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BIODIVERSITY OF PLANT COMMUNITY IN NATURAL FOREST IN PA DOI BO NATIONAL FOREST RESERVES, CHIANG RAI, THAILAND

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Abstract

This study aimed to explore biodiversity of the plant community in a natural forest. It was in terms of structure of the natural forest, plant species composition and biodiversity of the natural forest (mixed forest). The exploration was conducted during July and August 2021. Firstly, placed 3 temporary plots of 20x50 meters. Each plot was divided into 10 study plots of 10x10 meters to collect big tree data. Besides, placed a plot of 4x4 meters to collect sapling data. Then, explored plant species, measured the size and height of trees, and explored plant species composition/biodiversity. Obtained data were analyzed for finding plant species diversity index. It was found that there were 151 trees, 44 saplings included in 47 species, 41 genera and 26 families. The natural forest was 603-615 meters above sea level and the forest canopy was 4.20 meters in height. Most of the trees there were deciduous. FABACEAE had an important value index (IVI) equivalent to 55.39. The most predominant plant varieties there was *Tectona grandis* (33.31 in value). The index of species diversity of the sample plots was 2.59 and the species evenness was equivalent to 0.67 Teak *(Tectona grandis*) planting should be promoted to replace big trees in the area for natural reproduction.

Keywords: Biodiversity of the Plant Community, Pha Doi Bo National Forest Reserves, Natural Forest Area

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Introduction

The situation of forest resource in Thailand during the past 40 years face rather severe forest encroachment. This made the forest area was greatly reduced due to forest destruction. In 1973, the forest in Thailand covered an area of 138,566,875.00 rai or 43.21 percent of Thailand area but it was decreased to 102,484,072.71 rai or 31.68 percent of the country area in 2019 (Royal Forest Department, 2019). In fact, Chiang Rai province has mountains interspersed with plains and abundant natural resources. A lot of forest resources there result in high biodiversity. At present, however, there is a natural resource crisis in Chiang Rai due to unlimited exploitation of natural resources, forest encroachment, urban expansion, etc. The forest in Chiang Rai in 2000 covered an area of 3,274,125 (44.85% of the province's area) but it decreased to 2,865,464 rai (39.86%) in 2019 (Royal Forest Department, 2019). Pa Doi Bo forest was proclaimed to be a national forest reserve in 1974 covering an area of 149,185 rai. In other words, it covered areas of Pa Tueng sub-district (Mae Chan district) and Mae Yao/Ban Doo sub-districts (Mueang district). Although there is forest encroachment but the general forest condition still have species at the original level and continue to reproduce naturally. Therefore, this study aims to explore structure, species composition, and biodiversity of plant community in the natural forest a Pa Doi Bo national forest reserve. The results of the study will lead to making a plan for the forest area managerial administration.

Literature Review

Thammanu et al. (2020) conducted a study on diversity of plant species and environmental factors affecting the distribution of deciduous forest plant community in Mae Chiang Rai Lum community forest, Lampang province. It was found to have a diversity value (based on Shannon-Wiener Index) at 2.491±0.281. This comprised 197 species and 144 genera in 62 families. It could be sorted into 3 groups: Shorea obstusa-Sindora siamensis Stand, Shorea siamensis-Shorea obtusa Stand and Mixed deciduous Stand.

Kongdam et al. (2016) conducted a study on structure and plant species composition in Forest structure and species composition in restoration by Teak plantation at Jedkhod-Pongkhonsao Natural Study and Ecotourism Center, Kheang Khoi District, Saraburi Province. Results of the study revealed that there were 44 families 106 genera and 139 species. The density and basal area were equivalent to 4,304 trees/hectare and 26.50 m^2/hectare, respectively. Local plants from the dry evergreen forest that were well established in the rehabilitation forest were *Diospyros variegata, Mallotus philippensi, Lepisanthes tetraphylla, Aporosa octandra* and *Pterospermum littorale*. Hence, forest rehabilitation should select plant species which are wide eco-tolerant. Besides, the implementation procedures should start from the rehabilitation of around the age of the inner forest that is adjacent to the natural forests. This will help the forest rehabilitation be more rapid.

