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Identification of Plants Diversity Composing Peatland Vegetation After Forest Fires in the Mount Bongkok Reserved Forest

Ivan Eldes Dafrita, Tesa Manisa(*), Novi Nurmayanti

IKIP PGRI Pontianak, Jln. Ampera No. 88, Pontianak, West Kalimantan, Indonesia Postcode 78116

***Correponding author**: tesamanisa68@gmail.com

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Abstract

This research aims to identify the diversity of plants that make up peatland vegetation in the Mount Bongkok Reserved Forest after forest fires. This research is a quantitative qualitative descriptive research. The method used is the plot method. Area of observations were determined using purposive sampling with the assumption that the existing vegetation could represent the entire community. The sampling size/intensity (IS) used was 5% of the total area of 100 Ha, so the total sampling area was 5 hectares. The sampling location was divided into 50 observation plots with a size of 25x40m each plot. The results showed that Ubah (Syzygium sp.) and Pulai (Alstonia pneumatophore) plants were found at all sampling points. Geronggang plants (Cratoxylon arborescens) and Jelutung plants (Dyera lowii) were found at more than 50% of sampling points. These four plants are plants that are suitable for habitats in peatlands. This shows that this plant is suitable for growing in the peatland habitat and can be used for peatland conservation.

Keywords: *Forest Fires, Identification of Plant Diversity, Mount Bongkok Reserved Forest, Peatlands*

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INTRODUCTION

Peat is a pile of organic material and has the potential to be a carbon reserve. In natural forest conditions, peatlands emit emissions of 20-40 tonnes of CO2-eq ha-1 year-1(Putra et al., 2020), but it is estimated that the average annual emissions from peatlands in Indonesia in 2000-2006 were around 903 million tonnes of CO2, including emissions that may occur from peat fires (Agus et al., 2014). Kubu Raya Regency is one of the districts in West Kalimantan that frequently experiences land fires (Ruliyansyah & Pramulya, 2022). Many of the Kubu Raya peatland areas have been cleared for smallholder plantations, large plantations, and mixed plantations. Land clearing begins with tree cutting activities which can increase the amount of CO_2 in the atmosphere because of the decomposition of dead plants and the reduction of CO_2 absorption. The standard method

for clearing land in the Kubu Raya area is the peat burning system. This can cause CO_2 gas emissions between 100-400 mg m-2 hours-1 which is equivalent to 9 – 35 tons hectares-1(Iswati et al., 2013). This burning system can lead to forest fire (Ruliyansyah & Pramulya, 2022).

Based on research data from Ruliyansyah & Pramulya (2021), it shows that there are 4 sub-districts in Kubu Raya Regency that have extensive fire vulnerability, namely Batu Ampar, Kubu, Sungai Raya and Sungai Ambawang sub-districts. Batu Ampar District has an area susceptible to fire of 78,866.17 ha. In January 2023, a forest and land fire (Karhutla) occurred in Batu Ampar District covering an area of 2 Ha with insufficient water sources and a remote location. Forest and land fires can spread quickly if strong winds blow, making the fire reappear. The forest and land fires were caused by burning forests to clear agricultural land. This can be detrimental to life because it can cause limited air, sea and land visibility, which can cause economic losses, ecological losses, political impacts and health problems (ISPA) (Polresta Pontianak, 2023).

Gunung Bongkok Forest is a forest located in Batu Ampar District, Kuburaya, West Kalimantan. Local residents often use this forest for settlements and clearing plantation land. The characteristic of this forest is peat forest. The characteristic of peat forests is that they burn easily during the dry season. It will be difficult to extinguish the fire if it is on fire. Sometimes it takes days to months to extinguish the fire. This is very detrimental to various parties, worsening the air quality in West Kalimantan. It even causes various respiratory system diseases. Apart from that, sometimes during forest fires, school learning activities are also closed. Thus, it is crucial to see what potential plants are suitable for planting in the area after the fire. The aim is to prevent larger forest fires so that they do not harm the wider community.

