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Research Article
Impact of Opening Forest Tourism on Vegetation Rejuvenation in Bukit Barisan Forest Park, Indonesia

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Abstract

Background and Objective: Vegetation analysis is a way of studying the arrangement and composition of vegetation in the form (structure) of plants. This study aims to analyze the vegetation and describe the differences in vegetation in the tourism forest area and the intact forest. **Materials and Methods:** This research was conducted at the Bukit Barisan Forest Park, this research uses the important value index method by researching at the seedling, sapling, pole and tree level, then used the interview method with the community and processed using the Likert scale method. Province using a systematic sampling method with random start with a sample plot area of 100×100 m and conducting questionnaires to visitors. **Results:** The tourism forest area, 5 tree species with the highest importance value index were found, namely *Eucalyptus* and in intact forest areas, 24 tree species with the highest Importance Index were found, *Macropanax* sp. In intact forest areas there are 24 species of trees, 21 species of poles, 22 species of saplings, 23 species of seedlings and in tourist forest areas there are 5 species of trees, 5 species of poles and 3 species of saplings and 4 types of seedlings. Visitors who come to the Puncak Tangke Tabu tourist area agree and participate in preserving the tourist forest. **Conclusion:** The diversity of seedlings in intact forests is quite high, in contrast to tourist forests due to quite a lot of visitor activity.

Key words: Tourism forest, intact forest, vegetation analysis, tahura, Puncak Tangke Tabu, Likert scale

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The entire area of North Sumatra's Bukit Barisan Forest Park is 51,600 ha. Administratively, the Karo, Simalungun, Langkat and Deli Serdang Regencies encompass the Bukit Barisan Tahura Area. This region is about 76 km or roughly 2 hrs driving, from Medan, the capital of North Sumatra. The Bukit Barisan Tahura Area is situated in the Northern, Eastern and Southern regions of the Langkat Regency area, the Western region of the Simalungun Regency area and the Southern section of the Karo Regency area[1].

The area of the Bukit Barisan Tahura Area, which has dense and virgin forest, covers the area of the Government of Karo Regency with an area of 19,805 ha, Deli Serdang with 17,150 ha, Langkat with 13,000 ha and Simalungun with 1,045 ha. The entire area, which covers 51,600 ha, comes from 38,273 ha (74.17%) Protected Forest, 13,000 ha (25.20%) National Park, 200 ha Sibolangit Scout Campground (0.39%), 120 ha Sibolangit Nature Reserve. (0.23%) and Lau Debuk-debuk Tourist Park 7 ha (0.01%). In general, the topography of the Bukit Barisan Tahura field is partly flat, steep and hilly. In several places there are mountains and the highest peak, namely Mount Sibayak with an altitude of 1.430 to 2.200 m above sea level. Based on the classification of Schmidt and Ferguson Tahura Bukit Barisan is included in the classification of type B with an average annual rainfall of 2.000 to 2.500 mm. The minimum air temperature is 13°C and maximum 25°C with average humidity ranging from 90-100%[2].

One of the things that is done so that forest resources are preserved, the thing that is done is managing forest resources needs to be done properly so that their quality and function can be properly maintained and can be used sustainably. Forest sustainability as a high-value resource cannot be separated from the problem of establishment and management of stands. Forests will still be able to play a role by their social, economic and ecological functions if forests are managed optimally and comprehensively, according to their functions and roles[3].

Vegetation has a role in many ongoing stages in an ecosystem as revealed by researcher, including: (a) Storage and nutrient cycles, (b) Carbon storage, (c) Water purification and (d) Balance and distribution of important components making up the ecosystem such as detrivores, pollinators, parasites and predators. Changes in the vegetation have a significant impact on the trophic structure, stability, productivity and movement of ecosystem components. Monitoring alterations in the content and structure of vegetation is therefore necessary to assess how an ecosystem is functioning overall. Vegetation analysis is used to detect changes in the composition and structure of the vegetation[4].

Indonesia's tourism potential is very much. In general, ecotourism is a sustainable tourism development that aims to support efforts to preserve nature, increase community participation in managing it. Ecotourism emphasizes conservation principles, community participation principles, economic principles and tourism principles. These principles work together and are integrated. However, damage to the land due to ecotourism is a reference point for the loss of forest vegetation on the land[5].

Changes in vegetation on tourist areas in the Bukit Barisan Forest Park cause disruption of vegetation rejuvenation. This study aims to analyse the existing rejuvenation vegetation in the tourist forest area and intact forest in the Bukit Barisan Grand Forest Park; and describe the differences in vegetation in the tourist forest area and the intact forest in the Bukit Barisan Grand Forest Park.

MATERIALS AND METHODS

Study area: This research was carried out for 3 months, from February to May, 2023. This research was carried out in the Bukit Barisan Forest Park, namely the forest as a tourist location and the forest which is still intact. This research area is located in Dolat Rakyat Village, Dolat Rakyat District, Karo District, North Sumatra Province.

The tools used for data collection in the field were phiband, tape measure, clinometer, tally sheet, knife, machete, raffia rope, plastic bag, stationery, stakes/pacak and camera and laptop. The material used is a tree as a material for measuring height and diameter[6].