Sumon et al. (2021) conducted a study on structure and plant species composition in the area at the junction of the rainforest and agricultural area, Kathun Wildlife Sancluary in Nakhon Si Thammarat province. It was found that there were 82 species, 68 genera and 41 families. The density and basal area were equivalent to 2,145 trees/hectare and 16.30 m^2/hectare, respectively. The diversity of plant species was at a high level ($H' = 3.86$). The distinctive genera based on the highest number of species was Euphorbiaceae. Thus, the selection of Plant species for forest rehabilitation based on appropriateness with environmental factors tends to increase the efficiency in the forest rehabilitation.

Sasunti et al. (2021) conducted a study on the structure of plant community and soil factor in a 40-year-old reforestation area at Mae Sakhon upstream site, Nan province. It was found that there were 61 species, 53 genera and 27 families out of 476 trees found there. In this respect, Burmese ebony planting plot and teak planting plot had diversity index, basal area size, density and similar index ere resemble with the mixed deciduous forest most. However, the dominant

plant species in the Burmese ebony planting plot were not clearly identified. According to results of the study, it indicated that the rehabilitation of the upstream forest by planting native plant species could make the forest condition return to be resemble to the natural forest.

Asanok & Taweesuk (2019) conducted a study on composition of functional characteristics of plants in border of deciduous dipterocarp forest and mixed deciduous forest in Mae Kham Mee River basin, Phrae province. It was found that the dominant tree species in the edge of the deciduous dipterocarp forest revealed their functional characteristics that differed from the nondominant species in the marginal mixed deciduous forest. Thus, use of functional characteristics of plants can sort growth potential of plant species in the forest edge area. The forest rehabilitation should use functional characteristics of plants for selecting plant species which are suitable for planting.

Hermhuk et al. (2021) conducted a study on influence of environmental factors on the distribution of species of deciduous dipterocarp forest and San Sai Forest reserve, San Sai district, Chiang Mai province. Findings showed that the deciduous forest in the area had 51 species, 37 genera and 27 families. Results of the study can be applied to rehabilitate the forest and selection of plant species based on proper environmental factors.

Research Methodology

Locale of the study: The natural forest in the area where Mae Yao/Mae Xai Forest Park project had cut off an area in Pa Doi Bo Forest reserve to be a conservative forest covering an area of 500 rai. It was in Ban Huaykhom Nork community area, Mae Yao sub-district, Mueang district, Chiang Rai province (Lampang Forest Industry Organization, 2018). (Figure 1)

Figure 1 A map showing the location of the area to explore biodiversity of plant community in the natural forest at Pa Doi Bo natural forest reserve, Chiang Rai province

Materials/equipment

Two diameter measuring tapes or four KONICHIWA measuring tapes; One 50-meter-long tape measure (STANLEY 34-263 brand (20 meters in length); LEICA Tree Height GAUGE Model D2; Garmin brand coordinates, model Etrex vista C, made in Taiwan; record form; device for recording.

Survey and data collection

This study conducted the survey and data collection in the natural forest area of Pa Doi Bo national forest reserve in Chiang Rai province. It was a mixed forest covering an area of 500 rai. It was located at a geographic coordinate between 19 degrees 59 Libda 50.35 North Filibda and a line of longitude over 99 degrees 46 Libda 6.03 East Filibda. The forest area and level of plant fertility were taken into consideration and could be used as the representative of the plant

community in each forest type. Also, there was the location of plots in the planted forest and the natural forest as shown in Figure 2.

Placing sample plots

Placing sample plots to be the representative of the plant community to be investigated. The sample plots were 20x50 m^2 and there were 10 sub-plots with the size of 10x10 meters. This was to collect tree data (Diameter at Breas Height, DBH of 4.5 cm. and above as well as girth at breast level: GBH of 15 cm. and above). For placing sample plots of sapling (DBH of less than 4.5 cm. or GBH of less than 15 cm. and 1.30 cm. in height and above). The sample plots were to place a parallel plot of 4x4 square meters overlapping at one corner of the plot of 10x10 square meters. Data collection started from recording names of plant species. This was based on identification of plant species surveyed found in the sample plot; refers to the plant taxonomic documents and the Plant Species Classification Manual of Thailand, amended edition (Samitinun, 2014) and Northern City Trees (Gardner et al., 2000). The tape was used for measuring the tree diameter at the height level of 1.30 meter and the Haga hypsometer was used for measuring the tree height. Regarding data of the 10x10 square meter sub-plots determined to prepare a profile diagram, the following were recorded: crown cover, imaginary north, imaginary south, imaginary east and imaginary west. Also, the coordinated of the location of the trees according to the coordinate distance were recorded for the investigation of the laced that were not plotted were studied as a whole type of survey (Figure 2).

