was observed beneath the trees and along pathways. These materials accumulated over time, reflecting inadequate waste-disposal practices in the vicinity. Several tree stumps and partially cut trunks were also recorded near and within the sampling quadrats, indicating recent tree felling activities likely for domestic use (Fig. 2D).

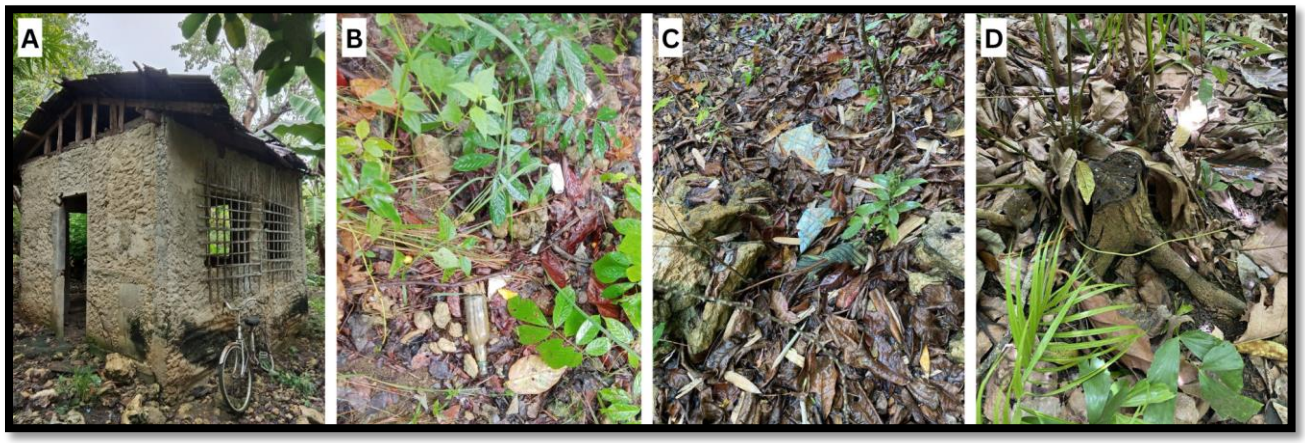

Figure 2: Observed anthropogenic disturbances and threats to tree diversity in Sitio Sak-Sak, Buanoy, Balamban, Cebu: abandoned human settlements near the sampling area (A), improperly disposed solid wastes (B–C), and intentional cutting of trees (D).

DISCUSSION

TREE COMPOSITION AND DOMINANCE PATTERNS

Two of the five tree species identified are considered invasive in the Philippines, namely, *G. arborea* (gmelina) and *S. macrophylla* (mahogany), mainly because they host insect pests (Joshi, 2006). Bruton and Merron (1985) define invasive species as species introduced or translocated into indigenous areas that can self-sustain in populations in natural or semi-natural environments. Among other known invasive species, *S. macrophylla* is one of the most threatening in the Philippines (Coracero, 2023).

S. macrophylla was intentionally introduced first in Manila, Philippines, in 1907 for forest production, timber, and reforestation (Baguinon et al., 2005; Pinol et

al., 2006). The plant became invasive due to its resilience and dominance in reproduction, dispersal, and growth. A single *S. macrophylla* tree can produce approximately 3,000 seeds per fruiting season, which are dispersed 20–40 m from the mother tree, facilitated by its morphologically winged structure, which is adapted for wind dispersal (Paderes, 2022). Its seeds can germinate in less than a month and can also germinate hypogeally inside the pod, as they contain food reserves. This means that young *S. macrophylla* can germinate in poor light conditions and initiate growth without photosynthesis. Their first young leaves are scales, and their photosynthetic leaves in subsequent growth do not require full sunlight, as they can survive in partial shade and are drought-resistant. *S. macrophylla* seedlings can also tolerate open areas, provided that the soil remains sufficiently moist. The aforementioned hardy attributes increase the likelihood that *S. macrophylla* will monopolize the forest floor (Pinol et al., 2006). This was evident in this study, where the understory vegetation in Quadrat 1 (not included in the tables but noted) was dominated by *S. macrophylla* seedlings growing relatively well.

S. macrophylla, with the highest Importance Value of 98.43%, indicates its high frequency, density, and dominance relative to other tree species in Sitio Saksak. This monopoly has become a national threat to biodiversity, affecting indigenous species and interactions (Pinol et al., 2006). As a bioinvasive species, mahogany threatens to compete with tree species that are vital in supporting tropical forest ecosystems (Baguinon et al., 2005): native dipterocarp and non-dipterocarp (Krishnapillay, 2004). The annually and regularly producing *S. macrophylla* tree dominates and outcompetes dipterocarps, which irregularly produce fruits and seeds every 4 to 5 years (Baguinon et al., 2005). *S. macrophylla* also possesses allelopathic capabilities, which were investigated both *in situ* and in laboratory conditions. *S. macrophylla* leaf litter was found to inhibit the growth of *Pterocarpus indicus* Willd. (narra) seedlings, a Philippine native tree (Galano and Rodriguez, 2021), and other plants under its canopy (Mukaromah et al., 2016).