Procedure: Vegetation analysis was carried out in two places, namely forests whose conditions had been disturbed due to tourist sites and forests that were relatively intact. The data obtained were analyzed to determine dominance, species richness, evenness of species, species diversity and species similarity index of each forest type. Forest profile diagrams are also illustrated and dominant species associations are analyzed from each different forest location[7].

Data collection techniques: In the forest which is a tourist location there are 10 ha, thus the sampling intensity used is 10% (1 ha) which cuts the contour from the starting point of observation to the area[8]. In intact forest, the sample plots

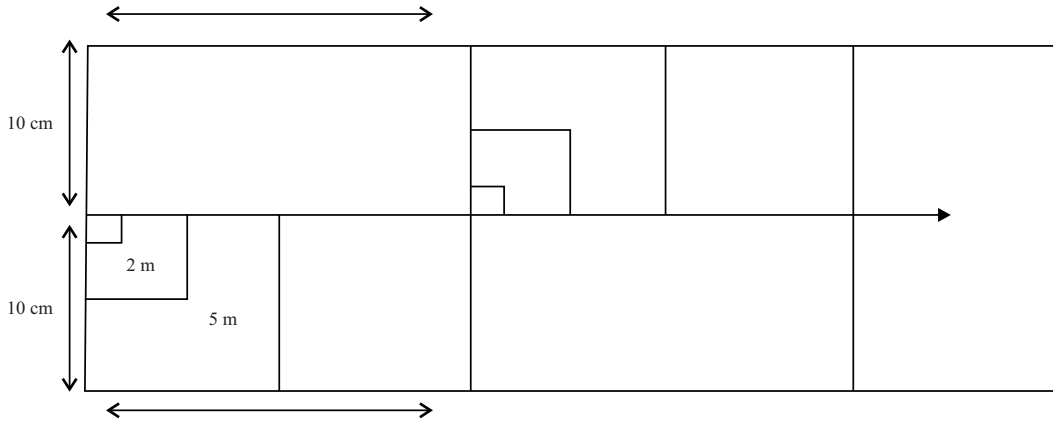

Fig. 1: Design of checkered path technique data collection

covering the same area of 1 ha were used for comparison. The plots were divided into four sizes, namely 20×20 m for the tree level, 10×10 m for the pole level, 5×5 m for the sapling level and 2×2 m for the seedling level. Vegetation analysis was carried out using the strip and grid technique and the placement of sample units was done in nests, where the placement of sample units used a systematic sampling method with random start (Fig. 1).

Growth criteria observed in the analysis of standing vegetation were[9]:

- Seedlings are saplings starting to germinate to a height of <1.5 m
- Saplings are saplings with a height of ≥1.5 m and a diameter of <10 cm
- Poles are young trees with a diameter ranging from 10 to <20 cm.
- Trees are mature trees ≥20 cm in diameter

The transect line takes the direction of the transect perpendicular to the contour at the study site. Data taken from standing vegetation analysis, namely tree species, diameter and tree height in each plot size. Tree height was measured using an clinometer and diameter was measured using a phiband which was measured at a height of 130 cm from the ground.

Data analysis: To determine the dominant species, the importance value index (INP) method is used. The important value index consists of relative density, relative frequency and relative dominance, according to Zimmerman *et al.*[9] which can be calculated based on the following equation:

Species density:

$$\text{Density} = \frac{\Sigma\text{Individual of a species}}{\text{Area of sample plots}}$$

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

Frequency:

$$\text{Frequency} = \frac{\text{Number of plots found of a type}}{\text{Total sample plot area}}$$

$$\text{Relative frequency (\%)} = \frac{\text{Frequency of a species}}{\text{Total frequency of all species}} \times 100$$

Domination:

$$\text{Dominance} = \frac{\text{Basal area of a species}}{\text{Area of sample plots}}$$

$$\text{Relative dominance (\%)} = \frac{\text{Dominance of a species}}{\text{Total dominance of all species}} \times 100$$

Procedure is used to determine the components of the richness index (stating the number of species in a community) and the species evenness index (stating the evenness of species in the community)[10]. Calculation of diversity and similarity of species is calculated by:

Richness index: Using the margalef similarity index (R'), namely as follows:

$$R' = \frac{S - 1}{\ln (n)}$$

Where:
R′ = Species richness index
In = Natural logarithm
N = Number of individuals observed
S = Number of species observed

Evenness of type: The concept of "evenness" shows the degree of evenness of individual abundance for each species. The measure of evenness is an indicator of dominance between species in a community. If each species has the same number of individuals, then the community has the maximum evenness and vice versa[11]:

$$E^5 = \frac{1/\lambda - 1}{e^{H'} - 1}$$

Where:
E^5 = Evenness index from Hills' ratio (0-1)
λ = Simpson diversity index
H′ = Shannon diversity index

Species diversity: Using a diversity index, namely the diversity index of Shannon. The Shannon diversity index is calculated by the formula[12]:

$$H' = -\sum_{i=1}^{S}\left[\left(\frac{ni}{n}\right)\ln\left(\frac{ni}{n}\right)\right]$$

Where:
H′ = Shannon diversity index
ni = Number of individuals of the i-type
S = Number of types
n = Total number of individuals

In addition, each type of sapling that was present was also counted, by looking at the density at each level of seedlings, saplings, poles and trees. The tree species observed are those with little or no regeneration, which are categorized as low populations. This analysis was carried out on forests that are used as tourist sites and intact forests[13].

