



Species richness, importance and conservation status of trees on natural forests in southern part of Mt. Malindang, Philippines

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Abstract. Trees are considered as critical indicators of forest's health and status which are essential for the continuous provision of ecosystem services. The inventory of trees in natural forests of the southern portion of Mt. Malindang Range Natural Park was conducted using a modified belt-transect method. All tree species with a diameter of 10 centimeters and above were identified and measured. Importance value and diversity index were computed, and endemism and conservation status of trees were assessed. A total of 46 tree species with 275 individuals belonging to 28 families of Angiosperms and two families of Gymnosperms were recorded. The diversity index ranged from 1.63 to 2.89 implied that the area had very low to moderate tree species diversity. The top abundant species with high importance include *Lithocarpus philippinensis*, *Lithocarpus mindanaensis*, *Shorea contorta*, *Melastoma malabatricum*, *Morella javanica*, *Gymnostoma rumphianum*, and *Cinnamomum mercadoi*. There were ten threatened species recorded. *Shorea contorta*, *S. squamata*, *S. negrosensis* and *S. polysperma* were considered critically endangered by the International Union of Conservation Nature. Results are vital for the protection and conservation of Mt. Malindang.

Key Words: importance, inventory, Mt. Malindang, natural forest, *Shorea*, transect.

Introduction. Mt. Malindang Range Natural Park (MMRNP) is one of the protected areas situated in the province of Misamis Occidental located in the Northwestern part of Mindanao, Philippines (RA 9304; RA 7586). It is also identified as one of the Key Conservation sites of the Philippines (Mallari et al 2001). In October 2011, the protected area (PA) was declared as an ASEAN Heritage Park (AHP) by Ministers of ASEAN Members State because of its unique biodiversity, ecosystems and outstanding universal values. Its recognition as important conservation area has corresponding responsibility to uphold the integrity of the area as representative in ASEAN Region by preserving the park's and maintain its scenic, educational, research and recreational and tourism values.

Before its designation as Natural Park, the Mt. Malindang Range was a logging concession area, but the operation stopped due to the logging ban sometimes in 1986 (Bugayong 2006). Practically, almost all matured trees in accessible areas were cut (Van Gardingen 1998) leaving the residuals and small trees. With the termination of the logging operation, it provides opportunities for residents to expand agricultural clearings (Cruz & Cruz 1990) and timber poaching activity for the area to be of open access (Bugayong 2006). Moreover, the presence of community near the forest collecting forest products created more pressure to forest resources and leaving behind little old growth

forest (Chechina 2015). Indeed, logging and timber poaching threaten diversity specifically trees (Li et al 2010; Lillo et al 2019). Consequently, anthropogenic activities (Rebugio et al 2007) contributed to forest fragmentation (Cayuela et al 2006) which eventually paved a way to forest denudation which is the primary cause of biodiversity loss or introduction of new exotic species (Hooper et al 2005).

The species richness and diversity of trees are fundamental to total forest diversity and to other forest-dependent species, both flora, and fauna (Rennols & Laumonier 2000). It is significant to know tree diversity to generate data needed for its conservation and protection endeavors (Amoroso et al. 2006; Baraloto et al. 2013; Malik & Nautiyal 2016). Knowing tree diversity of the forest area is imperative to gauge if the forest has coped with the various environmental pressures and the capacity of the species to regenerate naturally. Likewise, enough knowledge of tree diversity is a useful tool in determining the conservation value of tree species for proper prioritization and effective management.

A comprehensive study on species diversity was done in the Northern part of the protected area more than a decade ago (Arances et al 2004; Gomez-Roxas 2005; Amoroso et al 2006). But, with the vast area of the PA with 53,282 ha (DENR 2016), previous data cannot represent the whole Mt. Malindang. There is a need to assess the southern part relative to species diversity focusing on trees. The result of the study is helpful in improving database and generates a precise figure that practically represents tree diversity in the southern side Mt. Malindang. The study aimed to determine the species richness and degree of importance of the tree species in the southern part of Mt. Malindang Range Natural Park, Misamis Occidental.

Material and Method

Protocol. Before sampling, clearance was secured from the Protected Area Management Board and Philippine Army. The assessment team was then organized comprised of local guides as local researchers, Bantay lasang from the DENR-Protected Area Office and Technical personnel/researchers from Misamis University. An orientation was conducted to define specific roles of the team members that include area survey, quadrat establishment, geotagging, trees inventory (identification and collection of specimens) and documentation. The study was conducted on November 6-15, 2017.