Meanwhile, *G. arborea* is a fast-growing tree species native to India, Bangladesh, Sri Lanka, Myanmar, Southern China, Laos, Thailand, and Sumatra, Indonesia (Warrier et al., 2021). This exotic tree species was first introduced and planted in Minglanilla, Cebu, in 1960 by the Bureau of Forestry (Baguinon et al., 2005). As a pioneer species, it possesses opportunistic traits that can disrupt natural succession and dominate native plants (Herbito et al., 2024). Both *G. arborea* and *S. macrophylla*, known invasive species, have also been observed to thrive in urban areas such as Cebu City (Jumonong et al., 2022; Pansit, 2019). This may be attributed to past Department of Environment and Natural Resources (DENR) promotion of these species through reforestation programs (Alvarico, 2019) and initiatives to create greener urban spaces (Pansit, 2019). These known invasive species have been observed to co-exist with native species in secondary forests (Replan and Malaki, 2017; Alvarico, 2019) and protected areas (Herbito et al., 2024). Despite this, *G. arborea* and *S. macrophylla* disrupt natural ecosystem functions, alter the composition and structure of native plant communities, and outcompete local species, leading to a decline in native plant diversity.

DIVERSITY INDICES

The overall H′ for the study site is 1.461, which is classified as very low diversity according to the Fernando biodiversity scale (Fernando et al., 1998, as cited in Coracero et al., 2021. Similar studies assessing tree diversity in Cebu Province acquired various values for H'. Lillo et al. (2021) recorded an H' of 2.74 on average when evaluating the diversity of native trees at the Mount Capayas Key Biodiversity Area (KBA) in Cebu. Chavez and Lillo (2022) determined an average H' of 2.40 across the sampling sites in Mt. Lantoy KBA, Argao, Cebu. Although not directly related to tree assessment, De La Torre et al. (2016) measured an H'of 1.116 for the species of palms present at the peak of Mt. Manunggal. These values are considered moderate, low, and very low for tree diversity, respectively.

Outside Cebu Island, Paderes (2022) evaluated tree diversity in the interior and exterior of the mining site in Licuan, Baay, Abra. The H' in the interior and exterior of the mining site was 2.36 and 2.43, respectively, with both sites having a relatively low species diversity. Similarly, Coracero et al. (2021) evaluated the tree composition at Laguna State Polytechnic University, San Pablo, which recorded a very low tree diversity (H'= 1.705), higher than that observed in our study. *S. macrophylla* was also found to be present and abundant, if not dominant, in several of these studies (Chavez and Lillo, 2022; Coracero et al., 2021; Paderes, 2022), reflecting its widespread occurrence and invasive potential in both urban and forested environments.

Although our study had a very low diversity based on H', the calculated Shannon Evenness Index (E) for the overall tree communities is 0.908. The calculated E value is considered even when species are evenly distributed throughout the study area, and no species are significantly dominant (Fernando, 1998, as cited in Coracero et al., 2021). Similarly, although lower than in our study, Lillo et al. (2021) indicated that the distribution of their observed native trees is essentially even across their study site. In contrast, Paderes (2022) obtained lower *E* values for both areas in his study: 0.689 and 0.698 for the interior and exterior areas of the mining site, respectively. This could mean that the observed trees in the study site are not evenly distributed, and a few species dominate. Coracero et al. (2021) reported an even lower *E* value of 0.367, as their study had a single dominant species and several abundant species, resulting in lower evenness. Although this study reported a higher *E* value than previous reports, the result cannot necessarily be interpreted as indicating high evenness, given the limited number of individual tree species observed, differing from other studies that examined more than 100 individuals.

The Simpson's Index of Diversity ($1-\lambda=D$) across the study area was 0.792, indicating moderate tree diversity and relatively low species dominance (Napaldet, 2023). The corresponding Simpson's Index of Dominance (λ) value of 0.208 suggests that the probability of selecting two individuals from the same species at random is low. These results are consistent with the Shannon-Wiener Index (H' = 1.461), both showing limited species richness yet a relatively even distribution of individuals. Comparable Simpson's diversity values were reported by Lillo et al. (2021), who reported an average value of 0.895 across all sampling quadrats. The results of their study indicate that the native trees found in Mount Capayas KBA were in a high-diversity category. Chavez and Lillo (2022) also reported that their sampled trees in

Mount Lantoy KBA ranged from moderately high to high tree diversity, with four out of nine quadrats being relatively close to 1.0, that is, absolute (perfect) diversity. (The latter values were estimated from graphical data, as numerical labels were not provided.)