Stand structure profile diagram: In each area, a strip measuring 100×20 m parallel to the contour is selected which represents the condition of the surrounding forest for making a profile diagram. Each route was divided into observation plots measuring 20×20 m, which then recorded data on field conditions such as slope, tree name, diameter, branch-free height and total tree height[14]. After that it is drawn on the profile diagram map vertically and horizontally using Corel Draw.

Questionnaire data retrieval techniques: Data collection techniques are carried out in three ways, namely:

- Observation: The object to be examined is farmer groups involved in managing the surrounding community forest in Pasar Rawa Village, Gebang District, Langkat Regency
- Data collection techniques are carried out by compiling a list of questions answered by respondents, which are arranged systematically and can function in research
- Techniques used to collect secondary data needed for research

Data analysis methods: This Likert scale is also known as the Summated Ratings Method of Chen *et al.*[15]. By using the Summated Ratings Method, scores will be found on the Likert scale measurement, namely the highest and lowest scores for each answer to the questions asked to respondents. In this study, the highest score for the answer to the question will be determined, which is 3, while the lowest score for the answer is 1. The answer between the two scales is adjusted according to the number of answers. For the question scale, those who answered agree were given a value of 3, doubtful were given a value of 3 and those who did not agree were given a value of 1.

After the data is obtained, the score is sought to find out the percentage of respondents. For more details, see as follows:

Score interpretation:

$$TS = Re \times SL$$

Where:
TS = Total score
Re = Respondent
SL = Selected Likert score

$$x = ST \times \Sigma R$$

$$y = ST \times \Sigma R$$

Where:
ST = Likert highest score
SR = Likert lowest score
∑R = Number of respondents

$$In\ (\%) = TS \times 100$$

Where:
In = Index (%)
TS = Total score

Data presentation:

$$I = \frac{100}{LT}$$

Where:
I = Interval
LT = Highest Likert score

Score interpretation criteria based on intervals:

- Number 0-33% = Disagree
- Number 34-66% = Undecided
- Number 67-100% = Agree

RESULTS AND DISCUSSION

Vegetation analysis: Based on the results of the analysis of vegetation in all research plots covering an area of 1 ha at an altitude of 1300 masl, it was found that in forest areas used for tourism areas there were found 5 tree species and in intact forest areas found 24 tree species.

Species composition in tourism forest areas. The results of the analysis of vegetation in the form of the composition of plant species that exist in the tourist forest area. Based on the analysis of vegetation in the tourism forest area at the tree level of 1 ha, out of 5 tree species it was found that the dominating species was Eucalyptus trees (*Eucalyptus*) with an IVI of 175.42%, followed by Pinus trees (*Pinus merkusii*) with an IVI of 65.10% and Nggersap trees (*Macropanax* sp.) with an IVI of 50.94%. The importance value index values for trees, poles, saplings and seedlings in the tourism forest area can be seen in Table 1.

In the tourism forest area there was no growth at the seedling level. At the tree level, there were 5 species of trees, namely *Eucalyptus*, *Pinus merkusii*, *Macropanax* sp., *Manglietia glauca* and *Quercus subsericea* A.Camus. In this tourist forest area, it is used as a support for rides on tourist objects at Tangke Tabu Peak. The tree that is used as a buffer is not damaged but is used periodically. At the pole level it was found that of the 5 tree species it was found that the growth rate was dominated by Eucalyptus (*Eucalyptus*) with an IVI of 187.09%, followed by Nggersap (*Macropanax* sp.) with an IVI of 46.23% and Pinus (*Pinus merkusii*) with an IVI of 44.42%. At the sapling level of the 3 tree species it was found that the growth rate was dominated by Nggersap (*Macropanax* sp.) with an IVI of 92.31%, Pinus (*Pinus merkusii*) with an IVI of 92.31% and Cemara (*Casuarina equisetifolia*) with an IVI of 15.38%. At the seedling level, 4 species were found, namely Ketapang Kencana (*Terminalia mantaly*) with an IVI of 59%, Pinus (*Pinus merkusii*) with an IVI of 49%, Sitelu bulung (*Evodia robusta* Hook.F.) with an IVI of 54% and Nggersap (*Macropanax* sp.) with IVI 38%.

Based on the table it can be seen as a whole that starting from the sapling level to the tree level, it seems that there is no consistency in the dominant species from the sapling level to the tree level. Nggersap (*Macropanax* sp.) appears to be dominant at the sapling level, while at the pole and eucalyptus levels it is more dominant. Thus the tree species is not reflected in the rejuvenation of the sapling level. Several types of trees and poles with low populations in the lowest tourism forest area are Fallen Wood (*Manglietia glauca*). Meanwhile, at the sapling level, the lowest population was Cemara (*Casuarina equisetifolia*).

This is due to the small number of trees followed by rejuvenation at the sapling level, poles. Meanwhile, at the level of seedlings not owned by the tourism forest area, this is due to plant maintenance and the large number of visitors who come to the tourist forest area causing some seedlings growing from a tree to be disrupted and unable to develop properly.

