p-ISSN 2012-3612 | e-ISSN 2782-8824
www.edjournal.cfnr-uplb.org

Ecosystems and Development Journal
Volume 12 | Number 1 | pp. 71–82 | 2022

Floral diversity assessment of Abasig Matogdon-Mananap Natural Biotic Area (AMMNBA) in Camarines Norte, Philippines

Luisito B. Terbio[1]*, Arthur Glenn A. Umali[2], Pastor L. Malabrigo Jr.[2,3,4]

[1]*Department of Forestry and Agroforestry, College of Agriculture Systems and Technology, Pampanga State Agricultural University, Magalang, Pampanga, Philippines; Email: lbterbio@up.edu.ph*
[2]*Department of Forest Biological Sciences, College of Forestry and Natural Resources, University of the Philippines, Los Baños, College, Laguna, Philippines*
[3]*Museum of Natural History, University of the Philippines Los Baños, College, Laguna, Philippines*
[4]*Land Grant Management Office, University of the Philippines Los Baños, College, Laguna, Philippines*

ABSTRACT. Abasig Matogdon-Mananap Natural Biotic Area (AMMNBA) is geographically situated in Camarines Norte, Philippines. It has a total land area of 5,420.12 ha, spanning over three municipalities in Camarines Norte; San Lorenzo Ruiz, San Vicente, and Labo. AMMNBA is one of the four protected areas categorized as Natural Biotic Areas in the Philippines. This study generally aims to provide an updated floral profile of AMMNBA, which the Protected Area Management Board and other field implementers of the protected area can be used to formulate or update management and conservation plans. This study employed the Biodiversity Assessment and Monitoring System, a standardized method of assessing terrestrial protected areas in accordance with the Biodiversity Management Bureau's Technical Bulletin No. 2016-05. Two 2-km transect lines were explicitly established at the portion of San Vicente. Results show that the sampled area in AMMNBA was classified as tropical lowland evergreen rain forest, having stand maturity of both early and advanced second-growth forest due to anthropogenic disturbances such as charcoal making. Results revealed that the park is home to 202 species of plants. Species such as *Ficus minahassae*, *Astronia* sp., *Hopea philippinensis*, and *Kibatalia gitingensis* dominate the sampled area of AMMNBA. Additionally, the analysis showed that AMMNBA has a very high biodiversity value of 4.125. It is home to 46 new province record species, 58 endemic species, and 22 threatened species. The study demonstrated that the Abasig Matogdon-Mananap Natural Biotic Area harbors a significant number of threatened, endemic, and indigenous plant species that could contribute to the ecosystem's overall health.

Keywords: important plant area, modified belt transect method, protected area, threatened species

INTRODUCTION

Abasig Matogdon-Mananap Natural Biotic Area (AMMNBA) was formerly proclaimed as a watershed forest reserve in accordance with the Presidential Proclamation No. 836 by virtue of President Corazon C. Aquino. Under the National Integrated and Protected Areas System (NIPAS) law, it became a protected area categorized as a natural biotic area through Presidential Proclamation No. 318 on May 31, 2000. AMMNBA is geographically situated in Camarines Norte, Philippines comprising of three municipalities with three barangays for each municipality covered; San Lorenzo Ruiz (Barangays Matacong, Maisog, and San Isidro), San Vicente (Barangays Fabrica, Iraya Sur, and San Jose), and Labo (Barangays Baay, Lugui, and Tulay na Lupa). Its elevation ranges from 30–1,544 m asl and is topographically characterized as mountainous with rolling to rugged terrain (Nieva *et al*. n. d.).

Based on the assessment report submitted to the DENR by the Resource Basic Inventory (RBI) team conducted on March 17–20, 1997, they traversed Mount Labo from Barangay Tulay na Lupa, Labo and San Vicente, Camarines Norte and recorded the species encountered at every 100 m asl elevation. The study revealed that there were remaining virgin and mossy forests in AMMNBA, although only a few dipterocarp species such as bagtikan [*Parashorea malaanonan* (Blanco) Merr.] and yakal (*Shorea astylosa* Foxw.) were recorded. Overall, the inventory recorded 71 taxa and 34 shrub families.

The more recent floral assessment report by the Biodiversity Monitoring System (BMS) team of the DENR R5 on August 15–18, 2017, recorded 49 species within the new 2-km transect. It also revealed that white lauan (*Shorea contorta* S. Vidal) had the highest relative dominance and importance value (IV) among the species in AMMNBA.

Since the two previous flora assessments were not based on the standardized methodology for assessing the terrestrial ecosystem in accordance with the BMB TB 2016-05 and were limited only to tree flora, these were deemed not representative of the true level of diversity of the area. Hence, this study will significantly update the current information on the terrestrial flora ecosystem of AMMNBA.

The study aimed to provide an updated floral data assessment report baseline that can be used to improve and develop management and conservation plans for the protected areas. Specifically, it aimed to provide a taxonomic list of all the recorded floral species with their corresponding endemism and conservation status; identify the forest formations and maturity of the stand along the transect, and determine the level of diversity of the area using various diversity indices.

METHODOLOGY

This flora assessment was conducted on July 12–16, 2018, in AMMNBA, San Vicente, Camarines Norte, Philippines (**Figure 1**). The survey team used the updated Biodiversity Assessment and Monitoring System (BAMS) methodology prescribed by the Biodiversity Management Bureau (BMB) for all the protected areas in the country. It employed a modified belt transect method wherein nine quadrats (20 m x 20 m) were laid out along a 2-km transect at every 250 m interval (**Figure 2**). Two levels of the assessment were conducted; ecosystem and species levels. The ecosystem level assessment was done at every 50 m interval (section), while the nested quadrat at every 250 m interval was used for the species level assessment (**Figure 2**). For ecosystem level assessment, each section was classified following the 12 forest formations developed by Fernando *et al*. (2008). In addition, the forest structure was characterized based on the maturity of the stand, *i.e.*, early secondary growth, advanced secondary growth, and old growth. Observed disturbances (*i.e.*, clearing, cutting, kaingin, and presence of invasive species) from each section were also noted. For species level assessment, a nested quadrat sampling technique was used to assess and characterize the structure and species composition of the different plant communities (**Figure 3**). Trees at least 10 cm diameter at breast height (DBH) inside the 20 m × 20 m quadrats were identified, measured, and recorded. The number of individuals of intermediate species, shrubs, poles, and saplings were counted inside the 5 m × 5 m quadrats. Moreover, the percentage cover of understory species (grasses and other plant species of less than 1 m) inside the 1 m × 1 m was determined (**Figure 2**). Additionally, an opportunistic survey along the trail (inside and outside quadrats) was employed to account for the maximum possible species in the area.

