RESEARCH ARTICLE

MEDIA KONSERVASI
SCIENTIFIC JOURNAL IN CONSERVATION OF NATURAL RESOURCES AND ENVIRONMENT

Vegetation Diversity of the Growth Rate Stand in the PBPH PT. Hutan Mulya Central Kalimantan's

Gusti Hardiansyah[a], Afni Fitriani[a] and Akhmad Yani [a]

[a]Department of Environmental science Masters Study Program, Tanjungpura University

Article Info:
Received 15 November 2023
Revised 02 February 2024
Accepted 07 February 2024

Corresponding Author:
Afni Fitriani
Department of Environmental science Masters Study Program
Tanjungpura University
E-mail: afnifitriani98@gmail.com

Abstract

PT. Hutan Mulya is one of the companies engaged in natural forest management, carrying out logging activities that cause changes in the value of species diversity in the remaining stands (LoA). There are 651 individuals of 87 plant species in the LoA area (2016 and 2016) and 63 plant species in virgin forest areas, so there are a total of 32 plant groups. The highest Importance Value Index is found in Meranti Merah (*Shorea leprosula* Miq) and Suhi (*Shorea atrinervosa* Symington) in virgin forest areas. In contrast, the LoA is dominated by the Jambuan (*Syzygium* Gaertn) species because it is a source of animal feed and is not produced by companies. The diversity index of tree species, poles, and saplings in the virgin forest is high (>3.00), whereas, in the LoA area (2016 and 2022), the level of trees is high (>3.00), the level of poles is medium (1.00–3.00), and the level of saplings for LoA 2022 is low (1.00<). Meanwhile, the virgin forest similarity index and LoA (2016 and 2022) are in the same or medium category, between 0.31 and 1.00.

Keywords: *Important Value Index, Diversity of Types, Logged Over Area*

1. Introduction

The diversity of species in tropical forests is very high because it has developed for a long time and has become a history in forming tropical forests. Various tropical forest plants can thrive and receive sunlight throughout the year, making them very productive in producing oxygen. Forests in Indonesia are of the tropical rainforest type due to their high vegetation diversity and potential for large amounts of carbon sequestration [1].

According to Permenhut PP. No. 11 of 2009 [2] TPTI, stands for Tebang Pilih Tanam Indonesia (Indonesian selective logging and planting) - is a silvicultural system that regulates logging and artificial propagation procedures in forests. This system is applied to non-longleaf forests through the implementation of individual logging. Harvesting that is applied in the selective logging system is in the form of trees with a certain diameter limit and commercial species, but still pays attention to biodiversity with a limit of trees cut for the forest is 50 cm up. The book by Hardiansyah and Ridwan [3] said that the TPTI system is a suitable concept for Indonesia. Conceptually, TPTI is compatible with the condition of Indonesia's natural forests. The suitability includes, among others, first, natural forests consisting of various types of flora and fauna and so on. Tebang Pilih Tanam Indonesia, abbreviated as TPTI, is the result of a refinement of the TPI system for the forest management system in Indonesia.

Forest management companies that are PHPL or FSC certified will carry out harvesting by implementing a low-impact logging system, namely Reduce Impact Logging (RIL), so that not all tree stands are cut down in the area. Still, some trees are left to stay, grow, and continue to develop, such as parent tree species, endemic, rare, critical, or protected.

The few stands of trees that are not felled in the logging area are called core trees, which will be felled during the next logging rotation in the future. This research aims to determine the value of the Index of Diversity in the LoA area and virgin forests. Meanwhile, this research is expected to provide a broader insight into species diversity in the LoA area in production forests.

2. Research Methodology

2.1 Data Collection Method

This study uses quantitative methods with primary data collection with different growth stage levels, such as saplings (5.0-9.5 cm), poles (10.0-19.5 cm), and trees (20 cm Up), as many as 5 randomly cut plots with data collection techniques by purposive sampling for each plot. According to the ICRAF Plot Design of Hairiah et al. [4]

The research process involved data processing (for field data collection preparation), field data collection, and analysis. Data processing for field data collection preparation was conducted by planning sample plots measuring 20x20 meters based on the IPCC (2006) [5] guidelines for tree measurements. Each selected plot will be sampled with a plot area of 20 x 100 m for the tree level. In the plot, there is another plot measuring 5 m x 40 m for the measurement of pole and sapling with a diameter of 5.0 cm to 19.5 cm. Tree measurements were taken at chest height (120 cm above ground level).

