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Richness and Abundance of Tree Species in the Bonsai Field, Mount Hamiguitan, San Isidro, Davao Oriental

JAN REY SARABIA HAPINAT
Bachelor of Science in Environmental Science Major in Resource Management, Davao Oriental State College of Science and Technology, Mati City, Davao Oriental, Philippines

Abstract

The study aimed to assess the richness and abundance of tree species in the Bonsai Field, Mt. Hamiguitan, Davao Oriental. Sampling was conducted within the Bonsai Field, where ten remote-sensed sample plots were established. Each plot measured 10 m × 10 m and was randomly placed at 100 m intervals. Presence of Bonsai tree species in all plots was recorded, counted, and identified using mechanical sampling with a line plot method. Species identification employed both reference methods and the Indigenous Knowledge System (IKS), using local common names for all species. A total of 67 species were documented, of which 38 species (57%) were identified with local names and 29 species (43%) remained unidentified. Seven species showed 100% constancy, and 12 species (18%) had 90% fidelity. Eleven species (16.41%) exhibited high mean density, ranging from 1,000 to over 5,000 stems/ha, with a total mean percent cover of 62.74%. Eleven species were dominant while 56 were rare. Among dominants, Chinese cedar (*Toona sinensis*) had the highest mean density (5,280 stems/ha) and percent cover (15.20%), followed by Bitanghol (*Calophyllum blancoi)* (2,340 stems/ha, 6.88%) and Malasulasi (*Leptospermum flavescens Sm.*) (2,220 stems/ha, 6.39%). Distribution of bonsai trees showed a clumped pattern; highest variance values were recorded for Chinese cedar (*Toona sinensis*) (1,257.73) and Zysigium spp. (*Syzygium P. Browne ex Gaertn*) (1,138.80), while Unknown species_2 had the lowest (0.50). Shannon Diversity Index (H') was 3.4060, Evenness Index (E') 0.8101, and Dominance Index (D') 21.1416, indicating high species diversity. The data provide baseline information for environmental management, proper utilization of forest resources, and conservation of the Bonsai Field and Mt. Hamiguitan Range.

Keywords: Abundance, Richness, Mt. Hamiguitan, Bonsai, Species

Introduction

Tree is a large, woody, perennial plant with a distinct trunk that gives rise to each branch and leaves in some distance from the ground. Trees are plants that dominate the forest ecosystem. Forest ecosystem is one of the most diverse among the terrestrial ecosystems. It is a community of different flora, fauna and microorganism, and those physical environments that they inhabit, and dominated by different tree species. These trees have a bigger role in our environment, they provide habitat for the different flora and fauna, regulate the climate and maintain the production of water in the ecosystem (Hunter, 1990).

Bonsai or pygmy forest is one kind of forest ecosystem. It is the area that is covered with miniature trees, with trunk diameter of half an inch and standing two to three feet high. Every forest differs from one place to another due to several factors, especially its topography and soil (Miller, 1990). A discontinuous but pervasive iron or clay pan may impede the root growth on pygmy forest soils. Poor drainage that will cause flooding and low aeration in pygmy soils may inhibit the growth when moisture is most available. Extremes exist in a wide range of soil nutrients and possibly deficiencies or toxicities, of one or two of these or sub critical levels of many causes dwarfing. Through the presence of microorganisms as toxicants or pathogens, or by their activity in the litter or rhizosphere may be pivotal: other possibilities exist.

Mt. Hamiguitan was declared as Protected Area under the category of Wildlife Sanctuary through RA 9303. According to the San Isidro Tourism Office File (2001), it is also a "sanctuary of rare and endemic flora and fauna and exotic birds, that include our world-famous Philippine Eagle. Also, it is the only mountain in Mindanao that has a unique "pygmy" forest. It consists of more than 100 hectares of wide Kapatagan Valley and of scenic beauty century-old trees. Due to its beauty and uniqueness, the area is potential for tourist destination. Because of this the area is exposed to different human activities (San Isidro Tourism Office File, 2006).

To protect, conserve and manage the natural resources, assessment of its richness and abundance is very important (Stephenson et al. 2022). A diverse area can provide a high quality of goods and services to human especially for the sustainable production of wild resources. Most of the natural resources that have high economic and medicinal values are directly used and consumed by local and indigenous people. Through this assessment the needs can be sustained, especially demands in production (DENR and UNEP, 2000).

