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Woody Species Diversity and Conservation Status of Tumauni Watershed Natural Park, Isabela, Philippines

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ABSTRACT

The study was conducted within the Protected Area of the Tumauini Watershed Natural Park located in the municipality of Tumauini province of Isabela along the western part of the Northern Sierra Madre Natural Park. The protected areas in the Philippines cover 39% of the total forest cover. Protection and conservation of protected areas is significant due to the increasing habitat loss and biodiversity loss. The main objective of the study is to assess the tree diversity of the park using the modified belt-transect method adopted by the Department of Environment and Natural Resources (DENR). The transect line has a distance of 2 kilometers and a total of 9 stations. A Nested Quadrat was established along the transect line for tree identification. Results of the assessment show that the park has a species richness of 34 tree species in eight families and 26 genera. Species diversity indicates low (2.4) to very low (1.12) based on the Shannon-Weiner Diversity Index despite the high number of individuals found in the watershed area. The low diversity of the watershed is affected by the rampant anthropogenic activities and naturally-induced hazards occurring in the protected area. Shorea polysmerma is the most dominant and the most important species, with an Importance Value index of 38.78. Three species of trees were recorded as generalists in the area such as *Calophyllum blancoi, Shorea palosapis*, and *Ficus* sp.

INTRODUCTION

The Tumauini Watershed Natural Park was identified as a natural park through the Republic Act 11038, otherwise known as the “Expanded Natural Integrated Protected Areas System Act of 2018” from the previously Tumauini Watershed Forest Reserve. The park has a total land area of 6,509.38 hectares and is currently exposed to various anthropogenic activities. The Tumauini River within the watershed is one of the tributaries of the Cagayan River, which is identified as the longest river in the Philippines. The park was established across the municipalities of Tumauini and Cabagan in the northernmost part of the province of Isabela (Fig. 1).

Various rehabilitation projects were implemented in the lowland and upland areas of the watershed. Some of the projects in the area are the establishment of bamboo plantations along the riverbanks of the Tumauini River of the watershed and the National Greening Program under the Department of Environment and Natural Resources.

Several wildlife species, both flora and fauna, are found in the forest habitat types. The water resources of the watershed are primarily used for irrigation in the lowland agricultural areas of the municipality.

According to Malabrigo et al. (2015), the condition of a watershed is vital to its provision of goods and services. Unfortunately, a lot of watersheds in the Philippines are degraded due to various causes like deforestation and mining. Most of the threats observed in the TWNP are driven by unsustainable farming

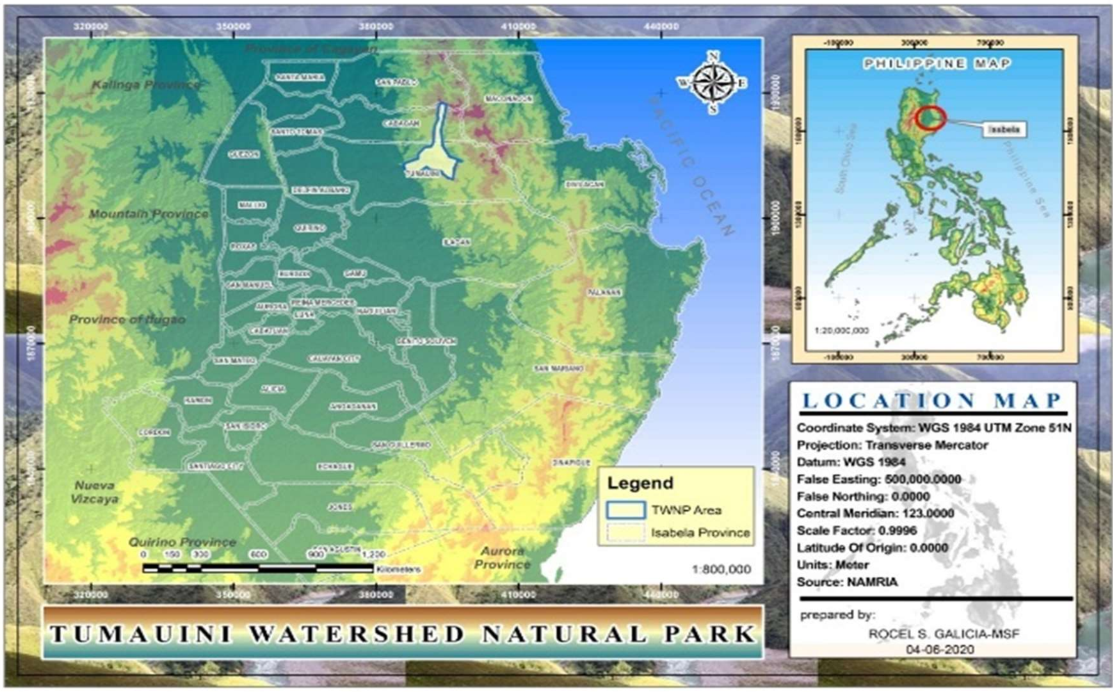


Fig. 1: Location map of the study area.

practices encroaching on the forest zones of the watershed. The TWNP area is relatively large, consisting of various plant communities and land use patterns. Quantification and identification of the tree species within the secondary forest of the watershed is a very challenging task for the management, considering the vast area to quantify. The presence of threatened, invasive, native, and economically important tree species is just a few of the characteristics/ status of species sought to discover in the study.

Nowadays, there is a rapid degradation of watersheds in the municipality due to the increase in population, continuous conversion of kaingin with a monoculture of banana production, as well as the expansion of corn-based farming with rampant use of agrochemicals and timber poaching. In addition, it is also vulnerable to hazards like typhoons and drought that lead to soil erosion and landslides, as well as quality and supply of water. If these conditions continually persist, the use of watershed natural resources will eventually be depleted.

Tree diversity assessment is an activity to monitor biodiversity status and ecosystem changes which is an important tool for managing important watershed and biodiversity conservation areas sustainably (Castillo et al. 2020). The tree diversity assessment in the TWNP serves as baseline data in the region of the watershed where the study was conducted. It is important to monitor forest areas such as declared protected critical watersheds to note any development or improvements that have happened since the declaration as a protected area.

