Floristic Composition Of The Remaining Forests In Upland Cavite, Luzon Island, Philippines

Maria Melanie P. Medecilo and Myra N. Lagat

ABSTRACT

Cavite Province lies in the western monsoon forest zone of the Philippines and is considered as a tropical lowland rainforest making it a haven for diverse flora and fauna. The existing total land forest area is 8,624.956 hectares, but the only proclaimed national park is Mts. Palay-palay/Mataas na Gulod Protected Landscape. Unfortunately, the remaining forests are not spared from biodiversity loss because of its accessibility to Metro Manila, which eventually leads to unsustainable use of natural resources. This study was conducted to characterize the floristic composition, analyze the vegetation structure, and provide an inventory of plants in the provinces’ remaining forests. Data collection was done from June 2014 to March 2016. Forty-six plots (20m x 20m) were used for tree species composition. The plot size for shrub and non-woody plants was 5m x 5m quadrats while for herbaceous plants it was 1m x 1m quadrat. Plant diversity and environmental parameters in each plot were measured and recorded. Canonical Correspondence Analysis (CCA) was employed to analyze the relationships between vegetation and environmental variables. The study documented 501 species belonging to 336 genera and 113 families. Three vegetation types, secondary forest, agricultural ecosystem, and semi-secondary (mixed forest) were documented in the remaining forests in Upland Cavite and the Protected Area (PA) part is characterized as lowland evergreen dipterocarp rainforest dominated by Shorea guiso, Ficus chrysolepis, Diospyros pyrrhocarpa, Buchanania arborescens and Strombosia philippinensis. The forest floor is dominated by Anaxagorea luzonensis, Aglaonema commutatum and Bolbitis rhizophylla.

KEY WORDS: Plant diversity, Vegetation, Lowland dipterocarp forest, Mts. Palay-palay/Mataas Na Gulod Protected Landscape, Conservation.

INTRODUCTION

The Philippine archipelago is considered as one of the megadiverse countries in the world (Conservation International, 2012) and recognized as one of the eight “hottest spots” in terms of biodiversity (Myers et al., 2000). With more than 7,100 islands and a unique geography, the country is a home to thousands of known as well as undocumented species of plants and animals. It is also a powerhouse because it supports a high rate of endemism and ranks second to Madagascar in terms of endemics, endemic species/area ratios and habitat loss having 64.7 species of endemic plants/area ratios per 100 km (Myers et al., 2000). The country is inhabited by 15,000 species of plants of which more than 8000 species are angiosperms (Madulid, 2005). However, the state of biodiversity is under severe pressure because of human activities such as unstoppable deforestation, pollution, mining and conversion of land leading to excessive loss of plants and animals. Destruction of tropical forests occurred at a rate of 1.4% or 89,000 hectares annually in 1990 (FAO, 2003) but in 2000-2005 the rate of forest cover change decreased by 20.2% to 1.98% per annum (Hansen et al., 2013).

Cavite is one of the provinces in the Philippines and lies in the western monsoon forest zone where most of its vegetation is considered as a tropical lowland rainforest (Cavite Profile, 2009) making it a haven for diverse plants and animals. The province experiences monsoon rains yearly, making some parts of the province a friendly habitat to thousands of classified and unclassified biodiversity.
species. Based on the profile of the province in 2009, there are two categories of land resources, namely forest and alienable and disposable lands. The existing total forest area in Cavite is 8,624.956 hectares. However, the only proclaimed national park is Mts. Palay-palay and Mataas na Gulod Protected Landscape with an area of 4,000 hectares while five unclassified forests are found in Upland Cavite (Cavite Province Report, 2009). These forests are rich in different products such as timber (Luyon and Medecilo, 2006; Cervillon, 2007) and rattans (Silveo, 2008) as well as in sources of water. However, the remaining forests are not spared from threats of biodiversity loss. It is therefore necessary to document these plant species before they vanish. Cataloguing plant species in database would not only contribute to the increasing knowledge to the field of taxonomy but would also add awareness regarding the conservation status of plant species studied.