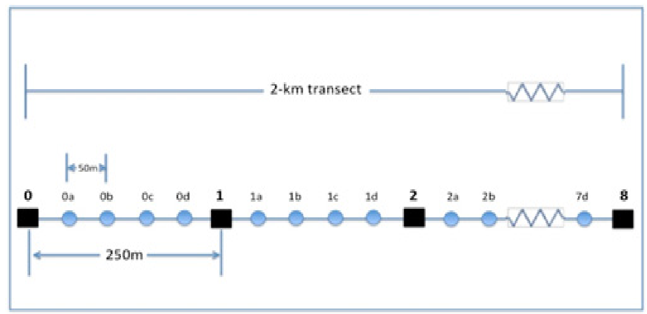

Figure 2. Modified belt transect employed for the floral assessment in AMMNBA (Source: Cruz *et al*. 2017).

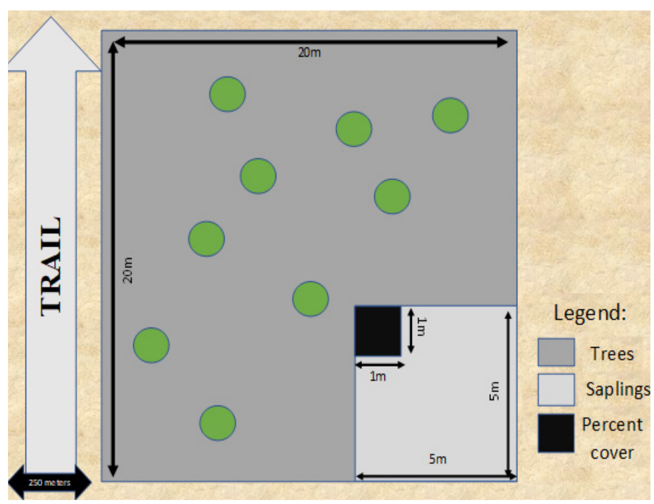

Figure 3. The nested quadrat used in the biodiversity assessment, established at every 250 m distance along the transect.

Collection of herbarium specimens

Sample specimens of each species that were difficult to identify in the field were collected. However, since this study was part of the DENR V Regional Office project and the authors were providing technical assistance, there was no need for the issuance of the Gratuitous Permit (GP). The specimens were processed at the end of the survey to preserve them before identification. Sweinfurth's method

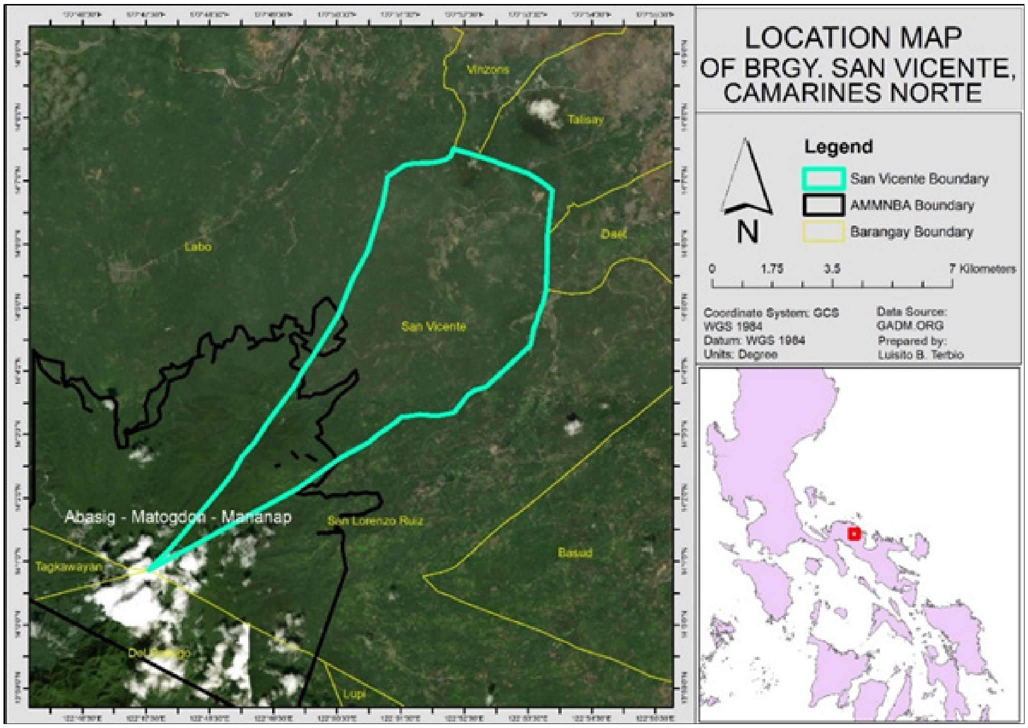

Figure 1. Location map of Brgy. San Vicente, Camarines Norte, Philippines.

was employed, commonly known as the "wet collection" approach and a standard plant collection technique, was employed. This technique involves soaking properly labeled specimens in ethyl alcohol to avoid rapid wilting and crumpled drying. Important information such as habitat, physiognomy, slope, aspect, and characteristics of the plants that became unobservable after drying were noted along with DBH and TH. Before storage, each specimen was tagged using proper coding (**Figure 4**). The specimens were then sealed in polyethylene bags for further analysis at the Taxonomy Laboratory of the Department of Forest Biological Sciences (DFBS) at the College of Forestry and Natural Resources (CFNR), University of the Philippines Los Baños (UPLB). Herbarium specimens were deposited at the Museum of Natural History (MNH) in the CFNR, UPLB, Laguna.

Literature review and access to online databases

Published books, articles, and repositories of online databases were accessed to acquire the needed information on species identification. Relevant literature such as the Co's Digital Flora of the Philippines, Flora Malesiana, Flora of Manila, Enumeration of Philippine Flowering Plants, Lexicon of Philippine Plants, Blumea, Leaflets of Philippine Botany, among others, were consulted for initial identification of the dried plant materials. Subsequently, photos of unknown plants were compared with online digital images such as JSTOR Plant and PhytoImages.

Names of the specimens identified were verified in the International Plant Names Index (IPNI) and standardized based on the Plants of the World online (http://www.plantsoftheworldonline.org). The distribution and endemism of plants were determined using online databases such as the Catalogue of Life (http://catalogueoflife.org/), Tropicos (http://www.tropicos.org/), and Global Biodiversity Information Facility (http://GBIF.org).

The conservation status of each species was based on the updated assessments of the International Union for Conservation of Nature (IUCN 2021-3) and the Updated List of threatened Philippine plants and their categories (DAO 2017-11).

Figure 4. Sample herbarium specimens with proper tagging.

Data analysis

Diversity indices

The plots' diversity indices (Shannon or H', Simpson's or D,' and Evenness or E) were computed using the Paleontological Statistical software package for education and data analysis (PAST version 3.20). Data on the occurrence of each species and their richness in surveyed quadrats were used in the computation of indices.