Because of the high value of life as well as all life forms in the environment, there is a need to assess, conserve and manage the unique species of bonsai trees and all species in Mt. Hamiguitan Range. Bonsai plants are rare, so, people in Davao Oriental are lucky to have these in their province. In this aspect, however, it needs basic information relative to management as well as diversity of all life forms. Thus, this study will provide information on the richness and abundance of tree species in the Bonsai field, which could be an important input to the conservation and management of Mt. Hamiguitan, in Davao Oriental.

Methodology

The study was conducted at the Bonsai field in Mt Hamiguitan, Davao Oriental. It is geographically located at 06° 42' 44" north latitude and 126° 11° 06" east longitude. It consists of approximately 1,000 hectares scenic beauty of wide Kapatagan Valley of Bonsai trees and many other endemic species. It is situated from 1,136 1,322 meters above sea level. Three municipalities, namely: Mati, San Isidro and Governor Generoso in Davao Oriental surround it. The sampling method employed in the study is the mechanical sampling system. It is a system by which sampling pattern uses a definite grid whereby lines of plots and strips have the same distance interval. A steel tape was used for measuring strips and sampling plots, while Global Positioning System (GPS) was used for determining sample plot geographical locations. For the Line plot method that was used as a sampling pattern. This method employs the use of imaginary line as transect lines in a 10mx10m plots with 100m interval for each plot. In this sampling activity, the existing trails

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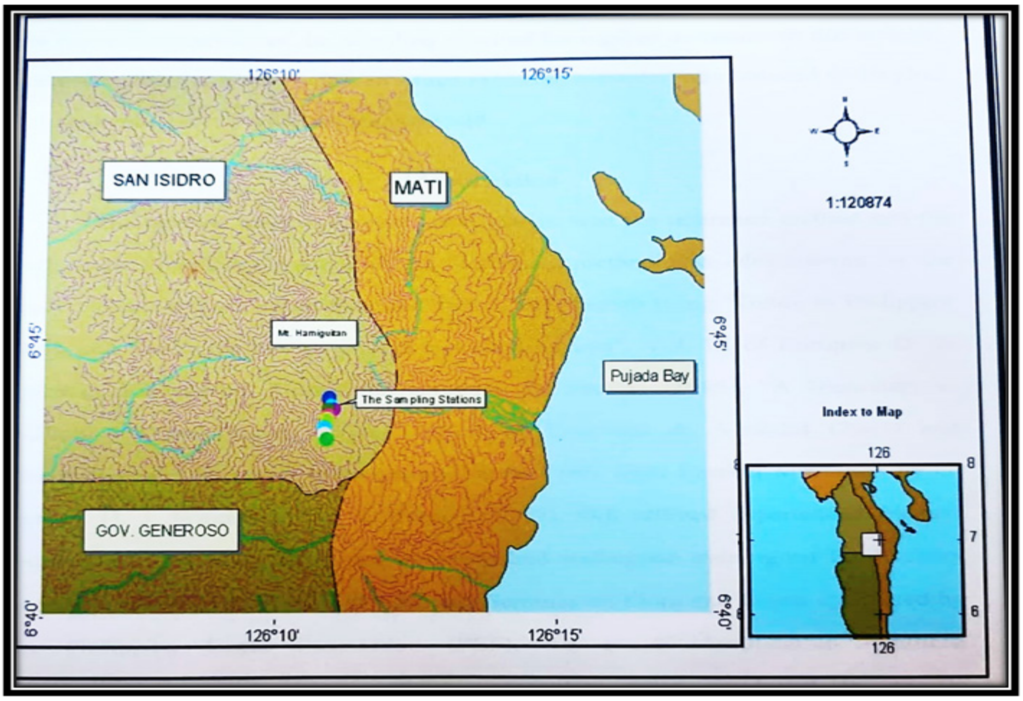

Figure 1: Map showing the geographically referenced locations in the study stations at Mt. Hamiguitan, San Isidro, Davao Oriental.

Sampling intensity

Sampling intensity was based on the size of the area. The larger area sampled, the lower the intensity of the sampling required for a given accuracy. In this activity, since the area has a very wide coverage, sampling intensity was reduced to 10 plots traversing the inner part of the Bonsai Field.