Sampling area. The study area is located in the forest of Barangay Fertig Hills formerly known as Hoyohoy in Tangub City, Province of Misamis Occidental, Philippines (Figure 1).

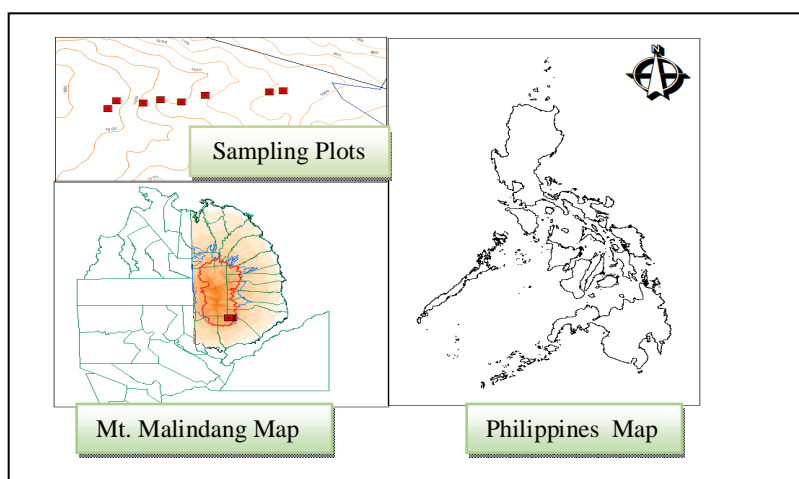


Figure 1. Location of the study area with sampling points in Mt. Malindang, Misamis Occidental, Philippines.

The site is characterized by undulating to steep slopes with elevation ranges from 1000 to 1600 masl. Based on the model developed by Fernando et al (2008), the sampling sites are lowland evergreen rainforest to tropical lower montane rainforest and mostly dominated with *Lithocarpus* species. The forest development is from young growth (lower portion) to old and increases in the upper portion (Table 1).

Table 1

Description of the sampling plots where the dominant species found

<i>Plot</i>	<i>Elevation (masl)</i>	<i>Forest type</i>	<i>Dominant species</i>
1	1194	Tropical lowland evergreen rain forest, intermediate growth.	<i>Lithocarpus philippinensis</i>
2	1273	Tropical lower montane rain forest, old growth.	<i>Lithocarpus philippinensis, Myrica javanica,</i>
3	1318	Tropical lower montane rain forest, old growth.	<i>Shorea contorta</i>
4	1375	Tropical lower montane rain forest, intermediate growth.	<i>Lithocarpus philippinensis, Lithocarpus mindanaensis, Myrica javanica, Shorea contorta</i>
5	1450	Tropical lower montane rain forest, old growth.	<i>Gymnostoma rumphianum</i>
6	1467	Tropical lower montane rain forest, old growth.	<i>Melastoma malabathricum</i>
7	1525	Tropical upper montane rain forest, old growth.	<i>Lithocarpus philippinensis</i>
8	1550	Tropical lower montane rain forest, intermediate.	<i>Gymnostoma rumphianum, Duabanga moluccana</i>

Data gathering. A two km transect line was established, and quadrats measuring 20 x 20 m in every 250 m interval along the transect line were measured and tagged. These quadrats were established in alternating directions along the perimeter of each quadrat. Corners were marked, and geo-tagged photos were taken in four cardinal directions.

All tree species with a diameter of ≥ 10 cm were identified and measured. The abundance, diameter at breast height (DBH) and merchantable height (MH) were determined. For not readily identified trees, voucher samples were collected, brought to the campsite, tagged and photographed. The online database, Co's Digital Flora of the Philippines (Pelser et al 2011) and works of Merrill (1923-1926) and Salvosa (1963) were used for identification. Hard to identify specimens were sent to experts for proper identification and verification.

The endemism and ecological or conservation status of the different species were assessed to determine the ecological importance of the vegetation in the area using CO's Digital Flora of the Philippines (2018), DENR Administrative Order No. 2017-11 and IUCN (2018).

Data analysis. To facilitate data analysis, all information from the inventory were encoded/tabulated in Excel worksheet. Indices for each species were calculated which include: relative density, relative dominance, relative frequency values and importance value. The Shannon diversity value for each plot was determined. The classification scheme on diversity developed by Fernando (1998) was used in the interpretation of the diversity index.