Importance value

The relative density, relative dominance, and relative frequency values for each tree species were determined to obtain their importance value (IV) – a standard measurement in forest ecology to determine the rank relationships of species. The relative values indicate different aspects of a species' importance in a community. Importance values were computed using the following formula of Curtis & McIntosh (1951):

$$Density = \frac{number\ of\ individuals}{area\ sampled}$$

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

$$Frequency = \frac{number\ of\ plots\ in\ which\ species\ occur}{total\ number\ of\ plots\ sampled}$$

$$Relative\ Frequency = \frac{frequency\ value\ for\ a\ species}{total\ frequency\ for\ all\ species} \times 100$$

$$Dominance = \frac{basal\ area\ or\ volume\ for\ a\ species}{area\ sampled}$$

$$Relative\ Dominance = \frac{dominance\ for\ a\ species}{total\ dominance\ for\ all\ species} \times 100$$

$$Importance\ value = Relative\ Density + Relative\ Frequency + Relative\ Dominance$$

Identification of important plant areas (IPAs)

Important Plant Areas (IPAs) are areas comprising high plant diversity and are habitats for numerous rare, endemic, and threatened species. This will be the basis for identifying the quadrat for establishing the permanent biodiversity monitoring area. It can be determined using the following criteria set by Anderson (2002):

- Criterion A – The site holds a significant population of one or more species of global or European conservation concern.
- Criterion B – The site has an exceptionally rich flora in relation to its biogeographic zones.
- Criterion C – The site is an outstanding example of a habitat type of global plant conservation and botanical importance.

RESULTS AND DISCUSSION

General vegetation of AMMNBA

AMMNBA has a total land area of 5,420.12 ha, classified as 80% of closed forests, 14% of shrub land, 4% of wooded grassland, 2% of open forest, and almost 0% of inland water and perennial crops (Nieva & De la Cruz n. d.). In the sampled area, the forest formation can be characterized as a tropical lowland evergreen rainforest having a stand maturity of both early and advanced secondary growth forests.

The elevation of transects ranges from 231 m asl to 543 m asl. Furthermore, the types of soil present in AMMNBA were Louisiana clay loam, aluminous clay loam, and mountain soil, and generally, the area sampled has a Type II climate (Nieva & De la Cruz n. d.). Combining the physical traits with the recorded dominant trees, this study suggests that forest formation of the area sampled in AMMNBA can be classified as tropical lowland evergreen rainforest (TLER). Regarding stand maturity, early and advanced secondary growth forest has been observed in the two transects. The first 350 m of Transect 1 and the first 600 m of Transect 2 were classified as early secondary growth forests because of the evidence of anthropogenic disturbances like charcoal making. The processing area of charcoal making was spotted at Quadrat 1 of Transect 1, which probably led to the decline in the number of individuals and species encountered in this quadrat. This concurs with Fernando *et al*. (2008) observation that much of TLER had been exposed to deforestation mainly due to accessibility (low elevation) and the richness in arborescent flora. Garrity *et al*. (1993) also mentioned that almost 300,000 ha of this forest had been lost between 1976 and 1980. These cases may also have happened to the vegetation of the AMMNBA. On one hand, the succeeding quadrats and stations after the abovementioned distances in Transects 1 and 2 were classified as advanced secondary growth forests.

Tree flora and stand structure

A total of 202 morpho-species belonging to 149 genera from 67 families were recorded in the two transects. From this, 164 species have been identified at the species level, while the other species were only identified up to the most probable genus. These were mainly due to the absence of identifying key features of the specimens collected, such as flowers and fruits. Of the total recorded species, 50 species were collected through the opportunistic survey or outside the sampling quadrats. This was relatively higher than other studies conducted in other terrestrial protected areas in the Philippines. Although sampling methods were varied, these were done in areas with at most 500 m asl elevation. Such studies were conducted by Lagbas *et al*. (2016) in Roosevelt Protected Landscape, Cabansag (2016) in Ilagan Sanctuary, Ordas *et al*. (2017) in Taal Volcano Protected Landscape, Buot (2009) in Mt. Mayon National Park, Partosa *et al*. (2013) in Pasonanca Natural Park, and Malabrigo *et al*. (2016) in Mount Makiling Forest Reserve (MMFR), wherein the total number of species recorded was 52, 71, 47, 71, 45, and 155, respectively. However, it was lower than the study of Paclibar & Tadiosa (2020) in the lowland forests of Quezon Protected Landscape, where they recorded 328 species.

The families with the highest number of individuals measured in the sampling area were Dipterocarpaceae (56), Rubiaceae (40), Euphorbiaceae (38), Phyllanthaceae (33), and Lauraceae (32) (**Figure 5**). This plant assemblage conforms with the structure and composition of a tropical lowland evergreen rainforest.

A total of 125 individuals of trees were recorded in the sampling area. Based on the tree diameter classification of Malabrigo *et al*. (2016) (**Table 1**), 73.6% were small trees, 24.8% were medium-sized trees, and 1.6% were large trees. The average tree diameter is 25 cm which falls under small trees. These data conform with the general vegetation characterization that the sampled area is a secondary growth forest in either an early stage or relatively advanced stage of forest succession.

Table 1. Number of individuals per diameter class.

Diameter class	Diameter range (cm)	No. of individuals
Small trees	10 to <30	92
Medium-sized trees	30 to <60	31
Large trees	>60	2

Species diversity

Results showed that AMMNBA has a very high diversity of 4.12 in terms of D' and H' (**Table 2**). Its H' is higher compared to that of Taal Volcano Protected Landscape (Ordas *et al*. 2017) (H' = 2.61), Pasonanca Natural Park (Partosa *et al*. 2013) (H' = 2.46), Ilagan Sanctuary (Cabansag 2016), MMFR (Paquit & Pampolina 2017) (H' = 2.2), and Quezon Protected Landscape (Paclibar & Tadiosa 2020) (Average H' = 2.44).

This biodiversity index remains underestimated since those recorded from the opportunistic survey were not included in the computation. This means that the diversity value will increase if additional sampling is conducted. Although some anthropogenic disturbances were observed in Transect 1, both transects showed very high diversity values.

Table 2. Summary of the computed diversity indices of the two transects.

Transect	No. of species	No. of individuals	Diversity indices		
			Simpson index (D')	Shannon index (H')	Evenness (E)
T1	52	116	0.97	3.67	0.75
T2	62	141	0.97	3.84	0.75
Overall	91	257	0.98	4.12	0.68

Value Interpretation for H': VERY HIGH = ≥3.5 ABOVE, HIGH = 3.0–3.49, MODERATE = 2.5–2.99, LOW = 2.0–2.49, VERY LOW = ≤1.9 AND BELOW (Fernando *et al*., 1998); for D: 0 = lowest, 1 = highest.