Species composition in intact forest area: The results of the analysis of vegetation in the form of the composition of plant species in intact forest areas. Based on analysis of vegetation in intact forest areas at the tree level of 1 ha, out of 24 tree species it was found that the dominant species was the Ober tree (*Ficus fistulosa* Reinw.) with an IVI of 37.29%, followed by the Nggersap tree (*Macropanax* sp.) with IVI 36.05% and Kecing Batu tree (*Quercus subsericea* A. Camus) with IVI 29.92%. IVI values for trees, poles, saplings and seedlings in intact forest areas can be seen in Table 2.

At the pole level, it was found that of the 21 species, the growth rate was dominated by Nggersap (*Macropanax* sp.) with an IVI of 40.65%, followed by Kecing Batu (*Quercus subsericea* A.Camus) with an IVI of 27.15% and Kencing Bunga (*Castanopsis tungurrut* Bl) with an IVI of 23.80%.

At the sapling level of 21 species it was found that the growth rate was dominated by Nggersap (*Macropanax* sp.) with an IVI of 34.95%, followed by Ober (*Ficus fistulosa* Reinw.) with an IVI of 25.70% and Kencing Bunga (*Castanopsis tungurrut* Bl) and Kecing Batu (*Quercus subsericea* A.Camus) with an IVI of 12.8%.

Table 1: Important value index for several types of rejuvenation found in plots of tourism forest areas

		Important value index (%)			
Local name	Scientific name	Seed	Sapling	Pole	Tree
Eukaliptus	*Eucalyptus*	-	-	187.1	175.4
Pinus	*Pinus merkusii*	49	92.3	46.2	65.1
Nggersap	*Macropanax* sp.	38	92.3	44.4	50.9
Kayu Jatuh	*Manglietia glauca*	-	-	15.9	02.85
Kecing Batu	*Quercus subsericea* A.Camus	-	-	6.3	05.69
Cemara	*Casuarina equisetifolia*	-	15.3	-	-
Sitelu Bulung	*Evodia robusta* H.F	54	-	-	-
Ketapang Kencana	*Terminalia mantaly*	59	-	-	-

Table 2: IVI values for trees, poles, saplings and seedlings in intact forest areas

		Important value index (%)			
Local name	Scientific name	Seed	Sapling	Pole	Tree
Nggersap	*Macropanax* sp.	27.7	34.9	40.6	36
Cepcepen	*Saurauia* sp.	7.68	7.1	6.4	6.3
Jambu	*Cinnamomum parthenoxylon Meissn*	13.1	10.3	16.8	12.1
Kabung	*Meliosma nitida* Bl	-	-	5.9	0.9
Kandis	*Garcinia dioica* Bl	1.4	3.8	1.9	3.5
Jatuh	*Manglietia glauca*	12.4	7.9	6.6	14.2
Kec. Batu	*Quercus subsericea* A.Camus	18.9	12.2	27.1	29.9
Kec. Bunga	*Castanopsis tungurrut* Bl	17.5	12.2	23.8	29.7
Kec. Kerahkah	*Quercus javanica* A.DC	6.5	4.6	-	7.9
Martelu	*Schima wallichii*	5.4	3.2	1.9	7.6
Mayang	*Madhuca cuneata*	2.6	4.3	6.1	4.5
May Batu	*Payena leerii*	4.8	1.3	-	7.3
Bakir	*Dysoxylum alliaceum* Bl	-	2.7	-	0.9
Mei-mei	*Turpinia sphaerocarpa* Hassk	8	5.7	22	12.6
Nde. Biasa	*Eugenia* sp.	1.4	7.1	8.1	6.8
Nde. Bunga	*Eugenia* sp.	6.2	7.9	11.4	9.7
Nde. Jambu	*Eugenia* sp.	4	6	5	5.9
Nderung	*Trema orientalis* Bl	7	-	8.4	13.8
Ngalkal	*Ilex brasiliensis* Loes	2.2	5.4	1.9	5.5
Ober	*Ficus fistulosa* Reinw	14.5	25.7	59.1	37.2
Pipi Udan	*Symplocos fasciculata* Zoll	12.9	10.3	14.9	11.8
Sibernaik	*Vernonia arborea* Ham	2.4	6.8	1.9	15.3
S. bulung	*Excoecaria robusta* Hook.F	6.4	9.3	15	9.4
Tampu	*Macaranga rhizinoides*	3.6	10.3	14.3	110
Rahu	*Tarrietia javanica*	0.4	-	-	-

At seedling level, it was found that of the 21 types of seedlings, it was found that the growth rate was dominated by Nggersap (*Macropanax* sp.) with an IVI of 27.71%, followed by Kecing Batu (*Quercus subsericea* A.Camus) seedlings with an IVI of 18.96% and Kecing Bunga. (*Castanopsis tungurrut* Bl) with an IVI of 17.58%.

Based on the dominant growth results in intact forest areas, the dominant regeneration is Nggersap (*Macropanax* sp). When compared with the condition of the vegetation in the tourist forest area, it is known that the amount of vegetation is very different from the intact forest area. Where in the intact forest area there were 24 types of rejuvenation, while in the tourist forest area only 5 types of rejuvenation were found. This indicates that the type of regeneration in the tourism forest area has special maintenance.