The natural park's general goal is to protect outstanding natural and scenic areas of national or international significance for scientific, educational, and recreational use (eNIPAS Act 2018). One way to protect the park is through the enhanced restoration of forest cover in the denuded watershed area.

The outputs of the study were presented to the Protected Area Management Board of the TWNP for the awareness of the stakeholders. The data gathered, and findings of the research were turned over to the data manager of the board for its utilization. The output of the study is relevant for the updating of management plans, input for policy formulation, and for the appropriate conservation efforts to be implemented in the protected area.

The main objective of the study is to assess the tree diversity of the Tumauini Watershed Natural Park. The study specifically aimed to assess the Importance Value (IV) of trees, tree diversity, and conservation status of trees in the protected area.

MATERIALS AND METHODS

The study was conducted within the secondary forest of the Tumauini Watershed Natural Park located in the upland barangays of the municipality of Tumauini, province of Isabela in the northern part of the Philippines (Fig. 2). The

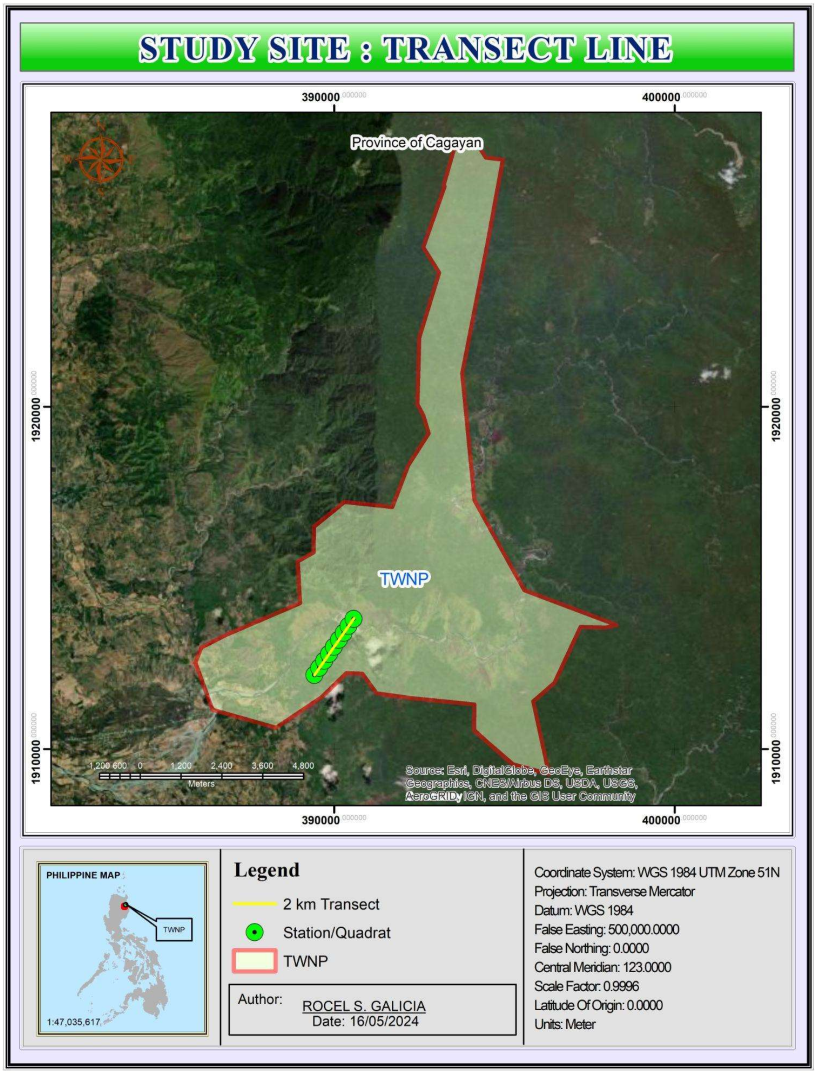


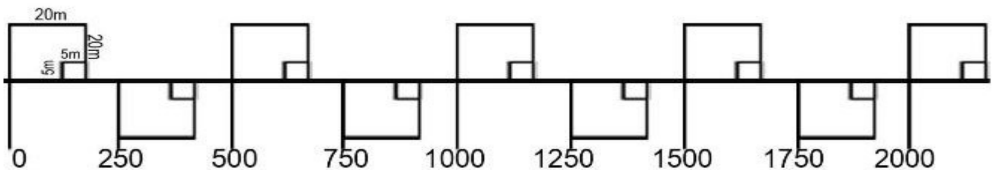
Fig. 2: Transect Line.

Northern Sierra Madre Natural Park, one of the largest Dipterocarp forests in the country is found on the eastern side of the TWNP.

A modified belt transect method with a 2 km transect line) was established for the tree diversity assessment (DENR-BMB, 2018-02). Quadrats were established every 250m interval in alternate positions (Fig. 3). A total of 8 plots with dimensions 20m x 20m. A transect line was established across the different elevation levels (258-462 masl) to represent different plant communities. Opportunistic Sampling was conducted along the transect to record some species outside the sampling areas, particularly along the transect, trails, riverbanks, grassland, and other areas. The data recorded during the opportunistic sampling was not part of the data analysis but listed as additional species that are relevant to the planning and management of the protected area.

All trees within the quadrats along the transect line with DBH of $\geq$10 cm were measured and identified. For the Upper Canopy Diversity Assessment, Diameter at Breast Height (DBH), Merchantable Height (MC), and Total Height (TH) were determined. Trees with $\leq$10cm diameters were identified within the 5m x 5m quadrat for the assessment of Understorey Diversity. Ground Cover diversity assessment was conducted within the 1m x 1m quadrat for the percent estimation of grasses and other ground cover species. All quadrats were assessed with a total area of 3,200 square meters or 400 square meters per quadrat.

The nested sampling is practically used in heterogeneous stratum, wherein the inventory site of the study is within a



(source: DENR-BMB, 2018-02)

Fig. 3: A 2-km Belt transect.

secondary forest. The forest is composed of different species of plants of various ages and biometry. The belt transect was used to represent the different land use patterns, elevation, soil fertility level, and other topographic characteristics of the site.