Results and Discussion. The southern part of Mt. Malindang is also the home of numerous species of trees as shown in Table 2. It showed a total 46 tree species with 275 individuals belonging to 28 families of angiosperms and tree species with five individuals under two families of gymnosperms. Among the families recorded, Myrtaceae family got the highest number of recorded tree species comprising six species of *Syzygium*. On the other hand, in the northern side of Mt. Malindang, according to the comprehensive study of Amoroso et al (2006) there were found 1,284 species of plants,

472 genera and 187 families. We found only 21.42% of the total species compared to the northern side. The location and elevation of the southern side may influence the number of species recorded for only up 1550 masl while in the northern side there are 2400 masl. The genus *Syzygium* is the largest in Myrtaceae being distributed in subtropical to tropical regions with valuable products including timber, horticultural, essential oils and other traditional medicinal purposes (Cock & Cheesman 2018). Myrtaceae was followed by Melastomataceae, Dipterocarpaceae, and Moraceae with three species each.

The present study also identified 21 endemic species comprising 45.65% of the total recorded trees. Of the endemic species, six species are only found in Mindanao. These are *Schefflera alvarezii*, *Macaranga ovatifolia*, *Syzygium rubrovenium*, *Syzygium hutchinsonii*, *Ixora crassifolia* and *Ternstroemia philippinensis* var *megacarpa*.

Figure 2 shows that *Lithocarpus philippinensis*, locally known as “gusukan puti” is the most abundant in the area. The species is believed to be remnants of logging operation since this kind of tree was considered lesser-known species with less commercial value at that time. The study of Amoroso et al (2006) revealed that *Lithocarpus* sp. is also the most abundant in three vegetative types (mossy forests, montane forest, and mixed dipterocarp forest) in the northern part of Mt. Malindang.

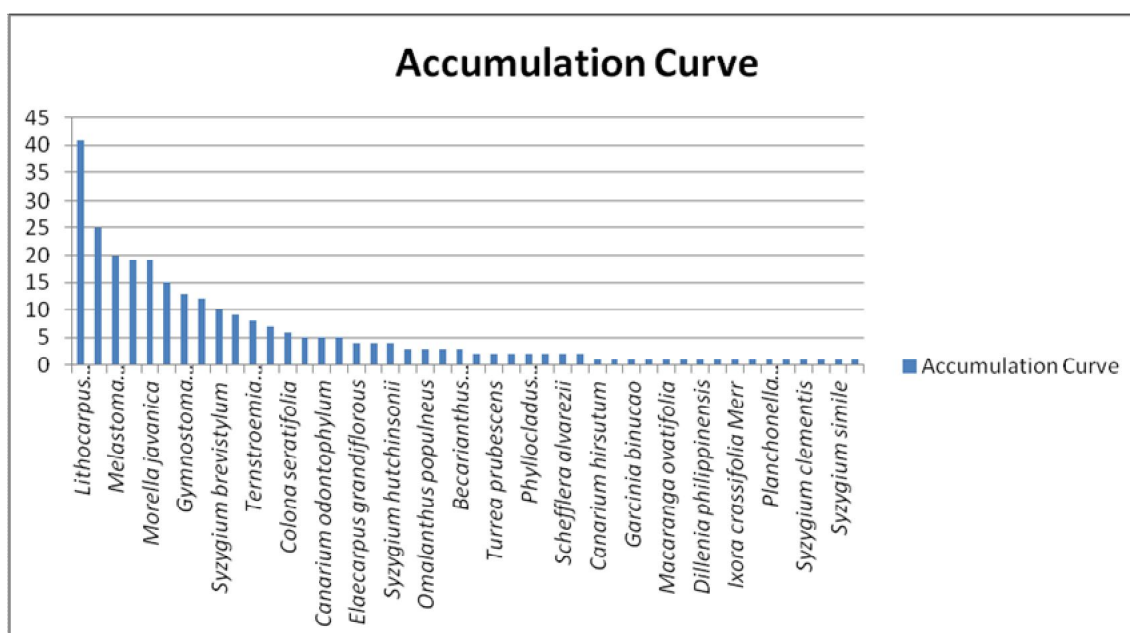


Figure 2. Species accumulation curve of trees recorded in the southern part of Mt. Malindang, Philippines.