Several studies have already been conducted in the protected area. Vegetation analysis was conducted in Mts. Palay-palay/ Mataas na Gulod Protected Landscape by Luyon and Medecilo (2006). This study focused only in the protected area with emphasis on tree species with Diameter at Breast Height (DBH) ≥ 10 cm using Point-Center Quarter Method (PCQM) with no data on shrub and herb species. Based on their study, the vegetation is classified as lowland evergreen dipterocarp forest dominated by Shorea guiso and other dipterocarp species. Causaren (2016) and Lagat (2012) studied the vegetation of forest fragments in Cavite in relation to the abundance and distribution of herpetofauna. No study has been conducted in other forests in Cavite.

Because of Cavite’s proximity to Manila and the establishment of industrial zones in the province, in-migration occurs leading to rapid increase in population. The province has the highest population next to NCR, and it is estimated that in 2017 the population will rise to six million (Barrera pers. comm.). Given this scenario, rapid urbanization, land conversion and non-sustainable use of natural resources will eventually affect the remaining forests of the province. The diversity and floral composition are important elements to determine the human activities as well as environmental factors affecting the vegetation of an area.

Lack of protection and unsustainable use of natural resources threaten the area’s biodiversity. It is therefore even more urgent to conduct vegetation studies in the pristine forests of Upland Cavite to determine what species are in need of protection and conservation. The output will also provide baseline information for policy makers of the province to highlight the impact of climate change if conservation measures would not be integrated in the future development plans. It is intended that the present study should form the basis for any future management plans for the province and add to the present knowledge on the effective management of its plant ecosystem.

The sites are the remaining forests in Upland Cavite i.e. Tagaytay City, Silang, Magallanes, Amadeo, Indang, General Aguinaldo (Bailen), Ternate and Maragondon. The present study is the first systematic survey of the vegetation in the province. Previous studies concentrated on tree species in selected habitat particularly Mts. Palay-palay Protected Landscape using the PCQM method. The present study aims to assess the species composition, describe the vegetation types and determine the conservation and taxonomic status of species of plants. The study also compared the vegetation in each site, documented all the species encountered and determined the threats and conservation status of each species.

**MATERIALS AND METHODS**

**Description of the Study Area.** The study was conducted in the remaining forests of Upland Cavite, more or less 65km away from Metro Manila. Upland Cavite covers the municipalities of Amadeo, Bailen, Indang, Magallanes, Maragondon, Silang, Ternate and Tagaytay City (Figure 1). It is located within the upland characterized as low agro-ecological zone and the forest structure can be classified as agricultural, secondary and lowland evergreen dipterocarp forest. Some of the forests are patches with an estimated size of 0.25 hectares to 0.75 hectares. The protected area with a size of more or less 4,000 hectares is found in the municipalities of Ternate and Maragondon- (Cavite) and Nasugbu, Batangas.

**Data Collection.** The collection of data was gathered from August 2014 to March 2016. A total of 46 quadrats (20 m ×

![Map of Cavite showing the research sites in Upland Cavite.](image)
Data Analysis. Density, Diameter at Breast Height (DBH), frequency, dominance, basal area, and Importance Value Index (IVI) were used for description of vegetation structure. The structural parameters were analyzed using the following formula:

1) Basal area of a tree = circumference (C) 2/4 or (2/39.5).
2) Diameter at Breast Height (DBH) = ( / )
3) Dominance = total cover or basal area of species A/ area sampled for each plot (20 m x 20 m).
4) Relative dominance = dominance for species A/ total dominance of all species x 100.
5) Density = (number of individuals of species A/ area sampled which is 20 m x 20 m).
6) Relative density = (number of individuals of species A/ total number of individuals in area (20 m x 20 m)) x 100.
7) Frequency = (number of plots in which species A occurs/ total number of plots sampled).
8) Relative frequency = (frequency value for species A/ total of all frequency values for all species) x 100.
9) Importance value = relative density + relative frequency + relative dominance.