The composition of plant species can be interpreted as a variety of flora species that make up a community. The composition of plant species is a floristic list that exists in a community[16]. Based on the number of species found, it can be said that the research location in the tourism forest area and intact forest area has a different diversity. This is influenced by different environments, such as altitude, air humidity factor, soil moisture, pH and the influence of dominant wind speed and direction. These factors greatly affect the growth and regeneration of plants in the study area.

States that the diversity of vegetation types in a place is the result of several factors, namely the time factor, the heterogeneity of the competition space, predation, environmental stability and productivity of these components[17]. The species composition in the tourist forest area has 5 types of vegetation regeneration. In contrast to the intact forest area which has 24 types of vegetation rejuvenation. This is due to the existence of several factors in the tourist forest area that cause the growth and variety of plants to decrease, including the disturbance of tourist visitor activities, the encroachment of several types of plants to add to the aesthetics of tourist sites, the maintenance of plants and plants by the manager so that the tourism forest area is maintained. its beauty. In intact forest areas there are many variations of vegetation regeneration due to undisturbed intact forest areas by human activities, there is only competition for growth between individual types of vegetation either due to nutrient availability, water availability and environmental stability.

An overall look at both the tourism forest area and the intact forest area shows that there are very striking differences starting from the seedling level to the tree level where the dominant species at the tree level are not reflected in their rejuvenation level. In the tourism forest area, no seedlings grew, whereas in the intact forest area the dominant seedling was Nggersap (*Macropanax* sp.), followed by Kecing Batu (*Quercus subsericea* A.Camus) and Kecing Bunga (*Castanopsis tungurrut* Bl) seedlings. At the sapling level that dominates the tourist forest area are Nggersap (*Macropanax* sp.), Pinus (*Pinus merkusii*) and Cemara (*Casuarina equisetifolia*). Whereas in intact forest areas it is dominated by Nggersap (*Macropanax* sp.), followed by Ober (*Ficus fistulosa* Reinw.) and Kecing Bunga (*Castanopsis tungurrut* Bl) and Kecing Batu (*Quercus subsericea* A.Camus). At the pole level, Eucalyptus (*Eucalyptus* sp.) dominates the tourist forest area, followed by Nggersap (*Macropanax* sp.) and Pinus (*Pinus merkusii*). In intact forest areas are dominated by Nggersap (*Macropanax* sp.), Kecing Batu (*Quercus subsericea* A.Camus) and Kecing Bunga (*Castanopsis tungurrut* Bl). At tree level in tourist forest areas, eucalyptus trees (*Eucalyptus* sp.) dominate, followed by pine trees (*Pinus merkusii*) and Nggersap trees (*Macropanax* sp.). In intact forest areas the Ober tree (*Ficus fistulosa* Reinw.), followed by the Nggersap tree (*Macropanax* sp.) and the Kecing Batu tree (*Quercus subsericea* A.Camus)[18].

When compared to the dominant vegetation in the tourist forest area and intact forest area, it was found that there were two types of the same individual, namely the Nggersap tree (*Macropanax* sp.) and the Kecing Batu (*Quercus subsericea* A.Camus). However, there are also several different species due to differences in the conditions of the tourism forest area, which was historically replanted and previously used as a farming area by the community. The lack of rejuvenation of climax trees at various growth rates in the tourism forest area will result in a significant decline due to the absence of seedling growth. In the rejuvenation of intact forest climax trees, some dominant species at the seedling, sapling, pole levels are replaced with other non-climax species.

Types of trees with low populations in forest tourism areas and whole forests: Several plant species with low populations in the tourist forest area are Falling Wood (*Manglietia glauca*), Kecing Batu (*Quercus subsericea* A.Camus) and Cemara (*Casuarina junghuhniana*). This is reflected in the small number of trees per hectare followed by rejuvenation at the seedling, sapling and pole levels, some of which even have no regeneration at all. Density in intact forest areas can be seen in Table 3.

Some plant species with low populations in intact forest areas are Kabung-kabung (*Meliosmanitida* Bl), Bakir (*Dysoxylum alliaceum* Bl.) and Rahu (*Tarrietia javanica*). This is reflected in the small number of trees per hectare followed by rejuvenation at the seedling, sapling and pole levels, some of which even have no regeneration at all. Density in intact forest areas can be seen in Table 4.

Stated that a species that has a higher relative density and frequency value because this species is winning in competition, has a wide tolerance so that large individuals will be found in its area per unit area and these species spread widely[19]. So, the types of individuals that are few in number will experience competition with other individuals so that the types decrease and cause at least the growth of these types of individuals.

Richness, diversity and evenness of species: The high or low diversity index of a plant community depends on the number of species and individuals of each type (species richness). Species diversity can be expressed to determine community structure. Species diversity can also be used to determine and measure community stability, namely the ability of a community to maintain itself stable despite disturbances to its components.

The results of calculating the index of richness, diversity and evenness of plant species in tourist forest areas and intact forest areas found in all research plots. The richness index (R') is an index that describes the richness of species in a community. The value of R' will increase if the number of species in a community increases[20].