Forest fires seriously threaten biodiversity and ecosystems, especially in vulnerable peatlands. Forest fires have become frequent in the Gunung Bongkok Protected Forest Park. This incident caused extensive damage to peat vegetation and threatened the survival of various plant species in it. Therefore, this research aims to identify the diversity of plants that make up peat vegetation after forest fires. With a better understanding of post-fire vegetation composition, appropriate conservation measures can be taken to support the recovery of disturbed peat ecosystems. Several recent studies relevant to this research examine the impact of forest fires on plant communities in peatlands. The research shows that forest fires significantly impact plant composition, with some species more susceptible to fire than others. These results provide an important foundation for our research to understand better how forest fires in the Gunung Bongkok Protected Forest Park affect plant diversity there.

Research on vegetation composition in forest reserves has indicated high diversity of woody species, emphasizing the importance of assessing and preserving plant diversity in such ecosystems (Mwaluseke et al., 2023). Studies on the impact of fire on peatlands have shown significant changes in bryophyte assemblages over long periods, underscoring the lasting effects of fires on vegetation dynamics (Magnan et al., 2012). Understanding the structure and composition of trees in nature reserves, such as Mount Tilu in Indonesia, provides valuable insights into ecosystem characteristics and biodiversity (Cahyanto et al., 2020).

Peatland fires, especially in peat swamp forests, impact not only land damage or degradation, but also biodiversity and the environment. Peat swamp forests are susceptible to drainage and fire, due to the dependence of their vegetation on peat components, which are influenced by the adequacy of water availability, canopy closure and leaf litter input. The peat swamp forest fires that occurred in Indonesia, especially in the KHDTK Tumbang Nusa area and its surroundings, have reduced the diversity of vegetation types, both at tree, and sapling levels (Tata & Pradjadinata, 2013).

One way that can be done to improve the condition of land and forest after a fire is to choose species of plants that are suitable for planting on that land. The choice of plant will significantly determine the success of peat ecosystem restoration efforts. The species of plants used for revegetation also depends on the restored area. In conservation areas, revegetation uses forest plant species intending to enrich germplasm (Harun, 2014). The benefits of replanting are optimizing land, diversifying crops, reducing the risk of failure, preventingand preparation for annual crops without burning, and increasing carbon reserve (Maftuah & Nurzakiah, 2017). Based on the background of the problem that has been explained, it is necessary to select plant species that are suitable for planting in the peatlands of Batu Ampar District, Kubu Raya Regency after forest fire occurred.

METHOD

The type of research carried out is descriptive qualitative quantitative research. Descriptive research tries to describe and interpret an object that is observed and does not give special treatment to the object (Sugiyono, 2021). This research describes the results of identifying the diversity of plants that make up vegetation in peatlands in the Gunung Bongkok reserved forest area, Batu Ampar Kubu Raya District after forest fire.

Sample

The variables observed were soil, soil pH, and vegetation composition in the Mount Bongkok reserved forest. The operational definition intended to relate to the terms in this research is the vegetation structure in the plot to be measured. The population used as the object of research is all the plants in the Mount Bongkos Forest, which has an area of 100 Ha. Samples were observed with a percentage of 5% of population area. This research was conducted in the Gunung Bongkok reserved forest area, Batu Ampar District, Kubu Raya Regency (Zulkarnaen, 2020).

Instrument, Data Collection, Procedure, & Data Analysis

The method used is the plot path method. The observation area was placed using purposive sampling with the assumption that the existing vegetation could represent all communities. The sampling size/intensity (IS) used is 5% of the total area of 100 Ha, namely 5 hectares. The sampling area was divided into 50 observation plots with a plot size of 25 X 40 m or an area of 0.1 hectare. Plant observations were carried out using the systematic sampling with Random Start sampling technique, namely the first measuring plot was made randomly and subsequent measuring plots were made systematically. The distance between the center points of the sample plot is 100 meters from north to south and 200 meters from west and east. A comprehensive vegetation inventory was carried out using observation variables, including scientific name, diameter, and height. The

criteria for inventoryed vegetation are differentiated based on the growth level classification in Table 1 (Tohirin et al., 2021).

Table 1. Classification and measurement criteria for vegetation inventory (Daniel et al, 1979).

No	Classification	Criteria
1.	Tree	Stem diameter > 20 cm
2.	Pole	Stem diameter 10 - > 20 cm
3.	Stake	Rejuvenation that is 1.5 m high and more to <10 cm in
4.	Seedling	diameter Tree saplings up to 1.5 m high

RESULTS AND DISCUSSION

The results of identifying plants diversity that make up peatland vegetation after forest fires in the Gunung Bongkok Reserved Forest Area, Batu Ampar Kubu Raya District can be seen in Table 2.

