Comparison of undergrowth diversity between post burned and unburned land in PT National Sago Prima, Riau Province

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Abstract. PT NSP is the only sago industrial plantation in Indonesia. Unfortunately, in 2014 there was a fire on the land with an area of burning estimated around 3,000 ha from the total area of 21,418 Ha. This caused PT NSP to be accused of reducing biodiversity in the area. However, there were no research results that show the amount of damage experienced by the fire. Damage caused by fire to vegetation can cause succession. Changes in vegetation caused by succession can be seen from the composition and structure of vegetation in the area. The purpose of this study was to determine the comparison of composition and structure of undergrowth between post-burned and unburned land. This research was conducted in February 2017 and 2019. The method used was a single plot method. The results showed that in post-burnt land 16 species were found in 2017 and 25 species in 2019. While in unburnt land, 20 species were found in 2017 and 21 species in 2019. The species that dominates was Nephrolepis hirsutula, this was due to the condition of the open land cover causing pioneer plants such as N. hirsutula to rapidly develop to cover all exposed land surfaces.

1. Introduction

Forest and land fires (karhutla) are forest or land burning events, both naturally and by human actions, resulting in environmental damage that results in ecological, economic, socio-cultural and political losses [1]. Fires often occur in Indonesia in recent years, especially during the dry season. Based on data from the karhutla monitoring system, between 2014 and 2019, the total area of fire-affected reached 4,646,691.55 Ha. Fire is considered a potential threat to sustainable development because of its direct effect on ecosystems, the contribution of carbon emissions, and their impact on biodiversity.

One of the fires that occurred in Indonesia was a fire at HTI of PT National Sago Prima (PT NSP) in 2014. PT NSP is the only sago HTI in Indonesia with a total area of ± 21,418 Ha. PT NSP sago production can reach ± 33,500 sticks per year. The existence of this company plays a role in providing one of the jobs for the surrounding community. But in 2014, around 3000 Ha of the area experienced a fire. But in 2014, around 3000 Ha of the area experienced a fire. This caused PT NSP to be accused of reducing biodiversity in the area. The Ministry of Forestry and Environment then sued the company to pay compensation for environmental damage and environmental recovery costs. Research was needed to determine the effects of fire damage to the ecosystem. Damage caused by fire to vegetation can cause succession. Changes in vegetation caused by succession can be seen from the composition and structure of vegetation in the area. The purpose of this study was to determine the comparison of composition and diversity of undergrowth between post-burned and unburned land.
2. Method

2.1. Time and Location
The study was conducted in post-burned and unburned land in PT National Sago Prima (PT NSP) on Februari 2017 and Februari 2019. Each observation sites were divided into 5 lanes. The general condition of each research site were showed on Figure 1 for unburned land condition on 2017, Figure 2 post-burned land on 2017, Figure 3 for unburned land condition on 2019, and Figure 4 for post-burned land condition on 2019.

2.2. Observation Method
Undergrowth data retrieval was carried out on 5 lanes in the post-burned and unburned area. In each lane, there was one plot with a size of 200 m x 200 m and 4 sub-plots with a size of 2 m x 2 m. The parameters were the type and number of undergrowth.

2.3. Data Analysis
2.3.1. Species diversity. The density of undergrowth species was obtained using the formula:

$$H' = - \sum P_i \ln P_i$$  \hspace{1cm} (1)

$$P_i = \frac{n}{N}$$  \hspace{1cm} (2)

Information:
H’ = Shannon-Wiener diversity index
3. Result and Discussion

3.1. Species Composition

The results of the analysis of undergrowth at HTI PT. National Sago Prima, Riau Province in 2017 and 2019 were shown in Table 1. Based on Table 1, in 2017 17 species were found on unburned land and 15 types on post-burned land. This was because the post-burned land was still undergoing a process of succession to restore the condition of its ecosystem. This was indicated by the dominating type of pioneers, namely Nephrolepis hirsutula with a total density of 67,750 individuals/ha. Research that was conducted by Rosalina in 2014 also showed that N. hirsutula was the dominant type of pioneer in this location. Open land cover conditions cause pioneer plants such as N. hirsutula to develop quickly to cover all exposed land surfaces [2], [3].

| No | Scientific Name     | 2017 | 2018 |
|----|---------------------|------|------|
|    |                     | Post Burned | Unburned | Post Burned | Unburned |
| 1  | Blechnum serrulatum | 1625 | 750  | 8750 | 4375 |
| 2  | Breynia coronata    | 0    | 125  | 2500 | 0    |
| 3  | Cissus hastata     | 0    | 375  | 3125 | 1875 |
In 2019, the number of species found was increased. The total species found in unburned land were 19 species and in post-burned land were 22 species. The number of species found in post-burned land was higher compared to unburned land. The observation in Borneo [4] shows that forest fires can increase the number of types of herbs in a community. The types that dominate were Stenochlaena palustris with a total density of 95,625 individuals/ha, Cyperus rotundus with a density of 28,750 individuals/ha, and Melastoma malabathricum with a density of 28,750 individuals/ha. Land cleared by fire is a suitable place for this species, coupled with the ability to live epiphytically by propagating other plants to help this plant to grow ([5]. There were differences in the composition of undergrowth between 2017 and 2019. This was because land fires that occur affect the succession process, resulting changes in the structure and composition of vegetation types [6]. Fire causes changes in the chemical properties of the soil. Ash deposits formed after a fire are alkaline, so they tend to increase the soil pH. The increase in soil pH and the presence of calcium, magnesium, potassium and phosphorus content in ash can increase the availability of phosphorus and nitrogen nitrate. When combined with high light intensity, these conditions can cause the number and richness of plant species in post-burn locations to be higher when compared to unburned land [7].