Identification

The method used in species identification was the reference method and the Indigenous Knowledge System (IKS). Reference method was administered by the study adviser and an expert Forester from USEP-Tagum using, "Guide to Philippine Flora and Fauna. Dipterocarps and Non-dipterocarps by Enriquito D. de Guzman, Ricardo M. Umali and Emiliano D. Sotalbo (1986)" ; "A Dictionary to Philippine Plant Names" by Domingo A. Madulid (2001)" and "Dendrological Characters of Important Forest Trees from Eastern Mindanao by G. Seeber, H. J. Weidelt and V.S. Banaag (1979)". IKS utilized experienced Bantay-Gubat personnel assigned in the area who had undergone training on Biodiversity Monitoring and Evaluation (BIOME) and Seminar on Flora and Fauna sponsored by the Philippine Eagle Foundation (PEF). To avoid identification conflicts, local/common names using various vernaculars were employed in species identification. Photographs of all species were also produced for documentation.

Study duration

The study was conducted on December 27 to 30, 2006. The sampling was conducted for a duration of three days with the assistance of one local resident. The study leader and his adviser, and two student numerators.

Sampling tools

Data analysis

To interpret the data, frequency and distribution were noted. To describe the distribution, descriptive statistics such as mean, standard deviation and coefficient of variation were determined.

Frequency

Frequencies of tree species were calculated using the formula (English et al. 1997).

$$F = \frac{\text{Frequency of species}}{\sum \text{Frequency of all species}} \times 100$$

Species density

The species density was calculated based on the formula below to get the total number per plot or the actual count per plot of an individual tree species.

$$\text{Species Density (Species/ha)} = \frac{\text{No of individual per category}}{\text{Area of the Plot}}$$

Stems per hectare

The number of stems per hectare was calculated using the formula.

$$\text{Stems per hectare} = \frac{\text{No of Stems in the Plot}}{\text{Area of the Plot}} \times 100$$

Distribution

The distribution of bonsai species was determined using Elliot's (1971) variance (S^2) to arithmetic mean (x) ratio test

$$X^2 = \sum \left[\frac{(x - X^2)}{n} \right]$$

Where:

x = the number of individuals (per species) in each plot
n = the number of plots
X = the mean density

$$S^2 = E \frac{(x - X^2)}{n-1}$$

When:

$S^2 = x$, distribution is random;
$S^2 < x$, distribution is uniform/regular,
$S^2 > x$, distribution is clump.

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Species density and equitability

Data on species composition and abundance was used to calculate the species diversity and evenness indices.

Diversity indices

Diversity indices incorporate both species richness and evenness into a single value known as heterogeneity indices (Peet, 1974).

Species diversity is described according to the Shannon Index (H) as in the following equation.

$$H^1 = -\sum \text{pi in pi}$$

Where:

pi, is the proportion of individuals found in the *i*th species.

Hence, the Shannon's index is a measure of average degree of "uncertainty" in predicting to what species and individual chosen at random from a collection of S species and N individuals will belong. This average uncertainty increases as the number of species increases and as the distribution of individuals among the species becomes even.

Evenness indices

Equitability index is used to compare the distribution of the number of individuals among the species in the different communities of samples since they are independent of the actual number of species involved.

$$\text{Evenness } H^1/\text{Hmax} = H^1/\text{ln.S}$$

Where:

H^1 = Shannon's weaver diversity index

Hmax = when all species are equally abundant

Diversity indices were determined on each plot distributed within the whole study area.

Dominance indices

Simpson's index was used to give the probability of any two individuals drawn at radom from a large community belonging to different species (Stiling, 1998);

$$D = \sum_{i-1}^{S} \text{p i}^2$$

Where:

p*i* is the proportion of the individuals in species / For finite or real communities:

$$D = \sum \left[\frac{n_i(n_i-1)}{N(N-1)} \right]$$

Where:

n_i = the number of individuals in the ith species

N = total number of individuals

As *D* increases, diversity actually decreases. To avoid this seeming contradiction, Simpson's index is often expressed as 1-*D* or 1/*D* so that increasing values mean increasing diversity (Stiling, 1998).

Results and Discussions

Species Composition

A total of sixty-seven species were found and listed from the sampling area in the Bonsai Field in Mount Hamiguitan. Of these, 38 species (57%) were identified with their local/common names while 29 species (43%) had not been identified. These unidentified species were tagged as Unknown species_1-29 (US_#). Among the total species found and listed, 33 species (49%) were within 50-100% constancy, while 7 species (10%) were found within 100%. On the other hand. 34 species (51%) were found within had high fidelity with 12 species (18%) were within 90 %. A higher percentage (49%) of species within high constancy of 50-100% indicates that the area has wider preferences for among those species to occupy and exist. Furthermore, those 7 species within 100% constancy were found having widespread populations in the whole area studied. Meanwhile 12 species within high fidelity were found only in one of the sample plots and had strong preferences for, or a limitation to. that particular area sampled. Basically, organisms are controlled in nature by the quality and variability of materials for which there is a minimum requirement and physical factors which are critical (Odum, 1971). These principles attributed to the study results implying that there are limiting factors for some species to grow and exist in their respective areas.