Table 3: Density of several types of rejuvenation found in the tourism forest area plot

		Density (%)			
Local name	Scientific name	Seed	Sapling	Pole	Tree
Eukaliptus	*Eucalyptus* sp.	-	-	204.7	138
Pinus	*Pinus merkusii*	-	240	38.1	31
Nggersap	*Macropanax*	-	240	38.1	7
Kayu Jatuh	*Manglietia glauca*	-	-	4.7	1
Kec. Batu	*Quercus subsericea* A.Camus	-	-	14.2	2
Cemara	*Casuarina junghuhniana*	-	40	-	-

Table 4: Density of several types of regeneration found in intact forest area plots

		Density (%)			
Local name	Scientific name	Seed	Sapling	Pole	Tree
Nggersap	*Macropanax* sp.	3100	544	64	34
Cepcepen	*Saurauia* sp.	900	112	12	7
Jambu	*Cinnamomum parthenoxylon* Meissn	1500	160	28	12
Kabung	*Meliosma nitida* Bl	-	-	8	1
Kandis	*Garcinia dioica* Bl	100	64	4	3
Jatuh	*Manglietia glauca*	2100	112	8	11
Kec. Batu	*Quercus subsericea* A.Camus	2700	192	36	26
Kec. Bunga	*Castanopsis tungurrut* Bl	2100	192	36	30
Kec. Kerahkah	*Quercus javanica* A.DC	600	64	-	6
Martelu	*Schima wallichii*	600	48	4	5
Mayang	*Madhuca cuneata*	400	80	8	3
May. Batu	*Payena leerii*	700	16	-	5
Bakir	*Dysoxylum alliaceum* Bl	-	32	-	1
Mei-mei	*Turpinia sphaerocarpa* Hassk	1000	96	44	12
Nde. Biasa	*Eugenia* sp.[1]	100	112	12	6
Nde. Bunga	*Eugenia* sp.[2]	800	112	16	8
Nde. Jambu	*Eugenia* sp.[3]	500	80	8	6
Nderung	*Trema orientale* Bl	1000	-	12	13
Ngalkal	*Ilex brasiliensis* Loes	300	64	4	4
Ober	*Ficus fistulosa* Reinw	1600	368	112	44
Pipi Udan	*Symplocos fasciculata* Zoll	1700	160	24	12
Sibernaik	*Vernonia arborea* Ham	600	80	4	12
S. bulung	*Excoecaria robusta* Hook. F	1600	128	24	9
Tampu	*Macaranga rhizinoides*	900	160	24	11
Rahu	*Tupaia javanica*	100	-	-	-

Table 5: Species richness, diversity and evenness index in the research location

	Type of forest					
	Tourism forest use			Undisturbed forest		
Type of growth	R'	H'	E[5]	R'	H'	E[5]
Seedling	7.5	1.3	0.4	3.6	2.8	0.9
Sapling	0.7	0.9	0.8	3.8	2.8	0.9
Pole	0.4	0.9	0.9	4.1	2.6	0.9
Tree	0.3	0.7	0.6	3.5	2.8	0.9

*R': Richness index, H': Diversity index and E[5]: Evenness index

Species diversity (H') shows the distribution of individuals within the species. The value of H' = 0 if there is only one species in the sample, the value of H' will increase if the number of species increases and the distribution of individuals between species is more even. The H' has the maximum value if all individuals of a species are represented by the same number of individuals. The index of richness, diversity and evenness of species in intact and tourism forest areas can be seen in Table 5.

Species diversity in the tourism forest area is low (H' 0.7-0.9). Meanwhile, in intact forest areas, species diversity was classified as moderate (H' 2.6-2.8). Species diversity at each growth rate in intact forest areas was higher than in tourist forest areas.

Results of vegetation analysis carried out on trees and their regeneration (poles, saplings, seedlings). Identified in the tourism forest area, there were 4 types of seedlings, 3 types of saplings, 5 species at the pole level and 5 species at the tree level (Table 2). The results for the value of species diversity in the tourism forest area were 0.7 for saplings, 0.4 for poles and 0.3 for trees. In intact forest areas, the value of species diversity is quite high, namely for seedlings, saplings and trees 2.8, while for poles it has a value of 2.6.

Based on the results of the calculation of the species richness index (R') and species diversity (H') in Table 6, it shows that the vegetation community in the tourism forest area has diversity and species richness is classified as low (H' 0.7-0.9) (R' 0.3-0.7). This shows that the types of tourism forest areas are limited. Judging from the evenness index (E^5), it can be seen that the evenness of species in the tourism forest area has decreased when compared to intact forest conditions, especially at the pole and tree level. This means that the species in the community are not spread evenly but are grouped into certain species.

Whereas in intact forest areas the calculation of the species richness index (R') and species diversity (H') in Table 3 shows that the vegetation community in intact forest areas has moderate diversity and species richness (H' 2.6-2.8), (R' 3.5-4.1) it can be seen that the diversity and species richness of intact forest areas is not limited. Judging from the evenness index (E^5), the evenness of species from intact forest areas is the same. This means that the species in the community are evenly distributed.

Vegetation analysis results show that intact forest areas have a higher number of species and diversity index values for trees and their regeneration (poles, saplings and seedlings). This shows that the clearing of tourism forest areas results in a decrease in the number and diversity of species in a community.