Photographs of fruit, flowers, leaves, and bark of trees were taken for verification and identification of unidentified species. Photographs were compared with the sample specimens in the Isabela State University Cabagan Herbarium and other online websites such as iNaturalist.org, Pl@antNet.org, Philippineplants.org, and The Catalogue of Plants 2021 for the verification and identification of unidentified species.

Data Analysis

Importance Value

$$\text{Density} = \frac{Number\ of\ individuals}{Area\ sampled}$$

$$\text{Relative Density} = \frac{Density\ for\ a\ Species}{total\ density\ for\ all\ species} \times 100$$

Frequency =

$$\frac{number\ of\ Quadrats\ where\ species\ A\ occurs}{total\ number\ of\ sample\ Quadrats} \times 100$$

Relative Frequency =

$$\frac{frequency\ of\ species\ A}{total\ frequency\ value\ of\ all\ species} \times 100$$

$$\text{Dominance} = \frac{basal\ area\ or\ volume\ for\ species\ A}{total\ area\ sampled} \times 100$$

Relative Dominance =

$$\frac{dominance\ of\ species\ A}{total\ dominance\ value\ of\ all\ species} \times 100$$

Importance Value = Relative Frequency + Relative Dominance + Relative Density

Diversity Index

$$\text{Diversity Index (H')} = -\sum_{i=1}^{n} (pi * LN\ pi)$$

The Diversity Index is analyzed based on the Classification scheme by Fernando et al. (1998)

Simpson Diversity Index

The Simpson Diversity Index of the protected area was computed using the formula

$$D = \Sigma ni(ni-1)/N(N-1)$$

where:

ni: The number of organisms that belong to species *i*

N: The total number of organisms

The value for Simpson's Diversity Index ranges between 0 and 1. The higher the value, the lower the diversity.

RESULTS AND DISCUSSION

The study area is within the secondary forest of the protected area with an elevation ranging from 258 meters to 462 meters above sea level. The location of the study is the transition zone of the Molave and Dipterocarp forests. Sporadic patches of natural grasslands and agricultural lands as a result of land conversion were observed in the area.

The transect line was established, representing the different elevations of the watershed, starting from Quadrat One (Q1) with an elevation of 258 meters above sea level to 462 m above sea level of Quadrat Eight (Q8). The transect line from Q1 to Q4 is along the creek while Q5 to Q8 are along the old logging road of the area.

A total of 34 tree species belong to 19 families and 26 genera (Table 2).

Moraceae was found to be the most speciose among the 19 families with five species, followed by Euphorbiaceae (4 spp.), Dipterocarpaceae (4 spp.), Fabaceae (3 spp.), and Lauraceae (3 spp.), as shown in Table 2.

Table 1: Classification scheme for diversity index by Fernando et al. 1998 (as cited in Baliton et al. 2017).

Relative Values	Shannon (H') Index
Very High	3.5 and above
High	3.0-3.49
Moderate	2.5-2.99
Low	2.0-2.49
Very Low	1.9 and below

Table 2: Identified Tree Species.

Scientific Name	Family Name
Calophyllum blancoi Planch. &Triana	Callophylaceae
Canarium ovatum Engl.	Burseraceae
Celtis luzonica Warb.	Cannabaceae
Chisocheton pentandrus (Blanco) Merr.	Meliaceae
Dillenia luzoniensis (S.Vidal) Martelli	Dilleniaceae
Dracontomelon dao (Blanco) Merr.	Anacardiaceae
Endospermum peltatum Merr.	Euphorbiaceae
Fagraea racemosa Jack ex Wall	Gentianaceae
Ficus minahasse (Teijsm. &Vriese) Miq.	Moraceae
Ficus nota (Blanco) Merr.	Moraceae
Ficus septica Burm.f.	Moraceae
Ficus sp.	Moraceae
Ficus variegata Blume	Moraceae
Gomphandra luzoniensis (Merr.) Merr.	Stemonuraceae
Goniothalamus elmeri Merr.	Annonaceae
Kleinhovia hospita L.	Malvaceae
Lithocarpus castellarnauianus (S.Vidal) A.Camus	Malvaceae
Litsea cordata (Jack) Hook. f.	Lauraceae
Litsea glutinosa (Lour.) C.B. Rob.	Lauraceae
Macaranga tanarius (L.) Müll. Arg.	Euphorbiaceae
Mallotus echinatus Elm.	Euphorbiaceae
Mangifera altissima Blanco	Anacardiaceae
Neonauclea bartlingii (DC.) Merr.	Rubiaceae
Neotrewia cumingii (Müll.Arg.) Pax&K. Hoffm.	Euphorbiaceae
Ormosia calavensis Blanco	Fabaceae
Palaquium lanceolatum Blanco	Sapotaceae
Phoebe sterculioides (Elmer) Merr.	Lauraceae
Pouteria macrantha (Merr.) Baehni	Sapotaceae
Pterocarpus indicus Willd.	Fabaceae
Shorea contorta S.Vidal	Dipterocarpaceae
Shorea guiso (Blanco) Blume	Dipterocarpaceae
Shorea palosapis (Blanco) Merr.	Dipterocarpaceae
Shorea polysperma (Blanco) Merr.	Dipterocarpaceae
Syzygium simile (Merr.) Merr.	Myrtaceae

The study on the floristic diversity of the Binaba Watershed (Sarmiento & Mercado 2019) showed a similar result where Moraceae is the most dominant family, followed by Euphorbiaceae. Guingab's (2019) study on the diversity and species composition of the Northern Sierra Madre Natural Park revealed that Euphorbiaceae, Moraceae, Fabaceae, and Lauraceae were among the top ten most speciose families in all forest types. Similar studies on the diversity and species composition of the world's tropical forests revealed that Euphorbiaceae is one of the most dominant families (Pahlevani et al. 2017). These qualitative data indicate similarities in the species composition of tropical forests in the Pacific region, including the Tumauini Watershed Natural Park.