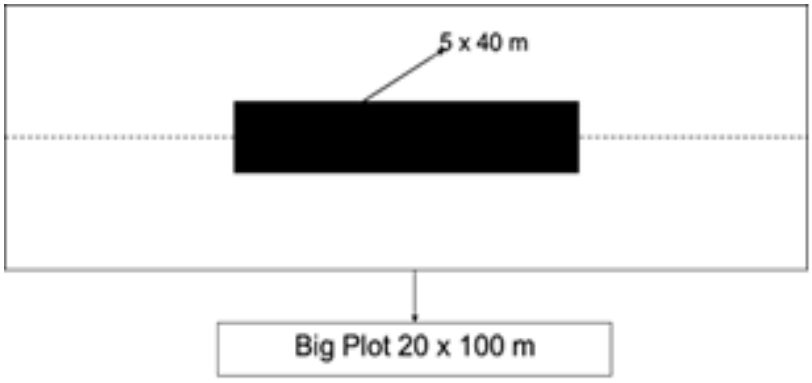

Figure 1. Desain Plot (according to ICRAF [4])

2.2 Location and Time of Research

Tree diameter data collection and documentation will be carried out in the standing forest area (LoA: Logged Over Area) Block RKT 2016, and Block RKT 2022 PT Hutan Mulya Central Kalimantan Province, Field research will be carried out for approximately 1 (one) month.

2.3 Data Analysis Method

Data analysis in this study uses a quantitative method through a statistical data processing approach. The data analysis uses vegetation analysis calculations to determine the value of Diameter, Stand Density, Stand Frequency, Stand Dominance, Important Value Index, Type Diversity Index, and Type Similarity Index in vegetation.

2.3.1 Diameter

The circumference measurement results are used to determine the tree diameter size with the following formula.

$$D = K/\pi$$

Where D =Diameter of Stand (cm); K = Tree Circumference (cm); π: *phi* (22/7 atau 3.14).

2.3.2 Important Value Index

The index of important value (IVI) is used to observe plant species in groups on each plot (Sugianto 1994):

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

$$\text{Relative density} = \frac{\text{Density of a species}}{\text{Density of all species}} \times 100\%$$

$$\text{Relative dominance} = \frac{\text{Dominance value of a species}}{\text{Sum of all species dominance values}} \times 100\%$$

Important Value Index = Relative Dominance + Relative Frequency + Relative Density

2.3.3 Diversity Index

The species diversity index is a value resulting from a combination of calculations between the richness index and the evenness index. The species diversity value can be calculated using the following Shannon-Wiener formula:

$$H' = -\sum[(Pi) \times ln\,(Pi)], \text{where } Pi = (ni/N)$$

where ni = number of individuals of a species; N = total individuals of a species; Criteria = H' < 1 low diversity; 1<H'<3 medium diversity; H' > 3 high diversity.

2.3.4 Similarity Index

The similarity index value is used to measure the degree of evenness/abundance of individuals in a community which illustrates the balance between communities.

$$E = \frac{H'}{ln\,S}$$

where H' = diversity index; S = number of species; Criteria = E < 0.31 (small similiarty, stressed community); 0.31 > E ≤ 1 (moderate similiarty, unstable community); E > 1 (high similiarty, stable community).

3. Results

3.1. Density

Based on the research results, it was found that there were 72 plant species with a total of 651 individual species at the growth rate of saplings, poles, and trees in 15 observation plot locations. These species were found in the virgin forest and LoA areas. In the virgin forest area, 63 plant species were found, while in the LoA area, there were 41 plant species.

Table 1. Diameter Class Density of Stand Growth Level

The Growth Rate (Cm)	Stand Density (N/Ha)			Total of Growth Rate	Average of Growth Rate
	Virgin Forest*	LoA**(2016)	LoA**(2022)		
Sapling (5.0-9.5 cm)	520	530	580	1,630	543
Pole (10.0-19.5 cm)	730	70	20	820	273
Tree (20 cm up)	203	128	75	406	135
Total	1.453	728	675	2,856	952
Average	484.33	242.67	225.00	952.00	317.33

* Note: Virgin Forest* : Protected area and LoA** : Logged Over Areal/Forestation

The graph of virgin forest density tends to be higher than in the live stand area, as seen in Figure 2, where the virgin forest density value is 1,453 trees/ha. While in the live stand area, RKT 2016 tends to have a higher density (728 trees/ha) than RKT 2022 (675 trees/ha). At the growth rate of the stand diameter class, the density in virgin forests is dominated by the pole level (10-19), while in the LoA 2016 and LoA 2022 areas, it is dominated by the sapling level, namely the diameter class (5 – 9.5 cm). The high-density value in the virgin forest is due to the absence of logging activities in this area, in contrast to the LoA area, which experienced logging in the previous year. The higher the stand density value in an area, the smaller the

tree diameter, and vice versa, so the larger the tree diameter, the fewer tree stands there are [7].