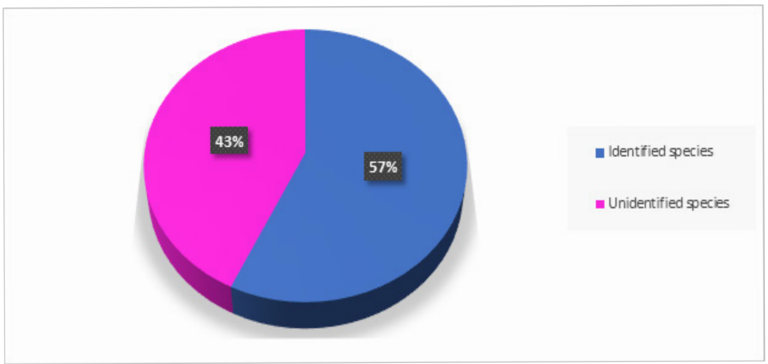

Figure 3. The percentage of identified and unidentified tree species.

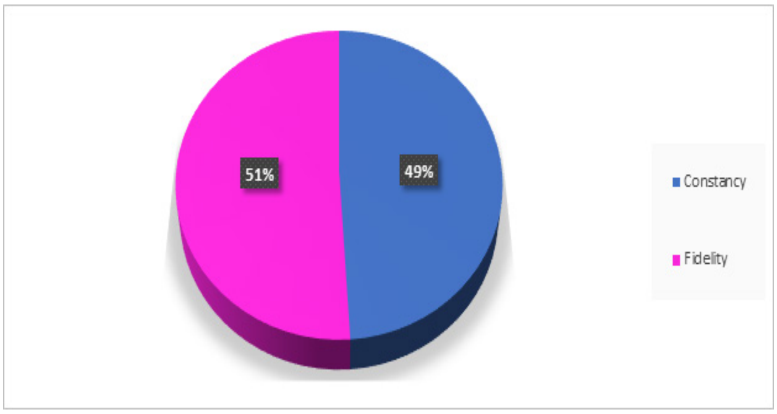

Figure 4. The percentage of constancy and fidelity of tree species.

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Density/Size Information

Based on the data gathered, 11 species (16 %) were found having higher mean densities ranging from 1,000 to more than 5,000 stems/ha and a mean percent cover of 63%. There were 55 species (84%) having low mean densities of below 1,000 stems/hectare with 37 percent cover. Among these species, Chinese cedar was very abundant in the area studied with a mean density of 5, 208 stems/hectare constituting a mean percent cover of 15.20%.