The abundance of Moraceae and Euphorbiaceae in the area indicates that TWNP is a secondary forest, and the presence of Dipterocapaceae indicates the type of forest, which is a mixed dipterocarp forest. The findings of the study are similar to the study of Aureo et al. (2021) conducted within the secondary-growth forest of Mt. Bandila-an Forest Reserve in the Philippines. Moraceae and Euphorbiaceae are among the 6 families dominant in the area.

Quadrats One (Q1) to Q3 were all established along the creek, while the rest were established along the old logging trail. The genus Ficus of the family Moraceae is mostly found in riparian areas in the country (Malabrigo et al. 2014) and is a good indicator of water quantity in a particular area. These species include *Ficusmina hassae, Ficus nota, Ficus septica, Ficus variegata*, and unidentified *Ficus*. Species of Euphorbiaceae, like the *Macaranga,* are pioneer species in the secondary forest.

Relative Density

Results of the study showed that the highest relative density among the 34 tree species identified is *Ficus nota,* with a value of 10.71% (Fig. 4). Relative density shows the numerical strength of the species in relation to the total.

Malabrigo et al. (2014) stated that Ficus nota (Fig. 5) is one of the most important species in riparian areas. It was observed particularly in the Kaliwa River Watershed, a portion of the Sierra Madre Mountain Range with a relative density of 9.35%; the result of the study in the TWNP is much higher than the Relative Density of Kaliwa River of about 1.36%. Similar to other watersheds, *Ficus nota* are usually observed and dispersed, especially along the water bodies and moist areas of the watersheds.

Relative Frequency

Result of this study shows that *Shorea palosapis*, Ficus sp., and *Calophyllum blancoi* have the highest relative frequency value of 7.25% among the 34 species within the quadrats (Fig. 6). These three species of trees frequently appeared in the different quadrats established. This indicates good regeneration performance in the area despite the presence of natural and man-made threats.

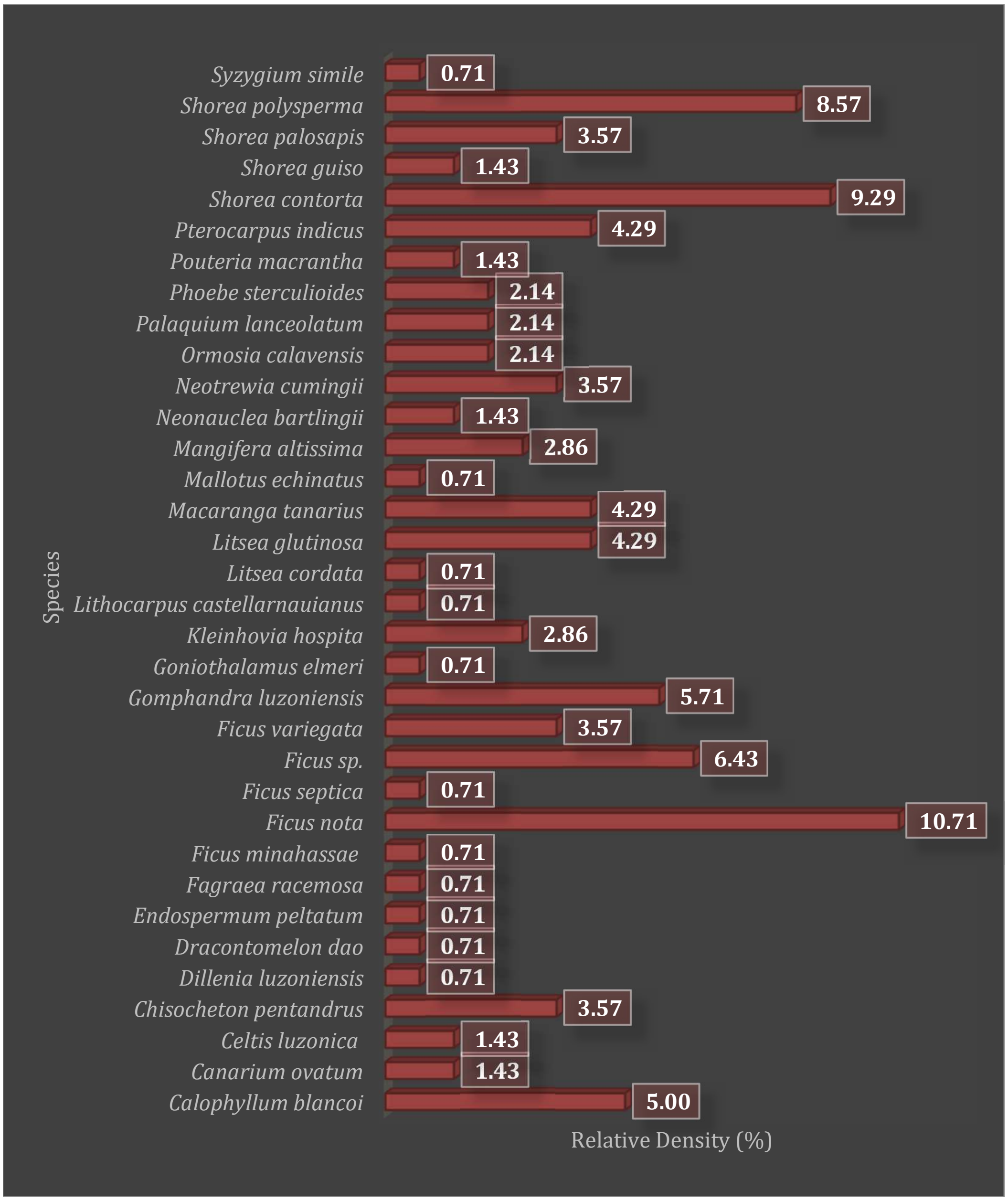


Fig. 4: Relative Density.

Calophyllum blancoi (commonly known as bitanghol) is a generalist species (Fig. 7). According to Guingab (2018), the most widespread species in the NSMNP is bitanghol, which occurs in all forest types except in mangrove forests. The same species was recorded as a generalist in the western slope of Mt. Pangasugan in Leyte Island as it occurred in all altitudinal vegetation zones (Gerhard & Belonias 2011).