Importance value

The five most important species in Transect 1 were hagimit (Ficus minahassae), white lauan (Shorea contorta), balanti (Omalanthus populneus), Astronia sp., and magong liitan (Neoscortechinia philippinensis) with an importance value of 22.17, 16.71, 13.94, 13.60, and 11.12, respectively (**Table 3**). Astronia sp. has the most frequent occurrence recorded in five quadrats (Quadrats 2, 3, 4, 5, and 8). In addition, hagimit was only found in Q0, generally along stream areas, which is its natural habitat.

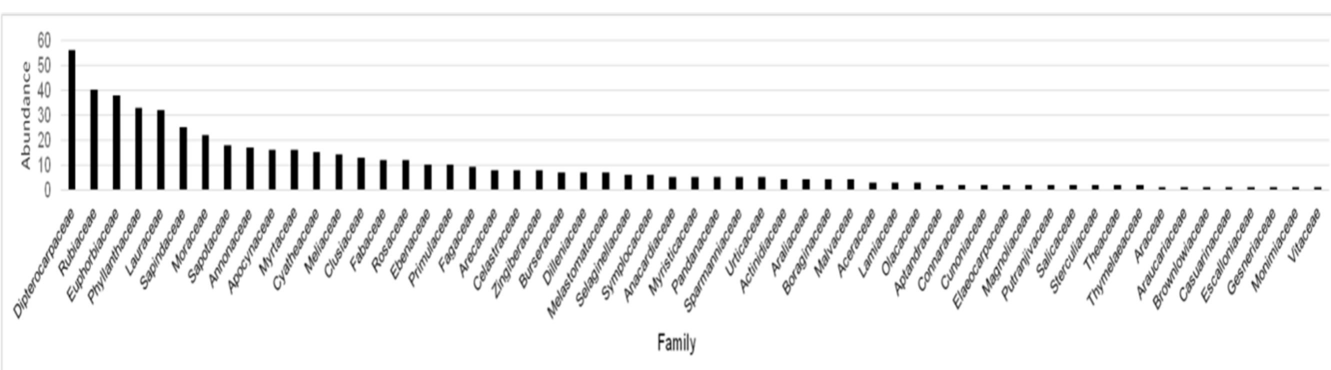

Figure 5. Summary of the total number of individuals encountered per family.

Table 3. Top 10 species with the highest importance value computed in Transect 1.

Species	Relative frequency	Relative density	Relative dominance	IV
Ficus minahassae (Teijsm. & Vriese) Miq.	1.37	7.76	13.04	22.17
Shorea contorta S.Vidal	1.37	4.31	11.03	16.71
Omalanthus populneus (Geiseler) Pax in Engl. & Prantl	2.74	5.17	6.03	13.94
Astronia sp.	6.85	4.31	2.44	13.60
Neoscortechinia philippinensis (Merr.) Welzen	2.74	4.31	4.07	11.12
Shorea polysperma (Blanco) Merr.	2.74	4.31	3.76	10.81
Saurauia sp.	4.11	3.45	1.64	9.19
Neonauclea lanceolata (Blume) Merr. ssp. *gracilis* (S.Vidal) Ridsdale	1.37	4.31	2.68	8.36
Pterocarpus indicus Willd. forma *indicus*	2.74	2.59	1.89	7.22
Parashorea malaanonan (Blanco) Merr.	1.37	3.45	2.16	6.98

In Transect 2, the five most important species were gisok-gisok (*Hopea philippinensis*), magong liitan (*Neoscortechinia philippinensis*), laneteng gubat (*Kibatalia gitingensis*), pangnan-bundok (*Lithocarpus philippinensis*), and malakmalak-bundok (*Palaquium montanum*), having an importance value of 52.47, 26.36, 15.01, 12.84, and 12.78, respectively (**Table 4**). Compared with the study of Nieva *et al*. (n.d.), *Shorea contorta* has the highest importance value of 25.06, while it has 10.95 in this study even though the quadrats surveyed were the same as in Nieva *et al*. (n.d.). The discrepancy could probably be due to the use of the collective term "lauan" for most of the dipterocarp species, which might have included the *Parashorea malaanonan*.

Intermediate and understory

In Transect 1, 35 morpho-species belonging to 25 genera were recorded inside the 5 m x 5 m quadrats. Most species in these quadrats belong to the genera of *Cyathea* (12), *Saribus*, *Pinanga*, *Alpinia*, and *Goniothalamus*. On the other hand, 66 morpho-species belonging to 55 genera and 36 families had been recorded in all the 5 m x 5 m quadrats in Transect 2. The five most dominant species recorded were *Coffea* sp., *Cyathea* sp., *Vatica pachyphylla*, *Goniothalamus* sp., and *Litsea fulva*. It is interesting to note that except for *Cyathea* sp., the study of Nieva *et al*. (n.d.) has no record of other most dominant species. Accordingly, rattan (*Calamus* sp.), tree ferns (*Cyathea* sp.), and lingatong (*Dendrocnide meyeniana*) were the dominant understory species.

Table 4. Top 10 species with the highest importance value computed in Transect 2.

Species	Relative frequency	Relative density	Relative dominance	IV
Hopea philippinensis Dyer	3.09	8.51	40.87	52.47
Neoscortechinia philippinensis (Merr.) Welzen	4.12	6.38	15.85	26.36
Kibatalia gitingensis (Elmer) Woodson	5.15	4.26	5.60	15.01
Lithocarpus philippinensis (A.DC.) Rehder	3.09	3.55	6.20	12.84
Palaquium montanum Elmer	4.12	3.55	5.11	12.78
Shorea contorta S.Vidal	3.09	3.55	4.31	10.95
Parashorea malaanonan (Blanco) Merr.	4.12	2.84	3.04	10.00
Macaranga hispida (Blume) Müll.Arg	1.03	3.55	3.67	8.25
Neonauclea lanceolata (Blume) Merr. ssp. *gracilis* (S.Vidal) Ridsdale	4.12	2.84	0.81	7.77
Erythrina variegata L.	2.06	2.13	2.90	7.09

Ground cover

A total of 16 morpho-species were recorded in the nine established 1 m x 1 m quadrats in Transect 1. This accounts for the ground cover species, either erect or crawling in the quadrats, that are concluded to be the offspring of the tree species in the sampled area. The top five species with the highest relative percent cover are *Cyathea* sp. (0.16), *Selaginella* sp. (0.13), and three unidentified species of *Alpinia* (0.10, 0.08, and 0.06). For Transect 2, 19 morpho-species have been recorded in the nine established 1 m x 1 m quadrats. Each species belong to a separate genus under 14 families. The top five species with the highest relative percent cover are *Selaginella* sp. (0.12), *Cyathea* sp. (0.10), kapulasan (*Nephelium ramboutan-ake*) (0.10), malabagang (*Glochidion album*) (0.06), and *Calamus* sp. (0.06).