Among the top eleven most abundant trees include *Lithocarpus philippinensis* (41), *Shorea contorta* (25), *Melastoma malabathricum* (20), *Lithocarpus mindanaensis* (19), *Morella javanica* (19), *Cinnamomum mercadoi* (15), *Gymnostoma rumphianum* (13), *Symplocos* sp. (12), *Syzygium brevistylum* (10), *Duabanga moluccana* (9) and *Ternstroemia megacarpa* (9).

To establish the rank relationship of each species, the importance values were computed and shown in Table 3. The ten most dominant species in the southern part of Mt. Malindang are *L. philippinensis*, *L. mindanaensis*, *S. contorta*, *G. rumphianum*, *M. javanica*, *C. mercadoi*, *M. malabathricum*, *D. moluccana*, *Symplocos* sp., and *S. brevistylum*. The *L. philippinensis* got the highest importance value because it is well represented in seven out of eight sampling plots. Aside from being the most abundant tree, its individuals are large compared with other trees occurred in the stand. The area favors to the *L. philippinensis* as the driving force behind the abundance and distribution of this species (Verberk 2012).

Table 2

List of tree species with endemism status recorded in the southern part of Mt. Malindang, Philippines

Angiosperm	<i>Species</i>	<i>Local name</i>	<i>Endemism</i>	<i>No. of individuals</i>
Chrysobalanaceae	<i>Maranthes corymbosa</i>	Santol-santol	Non-endemic	5
Anacardiaceae	<i>Mangifera caesia</i>	Manga-manga	Non-endemic	1
Araliaceae	<i>Schefflera alvarezii</i>	Taguima	Mindanao endemic	2
Symplocaceae	<i>Symplocos</i> sp.	Gapas-gapas	Non endemic	12
Burseraceae	<i>Canarium odontophyllum</i>	Salung-salung	Non-endemic	5
	<i>Canarium hirsutum</i>	Iba-iba	Non-endemic	2
Casuarinaceae	<i>Gymnostoma rumphianum</i>	Mountain agoho	Non-endemic	13
Clusiaceae	<i>Garcinia binucao</i>	Batuan	Philippine endemic	1
Calophyllaceae	<i>Calophyllum blancoi</i>	Bitanghol	Non-endemic	5
Dilleniaceae	<i>Dillinea philippinensis</i>	Katmon	Philippine endemic	1
Dipterocarpaceae	<i>Shorea contorta</i>	Danlugan	Philippine endemic	25
	<i>Shorea squamata</i>	Kalayaan	Philippine endemic	1
	<i>Shorea negrosensis</i>	Red Lauan	Philippine endemic	2
Elaeocarpaceae	<i>Elaeocarpus grandiflorus</i>	Tal – ot	Non-endemic	5
Phyllantaceae	<i>Glochidion camiguinense</i>	Bunot bunot	Philippine endemic	2
Euphorbiaceae	<i>Omalanthus populneus</i>	Bente bente	Non-endemic	3
	<i>Macaranga ovatifolia</i>	Hindang dalag	Mindanao endemic	1
Fabaceae	<i>Albizia lebbeck</i>	Hunop	Non-endemic	7
Fagaceae	<i>Lithocarpus mindanaensis</i>	Gusukan pula	Philippine endemic	19
	<i>Lithocarpus philippinensis</i>	Gusukan puti	Philippine endemic	41
Salicaceae	<i>Flacourtia rukam</i>	Malakube	Non-Endemic	2
Lauraceae	<i>Cinnamomum mercadoi</i>	Kalingag	Philippine endemic	15
Melastomataceae	<i>Astronia cumingiana</i> var <i>cumingiana</i>	Tungaw	Philippine endemic	1
	<i>Melastoma malabathricum</i>	Tungaw tungaw	Non-endemic	20
	<i>Beccarianthus pulcherrimus</i>	Tungaw tungaw puti	Philippine endemic	3
Meliaceae	<i>Turraea pubescens</i>	Hindang pula / sandana	Non-endemic	2
Moraceae	<i>Ficus baletae</i>	Balite	Philippine endemic	1
	<i>Ficus septica</i>	Lagnob	Non-endemic	4
	<i>Ficus nota</i>	Tubog	Non-endemic	3
Myricaceae	<i>Morella javanica</i>	Hindang	Non-endemic	19
Myrtaceae	<i>Syzygium rubrovenium</i>	Polayo	Mindanao endemic	1
	<i>Syzygium clementis</i>	Polayo (gamay dahon)	Philippine endemic	1
	<i>Syzygium blancoi</i>	Polayo pula	Philippine endemic	1