Cluster Analysis. The environmental parameters such as soil and air temperature, elevation, and relative humidity for each plot along with the number of species and individuals were tabulated in a matrix using Microsoft Excel. The different characters were then coded in a multi-state order. Each coded character state was recorded in binary order for the numerical analysis.

RESULTS AND DISCUSSION

Research Sites and Environmental Parameters. Forty-six (46) plots were established in different municipalities in Upland Cavite. The elevation ranged from 64 to 608 m.a.s.l. Air temperature varies in each site. The number of trees in the plots ranged from 9 to 44. The plots with the highest number of trees were found in Maragondon and Ternate since these sites are part of the Protected Area (PA). From the 46 plots, 11 were established outside PA and found in the municipalities of Amadeo, Bailen, Indang, Magallanes, Silang and Tagaytay City. Thirty-five (35) plots were delineated in Ternate and Maragondon that are part of PA. The number of plots from each municipality varied depending on the size of the remaining forests (Table 2).

The Canonical Correspondence Analysis (CCA) axis (Figure 2) shows that elevation and relative humidity are the most important variables in axis 1 and axis 2. Some of the
Table 1. List of research sites with corresponding environmental parameters, elevation, number of trees (≥ 10 DBH) and number of species.

<table>
<thead>
<tr>
<th>Sites</th>
<th>Municipality</th>
<th>Site Classification</th>
<th>Elevation (masl)</th>
<th>Air Temp. (°C)</th>
<th>Relative Humidity</th>
<th>Soil temp. (°C)</th>
<th># of tree individuals</th>
<th># of species</th>
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Legend: PA – Protected Area, Not PA – Not Protected Area
Table 2. List of plant species recorded in Upland Cavite, Philippines according to The Angiosperm Phylogeny Group Classification IV (2016), The Pteridophyte Phylogeny Group (2016) and their taxonomic/conservation status (DAO 2017; IUCN Redlist, 2016).

<table>
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<tr>
<th>FAMILY</th>
<th>SPECIES</th>
<th>TAXONOMIC/CONSERVATION STATUS</th>
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<td><strong>A. Lycophytes and Ferns</strong></td>
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<td>Aspleniaceae</td>
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<td>Asplenium tenerum G. Forst.</td>
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<tr>
<td>Athyriaceae</td>
<td>Diplazium esculentum (Retz.) Sw.</td>
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<tr>
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<td>Blechnum orientale L.</td>
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<td></td>
<td>Stenochlaena palustris (Burm. f.) Bedd</td>
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<td>Cyathea contaminans Copel.</td>
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<td>Davallia trichomanoides Blume</td>
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<td>Dryopteridaceae</td>
<td>Bolbitis rhizophylla (Kauf.) Hennipman</td>
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<td>Bolbitis heteroclitica (C.Presl) Ching</td>
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<td>Polystichum horizontal C. Presl</td>
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<td>Microsorum longissimum Merr.</td>
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<td>Lepisorus mucronatus (Fee) Li Wang</td>
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<td>Pityrogramma calomelanos (L.) Link.</td>
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<td><em>Blechum pyramidatum</em> Urb.</td>
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<td>*Voacanga globosa Merr.</td>
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<td></td>
<td><em>Neonauclea bartlingii</em> Merr.</td>
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<td></td>
<td><em>Ophiorrhiza stenophylla</em> Merr. EC in Cavite only</td>
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<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
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<tr>
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<td><em>Psychotria manillensis</em> Bartl. ex D.C.</td>
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<td><em>Psychotria</em> sp.</td>
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<td><em>Spermococe hispida</em> L.</td>
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<td><em>Tarennoidea wallichii</em> (Hook. f.) Tirverg. &amp; Sastre</td>
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<td><em>Wenlandia luzonensis</em> DC</td>
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<td><em>Harpullia arborea</em> (Blanco) Radlk.</td>
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<td>Kolowratia elegans Presl</td>
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**Legend:**
- * Species with <1 IVI (importance Value Index)
sampling plots in Maragondon and Ternate were strongly correlated with elevation while sampling plots in non-PA were strongly correlated with soil and air temperature. Canonical axis 1 (eigenvalue = 0.374) is associated with RH (positive end) while Canonical axis 2 (eigenvalue = 0.263) is associated with elevation. Majority of the plots centroid were near the center of axis 1 and axis 2 indicating that the vegetation cover is still intact with thick canopy and in good condition. The eigenvalues for axis 1 is 37% and is 26% in axis 2 which accounted to 63% of the occurrence or phenomenon in relation to the different environmental factors and species distribution. These were the plots inside PA with lowland tropical evergreen dipterocarp forest type. In gradient 2, however, soil and air temperature were high indicating that the plots were disturbed and the canopy is open since there was more sunlight penetration. This means that tree species in this axis are sensitive to disturbance. The vegetation is open canopy and considered as disturbed forests where soil and air temperature are strongly correlated to the species distribution.

