Vegetation Analysis of the Pasonanca Natural Park, Zamboanga City, Philippines

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Abstract

This study was a vegetation analysis of the Pasonanca Natural Park. The lack of recent biological studies focusing on the flora of the park has left many of its species, including their status unknown. Some of the species are of global conservation importance. The sampling sites covered Canucutan, Muruk 3 and Baluno. Three stations were established at intervals of 300 m each in Canucutan and Muruk 3 and 4 stations in Baluno. Five nested quadrats, each measuring 100 m^2 with subplots measuring 5m x 5m and 1m x 1m were plotted at intervals of 10 m in each station. There were 283 individuals belonging to 45 species, 27 genera and 25 families. The taxonomic composition was mainly angiosperms and Pteridophytes comprising 37 (82.22%) and 8 (17.78%) respectively. There were 30 species with known geographic range; and of these, 60% were endemic or native, 33.33% were cosmopolitan and 6.67% were exotic. Data on species composition, distribution, importance values, and diversity indices show that species diversity is high in all 3 sites. Species evenness though was fairly high in Canucutan compared to Muruk 3 and Baluno based on Simpson's measure of evenness. Conversely, all 3 sites have comparatively high species evenness based on Shannon-Wiener's measure of evenness. There were few species under the threatened category (either vulnerable or critically endangered). Several species though were either not threatened (33%) or not evaluated (27%). The ecologically important species belong to families Araceae, Arecaceae, Euphorbiaceae, Maranthaceae and Athyriaceae.

Keywords: Vegetation analysis, species diversity, species evenness, Natural Park

1. Introduction

Vegetation analysis attempts to understand relevant features of a plant community. A community is a function of both its biological structure (the mix of species) and physical structure (the physical features of the biotic and abiotic environment).

This study focused on attributes such as species number, relative abundance of species, and the kinds of species that comprise a community; hence, its biological structure.

Some of the recent works on vegetation analyses (Table 1) include Hayat, Kudus, Hanum, Noor and Nazre (2010), Irader (2010), Villegas and Pollisco (2008), Langerberger, Martin and Sauerborn (2006) and Langerberger (2006).

Hayat et al (2010) assessed the plant species diversity of a logged-over coastal forest within the Pasir Tengkorak Forest Reserve, Langkawi Island, Malaysia by establishing a 1-ha plot. The 1-ha plot was divided into 100 quadrats of 100 m^2 each. A total of 3, 414 individual trees representing 120 species, 81 genera and 31 families were recorded. The variables measured were species diversity using Simpson's index of diversity, Shannon-Wiener function and Brillouin index.

Irader (2010) evaluated the floral diversity in Barangay Ling-on, Manolo Fortich, within the areas of Baganao community and documented the active role of Higaonon people in conserving their floral resources. The number of individuals per species of trees, shrubs, herbs, and ferns in the area were counted and the ratio was classified through standardized criteria over 20 m x 20 m sampling plot with four subplots. As part of the data collection, trees, shrubs, herbs, and ferns were identified. Floral diversity was determined based on density, relative density, frequency, relative frequency, and species diversity. In Baganao, there were two endemic species of trees (one shrub, one herb), four economically important species of trees, and two rare species of ferns. Floral diversity and floral species were low due to the prolonged dry season and human activities like farming. There were only 25 species of trees, shrubs, herbs, and ferns.

Villegas and Pollisco (2008) surveyed the vegetation of the Laiban sub-watershed in the Sierra Madre Mountain Range in the Philippines. They characterized the various vegetation types and determine species richness and composition. Land uses were surveyed and representative vegetation types were selected using patch and quadrat sampling techniques and transect lines for the rapid assessment of the locale's vegetation. A total of 121 species representing 102 genera and 56 families were recorded. Of the 121 species, 53%, 27% and 20% comprise the indigenous, exotic and endemic species respectively. The vegetation types were mainly secondary and primary forests.