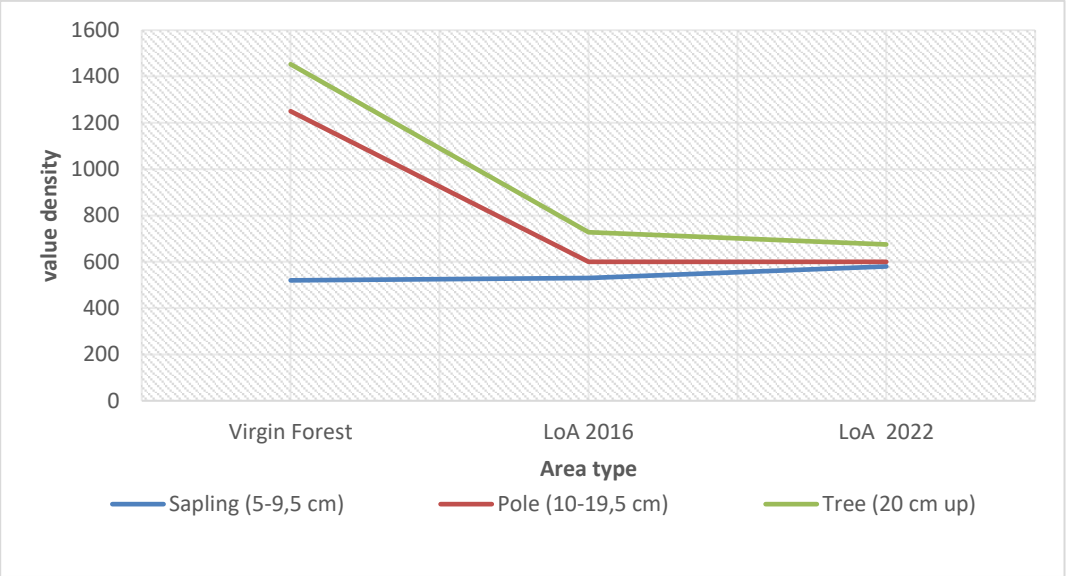

Figure 2. Stand Density Chart

3.2. Important Value Index

The results of research conducted in three locations, namely the LoA area (RKT 2016 and RKT 2022), by comparing vegetation data from the Virgin forest area show differences in the value of density, frequency, and dominance so that it affects the IVI value and diversity and evenness of species in the area, both at the sapling, pole, and tree levels. The top 10 groups of plant species with the highest IVI in Virgin forest and LoA areas from sapling, pole, and tree levels can be seen in Table 2 to Table 9.

Table 2. Important Value Index (IVI) of Tree Level in Virgin Forest Area

No	Local Name	Scientific name	N (Tree/Ha)	Total Plot	Average D (Cm)	RK (%)	RF (%)	RD (%)	IVI (%)	H	E
1	Meranti Merah	*Shorea leprosula Miq.*	29	5	31.12	14.29	4.67	3.59	22.55	0.28	0.07
2	Jambuan	*Syzygium Gaertn.*	21	5	31.12	10.34	4.67	3.59	18.61	0.23	0.06
3	Suhi	*Shorea atrinervosa Symington.*	19	5	31.49	9.36	4.67	3.68	17.71	0.22	0.06
4	Mahambung	*Shorea smithiana Symington.*	9	5	41.76	4.43	4.67	6.47	15.58	0.14	0.04
5	Kapur	*Dryobalanops lanceolata Burck.*	9	5	33.40	4.43	4.67	4.14	13.25	0.14	0.04
6	Tengkawang	*Shorea stenoptera Burk*	9	4	39.13	4.43	3.74	4.54	12.72	0.14	0.04
7	Nyatoh	*Palaquium obovatum (Griff.) Engl.*	9	4	30.39	4.43	3.74	2.74	10.91	0.14	0.04
8	Keruing	*Dipterocarpus kunstleri King.*	7	4	37.40	3.45	3.74	4.15	11.34	0.12	0.03
9	Kayu Arang	*Diospyros borneensis Hiern.*	8	4	32.56	3.94	3.74	3.15	10.83	0.13	0.03
10	Kumpang	*Myristica maxima Warb., Mon. Myrist.*	7	4	29.85	3.45	3.74	2.65	9.83	0.12	0.03

Based on the vegetation analysis in (Table 2) in the virgin forest area, which is the control data, 3 tree species have the highest IVI value, namely the Meranti merah (*Shorea leprosula Miq*) species (22.55%), Jambuan (*Syzygium Gaertn*) (18.61) and Suhi (17.71%). While when viewed from the lowest species, namely Kumpang (*Myristica maxima Warb., Mon. Myrist.*) (9.83%). The dominance of the Meranti merah species is influenced by the type of Kalimantan forest type, which is indeed the habitat of the Dipterocarpaceae group, especially the Meranti species, while for plant species, this species grows and develops a lot because it feeds animals in the forest.