**Floristic Composition.** A total of 178 woody species with DBH ≥ 10 cm representing 152 genera and 658 families were identified out of 1005 tree individuals. The top ten species with highest Importance Value Index (IVI) are as follows: *Shorea guiso* Blume (Dipterocarpaceae, 9.238), *Tarrenoidea walichii* (Hook. f.) Tirverg. & Sastre (Rubiaceae, 5.437), *Diospyros philippinensis* A. DC. (Ebenaceae, 5.154), *Diospyros pilosantha* (Ebenaceae, 5.027), and *Canarium ovatum* Engl. (Burseraceae, 4.689). These species constituted 60.16% of the total importance value while 39.84% of importance value represented the other 168 species. *Shorea guiso*, *Diospyros pyrocharpa*, *S. philippinensis*, and *B. arborescens* are the three most abundant species. Eighty-three species (46.63%) in all sites were represented by importance value less than 1%. Among the species included were *Aglaia lepantha* Miq. (Meliaceae), *Tabernaemontana pandacaqui* Poir. (Apocynaceae), *Citrus hystrix* DC (Rutaceae), *Aglaia korthalsii* Pellegr. (Meliaceae), *Wrightia pubescens* R. Br. (Apocynaceae) and *Palaquium foxworthyii* Merr. (Sapotaceae).

Luyon and Medecilo (1996) reported that 96 species occur in Mts. Palaypalay/Mataas na Gulod Protected Landscape belonging to 55 genera and 34 families where *Shorea guiso* had the highest IVI value. The sites are located in Ternate and Maragondon municipalities (Cavite) and Nasugbu (Batangas) using Point-Center-Quarter-Method composed of fourteen (14) transects measuring 100 m. The finding is similar to the present study’s results; however, the number of species is higher in the present study since other fragmented forests in Upland Cavite were included. In the study of Gascon *et al.* (2013) on trees, only 92 species representing 32 families were reported in Mt. Banahaw, which is quite low compared to our study.

However, with the addition of saplings, shrubs and herbs, a total of 501 species belonging to 336 genera and 113 families were recorded (Table 2). Angiosperms have the highest number of species (501 species), followed by pteridophytes (52 species) and gymnosperms (3 species). Out of 113 families, 33 families (29.21%) were represented by one species.

The family having the most number of species is Fabaceae with 27 species, followed by Moraceae (26 species), Euphorbiaceae (25 species), Rubiaceae (24 species), and Poaceae (19 species) (Table 2). Mossy forest does not occur in Upland Cavite and this contributes to the low numbers of epiphytes and endemic species. In the study of Amoroso *et al.* (2013), high endemicity is due to epiphytic species such as orchids, pitcher plants and other montane species.

In the study of Gascon *et al.* (2013), Moraceae, Euphorbiaceae, Theaceae and Meliaceae were the most represented families. This result is comparable to our present findings. However, Theaceae in Upland Cavite was
represented by only two species (Table 2). Mt. Makiling has high floral diversity (Fernando et al., 2004), and it can be depicted that it has more or less similar composition to Upland Cavite because of its proximity and geographical location.