Table 1 Works on vegetation analyses

Authors	Main objective	Locale	Method	Results
Hayat et al (2010)	Assessed the plant species diversity of a logged-over coastal forest	Pasir Tengkorak Forest Reserve, Langkawi Island, Malaysia	Divided a 1-ha plot into 100 quadrats of 100 m^2 each	Recorded 3,414 individual trees from 120 species, 81 genera and 31 families.
Irader (2010)	Evaluated the floral diversity; documented the active role of Higaonon people in conserving their floral resources.	Barangay Lingi-on Manolo Fortich within the area of Baganao community	Used 20 m X 20 m sampling plots with four subplots	Floral diversity and floral species are low.
Villegas and Pollisco (2008)	Characterized various vegetation types and determine species richness and composition.	Laiban sub-watershed in the Sierra Madre Mountain Range, Philippines	Patch and quadrate sampling techniques and transect lines	Recorded 121 species from 102 genera and 56 families.
Langerberger et al (2006)	Analyzed remnants of the Cordillera forest.	Island of Leyte, Phlippines	49 plots (100 m^2) were established	Recorded 685 taxa from 289 genera and 111 families of Philippine vascular plants
Largerberger (2006)	Documented locally available dipterocarp species as well as their distribution and habitat frequencies.	Leyte, Cordillera	Analysis was based on vegetation studies Langerberger conducted from 1996-1998	Recorded 18 species from the 6 Philippine dipterocarp genera and representing all 8 Philippine dipterocarp timber groups

Langenberger et. al. (2006) analyzed the remnants of the Cordillera forest on the island of Leyte, and evaluated their role as refuge to the largely destroyed lowland forest vegetation. A total of 49 plots (100 m^2 each) between 55 and 520 m a.s.l. were established to account for all vascular plant species except epiphytes. There were a total of 685 taxa from 289 genera and 111 families, representing nearly 8% of the known Philippine vascular plant species. Angiosperms and Pteridophytes account for 92.1% and 7.5 % of all species respectively. Philippine endemic species comprise more than half (52%) of the species. Forty one tree species (6% of all taxa recorded) are included in the IUCN red list, either as vulnerable, endangered, or critically endangered. Generally, the area provides an important gene bank of the highly threatened Philippine lowland forest vegetation and is highly valued for biodiversity conservation.

In a related but more specific study on the dipterocarp species in Leyte Cordillera, Langerberger (2006) documented the still locally available species of dipterocarp as well as their distribution and habitat frequencies. The study aimed at promoting the successful application of this important native timber group. The analysis was based on vegetation studies Langerberger conducted from 1996 to 1998. Eighteen species from the six Philippine dipterocarp genera and representing all eight Philippine dipterocarp timber groups were recorded. Distinct habitat distribution patterns and elevational ranges were observed and could serve as baseline information for local reforestation and tree plantation programs in terms of species-site suitability.

The foregoing studies were mainly vegetation analyses of forests and watershed reserves. The most used method was the quadrat sampling technique and occasional transect lines. Data analyses focus on species diversity, species richness and evenness of the investigated plant communities.

Vegetation analyses of plant communities are essential in biodiversity studies. Forest management and resource conservation foremost depend on biodiversity studies.

While the nature of the foregoing studies abounds abroad and elsewhere in the Philippines, there have been limited attempts at fortifying and or promoting the scarce literature in the local scene.

The Philippines is one of the biodiversity "hotspots." It is an area of exceptional concentrations of endemic species and experiencing exceptional loss of habitat (Alcala, 2004).

One of the few areas in the country that is densely forested and which is about 500 m above sea level (a.s.l) is Pasonanca Watershed Forest Reserve found in Zamboanga City, Mindanao. The watershed is a protected area under the category natural park. It was declared a protected area by Presidential Proclamation No. 199 on December 17, 1987. The protected area, including its buffer zone, covers a total land area of about 17,414 hectares. The park covers approximately 10, 107 hectares of the total land area. It is situated 7 km north of Zamboanga City at the tip of the Zamboanga Peninsula in southwestern Mindanao. It has the largest block of old growth lowland dipterocarp forest remaining in Region IX. Presently, the protected area is co-managed by the Department of Environment and Natural Resources (DENR), Zamboanga City local government and the Zamboanga City Water District.

Earlier studies on the vegetation of the natural park mainly focused on specific groups like the ferns and pitcher plants. Little is known then about the floral diversity of the forest including what measures must be undertaken in protecting and sustaining it.

The lack of recent biological studies focusing on the flora of the park has left many of its species, including their status unknown. Some of the species are of global conservation importance.