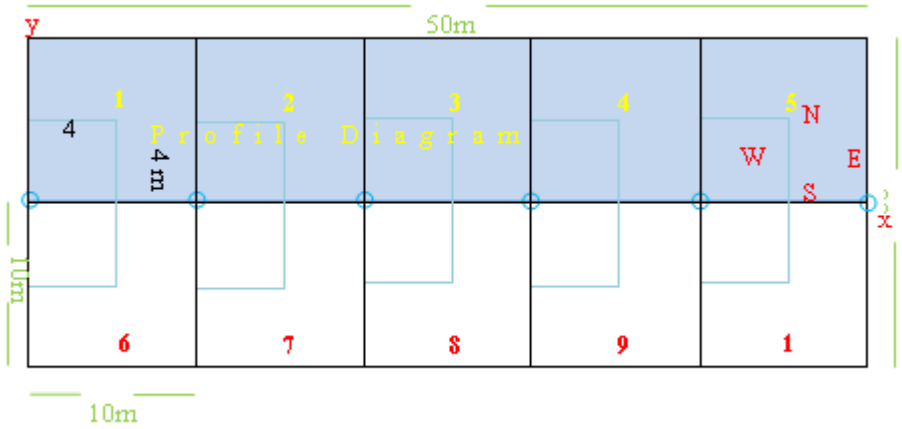

Figure 2 Placing the 20x50 square meter sample plot for investigating the plant community
Source: Adapted from Pattanakiat (2008)

Data collection

Data collected based on species diversity, the amount of biomass and carbon sequestration of the exploration site. Making the area survey of three 3x3 meters temporary sample plots distributed in the planted forest area. Then, placing a sub-plot size of 10x10 meters overlapped; a total of three large plots and thirty sub-plots were data collection in total. After that, making a survey of big trees which the diameter at breast height was more than 4.5 centimeters and the three height was more than 1.30 meters. Collecting information about the types of trees and measuring the diameter and height of big trees in every sub-plot of 10x10 meters. Then, making a list of plant species according to taxonomy (Samitinun, 2014).

Data analysis

Obtained data were computed for finding density, frequency of trees, predominance, basal area, relative density, relative frequency, and relative dominance. This was for the computation of importance value index and index of species diversity as well as species evenness as follows:
Estimation of an importance value index of plant species could be computed from the importance of the value of each species (Pattanakiat, 2008) as follows:

$$\text{Density value} = \frac{\text{The number of plants of that species}}{\text{All sample plot areas studied}}$$

$$\text{Frequency value} = \frac{\text{The number of sample plots where a given plant species was determined}}{\text{All sample plots which were studied}}$$

$$\text{Dominance value} = \frac{\text{All basal areas of determined plant species}}{\text{Sample plots area studied}}$$

Basal area of the trees = $\pi D^2/4$ (Size of the diameter at 1.30 meters in height)

$$\text{Relative density value} = \frac{\text{The density of that plant species}}{\text{The total density of all plant species}} \times 100$$

$$\text{Relative frequency value} = \frac{\text{The frequency of that plant species}}{\text{The total frequency of all plant species}} \times 100$$

$$\text{Relative dominance value} = \frac{\text{The dominance of all plant species}}{\text{The total dominance of all plant species}} \times 100$$