**Vegetation Structure.** Based on species composition and physiognomy of vegetation at each sampling station, four (4) vegetation structures were identified, namely: secondary forest, agricultural ecosystem, semi-secondary and lowland evergreen dipterocarp forest. Figure 3 shows the cluster analysis using Spearman Rho Correlation in relation to species composition. The sample plots were arranged according to similarities. The common ancestor was Maragondon and it was subdivided into two major clusters namely the plots inside PA and plots outside PA. The clusters outside PA are characterized as agro-ecosystem forest (Figure 4A) (Bailen-Tagaytay), secondary forest or disturbed (Figure 4B) (Indang), semi-secondary or mixed forest (Figure 4C) (Silang-Magallanes) and lowland evergreen dipterocarp forest (Figure 4D) (Ternate-Maragondon).

The vegetation structure of Bailen and Tagaytay is characterized as agricultural ecosystem since it is dominated by *Chrysophyllum cainito* L. (Sapotaceae), *Coffea* spp. (Rubiaceae) and *Mangifera indica* L. (Anacardiaceae). Secondary forest occurs in Indang and is dominated by *Ficus septica* Burm. f. (Moraceae), *Artocarpus blancoi* L. (Moraceae), *Macaranga grandifolia* Merr. (Euphorbiaceae), *Voacanga globosa* Merr. (Apocynaceae), *Kleinhovia hospita* L. var. *hospita* (Sterculiaceae), and *Ficus minahassae* (Teijsm. & de Vriese) Miq. (Moraceae) while Silang and Magallanes are considered semi-secondary forest or mixed forest dominated by *Ficus balete* Merr. (Moraceae), *Dracontomelon dao* (Blanco) Merr. & Rolfe, *D. edule* Merr. (Anacardiaceae), *Vitex parviflora* Juss. (Lamiaceae), *Alstonia scholaris* (L.) R. Br. (Apocynaceae) and *Sandoricum koetjape* Merr. (Meliaceae). However, Ternate and Maragondon was depicted as lowland evergreen dipterocarp forest dominated by *Shorea guiso* (Figure 3).

**Assessment of conservation status of plant species.** The assessment of the status of the different plant species was carried out to establish a foundation for their protection and conservation. There were at least 145 Philippine endemic species or 31% of the total number of species that were found in Upland Cavite. Among these species, *Impatiens caviteana* (Figure 6A) and *Oldenlandia stenophylla* Merr. (Rubiaceae) are endemic in Cavite alone. These two species grow near streams or wet areas and abundant during the rainy season (June to September). Some of the individuals bear flowers and fruits and reproduce easily. However, in the summer, these species dry up and eventually die.

Of the 145 endemic species, nine are vulnerable, two are critically endangered, five are threatened and one is endangered. These threatened species are: *Calamus ornatus* var. *philippinensis* Becc. (Arecaceae), *Myristica philippinensis* Lam. (Myristicaceae), *Shorea polysperma* Merr. (Dipterocarpaceae), *Syzygium densinervium* (Merr.) Merr. (Myrtaceae) and *Zizyphus talanai* Merr. (Rhamnaceae). Jade vine or *Strongylodon macrobotrys* A.
Gray (Fabaceae) (Figure 6D) is abundant in lower altitude areas, while Selaginella tamariscina (Beauv.) Spring (Selaginellaceae) (Figure 6C) is found only in Mt. Pico de Loro. Dillenia philippinensis Rolfe (Dilleniaceae) (Figure 6E) occurs only in the protected area and is economically important to the community because of its edible fruit. This species is also endemic with scattered distribution in the park. Several individuals of the endemic dipterocarp species are also abundant and in need of dire protection and conservation from illegal loggers because their occurrence is in places of lower altitude and can be cut or extracted easily by loggers.