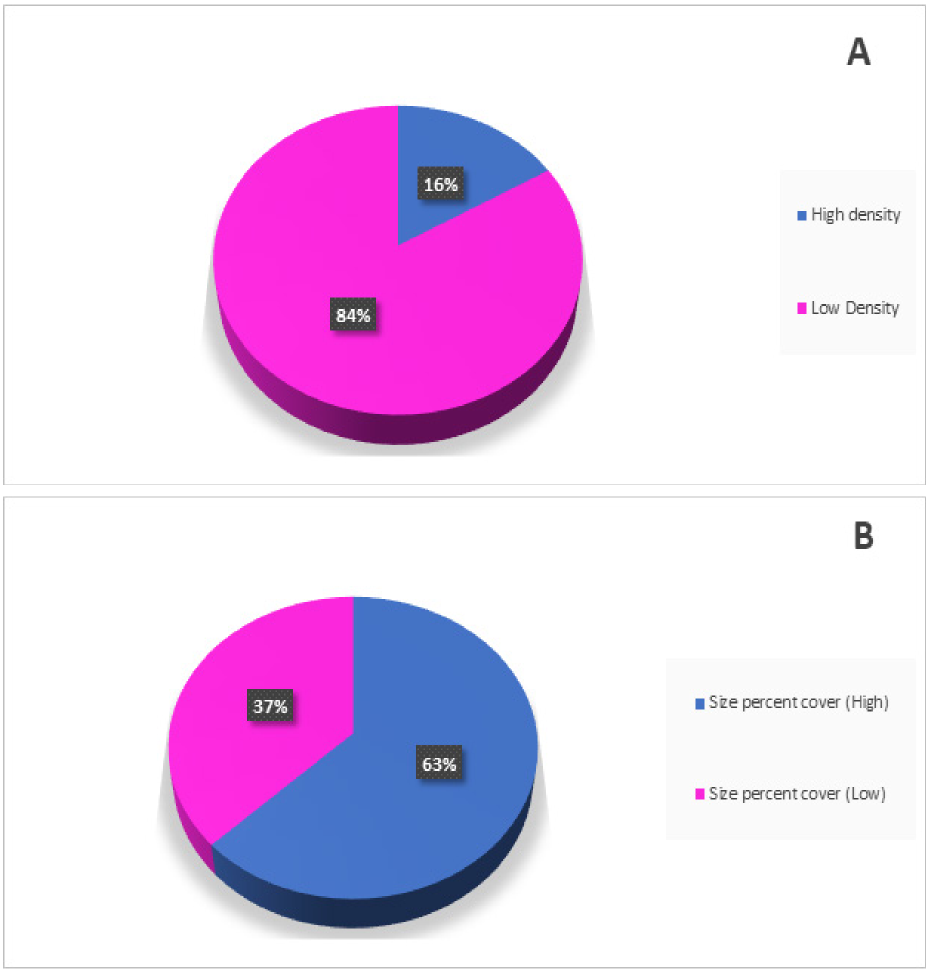

Figure 6. Density and size information of trees in the Mt. Hamiguitan bonsai field.

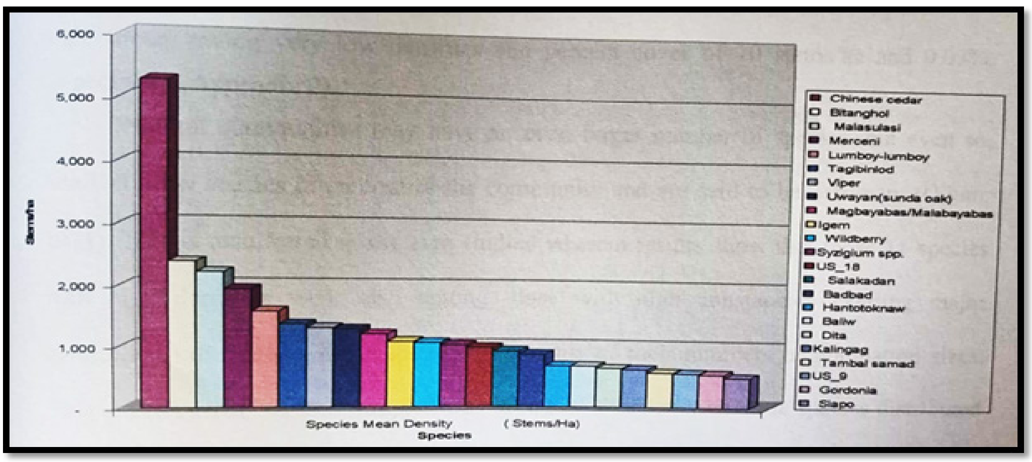

Figure 7. Mean density of tree species found in the Mt. Hamiguitan bonsai field.

It was followed by Bitanghol *(Calophyllum blancoi)* and Malasulasi (*Leptospermum flavescens Sm.)* with respective mean densities of 2,340 stems/hectare and 2,220 stems/ hectare and with mean percent cover of 6.88% and 6.39%. They were followed by 9 species with densities ranging from 1,000-1,500 stems/hectare with mean percent cover ranging from 2.97%-5.61%. On the other hand, 10 species 25 were found having very low densities and percent cover of 10 stems/ha and 0.03%, respectively. Natural communities may have an even larger number of species, but even so, relatively few species often control the community and are said to be dominant (Odum, 1971).

This is manifested in the area studied wherein results show that those 11 species with high densities were also among those with high constancies exerting major controlling influence in the whole area by virtue of their numbers or population sizes. This indicates that the area sampled was of higher abundance of these species distributed throughout the whole area and considered the common or dominant species in the whole area studied. These results have important implications in the conservation management of the area. Generally, dominants are those species in their trophic groups which have the largest productivity. Odum (1971) stressed that removal of these dominant species would result in the important changes not only in the biotic community but also in the physical environment (microclimate, for example) of the area. On the other hand, the high percentage of species (83.59%) having low densities and percent cover were considered rare in the community being sampled.