The total important value index for trees was 300
IVI = Relative density + relative frequency + relative dominance
The total important value index for sapling was 200
IVI = Relative density + relative frequency
Index of species diversity based on Shannon-Wiener Index
$H' = -\sum_{i=1}^{S} Pi\ Log\ 2\ Pi$
When H = Diversity index of Shannon-Wiener
S = A total number of all species
P = The proportion of the number of species i to the sum of all numbers of all species in the plant community
I = 1,2,3,…
Species eveness valud based on the equation of Shannon's evenness

$$J' = \frac{H'}{\ln S}$$

when J' = evenness' value
H´ = Diversity index of Shannon-Wiener
S = A total number of species

Research Results

The biodiversity exploration of the plant community in the natural forest revealed that the structure of the natural forest in the sample plot was 603-615 meters above sea level. The forest canopy was 4-20 meters in height depending on slope of the area (45-65°). Most of the trees there were rather high and mostly were decedous trees scattering in inequal distance. The forest canopy had light peneration for 10-20 percent. The forest floor was not overgrown and there were enough food plants. There were many types of lace found: *Croton roxburghii*, *Antidesma*

sootepense, *Albizia odoratissima*, *Pterocarpus macrocarpus*, *Antidesma acidum*, *Lepisanthes rubiginosa*, *Millettia brandisiana*, *Dalbergia cultrata*, *Aporosa villosa*, *Hubera cerasoides*, *Sterculia guttata*, *Pterospermum semisagittatum*, *Lannea coromandelica*, *Wrightia arborea*, *Anogeissus acuminata*, *Vitex canescens*, *Mallotus philippensis*, *Holarrhena pubescens*, *Lagerstroemia cochinchinensis*, etc. There were traces of wildfire that had taken place in the plot area. A large perennial plant was found-DILLENIACEAE such as *Dillenia ovata* and POACEAE such as *Dendrocalamus strictus*, *Bambusa nutans* and *Gigantochloa albociliata* was also found. According to the plant community in the natural forest in this study, 47 species, 41 genera and 26 family were found. An average number of species was 18.67, the density was 503.33 trees per hectare and the average basal area was 1.62 square meter per hectare (Table 1).

Table 1 A number of species, density, and basal area based on each plot in the natural forest

Plot	**Number of species**	**Density tree/Hectare**	**Basal area M^2/Hectare**
Natural forest1	20	470	1.31
Natural forest2	16	540	1.65
Natural forest3	20	500	1.91
Average	**18.67**	**503.33**	**1.62**

The locale of this study had 151 trees and FABACEAE family was found most (29 trees), followed by BURSERACEAE (28 trees), LAMIACEAE (22 tress) and others (72 trees). The total value of basal area was 4.87 square meters. It was found that FABACEAE family the basal area most (0.80 square meter), followed by BURSERACEAE (0.74 square meter), LAMIACEAE (0.73 square meter), ant other families (2.60 square meters). Regarding the importance value index of each tree in the top 5 families, the following were found: FABACEAE (55.39), BURSERACEAE (50.92), LAMIACEAE (42.45), EUPHORBIACEAE (35.38) and APOCYNACEAE (34.65), respectively. The top five dominant plant species were *Tectona grandis* (33.31), *Protium serratum* (33.10), *Albizia odoratissima* (31.05), *Aporosa villosa* (20.79) and *Dillenia ovata* (18.02), respectively (Table 2).

Table 2 Total basal area, number of trees, relative density, relative dominance, and importance value index (IVI) of tree species in each family