Table 2. Plants That Found on Peatlands After Forest Fires in the Gunung Bongkok Protected Forest Area, Batu Ampar Kubu Raya District

Species name	Number of Live Plants at Sampling Point												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Ubah (*Syzygium* sp.)	66	74	81	56	74	58	82	56	35	30	43	51	72
Geronggang (*Cratoxylon arborescens)*	32	9	8	19	20	18	2	12	3	-	18	15	9
Pulai (*Alstonia pneumatophore)*	3	3	2	6	2	5	6	18	20	62	29	5	2
Jelutung (*Dyera lowii)*	-	1	3	4	2	2	-	-	12	7	4	-	2
Meranti (*Shorea balangeran)*	-	1	-	-	-	-	9	2	-	-	-	-	-
Nyatoh (*Palaquium sp.)*	-	-	2	-	-	-	8	6	2	-	-	12	14
Pinang (*Areca catechu*)	-	-	1	10	10	-	-	-	-	-	-	-	-
Tumih (*Combretocapus rotundatus)*	-	-	-	-	2	3	1	5	8	-	-	9	6
Bengkirai (*Ploiarium alternifolium*)	-	-	-	-	1	5	6	5	16	-	-	9	1
Gelam (*Melaleuca leucadendron)*	-	-	-	-	-	1	-	-	-	-	18	-	-

The data obtained in the observation table shows that there are several species of plants found at all sampling points, such as Ubah *(Syzygium sp*.) and Pulai (*Alstonia pneumatophore*). Geronggang (*Cratoxylon arborescens*) and Jelutung (*Dyera lowii*) were found in almost all sampling points. Meanwhile Nyatoh (*Palaquium sp.),* Tumih (*Combretocapus*

rotundatus), and Bengkirai (*Ploiarium alternifolium*) were found at more than 50% of sampling points. Meranti (*Shorea balangeran*), Areca nut (*Areca catechu*), and Gelam (*Melaleuca leucadendron*) plants only grew at a few sampling points. The observation table 2 shows that most plants that grow on peatlands are Ubah, Geronggang, Pulai, and Jelutung, so they are assumed to be plants that are suitable for habitat on peatlands.

The Ubah (*Syzygium sp.)* is a species of tree and belongs to the dipterocarpaceae family which is very common in peat swamp forests (Ripin, et al., 2017). This tree has a diameter of 50 cm and a height of up to 25 m. The stem is cylindrical with flaky, reddish skin, bearing buds. This plant flowers almost all year round. The fruit is usually eaten by birds and bats and primates. Ecologically, this plant grows mainly in swamp forests, peat swamps and low hills, reaching a height of 700 m. It grows well on alluvia along riverbanks, sandy loam in hilly areas, ultramafic and limestone rocks, and the remaining natural stands of peat swamp forest (Partomihardjo et al., 2020).

Pulai plants (*Alstonia angustifolia*) can live in unburned peat swamp forests or open areas that have been burned. Pulai saplings need full sun, so the saplings are often found in open areas. This plant is pollinated by insects whose tiny seeds are equipped with fine hairs so the wind easily carries them and can be spread to distant places (Partomihardjo et al., 2020). In other hands *Alstonia scholaris* can reduce pollution that is proven by the air pollution tolerance ability of *A. scholaris* was higher along the polluted roads of Lahore than in the background control site. Leaf area, AAC, TCh and APTI decrease as traffic flows increase, indicating that the health of *A. scholaris* was affected by traffic flow (Mehmood et al., 2023).

Jelutung (*Dyera lowii*) has a large tree stature with a total height of up to 65 meters and a branch-free height of up to 30 m, a trunk diameter of up to 250 cm. Cylindrical stems, upright without buttresses with a smooth skin surface or slightly scaly and speckled, black and slightly reddish, when notched it emits abundant white sap. Adult plants have knee roots, which adapt to growing in flooded areas. Swamp jelutung has been widely planted in both Sumatra and Kalimantan to tap its sap (Partomihardjo et al., 2020).