### 3.2. Species Diversity

Table 2 contains a comparison of the value of species richness, diversity and evenness index. Based on Table 2, in 2017, unburned land had species richness index value of 1,474 and diversity of 1,967. This value were higher when compared to post-burned land. However, the species richness and diversity index in post-burned land in 2019 had a higher value compared to unburned land. Both of these index values can be influenced by the number of individuals and the number of species.

| No | Scientific Name             | 2017    | 2019    |
|----|-----------------------------|---------|---------|
|    |                             | Post Burned | Unburned | Post Burned | Unburned |
| 4  | Clidemia hirta              | 125      | 0       | 3750        | 3125     |
| 5  | Cyperus rotundus            | 2125     | 10125   | 13125       | 15625    |
| 6  | Daemonorops sp.             | 0        | 0       | 5625        | 2500     |
| 7  | Digitaria didactyla         | 2375     | 0       | 0           | 0        |
| 8  | Digitaria sp.               | 250      | 1375    | 0           | 0        |
| 9  | Dioscorea nummularia        | 0        | 0       | 1250        | 1875     |
| 10 | Eleocharis congesta         | 6250     | 4750    | 7500        | 5625     |
| 11 | Gleechenia linearis         | 14625    | 2500    | 0           | 0        |
| 12 | Imperata cylindrica         | 3000     | 250     | 2500        | 0        |
| 13 | Melastoma malabathricum     | 2125     | 3400    | 15000       | 13125    |
| 14 | Melinis repens              | 0        | 0       | 4375        | 3125     |
| 15 | Mikania micrantha           | 3250     | 375     | 5625        | 3750     |
| 16 | Nepenthes ampullaria        | 0        | 0       | 625         | 1250     |
| 17 | Nepenthis gracilis          | 0        | 0       | 1250        | 0        |
| 18 | Nephrolepis hirsutula       | 47375    | 20375   | 5000        | 3125     |
| 19 | Nephrolepis biserrata       | 0        | 125     | 8750        | 5000     |
| 20 | Ottolochia nodosa           | 0        | 0       | 1875        | 625      |
| 21 | Passoalum conjagatum        | 6750     | 375     | 8125        | 0        |
| 22 | Passiflora foetida          | 0        | 1875   | 625         | 1250     |
| 23 | passiflora sp.              | 0        | 375     | 0           | 0        |
| 24 | Pennisetum purpureum        | 0        | 0       | 4375        | 1250     |
| 25 | Plectranthus monostachyus   | 250      | 0       | 0           | 1875     |
| 26 | Stenochlaena palustris      | 61750    | 3875    | 56250       | 39375    |
| 27 | Tetradigma loheri           | 250      | 875     | 3750        | 3125     |

| Total Species | 15 | 17 | 22 | 19 |
|---------------|----|----|----|----|
| Grand Total   | 152125 | 51900 | 163750 | 111875 |
Table 2. Comparison of total, diversity, richness, and evenness species index

|       | 2017          | 2019          |
|-------|---------------|---------------|
|       | Post Burned   | Unburned      | Post Burned   | Unburned      |
| Dmg   | 1.173         | 1.474         | 1.749         | 1.548         |
| $H'$  | 1.654         | 1.967         | 2.468         | 2.294         |
| $E$   | 0.611         | 0.694         | 0.798         | 0.779         |
| SI    | 0.750         | 0.878         |

The index value on post-burned land was higher because many were dominated by pioneer plants that can grow well on open land. The growth of pioneer vegetation communities is a scheme in the process of succession of post-burnt land to reach climax conditions in an ecosystem [8]. Plants need sunlight to grow well. Fires that occur increase the diversity of undergrowth species because the land becomes open so that sunlight can easily reach the soil surface so that it stimulates the growth of understory [9], [4]. Species evenness index values on unburned land in 2017 had index values of 0.694 and 0.611 for post-burned land. The value of this index had increased in 2019, unburned land had a value of 0.779 and post-burned land had a value of 0.798. It can be said that the index value was quite high even though there were still dominant pioneer plant species such as N. hirsutula, M. malabathricum and S. palustris. The increasing of species evenness index can be an indicator that the condition of undergrowth in 2019 was more stable than in 2017. The higher the value of $E$ value, the more stable species diversity in the community and the lower the $E$ value, the lower the stability of species diversity in the community [10][11]. The community similarity index obtained was quite high in 2017 at 0.75 and in 2019 at 0.878. An increase in the species similarity index indicates that the post-burned land was still experiencing succession to restore the condition of its ecosystem. Overall, the value of all index in post-burned land had increased in 2019 compared to 2017. The index value was higher when compared to unburned land. This was consistent with research conducted by Rahmasari in 2011, which showed that the heavier the fire, the riches of shrubs increased [12].

4. Conclusion

Three years after the fire, unburned land had a higher number of species and value of species richness, diversity, and evenness index compared to post-burned land. However, five years after the fire, the number of species and value of species richness, diversity, and evenness index in the post-burned land were higher than the unburned land. This shows that the post-burned land was experienced succession to restore the condition of its ecosystem. This was reinforced by the increasing value of the community similarity index from 2017 to 2019.

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