Table 3. Important Value Index (IVI) of Pole Level in Virgin Forest Area

No	Local Name	Scientific name	N (Tree/Ha)	Total Plot	Average D (Cm)	RK (%)	RF (%)	RD (%)	IVI (%)	H	E
1	Meranti Merah	*Shorea leprosula Miq.*	10	4	15.46	13.70	7.02	7.45	28.17	0.27	0.07
2	Suhi	*Shorea atrinervosa Symington.*	10	4	13.90	13.70	7.02	6.03	26.74	0.27	0.07
3	Jambuan	*Syzygium Gaertn.*	5	4	15.59	6.85	7.02	7.58	21.45	0.18	0.05
4	Nipis Kulit	*Memecylon L.*	4	3	18.20	5.48	5.26	7.75	18.49	0.16	0.04
5	Nyatoh	*Palaquium obovatum (Griff.) Engl.*	2	2	18.31	2.74	3.51	5.23	11.48	0.10	0.03
6	Menjalin	*Xanthophyllum excelsum Blume ex Miq.*	2	2	17.31	2.74	3.51	4.67	10.92	0.10	0.03
7	Kapur	*Dryobalanops lanceolata Burck.*	2	2	15.30	2.74	3.51	3.65	9.90	0.10	0.03
8	Binuang	*Octomeles Miq.*	2	2	14.84	2.74	3.51	3.43	9.68	0.10	0.03
9	Rengas	*Gluta renghas Linn.*	2	2	14.54	2.74	3.51	3.30	9.54	0.10	0.03
10	Kumpang	*Myristica maxima Warb., Mon. Myrist.*	2	2	13.81	2.74	3.51	2.97	9.22	0.10	0.03

The results of the analysis of the sapling level shown in (Table 3) show that in the Virgin forest area, it is known that 3 plant species have the highest IVI, namely the red Meranti (*Shorea leprosula* Miq) species. This species dominates with an IVI value of 28.17%, while the highest pole species in second place is Suhi (*Shorea atrinervosa* Symington), and the third is Jambuan (*Syzygium* Gaertn). Meanwhile, the pole species with the lowest IVI value is Kumpang (*Myristica maxima* Warb., Mon. Myrist.), with an IVI value of 9.22%. The dominance of Meranti is due to the forest type, which is a habitat for dipterocarpaceae groups, especially the Meranti species. The greater the IVI value of a species, the greater the level of control over its community, and vice versa. The abundance of a particular species in a community occurs if that species dominates a greater portion of the available resources than other species [6].

Table 4. Important Value Index (IVI) of Sapling Level in Virgin Forest Area

No	Local Name	Scientific name	N (Tree/Ha)	Total Plot	Average D (Cm)	RK (%)	RF (%)	RD (%)	IVI (%)	H	E
1	Suhi	*Shorea atrinervosa Symington.*	6	4	7.30	11.54	9.52	3.32	24.39	0.25	0.08
2	Meranti Merah	*Shorea leprosula Miq.*	6	4	6.80	11.54	9.52	2.89	23.95	0.25	0.08
3	Jambuan	*Syzygium Gaertn.*	4	3	7.21	7.69	7.14	3.24	18.07	0.20	0.06
4	Nyatoh	*Palaquium obovatum (Griff.) Engl.*	3	3	6.91	5.77	7.14	2.98	15.89	0.16	0.05
5	Pasangan	*Quercus lineata Blume.*	3	2	7.27	5.77	4.76	3.30	13.83	0.16	0.05
6	Kayu Arang	*Diospyros borneensis Hiern.*	2	2	7.32	3.85	4.76	3.34	11.95	0.13	0.04
7	Kumpang	*Myristica maxima Warb., Mon. Myrist.*	2	1	9.55	3.85	2.38	5.69	11.92	0.13	0.04
8	Mahambung	*Shorea smithiana Symington.*	2	2	6.69	3.85	4.76	2.79	11.40	0.13	0.04
9	Menjalin	*Xanthophyllum excelsum Blume ex Miq.*	2	2	6.62	3.85	4.76	2.73	11.34	0.13	0.04
10	Emang	*Hopea dryobalanoides Miq.*	2	2	6.08	3.85	4.76	2.31	10.91	0.13	0.04

Vegetation analysis at the sapling level contained in (Table 4) in the virgin forest area shows that the Emang (*Hopea dryobalanoides* Miq.) species is the lowest species in the list of sampling species in this area because their IVI values are the lowest among other species at 10.91%. Meanwhile, when viewed based on the highest IVI value, it is dominated by Suhi (*Shorea atrinervosa* Symington) (24.39%), Red Meranti (*Shorea leprosula* Miq) (23.95%) and Jambuan (*Syzygium* Gaertn) (18.07%).

