Comparison of bird species diversity between 4\textsuperscript{th} ages burnt and unburnt land in PT Waimusi Agroindah, South Sumatera

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Abstract. Nowadays, one of the most highlighted issues in oil palm plantations is land fire. The fire event is thought to have a negative impact on biodiversity, including birds. One of the major fires ever occurred in Indonesia in 2015. The fire also struck on PT Waimusi Agroindah, South Sumatra. The high accusation that the fire only caused a negative impact triggered a lawsuit against oil palm companies that experienced fires to pay the cost of environmental damage fines. The small number of studies conducted to determine the impact of fires on bird species diversity requires further research to determine the condition of bird species diversity after the fire, especially on oil palm plantations. The method for estimating impacts of fire is to compare species diversity between unburnt and post-burnt land. While the observation method used is the line transect in the morning and afternoon with three repetitions. The results showed that there were 39 species of birds on burnt land and 36 species of birds on unburnt land. The highest type of Margalef index is shown by burnt land which is equal to 6.37 and the Evenness index is 0.90. Overall there was an increase in bird species diversity on post-burnt land because there were gains of 5 species and loss of 2 species. Changes in the composition of bird species in both land types are caused because post-burnt land has a higher feed potential. The majority of birds at the study site are insectivorous. There are 13 species of bird which is included into protected species according to the Permen LHK No. P 106 of 2018 and also CITES and IUCN status.

Keywords: birds, burnt, comparison, oil palm

1. Introduction
Various issues related to oil palm plantations in the community have indeed been developing for a long time. These issues include the assumption that oil palm plantations cause habitat destruction and loss, as well as biodiversity loss in the tropics [1]. Another issue that is most highlighted about oil palm plantations is the issue of fires that often occur on oil palm lands. The expansion of oil palm plantations is considered as one of the factors causing the occurrence of land fires that occurred in Indonesia in the last few decades [2]. Besides that, land fires are a routine event in Indonesia, even according to data from the Ministry of Environment and Forestry showing that the area of forest and land fires in Indonesia in 2018 reached 4 666.39 hectares [3].
Historically, a fairly large land fire occurred in Indonesia in 2015. One of the provinces that experienced a fire that year was South Sumatra Province, this is consistent with the statement that the South Sumatra region had the highest hotspot in 2015 [4]. PT Waimusi Agroindah is one of the oil palm plantations which experienced land fires in 2015 and is suspected to have a significant impact on its environmental conditions. The allegation that the company intentionally burned 400 hectares of land resulted in claims for payment of billions of rupiah in fines. The claim arises because forest and land fires are considered to have a very detrimental impact on ecological, economic and political aspects [5]. One of the ecological impacts that occur is the loss of bird species diversity, even though the existence of birds is said to be useful as an environmental indicator because it has a sensitive nature to changes in habitat [6]. These land fires are also considered to be able to influence the succession process which will have an impact in the form of changes in vegetation [7].

The current public perception is that land fires only cause negative impacts. This is different from the results of research conducted by Smith [7] which shows the results that not all fires can cause negative impacts on wildlife. This difference occurs because the impact of the fire felt by wild animals depends on the response of each animal. In fact, according to previous research at PT Waimusi Agroindah, it was found that the number of bird species found in burnt land locations was higher than that of unburnt land bird species which 36 species [8]. The difference in results related to the impact of the fire phenomenon causes the need for further research to compare the condition of species diversity between land 4 years after burning with unburned land. This is done so that it can be identified whether the recovery can occur on post-burnt land.

2. Method

2.1 Study site

The study was conducted at the PT Waimusi Agroindah (WMAI) oil palm plantation in Ogan Komering Ilir District (OKI), South Sumatra. The location of data collection was carried out on post-burnt land, unburnt land, oil palm plantation land, and High Conservation Value / HCV area. The post-burnt land chosen as the observation location was the area that had experienced a fire in 2015. The location of post burnt land data is located in the easternmost area of afdelling 11 and 12. The initial condition of the land affected by the fire was peat soil dominated by chinese water chestnut (*Eleocharis dulcis*). The types of vegetation that were also present on this land before the fire were a number of gelam poles (*Melaleuca leucadendra*) and perpat (*Combretocarpus rotundatus*). The unburnt land located in the western part of afdelling 11 and 12. The condition of this observation track is in the form of a path that is surrounded by chinese water chestnut (*Eleocharis dulcis*) and rija-rija (*Scleria sumatrensis*), and there are also several types of vegetation. Condition of unburnt land cover is almost the same as post-burnt land. The difference between the unburnt land and the post-burnt land is that it is surrounded by taller *Scleria sumatrensis*.