Dipterocarps were expected to occur in all quadrats because the vegetation type of the area is a mixed dipterocarp forest but only *Shorea palosapis* gave the highest relative frequency among four dipterocarp species. This means that other dipterocarps are specialists in the area. The wide dispersal of Ficus species in the area is an indicator of the presence of fruit bats, which play an important role in the reproduction of the species in natural forests (Preciado

Fig. 5: *Ficus nota*.

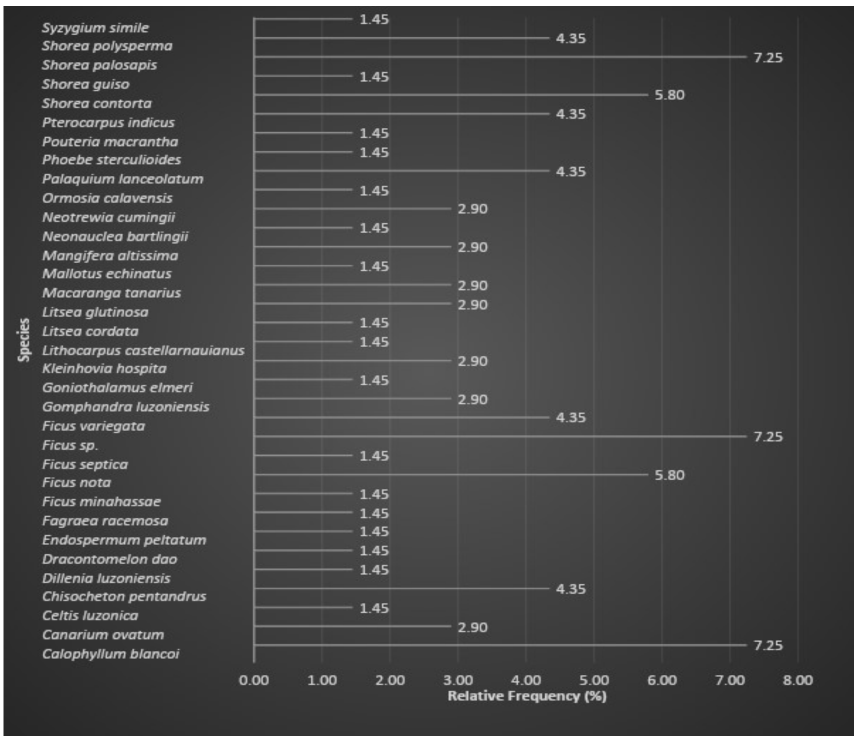


Fig. 6: Relative Frequency.

Benítez et al. 2015). Likewise, the presence of this genus indicates the possible presence of other wildlife species, like birds, which adds to the ecological value of the area.

Moraceae, specifically Ficus spp. found to be significant in secondary forests in the tropics, large Ficus species of trees are more effective restoration agents than other remnant trees in disturbed landscapes (Cottee-Jones et al. 2016). The occurrence of generalists such as Ficus sp., *Calophyllum blancoi,* and *Shorea palosapis* with high relative frequency value can contribute to the immediate rehabilitation of the fragmented areas of the park. The management board of the protected area can use these species of trees as the main commodity for reforestation because it is proven to have the

Fig. 7: *Calophyllum blancoi*.

Fig. 8: *Shorea polysmerma*.

capacity to spread and survive in the different elevations of the park.

Relative Dominance

Based on this study, *Shorea polysmerma* (Fig. 8) has the highest relative dominance index of 25.86% among the other 34 species of trees within the sampling area.

The dominance value of the species is influenced by the basal area covered. In this study, *S. polysperma* found in Quadrat 8 showed dominance with a diameter class ranging from 90cm to 110cm.

Shorea polysperma is one of the two most abundant species in five watersheds in Samar (Quimo 2016). The dominance of this species in TWNP (Fig. 9) indicates a high economic value of the forest, specifically the timber produced, and needs to be monitored and protected for the risk of illegal timber harvesting.

Importance Value (IV)

The result of this study revealed that *Shorea polysperma* has the highest IV of 38.78 among the 34 species of trees, followed by *Chisocheton pentandrus* with an IV of 22.18 (Fig. 10).

The species with the least IV is *Litsea cordata,* with a value of 2.30. This species has a DBH of 12cm, a total height of 10m, and one individual. It was located at Quadrat 5. Among the 34 species identified within the eight quadrats, *S. polysperma* is the most important species. It was