Table 5. Important Value Index (IVI) of Tree Level in LoA 2016 Area

No	Local Name	Scientific name	N (Tree/Ha)	Total Plot	Average D (Cm)	RK (%)	RF (%)	RD (%)	IVI (%)	H	E
1	Jambuan	*Syzygium Gaertn.*	10	5	37.04	7.81	5.75	6.62	20.18	0.20	0.05
2	Asam Keranji	*Dialium indum L*	7	5	42.07	5.47	5.75	8.54	19.76	0.16	0.04

No	Local Name	Scientific name	N (Tree/Ha)	Total Plot	Average D (Cm)	RK (%)	RF (%)	RD (%)	IVI (%)	H	E
3	Suhi	*Shorea atrinervosa Symington.*	13	4	30.81	10.16	4.60	3.67	18.42	0.23	0.06
4	Nyatoh	*Palaquium obovatum (Griff.) Engl.*	7	4	37.14	5.47	4.60	5.33	15.39	0.16	0.04
5	Pelepek	*Shorea pauciflora King.*	9	4	27.09	7.03	4.60	2.83	14.46	0.19	0.05
6	Mahambung	*Shorea smithiana Symington.*	5	4	36.31	3.91	4.60	5.09	13.59	0.13	0.03
7	Pasangan	*Quercus lineata Blume.*	6	4	28.50	4.69	4.60	3.14	12.42	0.14	0.04
8	Meranti Merah	*Shorea leprosula Miq.*	5	3	34.54	3.91	3.45	3.46	10.81	0.13	0.03
9	Meranti Putih	*Shorea virescens Parijs*	2	2	57.01	1.56	2.30	6.27	10.14	0.06	0.02
10	Mempisang	*Monocarpia polyneura Miq.*	3	3	36.57	2.34	3.45	3.87	9.67	0.09	0.02

(Table 5) shows that the tree-level data contained in the 2016 LoA area is dominated by the Jambuan (*Syzygium* Gaertn), Asam Keranji (*Dialium indum* L) and Suhi (*Shorea atrinervosa* Symington) species. These three species are the species with the highest IVI values, especially the Jambuan (*Syzygium* Gaertn) species whose IVI value is 20.18%. Meanwhile, the lowest species is Mempisang (*Monocarpia polyneura* Miq.) with the lowest IVI of 9.67%. This live stand area is an area after logging activities 6 years ago, different from the virgin forest area, which did not experience logging. In the LoA area, the tree species that are cut down are commercial species such as Meranti with a diameter of 50 cm up and leaving a live stand below the diameter limit to be used as a mother tree.

Table 6. Important Value Index (IVI) of Pole Level in LoA 2016 Area

No	Local Name	Scientific name	N (Tree/Ha)	Total Plot	Average D (Cm)	RK (%)	RF (%)	RD (%)	IVI (%)	H	E
1	Suhi	*Shorea atrinervosa Symington.*	2	1	14.25	28.57	16.67	19.95	65.19	0.36	0.20
2	Mahawai	*Polyalthia Blume.*	1	1	17.29	14.29	16.67	29.38	60.33	0.28	0.16
3	Banitan	*Polyalthia glauca (Hassk.) F.Muell.*	1	1	12.42	14.29	16.67	15.15	46.11	0.28	0.16
4	Nipis Kulit	*Memecylon L.*	1	1	11.15	14.29	16.67	12.21	43.16	0.28	0.16
5	Nyatoh	*Palaquium obovatum (Griff.) Engl.*	1	1	11.02	14.29	16.67	11.93	42.88	0.28	0.16
6	Meliti	*Antidesma neurocarpum Miq*	1	1	10.76	14.29	16.67	11.38	42.34	0.28	0.16

Table 6 shows that pole-level plant species in the 2016 LoA area are less than in the virgin forest area because they have experienced post-felling. At this level, there are 6 plant species dominated by the Suhi (*Shorea atrinervosa* Symington) species with an IVI value of 65.19%. The second highest IVI value after Suhi (*Shorea atrinervosa* Symington) is Mahawai (*Polyalthia* Blume), with an IVI of 60.33%. In contrast, the lowest species is the Meliti (*Antidesma neurocarpum* Miq) species with the lowest IVI among others, namely 42.34%.