Noteworthy species in AMMNBA

Some species are new records in the province of Camarines (46), endemic to the Philippines (58), and classified as threatened species (22) based on the Philippine Red List for plants (DAO 2017-11) and the IUCN red lists of threatened species. These noteworthy species should be considered in formulating of management plans and must be prioritized for conservation.

New province record

Forty-six species were discovered to be a new record in the province of Camarines based on the available literature (*i.e.*, Co's Digital Flora of the Philippines www.philippineplants.org). **Table 5** shows the list of all species recorded as a new distribution in Camarines. This relatively huge number of new province record species suggests the lack of previous plant diversity studies in the area.

Endemic species

Of the 164 species identified, 58 species belonging to 29 families are endemic to the Philippines (**Table 6**). This accounts for 35.37% of endemism, which is lower compared to the percent country endemism of 40%. The anthropogenic activities might have favored the proliferation of non-endemic pioneer species in the area, such as balanti (*Omalanthus populneus*). It is worth mentioning that 18 species were encountered in an opportunistic survey.

Threatened species

Based on the DAO 2017-11 and the IUCN red list of threatened species, 22 species recorded in this study were considered threatened species (**Table 7**). Most importantly, two species were recognized as critically endangered by the IUCN Red List of Species and DAO 2017-11, respectively. These species are Hopea philippinensis and Vatica pachyphylla. Moreover, 15 species are classified as vulnerable species and three species are categorized as other threatened species by DAO 2017-11.

Table 5. Summary of all new province record species in Camarines.

Species	Family name	Location	Species	Family name	Location
Acer laurinum Hassk	Aceraceae	T1_OPP, T1-Q5	*Litsea leytensis* Merr.	Lauraceae	T2_OPP
Aglaia angustifolia Miq	Meliaceae	T2-Q4	*Litsea varians* (Blume) Boerl.	Lauraceae	T1_OPP, T1-Q8, T2-Q8
Anacolosa frutescens (Blume) Blume	Aptandraceae	T2-Q3	*Matthaea sancta* Blume	Monimiaceae	T1_OPP, T1-Q2
Antirhea livida Elmer	Rubiaceae	T1-Q6	*Memecylon terminaliflorum* Elmer	Melastomataceae	T1_OPP, T2_OPP
Aquilaria brachyantha (Merr.) Hallier f.	Thymelaeceae	T2-Q5	*Mitrephora lanotan* (Blanco) Merr.	Annonaceae	T1-Q4
Canthium pedunculare Cav.	Rubiaceae	T2-Q6, T2-Q7	*Myristica agusanensis* Elmer	Myristicaceae	T1_OPP
Cleidion ramosii (Merr.) Merr.	Euphorbiaceae	T2-Q7	*Myristica simiarum* A.DC.	Myristicaceae	T2_OPP
Cryptocarya acuminata Merr.	Lauraceae	T1_OPP	*Neonauclea media* (Havil.) Merr.	Rubiaceae	T1_OPP, T2_OPP
Cynometra inaequifolia A.	Fabaceae	T2-Q1	*Palaquium montanum* Elmer	Sapotaceae	T2_OPP, T2-Q1, T2-Q4, T2-Q5, T2-Q8
Dacryodes incurvata (Engl.) H.J.Lam	Burseraceae	T1_OPP	*Palaquium foxworthyi* Merr.	Sapotaceae	T1_OPP, T1-Q7, T2-Q8
Dalbergia cumingiana Benth.	Fabaceae	T1_OPP, T1-Q7	*Phyllanthus microcarpus* (Benth.) Müll	Phyllanthaceae	T1-Q1
Decaspermum blancoi S.Vidal	Myrtaceae	T2_OPP, T2-Q3	*Pipturus dentatus* (C.B.Rob.) C.B.Rob	Urticaceae	T2_OPP
Dendrocnide meyeniana (Walp.) Chew	Urticaceae	T2-Q0	*Planchonella villamilii* (Merr.) Swenson	Sapotaceae	T2-Q6
Desmos chinensis Lour.	Annonaceae	T2-Q3, T2-Q5	*Polyalthia lanceolata* S.Vidal	Annonaceae	T2-Q3
Goniothalamus amuyon (Blanco) Merr.	Annonaceae	T1_OPP, T1-Q6	*Polyscias nodosa* (Blume) Seem	Araliaceae	T1-Q1

Table 5. (Con't)

Species	Family name	Location	Species	Family name	Location
Gonystylus reticulatus (Elmer) Merr.	Thymelliaceae	T1_OPP	*Pometia pinnata* J.R.Forst	Sapindaceae	T2-Q4
Grewia multiflora Juss.	Sparmanniaceae	T2_OPP	*Semecarpus cuneiformis* Blanco	Anacardiaceae	T1_OPP, T2-Q1, T2-Q3, T2-Q4
Guioa discolor Radlk	Sapindaceae	T1_OPP	*Sterculia cordata* Blume var. *montana* (Merr.) Tantra	Malvaceae	T1-Q4, T2-Q4
Helicia robusta (Roxb.) R.Br. ex Wall. var. *integrifolia* (Elmer) Sleumer	Proteaceae	T1_OPP	*Streblus glaber* (Merr.) Corner	Moraceae	T1_OPP
Helicia robusta (Roxb.) R.Br. ex Wall. var. *robusta*	Proteaceae	T1_OPP	*Syzygium tenuirame* (Miq.) Merr.	Myrtaceae	T2-Q7
Omalanthus populneus (Geiseler) Pax in Engl. & Prantl	Euphorbiaceae	T1_OPP, T1-Q3, T1-Q8	*Uvaria peninsula* Elmer	Annonaceae	T1_OPP
Homalium gitingense Elmer	Salicaceae	T1_OPP	*Weinmannia hutchinsonii* Merr.	Cunoniaceae	T2-Q2
Litsea fulva (Blume) Fern.-Vill.	Lauraceae	T1_OPP, T1-Q8, T2-Q1, T2-Q5, T2-Q8	*Xanthophyllum flavescens* Roxb	Polygalaceae	T2_OPP

Legend: T1 – Transect 1; T2 – Transect 2; OPP – Opportunistic; and Q – Quadrat

Table 6. List of all Philippine endemic species recorded in AMMNBA.