Compared with these studies (Chavez and Lillo, 2022; Lillo et al., 2021), the overall Simpson's diversity value of 0.792 in Sitio Sak-Sak, Buanoy, Balamban is notably lower, suggesting that the site supports fewer species and a less complex community structure. This moderate diversity could be attributed to anthropogenic disturbances, limited species recruitment, and the presence of invasive species such as *S. macrophylla*, which may outcompete native trees and other species for resources. The prevalence of such introduced species can alter soil conditions, light availability, and litter composition, thereby reducing opportunities for native species establishment (Baguinon et al., 2005; Galano and Rodriguez, 2021; Thinley, 2002).

CONSERVATION IMPLICATIONS

The conservation assessment of tree species in Sitio Saksak, Buanoy, Balamban, Cebu, reveals significant insights regarding the ecological condition of the study site. Based on the IUCN Red list of Threatened Species (2025), the majority of recorded tree species, such as *G. arborea*, *T. catappa*, and *M. tanarius*, are categorized as Least Concern (LC), while *S. macrophylla* and *A. altilis* fall under the endangered (EN) and Data Deficient (DD) categories, respectively. The dominance of LC species indicates that the area can support tree species capable of surviving moderately disturbed habitats, suggesting ecological stability and resilience. The absence of species listed under DAO No. 2017-11 further supports the observation that the study area is primarily composed of common, non-threatened tree species. This would mean that the area does not currently require the most stringent, species-specific conservation and protection efforts mandated under DAO No. 2017-11. Instead, the emphasis should be placed on general forest management and maintaining the existing ecological stability and resilience (DENR, 2017).

Despite the predominance of non-threatened species, the presence of *S. macrophylla*, an endangered species (IUCN, 2025), highlights an interesting conservation consideration of the study area. Although globally threatened by overexploitation and habitat loss (Grogan et al., 2014), in the Philippines, *S. macrophylla* is an introduced exotic species that has become ecologically invasive in several reforestation and secondary forest sites (Coracero, 2023; Galano and Rodriguez, 2021). Its widespread planting for timber production and soil rehabilitation led to the displacement of native flora, changes in litter composition, and the suppression of understorey plant species regeneration. Therefore, while its occurrence in Sitio Saksak demonstrates its adaptability and dominance, its proliferation may negatively impact the forest structure and biodiversity. Management interventions and continuous monitoring are thus essential to prevent its uncontrolled spread and to promote the restoration of native tree species of the area. Meanwhile, *A. altilis,* categorized as DD, lacks information on its wild populations and natural distribution; thus, continued monitoring and population assessment are vital to determine its conservation needs and ensure its sustainable use within the community, especially in the local settings.

The coexistence of native and introduced species in the study area has both ecological and management implications. Two species, *G. arborea* and *S. macrophylla*, observed in the study were introduced in the Philippines (Baguon et al., 2005; Pinol et al., 2006). Due to its rapid growth, *G. arborea* is commonly used in reforestation and timber production. However, it can still influence the dynamics and structure of the forest by competing for light, nutrients, and space (De la Cruz and Luna, 1994). *A. altilis* is a fruit-bearing species widely cultivated for its edible value and integrated into agroforestry systems (Mehta et al., 2023). While it is not invasive, its occurrence in forested areas reflects past human disturbance and land conversion (Lincoln et al., 2018). While these trees provide both ecological and economic benefits, it is still essential to implement a native-species management approach to conserve the area's natural biodiversity.

ANTHROPOGENIC PRESSURES

The anthropogenic disturbances documented in Sitio Sak-Sak, Buanoy, Balamban, Cebu, including the proximity of residential structures, improper waste disposal, and evidence of tree cutting, demonstrate a noticeable level of human interaction with the surrounding vegetation. These findings indicate that the area is not entirely isolated from community activities and is continuously influenced by nearby human settlements. Such interactions are similar to those described in other parts of Cebu and elsewhere in the Philippines, where urban development and resource use have altered forest composition and structure.

In Cebu City, Flores et al. (2020) and Jumonong et al. (2022) reported that rapid urban expansion and infrastructure development reduced native tree diversity and promoted the spread of ornamental and introduced species. A similar pattern can be seen in Sitio Sak-Sak, where the proximity of houses to the sampling quadrats shows how residential growth extends into natural areas. Although the area is not fully urbanized, dwellings near forest patches create an interface between human activity and natural vegetation. Residents living close to the site may use nearby trees for shade, construction materials, or other household needs, which increases the likelihood of disturbance.