Aside from endemic species there are also plants that are economically important to the community particularly those species that can be used as food, medicine, timber, handicrafts, building material and ornament. These include Artocarpus heterophylla Lam. (Moraceae), Garcinia binucao Choisy (Clusiaceae), Antidesma spp., Canarium spp., Syzygium spp., Citrus hystrix, Cinnamomum mercadoi S. Vidal (Lauraceae), Diplazium esculentum (Retz.) Sw. (Athyriaceae), Lygodium spp. (Lygodiaceae), etc.

Sixty five percent of all plant species is considered as native while 35% is introduced. Though there are species which are introduced in the country, they occur in wild habitat that in the long period of time become naturalized and can be considered as native.

The lowland evergreen dipterocarp forest contained the highest number of endemic species as well as highest...
Figure 5. Vegetation structure of the remaining forests in Upland Cavite, Philippines.

Figure 6. Some endemic angiosperm species in the remaining forests of Upland Cavite. A. *Impatiens caviteana* Merr. (Balsaminaceae); B. *Begonia calcicola* Merr. (Begoniaceae); C. *Selaginella tamariscina* (Selaginellaceae); D. *Strongylodon macrobotrys* (Fabaceae); and E. *Dillenia philippinensis* Rolfe (Dilleniaceae).
species richness. This vegetation type occurs in Mts. Palaypalay – Mataas na Gulod Protected Landscape located in the towns of Ternate and Maragondon (Cavite) and Nasugbu (Batangas). The sampling site close to PA is Magallanes, however, the vegetation was considered as a semi-secondary forest. The sites are distantly located from the community, but protection and conservation were not practiced. Some of the remaining forests in non-PA sites are privately owned (i.e. Kabangaan in Silang, Indang) and were safely guarded by the owners from possible encroachment and extraction of forest products.

**Threats.** The floral diversity of Upland Cavite reveals that there were 475 species belonging to 329 genera and 112 families that is considered high. With the remarkable data mentioned above, Upland Cavite has an ecological significance to the people and in the vicinities located in the entire province of Cavite. The protected landscape was considered as the last haven in Cavite, which should be conserved and protected to be beneficial to the populace.

The upland farming of the residents, infrastructure development, illegal encroachment and tourism endanger the biologically diverse ecosystem of Cavite due to illegal cutting of trees. Although some forests are privately owned, (Tagaytay and Bailen) extraction of forest products was observed. The large portion of the study sites was declared as protected area, but several threats were still observed. Other threats include agricultural expansion, charcoal making, ecotourism such as resorts and mountain hiking, infrastructure such as highway development, and settlers’ encroachment. Signs of “Private Property, No Trespassing” can be observed as one passes along the road from the entrance of Puerto Azul to the Philippine Marines Station. As a protected landscape, illegal encroachment is not allowed. Though tourism augments the income of the park, it also brings major damage to the area. Most of the visitors are unaware of the policies and regulations in using the facilities in the park. Garbage and other wastes are just thrown everywhere without knowing that it can also affect the cycle in the ecosystem. The influx of forest dwellers due to rapid increase in population in urban landscapes led to the destruction of natural forests, and as people try to find ways in order to survive, they continuously destroy the forests protected resources.

**CONCLUSION AND RECOMMENDATIONS**

Upland Cavite is a haven for diverse plants and animals because of its geographic location. It consists of 475 species representing 329 genera and 112 families. Among these species *Shorea guiso*, *Ficus chrysolepis* and *Diospyros pyrrocarpa* were the densest and the most dominant and frequent species with the highest IVI in the protected area. Based on the estimates of carbon stock, the mentioned top ten species with highest sequestered carbon and recommended be used as trees for reforestation and afforestation programs. Generally, the plots where the aforementioned tree species were sampled are located within the Mts. Palay-palay/Mataas-na-Gulod, Ternate/Maragondon, Cavite, Nasugbu, Batangas Protected Landscape. Thus, conservation of this Protected Landscape should be given priority to maintain important forest ecosystem functions and services such as carbon storage and tree productivity.

**ACKNOWLEDGEMENTS**

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**LITERATURE CITED**