Species	Family name	Location	Species	Family name	Location
Actinodaphne multiflora Benth.	Lauraceae	T1_OPP, T1-Q2, T2-Q3, T2-Q4, T2-Q7	*Dalbergia cumingiana* Benth	Fabaceae	T1_OPP, T1-Q7
Antherostele grandistipula (Merr.) Bremek.	Rubiaceae	T2-Q3	*Decaspermum blancoi* S.Vidal	Myrtaceae	T2_OPP, T2-Q3
Antidesma digitaliforme Tul.	Phyllanthaceae	T1_OPP, T1-Q2	*Diplodiscus paniculatus* Turcz	Brownlowiaceae	T2_OPP, T2-Q4
Antirhea livida Elmer	Rubiaceae	T1-Q6	*Discocalyx minor* var. *minor* Mez	Primulaceae	T1_OPP, T2_OPP, T2-Q7, T2-Q8
Aquilaria brachyantha (Merr.) Hallier f.	Thymelaeceae	T2-Q5	*Ehretia philippinensis* A.DC.	Boraginaceae	T2-Q1
Astronia cumingiana S.Vidal	Melastomataceae	T2_OPP	*Ficus fiskei* Elmer	Moraceae	T2-Q4
Astronia pulchra S.Vidal	Melastomataceae	T1_OPP, T2_OPP	*Garcinia rubra* Merr.	Clusiaceae	T2-Q8
Canthium pedunculare Cav.	Rubiaceae	T2-Q6, T2-Q7	*Goniothalamus amuyon* (Blanco) Merr.	Annonaceae	T1_OPP, T1-Q6
Cinnamomum mercadoi S.Vidal	Lauraceae	T1-Q6, T2-Q3	*Gonystylus reticulatus* (Elmer) Merr.	Thymelliaceae	T1_OPP
Cleidion ramosii (Merr.) Merr.	Euphorbiaceae	T2-Q7	*Guioa discolor* Radlk	Sapindaceae	T1_OPP
Cryptocarya acuminata Merr.	Lauraceae	T1_OPP	*Gymnacranthera farquhariana* (Wall. ex Hook.f. & Thomson) Warb var. *paniculata* (A.DC.) R.T.A.Schouten	Myristicaceae	T1-Q0, T2-Q3, T2-Q5
Cryptocarya lauriflora (Blanco) Merr.	Lauraceae	T1_OPP, T2-Q4	*Helicia robusta* (Roxb.) R.Br. ex Wall. var. *integrifolia* (Elmer) Sleumer	Proteaceae	T1_OPP
Cynometra inaequifolia A.	Fabaceae	T2-Q1	*Homalium gitingense* Elmer	Salicaceae	T1_OPP
Cyrtandra villosissima Merr.	Gesneriaceae	T2-Q2	*Hopea acuminata* Merr.	Dipterocarpaceae	T1_OPP, T2_OPP

Table 6. (Con't)

Species	Family name	Location	Species	Family name	Location
Hopea philippinensis Dyer	Dipterocarpaceae	T2-Q4, T2-Q5, T2-Q7, T2-Q8	*Palaquium foxworthyi* Merr.	Sapotaceae	T1_OPP, T1-Q7, T2-Q8
Ixora ebracteolata Merr.	Rubiaceae	T1-Q6, T2-Q5, T2-Q6	*Palaquium tenuipetiolatum* Merr.	Sapotaceae	T2-Q8
Kibatalia gitingensis (Elmer) Woodson	Apocynaceae	T1-Q2, T2-Q3, T2-Q5, T2-Q6, T2-Q7, T2-Q8	*Phaeanthus ophthalmicus* (Roxb. ex G.Don) J.Sinclair	Annonaceae	T2_OPP, T2-Q5, T2-Q8
Lepidopetalum perrottetii (Cambess.) Blume	Sapindaceae	T1-Q6	*Pipturus dentatus* (C.B.Rob.) C.B.Rob	Urticaceae	T2_OPP
Lithocarpus philippinensis (A.DC.) Rehder	Fagaceae	T1-Q6, T2-Q3, T2-Q4, T2-Q7, T2-Q8	*Planchonella villamilii* (Merr.) Swenson	Sapotaceae	T2-Q6
Litsea leytensis Merr.	Lauraceae	T2_OPP	*Polyalthia lanceolata* S.Vidal	Annonaceae	T2-Q3
Macaranga bicolor Müll.Arg	Euphorbiaceae	T2-Q1, T2-Q2	*Severinia disticha* (Blanco) Swingle	Rutaceae	T1_OPP
Memecylon terminaliflorum Elmer	Melastomataceae	T1_OPP, T2_OPP	*Shorea contorta* S.Vidal	Dipterocarpaceae	T1-Q2, T1-Q3, T2_OPP, T2-Q3, T2-Q5, T2-Q8
Microcos philippinensis (Perkins) Burret	Sparmanniaceae	T2-Q3, T2-Q5, T2-Q6	*Shorea polysperma* (Blanco) Merr.	Dipterocarpaceae	T1-Q7,T1-Q8, T2_OPP, T2-Q5, T2-Q6
Mitrephora lanotan (Blanco) Merr.	Annonaceae	T1-Q4	*Syzygium urdanetense* (Elmer) Merr.	Myrtaceae	T1_OPP
Myristica agusanensis Elmer	Myristicaceae	T1_OPP	*Ternstroemia philippinensis* Merr. var. *philippinensis*	Pentaphylaceae	T1_OPP
Myristica philippensis Lam.	Myristicaceae	T1-Q2	*Uvaria peninsula* Elmer	Annonaceae	T1_OPP
Neonauclea media (Havil.) Merr.	Rubiaceae	T1_OPP, T2_OPP	*Vatica pachyphylla* Merr.	Dipterocarpaceae	T1-Q6, T2-Q1, T2-Q3, T2-Q4
Palaquium montanum Elmer	Sapotaceae	T2_OPP, T2-Q1, T2-Q4, T2-Q5, T2-Q8	*Voacanga globosa* (Blanco) Merr.	Apocynaceae	T2-Q1, T2-Q3
Palaquium philippense (Perr.) C.B.Rob.	Sapotaceae	T2_OPP	*Weinmannia hutchinsonii* Merr.	Cunoniaceae	T2-Q2

Legend: T1 – Transect 1; T2 – Transect 2; OPP – Opportunistic; and Q – Quadrat

Table 7. List of all threatened species recorded in AMMNBA.