The improper disposal of solid waste in Sitio Sak-Sak also mirrors conditions documented in other areas of Cebu. Alvarico et al. (2019) reported that household waste accumulation in Minglanilla contributed to declining tree diversity and degradation of local habitats. This is also evident outside Cebu, where Medecilo-Guiang et al. (2021) observed similar improper garbage disposal in the trails in Mt. Agad-Agad, Iligan City. Scattered plastic materials, bottles, and food wrappers in the Sitio Sak-Sak sampling area indicate insufficient waste management and frequent human access. These wastes were mainly concentrated near paths and open clearings, suggesting that residents pass through or use the area for domestic purposes.

Tree cutting observed in Sitio Sak-Sak also aligns with findings from other forested areas in Cebu. Rosales et al. (2018) and Lillo et al. (2024) reported that selective logging and small-scale wood extraction in Alcoy, Carcar, and Sibonga reduced native tree abundance and altered forest composition. Coritico et al. (2022) also documented rampant small-scale logging in the Marilog Forest Reserve, Davao City, where forest composition was drastically changed, leaving only limited

remnants of forest patches. In Sitio Sak-Sak, several cut stumps and felled trunks were recorded near and within the quadrats, indicating that similar extraction activities occur, though at a smaller scale. Such cutting may be for domestic use, such as firewood or construction materials, common in communities adjacent to forested lands (Lillo et al., 2019; Rosales et al., 2018).

The human disturbances identified in Sitio Sak-Sak are consistent with those documented across Cebu and other places in the Philippines. The area also exhibits similar conditions, such as proximity to human habitation, the presence of solid waste, and evidence of tree cutting, which contribute to vegetation disturbance. These indicate that Sitio Sak-Sak is subject to the same gradual ecological pressures as other forested areas in the province and across the Philippines, suggesting that human impacts extend beyond city environments and upland ecosystems. Without proper management, these disturbances could further alter the forest composition of Sitio Sak-Sak and could lead to a decline in tree diversity.

STUDY LIMITATIONS

Although effective in capturing representative species within aggregated tree communities, using a selective sampling approach may have introduced sampling bias. The recorded tree composition may not fully represent the entire Sitio Sak-Sak area because the quadrats were not randomly established. The study utilized only three 10 x 10 m quadrats, which may not have been sufficient to capture the whole landscape and diversity of the site, unlike other studies, which have utilized larger quadrat dimensions and number of quadrat quadrats used (Coritico et al., 2022; Lillo et al., 2019, 2020, 2021; Malayao and Mendoza, 2013) or transect lines (Chavez and Lillo, 2022). Species identification was based primarily on morphological characteristics and verified through digital and published botanical references. The absence of reproductive structures, such as flowers or fruits, in some specimens may have reduced the precision of taxonomic identification.

In addition, the study was constrained by adverse weather conditions during the data collection period. The Philippines experienced successive typhoons (bagyos) at the time of fieldwork (UN-OCHA, 2025), which posed safety risks to the researchers and prevented the establishment of additional sampling quadrats. As such, further sampling was halted to avoid potential hazards. Future studies are therefore recommended to expand sampling effort under more stable weather conditions, using the present findings as baseline or foundational data for long-term monitoring and more comprehensive assessments of tree diversity in Sitio Sak-Sak and adjacent areas.

CONCLUSION

The present study provides baseline information on the tree composition and diversity of Sitio Sak-Sak, Buanoy, Balamban, Cebu. A total of five tree species, belonging to five families, were recorded, with *G. arborea* and *S. macrophylla* dominating. Relative frequency, relative dominance, relative density, and importance value calculations further revealed that *S. macrophylla* (IV = 98.43%) dominated the tree community, indicating its strong ecological influence in the area. The overall Shannon–Wiener diversity index (H’ = 1.461) and Simpson's index of Dominance (1

– λ = 0.792) indicate very low to moderate tree diversity, suggesting limited species richness but a relatively even distribution of individuals. The dominance of *S. macrophylla*, an exotic and invasive species, suggests potential suppression of native flora and alteration of the site's ecological balance. Given its high seed production each fruiting season, measures to minimize its natural proliferation, such as limiting seedling establishment and supporting native species recovery, are essential to prevent further dominance in the area.

Although most recorded species are classified as Least Concern by the IUCN (2025), the presence of introduced and invasive trees emphasizes the need for careful monitoring and management. Anthropogenic disturbances, such as tree cutting, improper waste disposal, and the proximity of residential areas, further contribute to ecological pressures that may reduce regeneration potential and forest resilience. These findings highlight the importance of promoting native species in reforestation and urban green space initiatives in Balamban to restore natural biodiversity and minimize the dominance of invasive species. Future studies should include larger sampling plots, multiple seasons, and a broader spatial scope to capture a more comprehensive picture of tree diversity in the area. Strengthening local awareness, implementing waste management, and supporting community-based forest management programs are likewise recommended to maintain and enhance the ecological integrity of Sitio Sak-Sak and nearby forest fragments.

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