In this light, this study was a vegetation analysis of the Pasonanca Natural Park. The foci of the study were to describe the composition of the plant community in terms of species and species number covering the vascular plants; identify the status of the plant species based on the International Union for the Conservation of Nature (IUCN) red list; and identify species of ecological importance.

The present study was designed to provide information on plant community composition and structure as bases for local conservation efforts of various agencies. Community composition refers to the plant species found in the three sites covering the vascular plants only. In this study, community structure includes attributes such as species number, relative abundance of species and the kinds of species comprising a community.

The study sites were limited to Canucutan, Muruk 3 and Baluno as representative secondary forests. The selection of the three noncontiguous sites was done in consultation with the DENR personnel. Only 0.5325 ha (5325 m^2) of the protected zone (10,107 ha) was covered in this study.

2. Method

Research Design

This study is descriptive quantitative aimed at vegetation analysis of the Pasonanca Natural Park, particularly the Canucutan, Muruk 3 and Baluno areas.

Quadrats measuring 10m X 10m (100 m^2) each were systematically set and spaced at intervals of 10 m. Also, subplots of 5m X 5m and 1m X 1m each were established for the shrubs and saplings and grasses and other herbs and tree seedlings respectively (Figure 1).

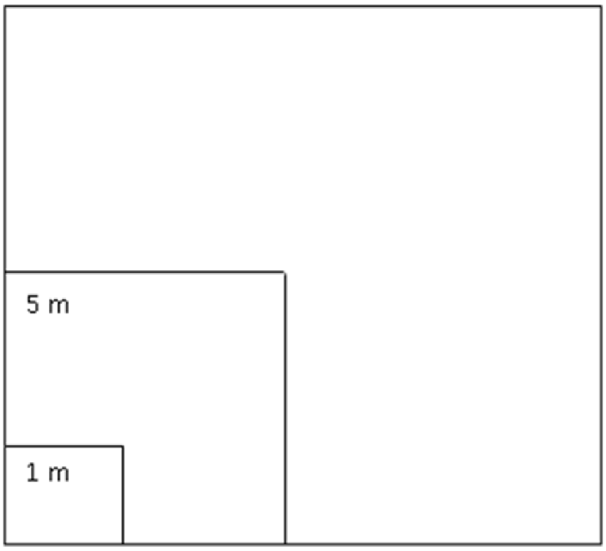

Figure 1 10m X 10m Nested Quadrat

Data on date and time of collections as well as the general topography of the study sites were noted; including vegetation characteristics. The general weather condition including temperature and humidity were also taken.

During sampling, the researchers gathered all identified and unidentified plants found in the subplots. Each specimen was numbered and placed in a plastic bag for later identification. All plants seen within the subplots including those on the plot boundary were recorded, including the location and distribution of each individual plant in a plot. The preliminary identification of plants was done in consultation with an expert from the National Museum, Manila, Philippines.

Data Gathering Procedure

Sampling in Canucutan was done from October 26-29, 2010. Sampling in Muruk 3 and Baluno was done from November 3-6, Nov 26-27 and December 1-4, 2010 respectively. There were three stations established at intervals of 300 m each in Canucutan and Muruk 3 and four stations in Baluno giving a sum of 50 plots.

Data on locality ID, altitude, slope, quadrat size, species composition and number and other pertinent information were noted.

Data were tabulated as bases for the following calculations: density, relative density, frequency, relative frequency, species richness and species evenness as variables of species diversity.

Data Analysis

For the vegetation analysis, data from the plots were used to calculate many factors of importance in biodiversity studies. To summarize the quadrat data, the density and frequency values were determined for each species separately for Canucutan, Muruk 3 and Baluno. The following were computed:

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

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

$$\text{Frequency} = \frac{\text{Number of plots in which species occurs}}{\text{Total number of plots sampled}}$$

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

Simpson's Index of Diversity:

$$Ds = \Sigma (n1 (n1-1)/N (N-1)$$

Complimentary form = 1-D

Reciprocal 1/D

Simpson's measure of evenness:

$$E1/D = 1/D$$

Shannon-Wiener Index (H')

$$H' = - \Sigma pilnpi$$

pi = proportion of the ith species

ln = natural logarithm

Shannon-Wiener's measure of evenness:

Evenness = H'/Hmax

Calculating community similarities:

$$\text{Sorenson's Coefficient (CC)} = \frac{2\,C}{S1 + S2}$$

Where C is the number of species the two communities have in common, S1 is the total number of species found in community 1, and S2 is the total number of species found in community 2.