Species	Family name	DAO 2017-11	IUCN 2021-3	Location
Agathis philippinensis Warb	Araucariaceae	VU	VU	T2-Q6
Aglaia angustifolia Miq.	Meliaceae	VU	VU	T2-Q4
Antirhea livida Elmer	Rubiaceae	VU	VU	T1-Q6
Aquilaria brachyantha (Merr.) Hallier	Thymelaeaceae	VU	DD	T2-Q5
Camellia lanceolata (Blume) Seem	Theaceae	VU	LC	T2-Q7
Cynometra inaequifolia A.	Fabaceae	VU	VU	T2-Q1
Diospyros pyrrhocarpa Miq.	Ebenaceae	VU	LC	T2_OPP, T2-Q4, T2-Q7, T2-Q8
Hopea acuminata Merr.	Dipterocarpaceae	EN	VU	T1_OPP, T2_OPP
Hopea philippinensis Dyer	Dipterocarpaceae	CR	EN	T2-Q4, T2-Q5, T2-Q7, T2-Q8

Table 7. (Con't)

Species	Family name	DAO 2017-11	IUCN 2021-3	Location
Kingiodendron alternifolium (Elmer) Merr. & Rolfe	Fabaceae	VU	NA	T2_OPP
Litchi chinensis ssp. *philippinensis* Sonn.	Sapindaceae	VU	NA	T1_OPP, T1-Q3, T2-Q1, T2-Q5, T2-Q7, T2-Q8
Litsea leytensis Merr.	Lauraceae	EN	NT	T2_OPP
Mitrephora lanotan (Blanco) Merr.	Annonaceae	OTS	NT	T1-Q4
Myristica philippensis Lam.	Myristicaceae	OTS	LC	T1-Q2
Nephelium ramboutan-ake (Labill.) Leenh	Sapindaceae	VU	NA	T1-Q1, T2-Q2, T2-Q3
Palaquium philippense (Perr.) C.B.Rob.	Sapotaceae	VU	LC	T2_OPP
Planchonella villamilii (Merr.) Swenson	Sapotaceae	VU	EN	T2-Q6
Pterocarpus indicus Willd. forma *indicus*	Fabaceae	VU	EN	T1-Q0, T1-Q1, T1-Q2, T2-Q2
Shorea contorta S.Vidal	Dipterocarpaceae	VU	LC	T1-Q2, T1-Q3, T2_OPP, T2-Q3, T2-Q5, T2-Q8
Shorea polysperma (Blanco) Merr.	Dipterocarpaceae	VU	LC	T1-Q7, T1-Q8, T2_OPP, T2-Q5, T2-Q6
Vatica pachyphylla Merr.	Dipterocarpaceae	CR	EN	T1-Q6, T2-Q1, T2-Q3, T2-Q4

Legend: *CR – Critically endangered; VU – vulnerable; OTS – Other Threatened Species; LC – Least concern; DD – Data deficient; NA – Not assessed/applicable; T1 – Transect 1; T2 – Transect 2; OPP – Opportunistic; and Q – Quadrat

Important plant areas (IPAs) in AMMNBA

The biodiversity value of each quadrat (**Table 8**) was computed based on three important parameters (species richness, endemism, and conservation status) set by Anderson (2002). The quadrat with the highest biodiversity value is T2-Q3. It obtained the highest number of species (21) measured where approximately 57% of these are endemic and 19% are threatened species. This means that this quadrat has the most IPA among the 18 quadrats established in this study and should be the priority in establishing a permanent biodiversity monitoring area.

Table 8. Biodiversity values of the different sampling plants in AMMNBA.

Location	No. of species	Rank	No. of endemic species	Rank	No. of threatened species	Rank	Biodiversity value
T2-Q3	21	3	12	3	4	3	9
T2-Q5	10	2	10	3	5	3	8
T2-Q8	14	2	10	3	5	3	8
T1-Q2	16	3	5	2	3	2	7
T2-Q7	15	2	7	2	4	3	7
T1-Q6	7	1	7	2	4	3	6
T2-Q1	12	2	6	2	3	2	6
T2-Q4	5	1	8	2	4	3	6
T1-Q3	12	2	1	1	2	2	5
T1-Q8	11	2	1	1	2	2	5
T2-Q6	5	1	6	2	2	2	5
T1-Q4	9	2	1	1	1	1	4
T1-Q7	5	1	3	1	2	2	4
T1-Q0	2	1	1	1	1	1	3
T1-Q1	2	1	0	1	1	1	3
T1-Q5	8	1	0	1	1	1	3
T2-Q0	7	1	0	1	0	1	3
T2-Q2	6	1	3	1	1	1	3

Note: The range used in ranking the criterion are the following: number of species (2-8=1; 9-15=2; 16-21=3); number of endemic species (0-4=1; 5-9=2; 10-12=3); and number of threatened species (0-1.6=1; 1.7-3.3=2; 3.4-5=3).

SUMMARY AND CONCLUSION

The general vegetation of AMMNBA can be characterized as tropical lowland evergreen rain forests having both early and advanced secondary growth forests. AMMNBA can be considered an important biodiversity area as it supports a highly diverse floral species with 58 Philippine endemics and 22 threatened species. Additionally, at least 46 species are probably new records. However, despite being a protected area, AMMNBA is experiencing destructive anthropogenic disturbances such as *kaingin* and charcoal making. Therefore, it is important that protected area managers strongly consider addressing this disturbance when crafting a comprehensive management plan.

In Transect 1, Quadrat 2 had the highest number of individuals (26) and species (16) and the highest diversity indices. *Ficus minahassae* was the most important species, while the most frequently-occurring species was *Astronia* sp. The most abundant saplings species was *Cyathea* sp., while *Selaginella* sp. had the highest percent cover of 0.16.

In Transect 2, Quadrat 3 was the most diverse and with the highest number of individuals (28) and species (21). *Hopea philippinensis* was the most important species in this transect, and thus, it has to be prioritized in conservation plans. The most frequently occurring species in this transect is *Kibatalia gitingensis*, while the most abundant sapling species was *Coffea* sp. Similar to Transect 1, the species with the highest relative ground cover was *Selaginella* sp. Having the greatest number of threatened and endemic species in the area, Quadrat 3 of Transect 2 had the most important plant area in the AMMNBA. Thus, the 2-ha permanent biodiversity monitoring area must be established in this part.

RECOMMENDATIONS

The results of this study may not be sufficient to represent the whole floristic component of the protected area as only two transect lines located from a single municipality were established. Hence, it is recommended to conduct additional plant surveys in other parts of AMMNBA employing the same standardized assessment method. To estimate the species richness of the entire protected area, future plant surveys should consider the other forest formations at the higher elevation, such as the tropical lower montane and tropical upper montane rain forests. Some plant specimens were not identified in the field because of the unavailability of reproductive structures. Thus, monitoring their flowering and fruiting and collecting samples for proper identification are recommended.

This study provides an updated floral profile of the AMMNBA using the prescribed standard method of assessing the terrestrial ecosystem. Therefore, the results are highly recommended to be considered by the Protected Area Management Office (PAMO) and other field implementers in the formulation and updating of management and conservation plans, especially focusing on the identified noteworthy species and important plant areas in AMMNBA.

LITERATURE CITED

Anderson, S. (2002) *Identifying Important Plant Areas: A Site Selection Manual for Europe, and a Basis for Developing Guidelines for Other Regions of the World.* United Kingdom: Plantlife International.