Table 7. Important Value Index (IVI) of Sapling Level in LoA 2016 Area

No	Local Name	Scientific name	N (Tree/Ha)	Total Plot	Average D (Cm)	RK (%)	RF (%)	RD (%)	IVI (%)	H	E
1	Nipis Kulit	*Memecylon L.*	8	4	6.21	15.09	10.53	9.34	34.96	0.29	0.09
2	Jambuan	*Syzygium Gaertn.*	6	3	6.04	11.32	7.89	6.62	25.84	0.25	0.08
3	Meliti	*Antidesma neurocarpum Miq*	4	4	6.69	7.55	10.53	10.82	28.89	0.20	0.06
4	Rengas	*Gluta renghas Linn.*	4	3	6.36	7.55	7.89	7.34	22.78	0.20	0.06
5	Jangkang	*Xylopia malayana Hook.f. & Thoms.*	4	2	7.64	7.55	5.26	7.07	19.88	0.20	0.06
6	Kumpang	*Myristica maxima Warb., Mon. Myrist.*	3	2	8.42	5.66	5.26	8.57	19.50	0.16	0.05
7	Suhi	*Shorea atrinervosa Symington.*	3	2	7.75	5.66	5.26	7.26	18.19	0.16	0.05
8	Kayu Arang	*Diospyros borneensis Hiern.*	3	2	5.73	5.66	5.26	3.97	14.90	0.16	0.05
9	Merpayung	*Scaphium macropodum (Miq.) Beumee Ex K Heyne.*	3	1	7.22	5.66	2.63	3.15	11.44	0.16	0.05
10	Nyatoh	*Palaquium obovatum (Griff.) Engl.*	2	2	5.25	3.77	5.26	3.34	12.38	0.12	0.04

The Nipis Kulit (*Memecylon* L) species has the greatest IVI value (34.96%), according to sapling level data from the RKT 2016 (LoA), followed by Jambuan (*Syzygium* Gaertn) (25.84%) and Meliti (*Antidesma neurocarpum* Miq) (28.89%). Meanwhile, the species with the lowest IVI value are Nyatoh (*Palaquium obovatum* (Griff.) Engl.), which both have an IVI value of 12.38%. The low IVI value at the sapling level is because some sapling species have regenerated after 6 years of logging to grow and develop into poles.

Table 8. Important Value Index (IVI) of Tree Level in LoA 2022 Area

No	Local Name	Scientific name	N (Tree/Ha)	Total Plot	Average D (Cm)	RK (%)	RF (%)	RD (%)	IVI (%)	H	E
1	Jambuan	*Syzygium Gaertn.*	11	4	38.26	14.67	7.84	7.09	29.60	0.28	0.08
2	Asam Keranji	*Dialium indum L*	8	5	38.71	10.67	9.80	9.07	29.54	0.24	0.07
3	Tengkawang	*Shorea stenoptera Burk*	9	4	42.13	12.00	7.84	8.60	28.44	0.25	0.07
4	Suhi	*Shorea atrinervosa Symington.*	6	3	37.97	8.00	5.88	5.24	19.12	0.20	0.06
5	Keruing	*Dipterocarpus kunstleri King.*	3	2	46.50	4.00	3.92	5.23	13.16	0.13	0.04
6	Pasangan	*Quercus lineata Blume.*	4	2	35.20	5.33	3.92	3.00	12.25	0.16	0.05
7	Katangis	*Dillenia excelsa (Jack) Martelli*	3	2	41.03	4.00	3.92	4.08	12.00	0.13	0.04
8	Kapur	*Dryobalanops lanceolata Burck.*	1	1	62.10	1.33	1.96	4.67	7.96	0.06	0.02
9	Meranti Merah	*Shorea leprosula Miq.*	3	2	39.36	4.00	3.92	3.75	11.67	0.13	0.04
10	Benuas	*Shorea laevis Ridley*	2	2	46.27	2.67	3.92	5.18	11.77	0.10	0.03

Table 8 shows that Jambuan (*Syzygium* Gaertn), Asam keranji (*Dialium indum* L) and Tengkawang (*Shorea stenoptera* Burk) dominate among other tree species, especially the Jambuan (*Syzygium* Gaertn) species which has the highest IVI value of 29.60%. Meanwhile, the species with the lowest IVI are Benuas (Shorea laevis Ridley) (11.77%). The IVI value's size depends on the tree's diameter and the density of the stand in the area because density indicates the quality of the place where plants grow [7].

Table 9. Important Value Index (IVI) of pole Level in LoA 2022 Area

No	Local Name	Scientific name	N (Tree/Ha)	Total Plot	Average D (Cm)	RK (%)	RF (%)	RD (%)	IVI (%)	H	E
1	Jambuan	*Syzygium Gaertn.*	1	1	10.19	50.00	50.00	50.79	150.79	0.35	0.50
2	Letang	*Shorea parvifolia Dyer*	1	1	10.03	50.00	50.00	49.21	149.21	0.35	0.50

Table 9 shows that the number of poles found in the LoA area is very small compared to the virgin forest area and LoA 2016, which is only 2 poles. This is due to the fact that the LoA 2022 area was logged after one year, so young trees were not seen growing back. The Jambuan (*Syzygium* Gaertn) species had the highest INP value of 150.79 %, and the Letang (*Shorea parvifolia* Dyer) species had the lowest IVI value of 149.21 %. The regeneration mechanism serves to ensure its existence. According to Posa et al. (2011), cited from Junaidi et al. [8], forest stands can be described as a complete picture of the number of individuals in each diameter class, ranging from seedlings to trees with the largest diameter [9]. Tropical forest regeneration depends on many variables, including the formation of natural gaps.