3. Results and Discussion

Data on aspect and direction, altitude, temperature and soil texture are important factors that affect biodiversity. Generally, the aspect was between 6° and 7°N and 122°E (Table 2). According to literature, the amount of sunlight an area of land receives has a big impact on its microclimate as to whether it is warmer or cooler, moister or drier than the surrounding areas. Although the interplay of the foregoing was not explored in this study, an earlier work by Gairola, Rawal and Todaria (2008) described trends in forest vegetation along altitude in three sites of sub-alpine forests, with emphasis on diversity and community composition. They noted a characteristic decline in total tree density and total basal area with increasing altitude.

Slight variation in vegetation type and diversity is associated with spatial variability of pedologic, climatologic and edaphic characteristics of the landscape (Frank, 1998). In addition, relationships between slope aspects and solar radiation control the range of vegetation types along the altitudinal gradient (Frank, 1998). Earlier studies relating species diversity along elevational gradients suggest that species diversity, richness and evenness vary with altitude (Hegazy, El-Demerdash & Hosni, 1998; Sharma, Ghildiyal, Gairola & Suyal, 2009; Li, Wang, Zerlee, Zhang & Fang, 2011; and Ren, Yang, Zhu, Qin, Wang, Liu & Feng, 2012).

In this study, the sampling sites were noncontiguous whose altitude ranged from 84 m to 749 m. Air temperature was between 24°C and 29°C. Soil texture was sandy to clay loam, which is characteristic of secondary forest (Table 2). There was only one recorded temperature in Baluno. The unexpected heavy rains on the next days of data collection made recording of temperature difficult.

Table 2 Data on location and soil texture

Locality ID	*Coordinates	*Alt	Temp	Soil texture
Canucutan	S1: 6.98 N, 122.07 E	84 m	26°C 9:39:54 am	Sandy clay loam
	S2: 6.98 N, 122.07 E	108 m	29°C 12:51:55 pm	
	S3: 6.99 N, 122.07 E	136 m	28°C 1:00 pm	
Muruk 3	S4: 7 N, 122.07 E	453 m	26°C 1:30:00 pm	Silt clay loam
	S5: 7 N, 122.07 E	442 m	24°C 10:00 am	
	S6: 7 N, 122.07 E	468 m	24°C 11:30 am	
Baluno	S7: 7.02 N, 122.03 E	749 m	26 °C 11:08 am	Clay loam
	S8: 7.01 N, 122.03 E	700 m		
	S9: 7.01 N, 122.03 E	678 m		
	S10:7.01 N, 122.03 E	724 m		

*Data on coordinates and altitude were all taken using a GPS unit Model C 20 eTrex Venture H

Vegetation Analysis

There were 283 individuals belonging to 45 species, 27 genera and 25 families recorded from the three sampling sites (Table 3).

Of the 45 species, nine were common in all three sites namely; species 1 of the Family Rubiaceae, *Caryota sp*., *Arenga pinnata*, *Selaginella sp.*, *Artocarpus altilis*, *Donax caneiformis*, *Bambusa multiplex*, species 16 of the Family Thelypteridaceae and species 17 of the Family Leea. There were 4, 5 and 20 species that were recorded only in Canucutan, Muruk 3 and Baluno respectively. Seven species were common in either two of the three sites.

The five species with the most number of individuals were *Caryota sp.*, species 1 of the Family Rubiaceae, *Donax caneiformis*, *Selaginella sp.*, and rattan species; each with 43, 40, 26, 25 and 18 recorded individuals respectively (Table 3).

The taxonomic composition is mainly angiosperms and Pteridophytes comprising 82.22% and 17.78% respectively (Table 4).

Of the 45 species, 33 (73.33%) were identified to species level, 31 (68.89%) to genus level and 30 (66.67%) to family level. Only 30 of the 45 species have known geographic range and distribution as data on some species were fragmentary. Of the 30 with known geographic range, 18 (60%) are endemic or native, 10 (33.33%) are cosmopolitan and 2 (6.67%) are exotic.