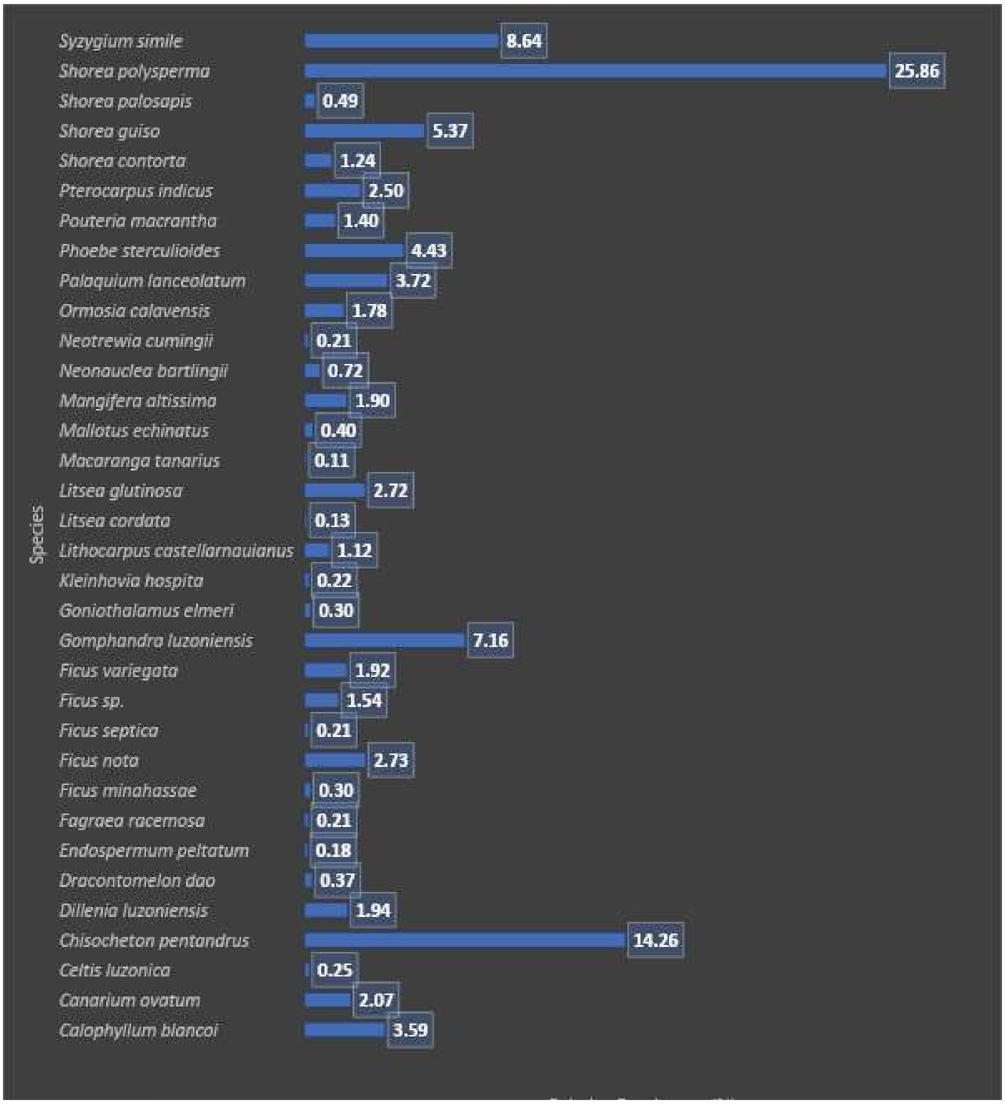


Fig. 9: Relative Dominance Index %.

previously classified as a Critically Endangered species in the 2013 IUCN Red List. The two species having a high IV are influenced by the DBH gained, basal area, number of individuals/count, and frequency. The Importance Value can reach a maximum value of 300, which is the total value of the three indices: Relative Density, Relative Frequency, and Relative Dominance.

Shannon-Wiener Diversity Index

The result of the study shows that Quadrat 8 is the most diverse among all quadrats, with a diversity index of 2.40, while the least is Quadrat 1, with a diversity index of 1.12 (Fig. 11).

Among the quadrats, the highest in terms of species richness and number of individuals was found in Quadrat 8 and it is the factor that influenced the diversity index of the area.

However, based on the classification scheme cited in the Manual on Biodiversity Assessment and Monitoring System for Terrestrial Ecosystems of the DENR (Table 1), Quadrat 1 and Quadrat 6 have "Very Low" values, while the others have "Low" values.

The result indicates immediate protection and rehabilitation of the protected area. Enrichment planting can arrest the status of tree diversity. The scenario is similar in other areas of the Philippines, which is commonly due to the rampant anthropogenic activities in protected areas, such as timber poaching and land conversion, among others (Alaman et al. 2019).

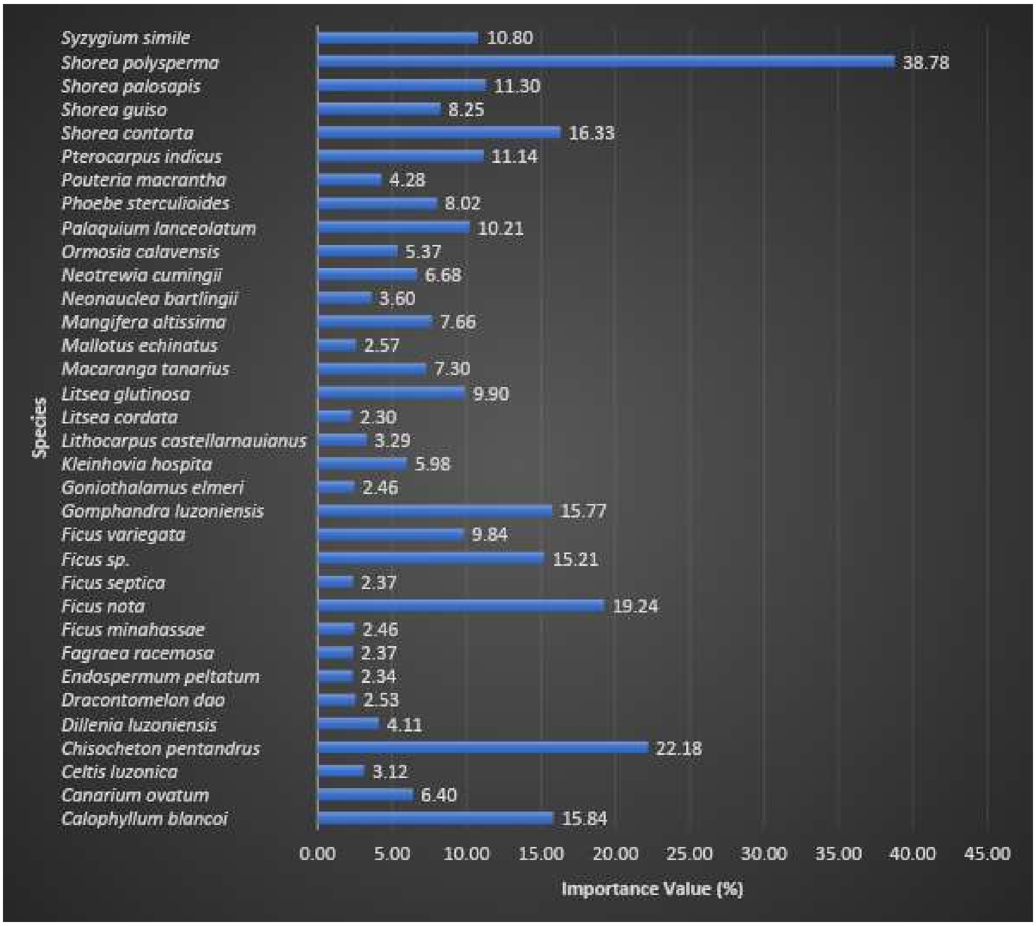


Fig. 10: Importance Value.