Growth, recruitment and mortality all have an impact on population dynamics and tree dominance. Many different kinds of trees cannot flourish and develop in the mother tree's shade. explains that in certain cases, the creation of canopy gaps or openings must be the starting point for the regeneration and growth of seedlings in certain tree species. This is related to the research location, namely the tourism forest area where the saplings and seedlings were few in number when the vegetation analysis was carried out. This can happen because the seedlings in the tourism forest area are often disturbed by maintenance activities by the management and visitors who come so that they are unable to grow and develop under the shade of the parent tree[21].

Characteristics of respondents: To find out the number of respondents in conducting interviews is to know the number of visitors to the Puncak Tangke Tabu tourist forest area. The number of visitors who came to the Puncak Tangke Tabu tourist site for 7 weeks was 760 people. The characteristics of visitors in the Puncak Tangke Tabu Tourism Forest area are divided into two, namely social characteristics and economic characteristics. Social characteristics consist of age, gender and education. Age is a benchmark to determine whether a respondent is of productive age or not. Gender and education are benchmarks to find out from the enthusiasm of respondents to the tourist areas visited. The social characteristics of visitors to the Puncak Tangke Tabu tourism forest area can be seen in Table 6.

The age characteristics of the highest interval respondents were in the age range of 31-40 years with a rate of 44.3%. While, the lowest interval is the age range of 50-60 years with a rate of 10.2%. The sex characteristics of the respondents tend to be more male dominant where the number interval is 61.4%, while women have a number interval of 30.4%. The educational characteristics of the respondents were dominated by the high school level with an interval of 48.9% and the lowest was not attending school with an interval of 3.4%.

Visit motivation: From the results of interviews with visitors, The motivation of visitors who come to the Puncak Tangke Tabu tourism forest area is divided into three, namely: Recreation/vacation, Research/education and others. The percentage results show that visitors come to this tourist area for recreation and holidays. While visitors choose others because visitors are just curious to come to this tourist forest area which coincides with an alternative road leading to Medan.

Information sources of Puncak Tangke Tabu tourism forest area: From the results of the interviews conducted, it was found that visitors know the location of this tour through print media, electronic media and oral information from relatives or relatives. Information is not only about the whereabouts of tourists, but also related to the management and officials who explain the formation of the Tangke Tabu Peak tourism forest area and its role. This information is insightful so that visitors can get to know the forest better and raise awareness and better understanding among visitors.

Visitor participation in the conservation of Puncak Tangke Tabu tourism forest: Following is a recapitulation of visitor participation data in the conservation of the Puncak Tangke Tabu tourism forest, which can be seen in Table 7.

Table 6: Social characteristics of visitors to the Puncak Tangke Tabu Tourism forest area

Age category (years old)	Frequency	Percentage
Age		
20-30	24	27.3
31-40	39	44.3
40-50	16	18.2
50-60	9	10.2
Total	88	100
Sex		
Man	54	61.4
Female	34	38.6
Total	88	100
Education		
Elementary school	9	10.2
Junior high school	21	23.9
Senior high school	43	48.9
Bachelor degree	12	14
Un-school	3	3.4
Total	88	100

Table 7: Recapitulation of visitor participation data in the conservation of the Puncak Tangke Tabu tourism forest

Indicators and benchmarks	Total score	Percentage	Category
Participation in planting	597	96.1	Agree
Participation in utilization	539	65.1	Doubtful
Participation in preservation	569	91.6	Agree
Average	568.3	84.3	Agree

Table 8: Dominance and dominant profile area of stands and gaps in each study location

		Area			
		Crown closing		Crown gap	
Forest condition	Profile	m^2	Percentage	m^2	Percentage
Undisturbed forest	Tree	1245	62.25	755	37.75
Tourist forest	Tree	1072.2	53.61	927.8	46.29

Based on Table 7, it can be seen that the results of the recapitulation of visitor participation in the conservation of the Puncak Tangke Tabu tourism forest area are divided into 3 indicators, namely participation in planting, participation in utilization and participation in conservation. The results of the table show that the total of the three percentages of these indicators is 84.3%, meaning that most of the visitors agree to participate in forest tourism conservation activities.

Protected forest areas that are used as tourist forest areas must be considered periodically so that in the future these activities are not carried out excessively. This can disrupt the balance of the existing ecosystem in the protected forest. So that the protected forest that has been used as a tourist forest area is maintained and the forest is preserved. By agreeing with visitors to participate in planting, utilizing and preserving it so that in the future tourist visits to the Puncak Tangke Tabu tourism forest area can be maintained[22].

Tree profile diagram: Based on observations on a 100×20 m strip that represents the average condition of the forest, a tree profile diagram is made to describe the condition of the vegetation in it. The following is a profile of intact forest vegetation and tourism forest vertically and horizontally (Fig. 2).

Figure 2 shows the difference in vegetation density in intact forest and tourism forest. In an analysis plot of 1 ha, 24 tree species were found in intact forest and 5 tree species were found in the tourism forest area. Furthermore, as a comparison, a tree profile diagram was made to determine the canopy closure and the gaps formed. Based on all the area profiles above, the width of the crown closure is then measured (Table 8).

From the data listed in Table 8, it can be seen that the gap openness in the tourism forest is higher than the intact forest. The tourism forest area has a small crown cover due to the activities of visitors who come, causing the existing plants to be very vulnerable so they can be exposed to invasion.