Table 10. Important Value Index (IVI) of Sapling Level in LoA 2022 Area

No	Local Name	Scientific name	N (Tree/Ha)	Total Plot	Average D (Cm)	RK (%)	RF (%)	RD (%)	IVI (%)	H	E
1	Jambuan	*Syzygium Gaertn.*	12	5	7.21	20.69	14.29	16.46	51.44	0.33	0.11
2	Nipis Kulit	*Memecylon L.*	9	3	7.01	15.52	8.57	9.35	33.44	0.29	0.10
3	Emang	*Hopea dryobalanoides Miq.*	6	4	6.20	10.34	11.43	9.77	31.54	0.23	0.08
4	Meliti	*Antidesma neurocarpum Miq*	7	3	6.43	12.07	8.57	7.87	28.51	0.26	0.09
5	Kenari	*Canarium pilosum Benn*	3	3	7.47	5.17	8.57	10.63	24.37	0.15	0.05
6	Rengas	*Gluta renghas Linn.*	2	2	6.96	3.45	5.71	6.14	15.30	0.12	0.04

No	Local Name	Scientific name	N (Tree/Ha)	Total Plot	Average D (Cm)	RK (%)	RF (%)	RD (%)	IVI (%)	H	E
7	Kapur	*Dryobalanops lanceolata Burck.*	2	2	6.21	3.45	5.71	4.89	14.05	0.12	0.04
8	Meranti Merah	*Shorea leprosula Miq.*	1	1	8.60	1.72	2.86	4.69	9.27	0.07	0.02
9	Banitan	*Polyalthia glauca (Hassk.) F.Muell.*	2	2	5.92	3.45	5.71	4.45	13.61	0.12	0.04
10	Letang	*Shorea parvifolia Dyer*	3	1	6.30	5.17	2.86	2.51	10.54	0.15	0.05

In Table 10, three species dominate the sapling level, namely Jambuan (*Syzygium* Gaertn) (51.44%), Nipis kulit (*Memecylon* L.) (33.44%) and Emang (*Hopea dryobalanoides* Miq.) (31.54%). Meanwhile, Letang (Shorea parvifolia Dyer) is the species with the smallest IVI value of 10,54%. Heriyanto, Priatna and Samsoedin [10] said that the density of species at the sapling, pole and tree levels in natural forests is generally different and varied. Quoted from Rahmah et al. [11], Kartawinata (2013) stated that the density or dominance of plant species in natural forests is different because of the different forms of variation in stand structure.

3.3 Stand Carbon Stock Potential AGB (*Above Ground Biomass*)

The highest IVI value is dominated by the tree level, especially in virgin forest areas because the better the growth of tree stands, it affects the diameter and the basic area of trees per unit area that is increasing. This follows the statement quoted from Hikmatyar et al. [12] that the greater the diameter of the stand, the more the age of a stand increases. In addition, growth competition between species also affects the high dominance and diversity of species in each location.

Table 11. Diversity Index and Similarity Index

The Growth Rate (Cm)	Diversity Index			Similarity Index		
	Virgin Forest*	RKT 2016 (LoA)**	RKT 2022 (LoA)**	Virgin Forest*	RKT 2016 (LoA)**	RKT 2022 (LoA)**
Sapling (5-9,5 cm)	3,09	2,86	2,55	0,94	0,91	0,87
Pole (10-19 cm)	3,28	1,75	0,69	0,90	0,98	1,00
Tree (20 cm up)	3,29	3,39	3,01	0,85	0,93	0,89

* Note: Virgin Forest* : Protected area and LoA** : Logged Over Areal/Forestation

The similarity values of the virgin forest area and LoA 2016 and 2022 are in the same category, between 0.31 and 1.00. Similarity index with a value of 0 indicates the level of similarity of plant species in the community is very uneven/unsimilar. If the value is close to 1, almost all species have the same or abundance. The results of the diversity index of virgin forest areas at the tree, pole, and sapling levels appear to have a value of > 3.00, which means they are included in the high category. In the LoA area, both in LoA 2016 and LoA 2022, the tree level diversity value is high (>3.00), while at the sapling level it is medium (1.00–3.00), but for the LoA 2022 pole level area, the diversity value is low because it is <1.00, as explained by Indriyanto (2006), quoting from Hidayat's research [13], that species diversity can be used to state the structure of community stability, namely the ability of a community to maintain itself. stable despite disturbances to community components.