Vegetation type in all 3 sites is secondary forest.

The total number of species for Canucutan, Muruk 3 and Baluno are 19, 19 and 32 respectively. Based on the computed relative densities of some species, species 1 of the family Rubiaceae was the most abundant in both Canucutan and Muruk 3 while *Caryota sp*. was most abundant in Baluno. The relative frequencies suggest that all species across the three sites tend to occur in clumps. The computed importance values show that species 1 was highest in both Canucutan and Muruk 3. In Baluno, *Caryota sp* was highest. Importance value is the sum of the relative frequency, relative density and relative dominance. However, getting the relative dominance of the species was impractical as the diameter breast height (dbh) of the tree species was not measured. In this study, the importance value was the average of two relative values (relative density and relative frequency) per species.

The foregoing measures of species richness and species abundance are used to measure the species diversity in a given community. In this study, the Simpson's index of diversity and Shannon-Wiener diversity index were used to measure the species diversity for Canucutan, Muruk 3 and Baluno (Table 6, Fig 2).

Table 3 Total number of plant species and their corresponding families

Plant Species	**Family**	**Botanical name (Specific epithet)**	**Site 1**	**Site 2**	**Site 3**	**N (283)**
Species 1	Rubiaceae		12	15	13	40
Species 2	Araceae	*Epipremnum pinnatum*	3	0	2	5
Species 3	Arecaceae	*Caryota sp.*	10	13	20	43
Species 4	Arecaceae	*Arenga sp.*	7	0	2	9
Species 5		*Hormalomena sp.*	1	0	0	1
Species 6		*Arenga pinnata*	1	2	5	8
Species 7	Commelinaceae		1	0	0	1
Species 8		*Selaginella sp.*	7	12	6	25
Species 9		*Costus speciosus*	3	0	0	3
Species 10	Moraceae	*Artocarpus altilis*	2	5	3	10
Species 11	Araliaceae	*Osmoxylon sp.*	1	2	0	3
Species 12	Maranthaceae	*Donax caneiformis*	2	9	15	26
Species 13	Athejriaceae		1	2	0	3
Species 14	Orchidaceae		4	0	0	4
Species 15	Poaceae	*Bambusa multiplex*	2	1	1	4
Species 16	Thelypteridaceae		1	3	7	11
Species 17	Leea		1	1	1	3
Species 18		*Macaranga tanarius*	1	2	0	3
Species 19		*Artocarpus*	1	0	0	1
Species 20	Datiscaceae	*Octomeles sumatrana*	0	2	1	3
Species 21		*Lygodium circinnatum*	0	2	0	2
Species 22	Rubiaceae		0	1	0	1
Species 23	Apocynaceae	*Alstonia scholaris*	0	1	0	1
Species 24	Vine unknown		0	2	1	3
Species 25	Moraceae	*Artocarpus odoratissimus*	0	1	0	1
Species 26		*Ardisia sp.*	0	1	0	1
Species 27	Arecaceae	*Pinanga sp.*	0	0	1	1
Species 28	Fern unknown		0	0	1	1
Species 29	Rattan		0	0	18	18
Species 30	Araceae	*Rhaphidophorra sp.*	0	0	8	8
Species 31		*Calanthe sp.*	0	0	12	12
Species 32		*Piper sp.*	0	0	1	1
Species 33	Spotaceae	*Palaquium luzoniense*	0	0	2	2
Species 34		*Saurauia prainiana*	0	0	2	2
Species 35		*Azidarachta indica*	0	0	1	1
Species 36		*Pleocnema sp.*	0	0	2	2
Species 37		*Proprium sp.*	0	0	10	10
Species 38	Guttiferae		0	0	1	1
Species 39		*Selaginella cupprisina*	0	0	2	2
Species 40			0	0	2	2
Species 41		*Chloranthus sp.*	0	0	1	1
Species 42		*Alpinia sp.*	0	0	1	1
Species 43		*Tetrastigma loherii*	0	0	1	1
Species 44	Araceae	*Pothos sp.*	0	0	1	1
Species 45		*Dioscorea sp.*	0	0	1	1