Geronggang (*Cratoxylum arborescens*) has the benefit of preventing forest fires in peatlands (Selaras et al., 2022). It is a tree native to Indonesian peatlands that has excellent potential as an alternative fiber-producing species for the pulp and paper industry because it is adaptable and does not have the potential to disrupt local ecosystems (Putri et al., 2023). The Geronggang tree has a branching taproot and can grow to a height of 10 m. The roots of the Geronggang tree have hairs that can spread long distances both vertically and horizontally and can be found above the ground surface. The roots of this tree can also form a symbiotic relationship with mycorrhizal fungi (Neo, et al., 2016). The roots of the Geronggang plant are able to store more water so that the humidity in the roots is very high. This meant that it could restore the properties of the peatland where it grows. Geronggang plant growth is also relatively fast, making it suitable for rehabilitating forests and peatlands after burning (Junaedi et al., 2020). Geronggang trees have been widely planted in the Riau area to prevent forest and land fires and have been proven to thrive in burned peatlands (Rochmayanto & Novriyanti, 2019). *Cratoxylum rotundatus* and *Cratoxylum arborescens* are successful and suitable for natural regeneration post forest firest

in peat swamp forest as long as the area is rewetted by hydrological restoration (canal blockings). Therefore, natural generation by these species is one option that can be selected for vegetation restoration, especially for the remote areas that need high cost (Suwito et al., 2021).

Meranti (*Shorea balangeran*), has a medium-large tree, trunk diameter reaches 100 cm, height up to 40 m and free branches up to 25 m. Cylindrical stem, buttressed with deep grooved pepagan brown to grey, fibrous yellowish brown inside and emits clear resin. Adult individuals were found growing sticking out in HCV areas of natural stands of unburned peat swamp forest. The wood is commonly used in construction and boat making, and it is also used for furniture. The resin is used for boat putty (Partomihardjo et al., 2020).

Figure 1. Species of Plants at Sampling Points

The condition of natural forests is increasingly being damaged by illegal logging, forest encroachment and conversion of forests into other use areas, as well as by fires, both intentional and unintentional. It turns out that degraded peat swamp forests are not easy to rehabilitate. This is due to the high level of soil acidity, the presence of acid sulfate, and some peat swamp areas have high levels of water, so it is necessary to pay attention to choosing the right type of plants (Tata & Pradjadinata, 2013).

Peat land is land that comes from organic materials such as trees, tree roots and wood which cannot rot completely, causing accumulation and creating layers of peat. Peatlands can absorb and channel water up to 100% to 130% of their mineral weight, in contrast to mineral soils which can only absorb less than peatlands, around 20-30% (Harenda et al., 2018). This happens because the pores in peatlands are large so the peatlands can easily absorb water. Another unique thing about peatlands is that the decomposition process does not run perfectly; this is because peatlands are anaerobic (with no oxygen), making them able to store very high levels of carbon. However, the acidity level in peatlands can be very acidic (pH<4), which makes the peatland tend to be alkaline, making the fertility of the peatland low because of the macro and micro elements (P, K, Ca, Mg, Cu, Zn, Mn and Fe) which are tends to be low compared to mineral soil so that only certain types of plants can grow in peatlands (Kurniasari et al., 2020).

Based on the results of initial observations, it can be identified that land cover at the location consists of two species, namely young swamp thickets and old swamp thickets. Based on this, the planting chosen was an intensive planting system, namely 1100 stems/ha. The planting location is not too far from residential areas, so there is a possibility that there will be interaction with protected forest areas. Therefore, the planting pattern combines multipurpose/MPTS tree types. The pattern used in planting is an intensive pattern which is done at a distance of 3x3 meters. This planting pattern was carried out because the land conditions were open land.

The BRMT (Friable Swamp Thicket) cover type is found in 6 work plots at 6 Sampling Points, namely Plot 2, Plot 3, Plot 7, Plot 8, Plot 11 and Plot 12. From the observations, the condition of the peatlands at these locations has been disturbed. Until it is damaged as a result of forest and land fires which cause changes in the function of peat in storing water and there is a decrease in the surface height of the peat (subsidence). Therefore, this location is classified into one land cover classification with almost uniform conditions. The limiting environmental factors in the BRMT land cover classification are the height of standing water and the number of water basins with a depth of 10-40 cm. The depression was formed due to the loss of the peat layer due to frequent fires. Flooding factors can disrupt plant root growth. This puddle condition will reduce the oxygen levels in the soil which are usually used by plant roots to grow. The species of plants in the BMRT land cover classification are as follows: Tumih (*Combretocapus rotundatus*), Gelam (*Melaleuca leucadendron*), Pulai swamp (*Alstonia pneumatophore*), Nyatoh (*Palaquium sp*.), Geronggang (*Cratoxylon arborescens*), Bengkirai Rawa (*Shorea laevis*), Meranti Rawa (*Shorea balangeran*), Jelutung (*Dyera lowii*), and Sago (*Metroxylon sp*.).