4. Conclusion

Based on the results of the study, 651 individuals of 87 plant species were found in the LoA area (2016 and 2022) and 63 plant species in the virgin forest. The highest Importance Value Index (IVI) is dominated by Red Meranti (*Shorea leprosula Miq*) and Suhi (*Shorea atrinervosa Symington*) in the virgin forest area, while in the LoA area it is dominated by Jambuan (*Syzygium Gaertn*), which is not produced by the company, so it is not cut down. The high IVI value in the virgin forest area is due to the absence of damage due to logging, as in the LoA area. The diversity index of virgin forest areas at the tree, pole, and sapling levels has a value of > 3.00, which means it is included in the high category. In addition, in the LoA area, the diversity value is at the high tree level (>3.00), the sapling level is moderate (1.00–3.00), but

at the pole level in the LoA RKT 2022 area, the diversity value is low because it is <1.00. The similarity index of virgin forest and LoA (2016 and 2022) is in the same or moderate category between 0.31 and 1.00.

Author Contributions

H: Review & Editing, **AF**: Conceptualization, Methodology, Survey, Entry Data, Writing - Editing; Supervision; **AY:** Review & Editing, Supervision

Conflicts of interest

There are no conflicts to declare

Acknowledgements

Thank you to all parties, supervisors and examiners of Tanjungpura University and PT Hutan Mulya employees who have helped conduct research and prepare this journal.

References

1. Ngo, K.M.; Turner, B.L.; Muller-Landau, H.C.; Davies, S.J.; Larjavaara, M.; Faizu, N.; Lum, S. Carbon Stocks in Primary and Secondary Tropical Forests in Singapore. *For. Ecol. Manage.* **2013**, *296*, 81–89, doi:10.1016/j.foreco.2013.02.004.
2. Permenhut Sistem Silvikultur Dalam Areal Izin Usaha Pemanfaatan Hasil Hutan Kayu Pada Hutan Produksi. Peraturan Menteri Kehutanan Nomor; P.11/Menhut-II/2009 2009.
3. Hardiansyah; Gusti; Ridwan, M. *REDD Peluang HPH Menurunkan Emisi Global*; Yunus, L., Ed.; Untan Press: Pontianak, 2012;
4. Hairiah, K.; Ekadinata, A.; Sari, R.R.; Rahayu, S. *Petunjuk Praktis Pengukuran Cadangan Karbon Dari Tingkat Lahan Ke Bentang Lahan*; 2nd ed.; World Agroforestry Centre, ICRAF SEA Regional Office: Bogor, 2011; ISBN 9789793198538.
5. IPCC Guidelines for National Greenhouse Gas Inventories 2006.
6. Saharjo, B.H.; Gago, C. Suksesi Alami Paska Kebakaran Pada Hutan Sekunder Di Desa. *Silvikultur Trop.* **2011**, *2*, 40–45.
7. Istomo; Farida, N.E. Potensi Simpanan Karbon Di Atas Permukaan Tanah Tegakan Acacia nilotica L. (Willd) Ex. Del. Di Taman Nasional Baluran, Jawa Timur. *J. Pengelolaan Sumberd. Alam dan Lingkung.* **2017**, *7*, 155–162, doi:10.19081/jpsl.2017.7.2.155.
8. Junaidi, A.; Hidayat, N.; Rizal, M.; Munthe, E. Serapan Karbondioksida Vegetasi Hutan Rawa Gambut Berdasarkan Tingkat Pertumbuhan. *J. Hutan Trop.* **2011**, *17*, 237–245.
9. Sadili, A.; Royyani, M.F.; Agusta, A.; Afandi, I.; Efendy, O.; Ashari, H.; Keim, A.P. Kajian Pendahuluan Floristik Dan Fitososiologi Pohon Di Pulau Simeuleu Provinsi Aceh. **2019**, *15*, 187–197.
10. Heriyanto, N.M.; Priatna, D.; Samsoedin, I. Struktur Tegakan Dan Serapan Karbon Pada Hutan Sekunder Kelompok Hutan Muara Merang, Sumatera Selatan. *J. Sylva Lestari* **2020**, *8*, 230–240, doi:10.23960/jsl28230-240.
11. Rahmah; Kartawinata, K.; Nisyawati, N.; Wardhana, W.; Nurdin, E. Tree Species Diversity in the Lowland Forest of the Core Zone of the Bukit Duabelas National Park, Jambi, Indonesia. *Lipi Reinwardtia* **2016**, *15*, 11, doi:10.14203/reinwardtia.v15i1.2440.
12. Hikmatyar, M.F.; Ishak, T.M.; Pamungkas, A.P.; Soffie, S.; Rijaludin, A. Estimasi Karbon Tersimpan Pada Tegakan Pohon Di Hutan Pantai Pulau Kotok Besar, Bagian Barat, Kepulauan Seribu. *Al-Kauniyah J. Biol.* **2015**, *8*, 40–45, doi:10.15408/kauniyah.v8i1.2704.
13. Hidayat, M. Analisis Vegetasi Dan Keanekaragaman Tumbuhan Di Kawasan Manifestasi Geotermal IE Suum Kecamatan Mesjid Raya Kabupaten Aceh Besar. *J. Biot.* **2017**, *5*, 114–124.