Rank	Family	Common name	Scientific name	Number of trees	Total basal area	Relative density	Relative frequency	Relative dominance	IVI
					Square meter				
1	FABACEAE	Kang khi mot	*Albizia odoratissima*	14	0.60	9.27	9.40	12.38	31.05
2	FABACEAE	Ket dam	*Dalbergia cultrata*	9	0.12	5.96	5.98	2.43	14.37
3	FABACEAE	Kra phi chan	*Millettia brandisiana*	5	0.07	3.31	3.42	1.55	8.28
4	FABACEAE	Ching chan	*Dalbergia oliveri*	1	0.01	0.66	0.86	0.17	1.69
5	BURSERACEAE	Ma faen	*Protium serratum*	20	0.42	13.25	11.11	8’74	33.10
6	BURSERACEAE	Ma kok kluean	*Canarium subulatum*	8	0.32	5.30	5.98	6.54	17.82
7	LAMIACEAE	Sak	*Tectona grandis*	17	0.65	11.26	8.55	13.50	33.31
8	LAMIACEAE	Pha sian	*Vitex canescens*	3	0.03	1.99	2.56	0.55	5.10
9	LAMIACEAE	Ka sam pik	*Vitex peduncularis*	2	0.05	1.33	1.71	1.00	4.04
10	EUPHORBIACEAE	Mueat lot	*Aporosa villosa*	12	0.25	7.95	7.69	5.15	20.79
11	EUPHORBIACEAE	Plao luang	*Croton roxburghii*	9	0.13	5.96	5.98	2.65	14.59
12	APOCYNACEAE	Mok man	*Wrightia arborea*	13	0.11	8.61	6.84	2.25	17.70
13	APOCYNACEAE	Mok luang	*Holarrhena pubescens*	3	0.24	1.99	1.71	4.88	8.58
14	APOCYNACEAE	Tin pet	*Alstonia scholaris*	1	0.33	0.66	0.86	6.85	3.37
15	DILLENIACEAE	San bai lek	*Dillenia ovata*	4	0.58	2.65	3.42	11.95	18.02
16	SAPINDACEAE	Ta khro	*Schleichera oleosa*	3	0.20	1.99	2.56	4.11	8.66
17	ANACARDIACEAE	Oi chang	*Lannea coromandelica*	3	0.11	1.99	2.56	2.25	6.80
18	CRYPTERONIACEAE	Ka am	*Crypteronia paniculata*	3	0.14	1.99	1.71	2.89	6.59
19	COMBRETACEAE	Ta khian nu	*Anogeissus acuminata*	3	0.03	1.99	2.56	0.68	5.23
20	PHYLLANTHACEAE	Ma mao sai	*Antidesma sootepense*	3	0.01	1.99	2.56	0.19	4.74
21	AQUIFOLIACEAE	Nao nai	*Ilex umbellulata*	2	0.12	1.32	0.86	2.46	4.64
22	RUBIACEAE	Kham mok luang	*Gardenia sootepensis*	1	0.12	0.66	0.86	2.39	3.91
23	EBENACEAE	Phaya rak dam	*Diospyros variegata*	2	0.04	1.32	1.71	0.84	3.87
24	TILIACEAE	Lai	*Microcos paniculata*	1	0.02	0.66	0.86	0.30	1.82
25	TILIACEAE	Po yap	*Colona winitii*	1	0.01	0.66	0.85	0.30	1.81
26	LAURACEAE	Sa thip	*Phoebe paniculata*	1	0.01	0.66	0.85	0.23	1.74
27	LAURACEAE	Ka thang	*Litsea grandis*	1	0.01	0.66	0.86	0.16	1.68
28	CLUSIACEAE	Ma da luang	*Garcinia xanthochymus*	1	0.07	0.66	0.86	1.52	3.04
29	DIPTEROCARPACEAE	Rang	*Shorea siamensis*	1	0.02	0.66	0.86	0.43	1.95
30	SALICACEAE	Kruai pa	*Casearia grewiifolia.*	1	0.02	0.66	0.86	0.33	1.85
31	MYRTACEAE	Wa khao	*Syzygium claviflorum*	1	0.01	0.66	0.86	0.14	1.66
32	MALVACEAE	Ngio pa	*Bombax anceps*	1	0.01	0.66	0.85	0.14	1.65
33	ANNONACEAE	Ka chian	*Hubera cerasoides*	1	0.01	0.66	0.85	0.04	1.55
	Total			**151**	**4.87**	100	100	100	**300**

There were 44 saplings in the locale of this study and the following families were found most: APOCYNACEAE and EUPHORBIACEAE (8 saplings each), FABACEAE (7 saplings), BURSERACEAE (5 saplings), BIGNONIACEAE (4 saplings) and other families (12 saplings). The top five importance value index of saplings in terms of dominant species included the following families: APOCYNACEAE (IVI = 32.90), EUPHORBIACEAE (IVI = 32.89), FABACEAE (IVI = 27.68), BURSERACEAE (IVI = 26.07) and BIGNONIACEAE (IVI = 20.85). The following were top five dominant sapling species: *Wrightia arborea* (IVI = 32.90), *Aporosa villosa* (IVI = 27.68), *Protium serratum* (IVI = 26.07), *Dalbergia cultrata* (IVI = 17.25) and *Oroxylum indicum* (IVI = 15.64), respectively (Table 3).