The soil acidity level at the planting location tends to be low (pH 4-5), this indicates that the ability to absorb nutrients by plant roots cannot be adequately achieved. Land fires occur when inundation conditions recede, so it can be ensured that inundation does not occur all the time at that location. The rise and fall of groundwater levels in this type of land cover needs to be anticipated by selecting plants that is able to accelerate land cover, namely the Fast Growing Species (FGS) type with Nitrogen-fixing (NF) capabilities. The use of FGS will accelerate the clearing and covering of land which affects the loss of water in the soil so that water evaporation due to high temperatures at sunlight intensity (49,000 LUX) can be reduced. The choice of species is directed at plants that

function as bio-drainage to stabilize groundwater levels and are expected to be able to provide moisture to the surrounding environment.

The Young Swamp Thicket (BRM) land cover is located in 5 Sampling Point Plots, namely Plot 4, Plot 5, Plot 6, Plot 9 and Plot 1. The peat land in this type of land cover has not experienced severe damage so its water absorption capacity is still good, apart from that, standing water found at the location are low puddles (0-10 cm) and water basins with standing water (10-20 cm). The problem at this location is the pH (3-4) and dense cover of resam fern bushes (1.5-2 m) so special treatment needs to be given when clearing the land. Therefore, this landscape is classified into one land cover classification because the conditions are almost uniform with the species chosen being as follows: Tumih (*Combretocapus rotundatus*), Gelam (*Melaleuca leucadendron*), Pulai swamp (*Alstonia pneumatophore*), Nyatoh (*Palaquium sp*.), Geronggang (*Cratoxylon arborescens*), Bengkirai Rawa (*Shorea laevis*), Meranti Rawa (*Shorea balangeran*), Jelutung (*Dyera lowii*), and Sago (*Metroxylon sp*.).

Table 1 shows that several plants can live in the entire sampling point area, namely Ubah (*Syzygium sp*.) and Pulai (*Alstonia angustifolia*). Apart from that, there were plants found at more than seven sampling points, namely Jelutung (*Dyera lowii*) and Geronggang (*Cratoxylum arborescens*). The choice of species plant will significantly determine the success of peat ecosystem restoration efforts. Revegetation activities for the restoration of peat ecosystems are also closely related to zoning, technically applicable, economically profitable, socially and culturally acceptable to the community and environmentally friendly (Maftuah & Nurzakiah, 2017). The selection of species plant to be planted in burnt areas, according to data from the Ministry of Environment and Forestry (2015) is in line with the research results. These plants are able to live at all sampling points, which shows that all parts of the plant can adapt well to the environment in which they grow. This indicates that these four plants can be planted well in all post-forest fire areas in the Gunung Bongkok protected forest area, Batu Ampar Kubu Raya District. There are several reasons this plant is suitable for planting in terms of its morphology and anatomy. Susanto et al., (2018), explained that the body shape of plants that are suitable for planting in peat is following their needs, such as having respiratory roots to obtain oxygen in peat swamp habitats, which are almost always flooded with water.

CONCLUSION

Ubah plants (*Syzygium sp*.) and Pulai plants (*Alstonia pneumatophore*) were found at all sampling points. Geronggang plants (*Cratoxylon arborescens*) and Jelutung plants (*Dyera lowii*) were found in almost all sampling points. Meanwhile, Nyatoh (*Palaquium sp.),* Tumih (*Combretocapus rotundatus*), and Bengkirai (*Ploiarium alternifolium*) plants were found at 50% of the sampling points. Meranti (*Shorea balangeran*), Areca nut (*Areca catechu*), and Gelam (*Melaleuca leucadendron*) plants are only a few sampling points that can grow. The research results show that the majority of plants growing on peatlands after forest fires are Ubah, Geronggang, Pulai, and Jelutung. This indicates that this plant is suitable for growing in the peatland habitat and can be used for peatland conservation.

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