This case is a manifestation of other bonsai areas where there are certain extents of pygmy tree growth and also areas devoid of trees entirely with many associations of rare species, due to the unique soil chemistry. This does not mean that the more numerous rare species are not important. They primarily determined species diversity of a trophic group and whole communities; and, an equally important aspect of community structure (Odum, 1971).

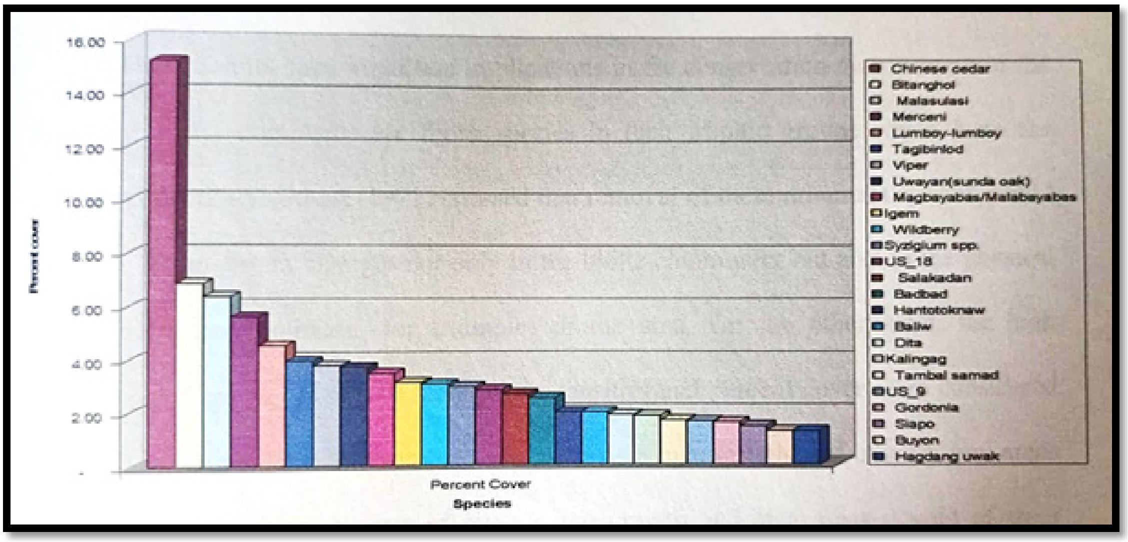

Figure 8. Mean percent cover of tree species found in the Mt. Hamiguitan bonsai field.

Species distribution

Table 1 shows the species distribution of the area sampled in the Bonsai Field. Mt. Hamiguitan. Generally, all species were found to have clumped distribution. Among the species listed, the highest values of variance were the Chinese cedar (Toona sinensis) and Syzigium spp (small leaf) with 1.257.73 and 1,138.80, respectively. Meanwhile, the lowest value of variance was the Unknown species 2 with a value of 0.50.

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Odum (1971) stated that in the case of clumped distribution, individual species are grouped aggregately or clumped in the same or varying sizes, and could be randomly or uniformly distributed with large unoccupied spaces. This pattern was observed in this study wherein tree species exhibited a clumped distribution. Based on personal observation, trees growing in Bonsai Field of Mt. Hamiguitan were in patches following topographical and altitudinal variations. In addition, since the area is well protected from poaching or cutting of bonsai trees, it is not surprising that this distribution pattern is a naturally-occurring pattern.

Table 1. Species distribution in the sampled area.