Table 3 Number of trees, relative density, relative frequency, relative dominance, and importance value index (IVI) of saplings in each family

Rank	Family	Common name	Scientific name	Number of trees	Relative density	Relative frequency	IVI
1	APOCYNACEAE	Mok man	*Wrightia arborea*	8	18.19	14.71	32.90
2	EUPHORBIACEAE	Mueat lot	*Aporosa villosa*	7	15.91	11.77	27.68
3	EUPHORBIACEAE	Plao luang	*Croton roxburghii*	1	2.27	2.94	5.21
4	FABACEAE	Ket dam	*Dalbergia cultrata*	5	11.37	5.88	17.25
5	FABACEAE	Kang khi mot	*Albizia odoratissima*	2	4.55	5.88	10.43
6	BURSERACEAE	Ma faen	*Protium serratum*	5	11.36	14.71	26.07
7	BIGNONIACEAE	Phe ka	*Oroxylum indicum*	3	6.82	8.82	15.64
8	BIGNONIACEAE	Khae sai	*Stereospermum neuranthum*	1	2.27	2.94	5.21
9	LAMIACEAE	Pha sian	*Vitex canescens*	2	4.55	5.88	10.43
10	LAMIACEAE	Ka sam pik	*Vitex peduncularis*	1	2.27	2.94	5.21
11	MALVACEAE	Po daeng	*Sterculia guttata*	2	4.55	5.88	10.43
12	MALVACEAE	Kham khua	*Pterospermum semisagittatum*	1	2.27	2.94	5.21
13	EBENACEAE	Phaya rak dam	*Diospyros variegata*	2	4.55	2.94	7.49
14	LYTHRACEAE	Salao dam	*Lagerstroemia venusta*	1	2.27	2.94	5.21
15	HYPERICACEAE	Tio khon	*Cratoxylum formosum*	1	2.27	2.94	5.21
16	PHYLLANTHACEAE	Ma mao sai	*Antidesma sootepense*	1	2.27	2.94	5.21
17	DILLENIACEAE	San bai lek	*Dillenia ovata*	1	2.27	2.94	5.21
	Total			**44**	**100**	**100**	**200**

Conclusion and Discussion

Regarding the structure of this natural forest of Pa Doi Bo national forest reserve, the natural forest was 603-615 above the sea level, depending on slope of the area (45-65°). Most of the trees there were deciduous perennial scattering in inequal distance. There were enough food plants in the forest and this forest had 2 canopies. There were 47 species, 41 genera and 26 plant families found in the forest. The total basal area representing the dominant plant species was 4.87 square meters. According to a total number of trees in this locale of the study, 151 trees were found which *Tectona grandis* was the most important dominant plant species found in this forest (IVI = 33.31). Index of species diversity was 2.59, species evenness was 0.67, and FABACEAE family had Importance value index most (55.39).

According to the study, it was found that Tectona grandis was a sapling dominant species not found in the area. Alternative reproduction would be a problem if the mature one die. That was, other deportment species would replace it and result in a change of the forest structure. Therefore, it should have a planning of the forest managerial administration to sustain the forest structure condition. In other words, teak trees (seedlings or saplings) should be planted more in this area to help nurture a balanced ecosystem. In this, 33 species were found which was different from a study of Chandaeng et al. (2020) which had less value than the study. It was found that the index of species diversity of than plant community in the mixed forest at Wang Nam Khieo Research and Training Station, Nakhon Ratchasima was equivalent to 2.844. Compared with other mixed forests, this forest condition is not so abundant as it should be. Also, sapling species do not support natural reproduction. It should have a planning of the forest managerial administration of sustainability such as reforestation. Therefore, a study on the natural forest landscape at Pa Doi Bo national forest reserve should be conducted in order to obtain more detailed information.

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Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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