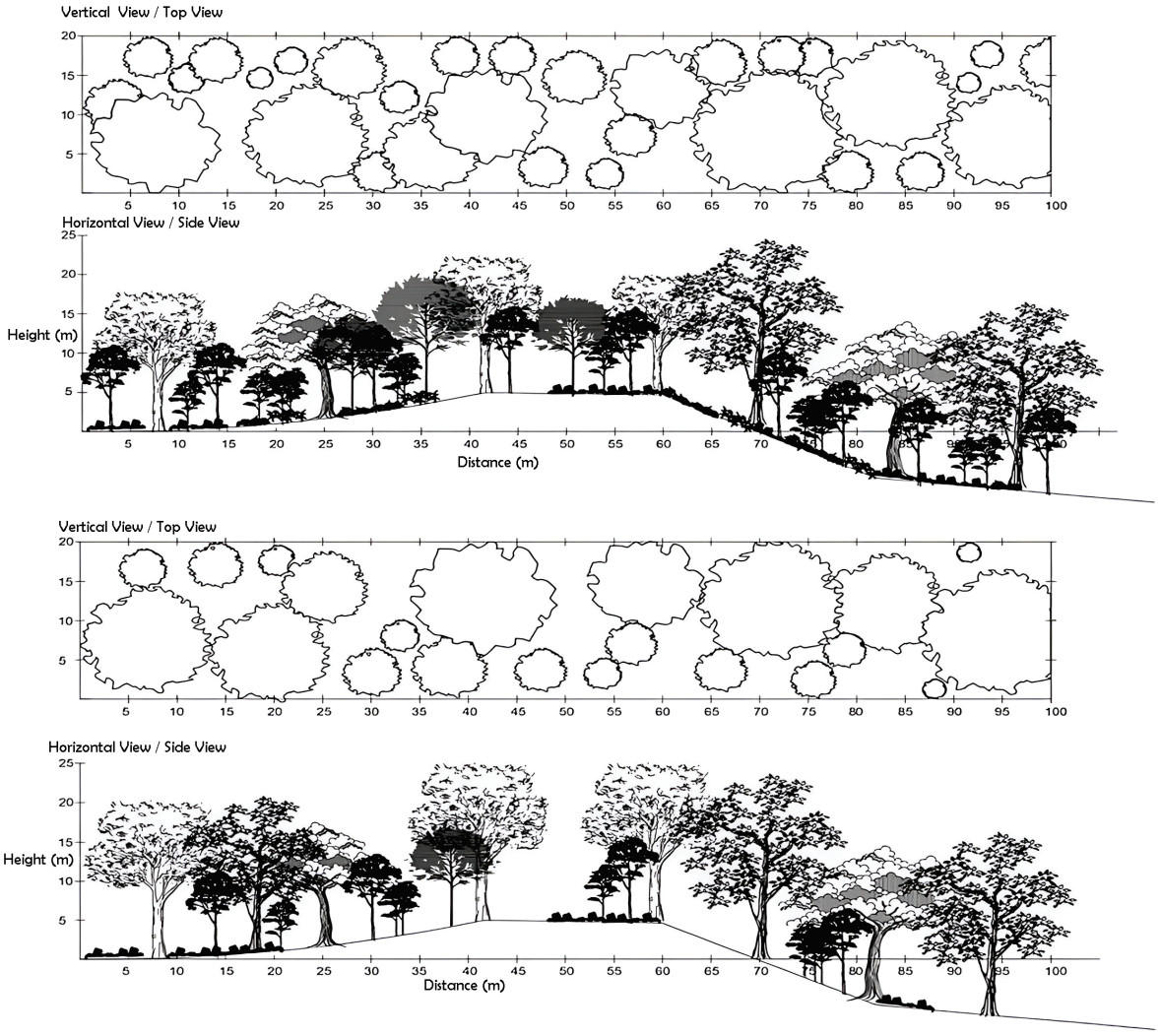

Fig. 2: Vertical and horizontal sections in undisturbed forest (above); vertical and horizontal section in tourism forest area (bottom)

CONCLUSION

In intact forest areas there are 24 species of trees, 21 species of poles, 22 species of saplings, 23 species of seedlings and in tourist forest areas there are 5 species of trees, 5 species of poles and 3 species of saplings and 4 types of seedlings. The diversity of regeneration species in intact forest is quite high. However, rejuvenation in the tourism forest area is inversely proportional because the tourist forest area has quite dense visitor activity so that the rejuvenation of vegetation in the tourism forest area is disrupted. The canopy closure of the tourism forest is smaller than that of intact forest, while the gaps for tourism forest are larger than that of intact forest. It is hoped that tourist forest areas will receive more attention. If not, the area will be further damaged.

SIGNIFICANCE STATEMENT

The change of forest areas into tourist areas has resulted in a number of declines in the quality of the forest. This is indicated by the differences in the composition and structure of the forest in the original forest and the forest that has been converted into a tourist area. In particular, the number of tree seedlings has decreased significantly due to the activities of some irresponsible visitors. Thus, if the forest rejuvenation process is allowed to take place naturally, it is impossible for the forest regeneration process in the tourist area to take place optimally. There must be an action to plant tree seedlings as well as maintain them until the seedlings can grow and develop into mature trees.

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