Species name	Mean	Standard deviation (SD)	Variance (S)	Distribution (D)
Chinese cedar *(Toona sinensis)*	52.80	35.46	1,257.73	Clumped
Bitanghol *(Calophyllum blancoi)*	23.90	9.92	98.32	Clumped
Malasulasi *(Leptospermum flavescens Sm.)*	22.20	18.65	347.75	Clumped
Merceni *(Mercenaria mercenaria)*	19.50	11.27	126.94	Clumped
Lumboy-lumboy *(Syzygium cumini)*	15.80	19.65	385.91	Clumped
Tagibinlod	13.70	8.08	65.27	Clumped
Viper *(Trimeresurus stejnegeri)*	13.10	9.04	81.78	Clumped
Uwayan (sunda oak) *Lithocarpus solerianus)*	12.90	6.35	40.32	Clumped
Malabayabas *(Tristaniopsis decorticate)*	12.10	14.02	196.53	Clumped
Igem *(Dacrycarpus imbricatus)*	10.90	6.77	45.86	Clumped
Wildberry *(Syzygium polycephaloides)*	10.70	6.43	41.34	Clumped
Syzigium spp (*Syzygium* P. Browne *ex* Gaertn)	10.30	33.75	1,138.80	Clumped
US_18	9.90	9.49	90.00	Clumped
Salakadan *(Canthium horridum)*	9.30	13.09	171.30	Clumped
Badbad	8.80	7.05	49.69	Clumped
Hantutuknaw *(Melastoma malabathricum)*	6.90	5.58	31.14	Clumped
Baliw *(Benstonea copelandii)*	6.90	5.85	34.27	Clumped
Dita *(Alstonia scholaris)*	6.50	6.45	41.61	Clumped
Kalingag *(Cinnamomum mercadoi* S. Vidal*)*	6.40	3.46	12.00	Clumped
Tambal samad (*Pterocarpus indicus)*	5.80	4.23	17.90	Clumped
US_9	5.70	4.39	19.27	Clumped
Gordonia *(Polyspora luzonica)*	5.60	2.27	5.16	Clumped
Siapo *(Broussonetia papyrifera)*	5.10	3.46	11.98	Clumped
Buyon (*Barringtonia littorea /Butonica speciosa*	4.50	5.56	30.95	Clumped
Hagdang uwak *(Polyscias nodosa)*	4.50	3.57	12.75	Clumped
US_20	3.40	3.18	10.14	Clumped
Marang timber *(Artocarpus odoratissimus* Blanco*)*	3.20	2.78	7.71	Clumped
US_17	3.00	6.08	37.00	Clumped
US_25	2.90	5.63	31.70	Clumped
US_15	2.40	1.15	1.33	Clumped
Almaciga *(Agathis philippinensis)*	2.30	2.17	4.70	Clumped
Dagpedumbong (red shoots)	2.10	3.56	12.70	Clumped

Lokinai (*Lithocarpus species)*	2.00	3.06	9.33	Clumped
Pittosporum *(Pittosporum resiniferum Hemsl.)*	1.80	2.65	7.00	Clumped
US_24	1.80	8.66	75.00	Clumped
Salagmanok *(*local name are the Philippine mahogany*, Swietenia macrophylla)*	1.70	4.27	18.25	Clumped
Malakawayan *(Podocarpus rumphii)*	1.60	1.41	2.00	Clumped
US_12	1.50	3.61	13.00	Clumped
US_14	1.40	1.41	2.00	Clumped
Bantigi *(Pemphis acidula)*	1.30	2.52	6.33	Clumped
Petsay-petsay	1.10	1.17	1.37	Clumped
US_21	1.10	1.10	1.20	Clumped
Medinilia *(Medinilla erythrotricha* Elmer*)*	1.00	3.21	10.33	Clumped
US_13	0.90	2.00	4.00	Clumped
US_28	0.90	2.12	4.50	Clumped
Dagpedumbong (white shoots)	0.70	0.58	0.33	Clumped
Bagtikan/Taglemonsito *(Parashorea malaanonan)*	0.70	1.53	2.33	Clumped
Syzigium spp (small-round leaf)	0.60	1.41	2.00	Clumped
US_5	0.50	1.15	1.33	Clumped
US_10	0.50	1.15	1.33	Clumped
US_16	0.50	2.12	1.50	Clumped
Bunol *(Combretum indicum)*	0.30	0.71	0.50	Clumped
US_2	0.30			
US_3	0.30			
US_23	0.30			
US_6	0.20			
US_8	0.20			
Mari-buhok	0.10			
US_1	0.10			
US_4	0.10			
US_7	0.10			
US_11	0.10			
US_19	0.10			
US_22	0.10			
US_26	0.10			
US_27	0.10			
US_29	0.10			

Species diversity indices

Table 2 shows species diversity and evenness indices of tree species listed from Bonsai Field, Mount Hamiguitan. Generally, the study resulted with a Shannon Diversity Index *(H')* value of 3.4060. Stiling (1996) expressed that values of the Shannon Diversity Index for real communities are often found to fall between 1.0 and 6.0, which is the maximum diversity. Furthermore, the maximum diversity of a sampled area will occur when all species are equally abundant. In this study, the diversity index result of 3.4060 falls above half of the range, implying that species diversity is approaching maximum while number of individual species is approaching equally abundant.