Aquino, A.P. & Vitto, A.H. (n.d.) *RA 7586: Protected Areas System in the Philippines*. Retrieved on April 14, 2019 from: <http://ap.fftc.agnet.org/ap_db.php?id=285&print=1>

BMB [Biodiversity Management Bureau]. (2015) *Guidebook to Protected Areas of the Philippines*. Biodiversity Management Bureau – Department of Environment and Natural Resources, Philippines. 100 p.

BMB-DENR [Biodiversity Management Bureau - Department of Environment and Natural Resources. (2016) *Guidelines on Biodiversity Assessment and Monitoring System for Terrestrial Ecosystems*. BMB TB 2016 – 05.

BMB [Biodiversity Management Bureau]. (2017) *Status of the Philippine Biodiversity*. Retrieved on April 14, 2019 from: <http://bmb.gov.ph/388-protection-and-conservation-of-wildlife/facts-and-figures/786-status-of-the-philippine-biodiversity>

Brown, W.H. (1919) *The Vegetation of Philippine Mountains*. 434p. Bureau of Science Publication No. 13, Manila.

Buot, Jr., I. (2009) An ethnobotanical study of the plant biodiversity of Mt. Mayon, Bicol Peninsula, Albay, Philippines. *Journal of Nature Studies* 8: 1–10.

Cabansag, M.G.S. (2016) Species composition, diversity and richness in understanding threats on biodiversity conservation of Philippine native and indigenous species of trees. *International Journal of Applied Environmental Sciences* 11(3): 59–772.

CBD [Convention on Biological Diversity]. (1992) *Convention on Biological Diversity. Secretariat of the Convention on Biological Diversity*. Montreal, Canada

CBD [Convention on Biological Diversity]. (n.d.) *Major Threats*. Retrieved on April 14, 2019 from: <http://www.biodiv.be/biodiversity/threats>

CBD [Convention on Biological Diversity]. (n.d.) *Philippines - Country Profile*. Retrieved on March 20, 2019 from: <https://www.cbd.int/countries/profile/default.shtml?country=ph>

Cruz, R.V.O., Malabrigo, Jr., P.L., Balatibat, J.B., Gonzalez, J.C., De Guia, A.P.O., Tiburan, C.T., Cereno, R.P., Fernandez, D.M., & Buhay, A. (2017) *Manual on Biodiversity Assessment and Monitoring System for Terrestrial Ecosystems – How-to Guidelines*. Biodiversity Management Bureau. 180 p. ISBN 978-621-8096-03-7.

Curtis J.T. & McIntosh R.P. (1951) An upland forest continuum in the prairie-forest border region of Wisconsin. *Ecology* 32: 476–496.

DENR [Department of Environment and Natural Resources]. (2017) *Updated National List of Threatened Philippine Plants and their Categories*. DAO 2017-11. Quezon City. Retrieved on April 14, 2019 from: <https://denr.gov.ph/section-policies/viewrec.php?id=4957&main=1>

Fernando, E.S., Balatibat, J.B., Perlas, J.R., & Jumawid, R.J.J. (1998) *Resource Inventory and Assessment of Biodiversity in Subic Bay Metropolitan Authority* (unpublished report).

Fernando, E.S., Suh, M.H., Lee, J., & Lee, D.K. (2008) *Forest Formations of the Philippines*. ASEAN-Korea Environmental Cooperation Unit (AKECU).

Garrity, D.P., Kummer, D.M., & Guiang, E.S. (1993) The Philippines. *In*: *Sustainable Agriculture and the Environment in the Humid Tropics*. pp. 549–624. National Academy Press, Washington, DC.

Lagbas, A., Buot, Jr., I. & Mendoza, L. (2017) Conservation status of the plant species in selected areas with frequent human activities in Roosevelt Protected Landscape, Bataan, Luzon Island, Philippines. *The Thailand Natural History Museum Journal* 10: 79–115.

Malabrigo Jr. P.L., Umali, A.G.A., Pulan, D.E., Eduarte, G.T., & Tobias, A.B. (2018) *Floral Assessment of Mt. Iraya Watershed Municipality of Basco, Batanes*. Unpublished

Malabrigo, P.L.Jr., Umali, A.G.A., Tiburan, C.L.Jr., Pampolina, N.M., Balatibat, J.B., Tinio, C.E., Abasolo, W.P., Luna, A.C. & Boncodin, J.C. (2016) Tree Diversity and Stand Structure of Permanent Biodiversity Monitoring Area in Mount Makiling. *Asian Journal of Biodiversity* 7. doi: http://dx.doi.org/10.7828/ajob.v7i1.885

Mooney, K.N. & Gibb, C. (n.d.) How are people affecting biodiversity. Retrieved on April 14, 2019 from: <http://www.fao.org/3/i3157e/i3157e02.pdf>

NIPAS [National Integrated Protected Areas System Act of 1992]. (1992) *Republic Act No. 7586. An Act Providing for the Establishment and Management of National Integrated Protected Areas System, Defining its Scope and Coverage, and for Other Purposes*. Retrieved on March 20, 2019 from:<https://www.lawphil.net/statutes/repacts/ra1992/ra_7586_1992.html>

Nieva, R.N. & De la Cruz, A. (n. d.) *Establishment of Two (2) Kilometer Permanent Monitoring Plot (#2) for Abasig Matogdon Mananap Natural Biotic Area (AMMNBA)*. Unpublished (Assessment Report).

Ordas, J.A., Thomas, S.G., Diesmos, A.C., Papa, R.D., & Banag, C.I. (2017) Rapid assessment of Taal Volcano Protected Landscape (TVPL) terrestrial biodiversity. *Philippine Journal of Systematic Biology* 11(1): 57–66

Paclibar, G.C.B. & Tadiosa E.R. (2020) Plant species diversity and assessment in Quezon Protected Landscape, Southern Luzon, Philippines. *Philippine Journal of Systematic Biology* 14(3). DOI 10.26757/pjsb2020c14010

Partosa, J. & Delos, L.J. (2013) Vegetation analysis of the Pasonanca Natural Park, Zamboanga City, Philippines. *Journal of Energy Technologies and Policy* (3): 90–100.

Pelser, P.B., Barcelona, J.F., & Nickrent, D.L. (2011) Co's Digital Flora of the Philippines. Retrieved on March 2019 from: <www.philippineplants.org>

IUCN [International Union for the Conservation of Nature]. (n.d.) The IUCN Red List of Threatened Species. Retrieved on April 14, 2019 from: <https://www.iucnredlist.org/>

The IUCN Red List of Threatened Species. (n.d.) Protected Area Categories. Retrieved on April 5, 2019 from <https://www.iucn.org/theme/protected-areas/about/protected-area-categories>

The Plant List. (2013) The Plant List - A Working List for All Plant Species. Retrieved on April 14, 2019 from: <http://theplantlist.org/ Version 1