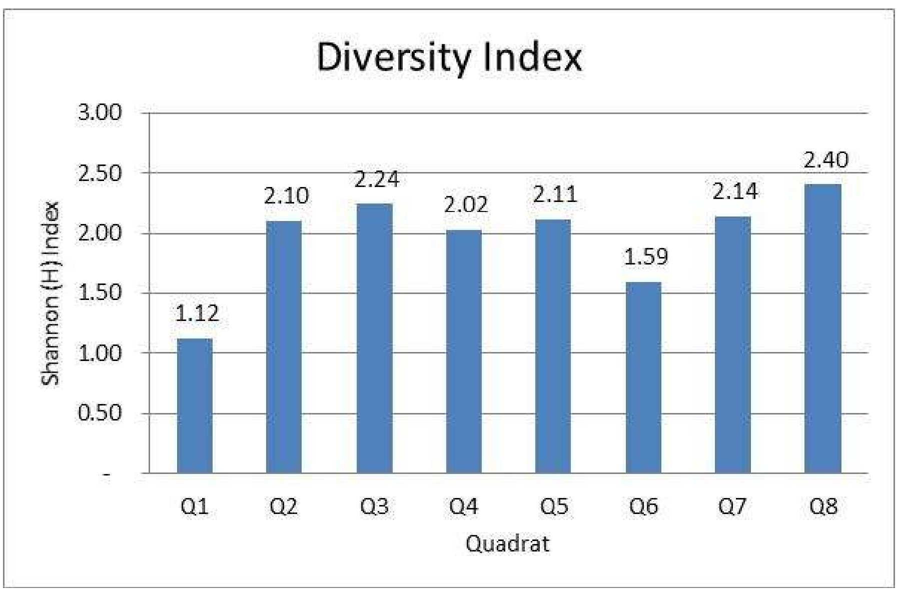


Fig. 11: Shannon-Wiener diversity index in TWNP.

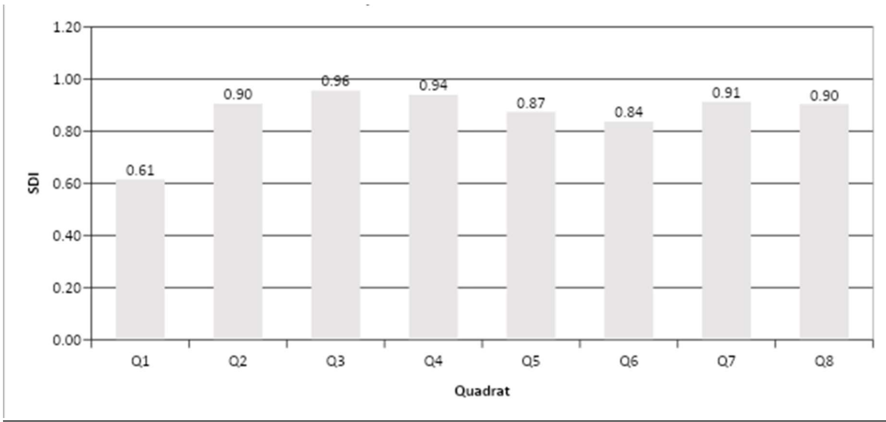


Fig. 12: Simpson's Diversity Index.

Fig. 13: Species samples through opportunistic sampling.

Quadrat 1 had the least diversity among all quadrats. The trees have a smaller diameter, less than 10cm dbh, which is outside the range of a diameter class criteria for the 20 x 20 m quadrat. The trees, however, were identified and recorded on the opportunistic sampling classification.

Simpsons Diversity Index

Results of the study showed that among all quadrats, Q3with the highest SDI value of 0.96, followed by Q4 (0.94) and Q7 (0.91), as shown in (Fig. 12).

Opportunistic Sample Collections

Although opportunistic sample collection outside the quadrats was not a part of the study, this may contribute to the overall understanding of the diversity of the area. Species of woody and non-woody plants were collected and identified outside the sampling area, some of these are species found along the trails, riverbanks, grassland, and other areas (Fig. 13).

An aggregate of 49 species of trees, shrubs, herbs, and grasses were identified (Table 3). The result of the opportunistic sampling showed a high diversity of flora in comparison to the area sampled.

Conservation Status

Based on the 2021 IUCN Red List and Department

Table 3: Identified plant species within the opportunistic sampling.