*Species 40 is from Genus Coniograme
Site 1 = Canucutan, Site 2 = Muruk 3 and Site 3 = Baluno

Table 4 Taxonomic composition of Canucutan, Muruk 3 and Baluno

	Angiosperms (%)	Pteridophytes (%)	Total (%)
Families	25 (83.33)	5 (16.67%)	30 (100)
Genera	27 (87.10)	4 (12.90)	31 (100)
Species	37 (82.22)	8 (17.78%)	45 (100)

As part of vegetation analysis, a summary of the quadrate data of selected plant species from Canucutan, Muruk 3 and Baluno is outlined in table 5.

Table 5 Measures of importance of plant species

Site	Plant Species	D	RD	F	RF	IV
Canucutan (n=19)	Rubiaceae[1]	0.8	19.7	80	19.7	19.7
	Caryota sp.[3]	0.67	16.4	67	16.4	16.4
	Arenga sp.[4]	0.47	11.5	47	11.5	11.5
	Selaginella sp.[8]	0.47	11.5	47	11.5	11.5
Muruk 3 (n=19)	Rubiaceae[1]	1	19.5	100	19.5	19.5
	Caryota sp.[3]	0.87	16.9	87	16.9	16.9
	Selaginella sp.[8]	0.8	11.7	60	11.7	11.7
	D. Caneiformis[12]	0.6	11.7	60	11.7	11.7
Baluno (n=32)	*Caryota sp.*[3]	1	13.8	100	13.8	13.8
	Rattan[29]	0.9	12.4	90	12.4	12.4
	D. Caneiformis[12]	0.75	10.3	75	10.3	10.3
	Rubiaceae[1]	0.65	9.0	65	8.97	9.0
	Calanthe sp.[31]	0.6	8.3	60	8.28	8.3
	Propium sp.[37]	0.5	6.9	50	6.9	6.9

D = density, RD = relative density, F = frequency, RF = relative frequency, IV = importance value

Table 6 Diversity indices per site

Diversity Index	Canucutan n = 61	Muruk 3 n = 77	Baluno n = 145
Simpson	0.90	0.89	0.93
$E_{1/D}$	0.52	0.47	0.42
Shannon-Wiener	2.53	2.46	2.90
Evenness	0.86	0.84	0.84
Sorenson's coefficient (CC)	.63[C & M]	.43[M & B]	.43[C & B]

*$E_{1/D}$ = Simpson's measure of evenness, CC = index of similarity, C & M = between Canucutan and Muruk 3, M & B = between Muruk 3 and Baluno, C & B = between Canucutan and Baluno

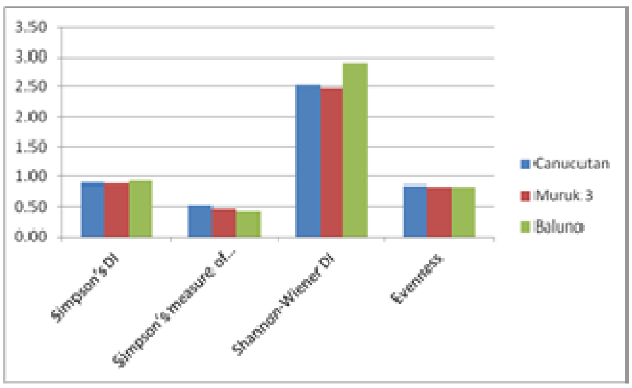

Figure 2 Comparison of measures of diversity and evenness

Both diversity indices show that all three sites were diverse. Baluno had the most diverse species, followed by Canucutan and Muruk 3. In terms of species evenness, Simpson's shows that Canucutan is relatively even compared to Muruk 3 and Baluno. Conversely, Shannon-Wiener's shows all three sites have high species evenness.

Diversity indices account for both abundance and evenness of the species present (Beals, Gross & Harrell, 1999). They are important measures in understanding community structure. Both diversity indices here account for the proportion of the *ith* species relative to the total number of species (*pi*) (Hayat, Kudus, Hanum, Noor & Narze, 2010). The Simpson's diversity index is a dominance index as it gives more weight to common or dominant species. It is not affected by a few rare species with few representatives (Sharma, Ghildiyal, Gairola, Sarvesh & Himalaya, 2009). Shannon-Wiener's diversity index however, is an information statistic index; which assumes that all species are represented in a sample (Hayat et. al, 2010 & Sharma, Ghildiyal, Gairola, & Suyal, 2009). Thus, for a given richness, diversity increases as equitability or evenness increases. Such is the case for all three sites based on the Shannon-Wiener's computed evenness.