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This is supported by its Evenness Index *(E')* which yielded a value of 0.8101. Stiling (1996) expressed that E is constrained between 0 and 1.0 and a measure that assumes all species in the community are present in the sample in this study result of *E'* (0.8101) is close to 1 This implies that almost all species in the study area are present in the sample plots. Furthermore, the Dominance Index *(D')* value of 21.1416 also supports the above findings. Stiling (1996) stressed that dominance index gives more weight to common or dominating species in the community, and often expressing an increase to its values mean increasing diversity. These are supported by the study results on quantitative aspect wherein only 11 species (16.41%) exhibited higher density (dominant) while 56 species have low densities (rare).

Table 2. Diversity Indices of tree species in the Bonsai Field, Mt. Hamiguitan

Indices	Value	Remarks
Shannon Diversity Index (H')	3.4060	Approaching maximum diversity
Dominance Index (D')	21.1416	Increasing dominance value means increasing diversity
Evenness Index (E')	0.8101	All species in the community are almost present in all sample plots

Implications to conservation and management of Mt. Hamiguitan Range

Conservation and management are very important especially in protecting and conserving our forest resources. It minimizes forest destruction, prevents habitat loss and degradation, and ensures the proper utilization of our natural resources (Henney et al., 1998). Conservation and management of any resources depend on different researches and study conducted which generate data/information of the different communities and trees species diversity, the status of trees, species composition and their distribution. Planners and policy makers can use these studies and researches as baseline information that could be helpful in both conservation and management of wildlife sanctuaries and protected areas, as well as in assessing the success of any conservation strategies and programs prepared. Mt. Hamiguitan was declared as protected area and wildlife sanctuary by the virtue of Republic Act 9303. This is because of the diverse and endemic species of flora and fauna, and the unique "pygmy" forest, which occur in this environment. The occurrence of many trails made by mountain trekkers was observed in the area. Forest vegetation must be protected since it plays an important role, especially in the survival of wildlife. It provides intangible ecological services such as watershed, pollutant trapping, flood and erosion control and ecosystem integrity as well as more tangible values like food, shelter or substrate for other organism in frequently diverse and abundant assemblages. High species richness or diversity values in this area may be attributed to high altitude, lower temperature and high rainfall, which are favorable for their production and regeneration (Hunter, 1990). On the other hand, other studies on richness and abundance of floral species in Mt. Hamiguitan Range will be needed for further information and as basis for the conservation and management of the area. The research data from this study can be used as baseline information to planners and policy makers at various levels in providing and promoting policies and programs which aim for the conservation and protection not only in the bonsai field but also to the entire Mt. Hamiguitan.

Conclusion

A considerable high percentage of unknown tree species was observed associating within the plant community of Bonsai Field in Mt. Hamiguitan. Recent literatures on dendrological characterization of plant species especially at the eastern part of Mindanao are unavailable. Almost all of the species were found having wider degree of restriction or limited preferences throughout the area, or had strong preferences for, or a limitation to that particular area sampled. This is an indicator that the area has wider scope of 34 limiting factors, controlling these species to successfully recopy and exit throughout the whole area. The area sampled exhibited species dominance and rarity Some were hund to be common or dominant species in the whole area studied. This was attributed by their high mean densities and mean percent cover. Chinese cedar, Bitanghol and Malasulasi were considered the most dominant species in the area. On the other hand, the species having low mean densities and mean percent cover were considered rare in the community being sampled. The presence of dominance has great attributes in the conservation and management of the area since their groups have the largest productivity in the area and important probable changes may happen once disturbances to their population occur. On the other hand, the high percentage of rare species is a great indicator that the area has higher diversity Species distribution of the area exhibited a clumped pattern. The highest values of variance were of the Chinese cedar and Syzigium spp (small leaf). Meanwhile, the lowest value of variance was of the Unknown species 2 (US_2).

This could be attributed to the presence of its primary limiting factor the soil, allowing plants to occupy certain space with favorable growth conditions in an aggregated manner or patches. Also, the area has wide gradients of environmental factors manifested by its topography and altitude The study area had higher number of many species (rare) with relatively lesser number of individuals distributed widely. This was indicated through the diversity indices results that revealed higher diversity of tree species in the studied area. This was manifested by the different indices employed by which results conform to each other. Theoretically, results from quantitative measures using species richness and abundance 35 were strengthened by the species indices employed having values of Shannon Diversity Index *(H')*, Evenness Index *(E')* and Dominance Index *(D')*.

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