	<i>Syzygium simile</i>	polayo puti	Non-endemic	1
	<i>Syzygium hutchinsonii</i>	Sagimsim	Mindanao endemic	4
	<i>Syzygium brevistylum</i>	Sagimsim puti	Non-endemic	10
Rubiaceae	<i>Ixora crassifolia</i>	Mangongkong	Mindanao endemic	1
Sapotaceae	<i>Palaquium luzoniense</i>	Nato pula	Non-endemic	1
	<i>Planchonella macrantha</i>	Nato puti	Non- endemic	1
Lythraceae	<i>Duabanga moluccana</i>	Loktob	Non-endemic	9
Malvaceae	<i>Pterospermum obliquum</i>	Bayog	Philippine endemic	4
Pentaphyllaceae	<i>Ternstroemia philippinensis</i> var <i>megacarpa</i>	Tagilumboy	Mindanao endemic	9
Malvaceae	<i>Colona serratifolia</i>	Anilaw	Non-endemic	6
Gymnosperm				
Araucariaceae	<i>Agathis philippinensis</i>	Almaciga	Non-endemic	2
Podocarpaceae	<i>Nageia wallichiana</i>	Cedar / Mala-almacig	Non-endemic	1
	<i>Phyllocladus hypophyllus</i>	(Podocarpaceae)	Non-endemic	2
Total no. of families:	28 Angiosperm; 2 Gymnosperm			
Total no. of species:	46			
Total no. of individuals:	275			
Total no. of endemic species:	21 (45.65%)			

Table 3

Importance value (IV) of species arranged in rank from highest to lowest

Scientific name	Relative density (%)	Relative frequency (%)	Relative dominance (%)	Importance value
<i>Lithocarpus philippinensis</i>	13.95	5.15	23.84	42.93
<i>Lithocarpus mindanaensis</i>	6.46	4.41	9.97	20.84
<i>Shorea contorta</i>	8.5	3.68	6.14	18.32
<i>Gymnostoma rumphianum</i>	4.42	2.94	8.56	15.92
<i>Morella javanica</i>	6.46	4.41	4.43	15.31
<i>Cinnamomum mercadoi</i>	5.1	3.68	3.67	12.45
<i>Melastroma malabathricum</i>	6.8	4.41	0.53	11.74
<i>Duabanga moluccana</i>	3.06	2.21	6.34	11.61
<i>Symplocos</i> sp.	4.08	3.68	3.4	11.15
<i>Syzygium brevistylum</i>	3.4	3.68	1.13	8.21
<i>Ternstroemia megacarpa</i>	3.06	2.94	1.75	7.75
<i>Elaeocarpus grandiflorus</i>	1.7	2.94	3.11	7.75
<i>Colona serratifolia</i>	2.04	2.94	1.51	6.49
<i>Calophyllum blancoi</i>	1.36	2.94	1.85	6.15
<i>Ficus baletae</i>	0.34	0.74	4.77	5.84
<i>Omalanthus populneus</i>	1.02	2.21	2.46	5.69
<i>Albizia lebbeck</i>	2.38	2.21	0.72	5.31
<i>Syzygium hutchinsonii</i>	1.36	2.94	0.83	5.13
<i>Pterospermum obliquum</i>	1.36	2.94	0.5	4.8
<i>Ficus séptica</i>	1.36	2.21	0.73	4.3
<i>Canarium odontophyllum</i>	1.7	1.47	0.93	4.1
<i>Maranthes corymbosa</i>	1.7	1.47	0.82	3.99
<i>Becarranthus pulcherrimus</i>	1.02	2.21	0.53	3.76
<i>Ficus nota</i>	1.02	1.47	0.58	3.07
<i>Canarium hirsutum</i>	0.68	1.47	0.78	2.93
<i>Agathis philippinensis</i>	0.68	1.47	0.61	2.76
<i>Flacourtia rukam</i>	0.68	1.47	0.43	2.58
<i>Turraea pubescens</i>	0.68	0.74	1.02	2.43
<i>Phyllocladus hypophyllum</i>	0.68	1.47	0.15	2.3
<i>Planchonella macrantha</i>	0.34	0.74	1.08	2.16
<i>Syzygium clementis</i>	0.34	0.74	1.05	2.13
<i>Shorea negrosensis</i>	0.68	0.74	0.39	1.8
<i>Schefflera alvarezii</i>	0.68	0.74	0.34	1.75
<i>Syzygium simile</i>	0.34	0.74	0.31	1.38
<i>Syzygium blancoi</i>	0.34	0.74	0.3	1.37
<i>Garcinia binucao</i>	0.34	0.74	0.23	1.31
<i>Shorea squamata</i>	0.34	0.74	0.15	1.22
<i>Palaquium luzoniense</i>	0.34	0.74	0.15	1.22
<i>Syzygium rubrovenium</i>	0.34	0.74	0.11	1.19
<i>Ixora crassifolia</i>	0.34	0.74	0.11	1.18
<i>Macaranga ovatifolia</i>	0.34	0.74	0.09	1.17
<i>Glochydion camiguinense</i>	0.34	0.74	0.08	1.16
<i>Nageia wallichiana</i>	0.34	0.74	0.08	1.16
<i>Dillinea philippinensis</i>	0.34	0.74	0.09	1.16
<i>Astronia cumingiana</i>	0.34	0.74	0.07	1.14
<i>Mangifera caesia</i>	0.34	0.74	0.05	1.13