To determine whether the plant communities surveyed were similar in terms of common species, Sorenson's coefficient was used. It gives a value between 0 and 1, such that the closer the value is to 1, the more similar the communities are. In this case, Canucutan and Muruk 3 were quite similar, while there is no overlap or similarity between Muruk 3 and Baluno and between Canucutan and Baluno (Table 6).

Plant species' conservation status

The conservation status of the plant species (Table 7) was mainly based on the International Union for the Conservation of Nature (IUCN) and related publications.

Table 7 Conservation status of plant species

Conservation status IUCN Red list category	Number of species	Percentage (%)
Threatened with extinction	1	2
Threatened	1	2
Critically endangered (CR)	1	2
Vulnerable (VU)	3	7
Least concern (LC)	4	9
Not threatened (NT)	15	33
Not evaluated (NE)	12	27
Taxa with either EN, VU or NT species	3	7
Data unavailable (DU)	5	11
Total	45	100

Since there is no existing data on Red List assessments at the regional level, the categories here refer to the global Red List assessment. As to whether the status of the respective species, genus and family is truly reflective of our plants in the local scene is uncertain. It is imperative then to conduct Red list assessments at the regional level.

The species that is threatened with extinction belongs to family Athyriaceae. The single species under the threatened category is a rattan species. Another species (*Pinangga sp*) is known to be critically endangered. Rattan and *Pinangga sp* both belong to the palm family Arecaceae. Several species though were either not threatened (33%) or not evaluated (27%).

Species of ecological importance

The selection of the species with their corresponding importance was mainly based on the species' relative importance (Table 5), conservation status (Table 7) and geographic distribution. In general, plants here are potential sources of food for human consumption, construction, infrastructure, livelihood, and floriculture. Some are known sources of folk medicine, others are known to be used as covers of pillars, and still others are good for soil conservation, urban greening and stabilizing ecologically-stable environment.

Of particular interest are species belonging to families Araceae, Arecaceae or Palmae, Euphorbiaceae, Marantaceae and Athyriaceae.

4. Conclusions and Recommendations

The foregoing data on vegetation analysis, conservation status of the species and their ecological importance point to the following:

Data on species composition, distribution, importance values, and diversity indices all show that species diversity is high in all three sites. Of the three, Baluno is the most diverse and had the most number of species (32); while Canucutan and Muruk 3 each had 19 recorded species. There were nine species common to all three sites. Species evenness though was fairly high in Canucutan compared to Muruk 3 and Baluno based on Simpson's measure of equitability or evenness. Conversely, all three sites have comparatively high species evenness based on Shannon-Wiener's measure of evenness. Sorenson's coefficient however, showed that among the three sites, Canucutan and Muruk 3 were quite similar, and there is no overlap or similarity between Muruk 3 and Baluno and Between Canucutan and Baluno. The species which had higher importance values were mostly recorded in all three sites. There are few species under the threatened category and several are neither threatened nor evaluated. The ecologically-important families are Araceae, Arecaceae, Euphorbiaceae, Maranthaceae and Athyriaceae.

The sites covered in this study were representative of secondary forests. There is considerable work ahead as far as vegetation analyses of the natural park are concerned since the present work was limited to three sampling sites.

The conservation status of the species here was mainly based on IUCN Red List category and it is uncertain if this were truly reflective of the status of the plants in the local scene. It is thus imperative to conduct Red list assessments at the regional level.

The Department of Environment and Natural Resources of Region IX can consider integrating inputs from this study into its existing forest management and resource conservation scheme. Of particular interest are *Arenga sp* and *Calamus sp*, of the Arecaceae or Palm family. These two species are apparently threatened. *Arenga sp* for example serves as diet of several endangered species and rattan species enhances the biodiversity of an area. Thus, provisions for a more stringent management and conservation scheme are critical.

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