Common Name	Scientific Name	Family Name
Bogus	*Acalypha amentaceae*	Euphorbiaceae
Putian	*Alangium javanicum*	Cornaceae
Langil	*Albizia lebbeck*	Fabaceae
	Alseodaphne sp.	Lauraceae
Binayuyu	*Antidesma ghaesambilla*	Phyllanthaceae
Kamansi	*Artocarpus altilis*	Moraceae
Antipolo	*Artocarpus blancoi*	Moraceae
Balinghasai	*Buchanania arborescens*	Anacardiaceae
Ilang ilang	*Cananga odorata*	Annonaceae
Pagsahingin	*Canarium asperum*	Burseraceae
Piling Liitan	*Canarium luzonicum*	Burseraceae
	Carica papaya	Caricaceae
Pugahan	*Caryota cumingii*	Areacaceae
Kalingag	*Cinnamomum mercadoi*	Lauraceae
Bakayau	*Cleistanthus myrianthus*	Phyllanthaceae
	Clerodendrum sp.	Verbenaceae
Kape	*Coffea Arabica*	Rubiaceae
	Dysoxylum parasiticum	Meliaceae
Malakaniue	*Elattostachys verrucosa*	Sapindaceae
Gubas	*Endospermum peltatum*	Euphorbiaceae
	Eschweilera sp.	Lecythidaceae
Bugauak	*Evodia confuse*	Rutaceae
Balatbuaia	*Fagraea racemose*	Loganiaceae
Aplas	*Ficus irisana*	Moraceae
Tabgun	*Ficus ruficaulis*	Moraceae
	Flamingia sp.	Fabaceae
Gmelina	*Gmelina arborea*	Lamiaceae
	Goniothalamus macrophyllus/elmeri	Annonaceae
	Hydnocarpus sp.	Salicaceae
	Kayea sp.	Clusiaceae
Amamali	*Leea aculeate*	Leeaceae
	Leptospermum amboinense	Myrtaceae
	Lithocarpus castellarnauianus	
Bangulo	*Litsea garciae*	Lauraceae
	Litsea varians	Lauraceae
	Macaranga stonei	Euphorbiaceae
Bangkal	*Nauclea orientalis*	Rubiaceae
Malauisak	*Neonauclea reticulate*	Rubiaceae
mamalis	*Pittosporum pentandrum*	Pittosporaceae
Litid	*Poikilospermum erectum*	Urticaceae
Galamay amo	*Schefflera elliptica*	Araliaceae
	Selaginella delicatula	Selaginellaceae
Ligas	*Semecarpus cuneiformis*	Anacardiaceae
	Sida rhombifolia	Malvaceae
	Solanum sp.	Solanaceae
	Trametes versicolor	Polyporaceae
	Trema micrantha	Cannabaceae
	Trigonostemon villosus	Euphorbiaceae
Salagong sibat	*Wilkstroemia lanceolata*	Thymelaeaceae

Administrative Order 2017-11 of the DENR, 15 species of trees are classified as Least Concern, 1 Endangered, 5 Vulnerable, 1 Other Threatened Species, and 1 Near Threatened among the 34 species identified in the TWNP (Table 4).

Table 4: Conservation Status of Species in TWNP.

Scientific Name	Category
Calophyllum blancoi Planch. &Triana	
Canarium ovatum Engl.	OTM
Celtis luzonica Warb.	VU
Chisocheton pentandrus (Blanco) Merr.	LC
Dillenia luzoniensis (S.Vidal) Martelli	VU
Dracontomelon dao (Blanco) Merr.	VU
Endospermum peltatum Merr.	LC
Fagraea racemosa Jack ex Wall	
Ficus minahasse (Teijsm. &Vriese) Miq.	
Ficus nota (Blanco) Merr.	LC
Ficus septica Burm.f.	LC
Ficus sp.	
Ficus variegata Blume	LC
Gomphandra luzoniensis (Merr.) Merr.	
Goniothalamus elmeri Merr.	LC
Kleinhovia hospita L.	LC
Lithocarpus castellarnauianus (S.Vidal) A.Camus	NT
Litsea cordata (Jack) Hook. f.	LC
Litsea glutinosa (Lour.) C.B. Rob.	LC
Macaranga tanarius (L.) Müll. Arg.	LC
Mallotus echinatus Elm.	
Mangifera altissima Blanco	
Neonauclea bartlingii (DC.) Merr.	LC
Neotrewia cumingii (Müll.Arg.) Pax&K. Hoffm.	
Ormosia calavensis Blanco	
Palaquium lanceolatum Blanco	
Phoebe sterculioides (Elmer) Merr.	
Pouteria macrantha (Merr.) Baehni	
Pterocarpus indicus Willd.	EN
Shorea contorta S.Vidal	LC
Shorea guiso (Blanco) Blume	VU
Shorea palosapis (Blanco) Merr.	LC
Shorea polysperma (Blanco) Merr.	VU
Syzygium simile (Merr.) Merr.	

Note: OTM- Other Threatened Species; VU- Vulnerable; EN- Endangered; LC- Least Concern; NT-Near Threatened.

Recording of the species with Conservation Status is very significant both for the government and interested groups, particularly for the possibility of propagation and conservation, as mentioned by Chan (2019). The EN and VU species found in the area have known potential timber value used for construction and furniture-making. This is the main reason for the declining quantity in the wild.

CONCLUSION

Results of the study showed that the TWNP has a total of 34 species from 26 genera of the eight families of trees within the 2-km transect line. Among the eight tree families, Moraceae has the highest number of species, such as *Ficus minahassae*, *Ficus nota, Ficus septica, Ficus variegata,* and an unidentified Ficus sp. Among 34 species, Ficus nota has the highest relative density with a value of 10.71%, followed by *Shorea contorta* with a value of 9.29%. Three species have the same relative frequency of 7.25%, which is the highest among all species, namely, *Shorea palosapis*, *Ficus* sp., and *Calophyllum blancoi*. The most dominant and important species is *Shorea polysperma,* with an Importance Value of 38.78%. The study also revealed that quadrat 8 has the highest diversity index of 2.40. All quadrats, however, indicated "low" diversity indexes. Results showed that Quadrat 3 has the highest Dominance Index of 0.96 among the rest of the quadrats.

The study reveals the need to regulate the harvesting and trading of *Pterocarpus indicus,* an endangered tree species found in the area. By all counts and with proven valid and reliable results, the secondary forest of the protected area is generally low in tree diversity. The status of the tree diversity area is affected by the rampant anthropogenic activities and naturally induced hazards occurring in the protected area, as observed during the assessment along the trails.

In conclusion, it is clear that *Shorea polysperma* is the most important tree species in the area; this tree belongs to the Philippine Mahogany group having high-quality timber and high economic value. Therefore, the forest areas of the watershed need constant monitoring to protect the economically significant native species of trees from the risk of extraction.

RECOMMENDATIONS

The transect method has been used in the assessment of flora and fauna of protected areas. The method is designed to cover the various ecosystems and vegetation of the protected area. Due to the diversified cover, forest types, and land uses of the study area, more transect lines are recommended to increase the sampling intensity for future assessment and research initiatives in the area. This is to provide a more comprehensive output.

An inclusive and intensive assessment of the flora is highly recommended, as observed in the opportunistic sampling wherein a greater number of species were listed outside the sampling area. Future research initiatives in the area shall include the fauna species for a better appreciation of the overall biodiversity of the watershed.

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