The next research location is oil palm plantation land. The observation lane on oil palm land is divided into three lines namely old oil palm land (2007-2010), medium oil palm (2010-2013) and young oil palm (2013-2016). The condition of this oil palm plantation is peat soil and there are water channels along its side, in addition, there is a barrier in the form of small canals which will overflow during the rainy season. The HCV in afdelling 4 is a forested area which is also a river border area of the Sungai Ijo. Some are covered by trees, but some are in the form of shrubs. Ground floor in the form of land covered by shrubs. While the another HCV called reservoir 37 is an area with empty ground floor with more open canopy cover compared to HCV in afdelling 4.

2.2 Data Collection

The data collection method uses the path transect method. The length of the transect used is 1 km with a width of 50 m. The observer walks the transect path by noting the type and number of birds seen or heard, the time of encounter and the substrate found of the bird. Observations were made on each land cover type path at the same time, namely in the morning at 06.00-08.00 WIB and in the afternoon at 16.00-18.00 WIB with three times repetitions. Vegetation analysis was also carried out to determine
the composition of plants in the study site using a single plot of 40 m x 40 m (1600 m$^2$) for data collection in the form of undergrowth, seedlings, and saplings. While the plot size for pole and tree growth rates is 113.14 m x 113.14 m (12 800 m$^2$).

![figure 1](image)

**Figure 1.** Illustration of observation using the transect line method

2.3 Data Analysis
A comparison of bird species diversity between post-burnt (PB) and unburnt land (UB) is done by comparing the species of birds found when observing on each land cover. A comparison between post-burn and unburnt land is done by comparing bird species found in the observation lane (assuming that the post-burn lane currently resembles land cover before the fire). To measure and compare bird diversity in all land covers, the number of species found in each land cover at PT WMAI was calculated. In addition, the Margalef species richness index is used to count the number of species found in each land cover. Evenness index is used to determine the evenness of species in each land cover and the similarity index is used to determine the similarity of bird species between land cover, and is used as a basis for assessing the effect of fire on bird species diversity, number of losses and also species of birds that increase.

3. Result and Discussion
3.1 Comparison of bird species diversity
Based on the results of observations that have been made, obtained some data regarding the number of species (Figure 2), richness index (Figure 3), and evenness of bird species (Figure 4) in each land cover pathway. A total of 60 bird species were obtained from 31 families in all land cover. Data shows that the type of land cover that has the highest number of bird species of 51 species is the HCV area. In addition, species of birds found on post-burnt land (39 species) were more than the number found on unburnt (36 species). While oil palm plantation area has a total of 27 species of birds, the limited number of bird species that are able to live and breed on oil palm land is due to the homogenous vegetation composition [9]. There is an increase in the number of bird species obtained compared to previous studies conducted which obtained a number of 36 species on post-burnt land [8]. This is consistent with the opinion of experts namely [10] found species of birds become more abundant after a fire. The difference in results is also influenced by the severity of the fire that occurs during a fire. Another thing that also affects is the location of fires close to other land cover causes the potential for bird species to move to that location to avoid fires. This is consistent with the opinion that some birds will fly away from their habitat when there is a fire and there are several species of birds that return to land after burning [7].

Other information also obtained based on this research is related to the conservation status of birds. There are 12 species of birds protected based on Permen LHK No. P 106 of 2018 was found at the study site. These species included into some of family namely Ciconiidae, Ardeidae, Accipitridae, and Muscicapidae. According to its trading status, there are 6 species of birds that are included in Appendix II, namely birds of the Accipitridae family. According to the rarity status of the IUCN Red List, there are two species bird which is classified as Vulnerable or VU, namely white nacked stork and white vented myna.
Figure 2. Number of bird species

More species of birds are found in lane 1st pairs, namely in post-burnt track 2 and unburnt track 1, as many as 30 species and 33 bird species were found (Figure 2). Meanwhile, the number of bird species in lane pair 3, i.e. in the post-burn pathway, obtained results of 30 species and in the unburned pathway, 28 species were obtained. The difference in the number of species found in the third lane pair is due to the lane pair is a land that is overgrown with chinese water chestnut and rija-rija (*Scleria sumatrensis*) high enough and has a small number of feed plants, so that the species of birds observed are less diverse and tend to have the same type. Another factor that also causes these differences is the diversity of habitat structure, i.e. the more diverse habitat structure (diversity of plant species and vegetation structure), the greater the diversity of birds [11], [12] states that habitats that are in good condition and far from human disturbances and contain a variety of sources of feed, allow having many species of birds. [13] said that various types of forests, such as primary forests, secondary forests and open land/shrubs are habitats for various species of birds. Some species of birds even use various types of habitat to look for food, reproduction and maintain their survival.