Among the species recorded, six are considered threatened globally (IUCN 2018) as shown in Table 4. Of these are four critically endangered species under Family Dipterocarpaceae. These include *Shorea contorta*, *Shorea squamata*, *Shorea negrosensis* and *Shorea polysperma*. *Cinnamomum mercadoi* and *Delinia philippinensis* are categorized as vulnerable species. In Philippine assessment, six are listed under DAO 2017-11 as vulnerable species. These include *Agathis philippinensis*, *Shorea contorta*, *Shorea negrosensis*, *Shorea polysperma*, *Cinnamomum mercadoi* and *Beccarianthus pulcherrimus*. There are also two species categorized as "other threatened species" that

include *Gymnostoma rumphianum* and *Nageia wallichiana*. All the protection and conservation efforts must give priority to the species above to prevent them from extinction specially the critically endangered ones.

Table 4

Tree species with their corresponding conservation status

Scientific name	Family name	Conservation status	
		IUCN 2018	DAO 2017-11
<i>Agathis philippinensis</i>	Araucariaceae		Vu
<i>Shorea contorta</i>	Dipterocarpaceae	CR	Vu
<i>Shorea squamata</i>	Dipterocarpaceae	CR	
<i>Shorea negrosensis</i>	Dipterocarpaceae	CR	Vu
<i>Shorea polysperma</i>	Dipterocarpaceae	CR	Vu
<i>Gymnostoma rumphianum</i>	Casuarinaceae		OTS
<i>Cinnamomum mercadoi</i>	Lauraceae	Vu	Vu
<i>Dillinea philippinensis</i>	Dilleniaceae	Vu	
<i>Nageia wallichiana</i>	Podocarpaceae		OTS
<i>Beccarianthus pulcherrimus</i>			Vu

Legend: CR - critically endangered; Vu - vulnerable; OTS - other threatened species.

Table 5 shows that among the eight sampling plots established in the southern part of Mt. Malindang, the first plot got the highest diversity index and described as moderate diversity while the eighth plot got the lowest diversity.

The lower quadrats were dominated by dipterocarps particularly *Shorea contorta*, while the lower montane forests are dominated by the species of genus *Syzygium* (Myrtaceae) and genus *Lithocarpus* (Fagaceae). Other relatively abundant species are *Symplocos* sp., *Morella javanica*, *Gymnostoma rumphianum*, and *Colona serratifolia*.

Table 5

Tree diversity in eight sampling plots of southern portion of Mt. Malindang, Philippines

Plot number	Shannon (H') index	Interpretation
1	2.89	Moderate
2	1.69	Very low
3	1.63	Very low
4	1.90	Very low
5	1.76	Very low
6	2.13	Low
7	1.95	Low
8	1.45	Very low

Conclusions. Based on the study, a total of 46 species of trees with a total of 275 individual trees were found in the southern part of Mt. Malindang Range Natural Park. Among the 46 species, 21 species are endemic to the Philippines of about 45.65% that supports a high species richness and endemism of trees of Mt. Malindang. Among the recorded species, *Lithocarpus philippinensis* got the highest importance value, and plot no. 1 is more diverse than other plots. It can be concluded that Mt. Malindang has remaining tracts of intact natural forests that need to be protected and conserved for its perpetual existence, ecological functions, ecosystem services, and watershed area.

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