Figure 3. Number of species richness

Based on the calculation of the richness index value it is obtained that the third lane pair has a higher richness index value on the post-burnt land (Figure 3). There was not a significant difference in the results obtained in lane 1 and 2 pairs where the value of the bird species richness index on unburnt land was higher than that of post-burnt land. The location of post-burnt land close to the highway is also suspected to be a cause of disturbance for certain types of birds due to the noise it causes.

The richness index characterizes a large number of species in a community. The species richness index obtained is also the same as research conducted by [8] which states that the bird species richness index in post-burnt land is higher than that of unburnt land. Margalef richness index calculation divides the number of species found with the natural logarithms function which indicates that the increase in the number of species is inversely proportional to the increase in the number of individuals. This also shows that usually in a community or ecosystem that has many species will have a small number of individuals in each of these species [14].

Determine the level of species richness and the number of species that exist in a location is the level of availability of feed and other resources. In addition, another thing that also affects the presence of
bird species at a location is the composition of tree species that exist in a community in order to create various environmental conditions and the availability of food that is specific to certain bird species (niche or ecological niches). This indicates that more tree species means that there will be many ecological niches that will allow for various species of birds to live together. Post burnt land has only a few trees that can be used as a source of food and a location to perch, unlike the case with unburned locations that are still found by several species of trees and minimal human disturbance. [15] further said that activity or disturbance by humans could affect the diversity of bird species, by causing nesting failure around agricultural land due to bush clearing and land maintenance, grassing and pesticides.

All pairs of observation pathways have an evenness index value close to one (Figure 4). This states that the distribution of bird species in the study site is stable. This is in accordance with the statement according to [16] where the evenness index values ranging from 0.5-1 indicate that the conditions of spreading are stable. In addition, [17] also explained that the evenness index values ranged from 0-1.

![Figure 4. Number of evenness index](image)

If the value of Evenness index approaches 0, the evenness between species is low, whereas if the value of E approaches 1, the distribution between species is relatively uniform. Evenness of bird species is closely related to the level of dominance of bird species that exist in each ecosystem, because the dominant bird will affect the evenness of species. Evenness of bird species in a habitat can be characterized by the absence of dominant species. If the evenness index obtained at each taxon shows a value close to 1, it can be interpreted that animals are spread evenly at the location and no species dominate [18].

The index value of diversity, richness and evenness of bird species in the study location is also influenced by the condition of vegetation. Based on the analysis of vegetation, it was found that the types that dominated in the study area both after burning and not burning were ferns and grass including *Nephrolepis biserrata* (Nephrolepidaceae), *Stenochlaena palustris* (Blechnaceae), and *Imperata cylindrica* (Poaceae). Plants from the Poaceae family are more commonly found in post-burnt land compared to unburnt land, this can be caused by soil conditions after a fire, and also the possibility of more even distribution of seeds by birds in the location resulting in many plant species growing [8].

One of the plants found on post-burnt and unburnt land is the *Nephentes gracilis*. This plant is a type of insectivorous plant. This plant species is also capable of living in nutrient-poor soils [19]. One supporting factor for the discovery of this plant is an increase in the type of insects in the study site due to fire. This is in accordance with the conditions on the ground that are found by many insectivorous birds.

Another plant species also found at the study site is Harendong (*M. malabathricum*). This species is an understorey found at each observation location. Harendong plants produce fruit that can be used by birds as a food source, so its presence is very important at the location. Fruit-producing plants have a very important role in the forest ecosystem. In addition to forming a microclimate and providing ecological niches, the fruits of these plants are the main food sources for various types of animals, especially fruit-eating birds [17]. Other types of undergrowth found under vegetation are weeds often found in oil palm plantations.
3.2 Comparison of bird species composition

The types of birds found at each study location have the same species from one location to another. According to [20] the same community can be seen based on the presence or absence of the same species in the two habitats that are compared. Based on the data generated, the community similarity value in lane 1 pairs has the highest similarity index compared to other lanes, while the total similarity index also has a fairly high index value of 0.9 (Figure 5). The community similarity index in the three-lane pairs states that the three lane pairs have high species similarity because they are above 50% or 0.50 [21]. This is due to the possibility of individual species migrating to the nearest unburnt area and being used as a refuge and returning to the location to help the recolonization of animals after the condition of the burned area has recovered [22]. [23] say that the distribution and population of birds in a habitat are influenced by a lot of factors including physical/environmental factors such as soil, water, temperature, sunlight and biological factors that include vegetation and other animals so that the existing bird species will adjust.

![Figure 5. Number of similarity index](image)

The post-burn land location is an open habitat area that is overgrown with shrubs, so in that location many species of birds that like open habitats are found such as Chinese pond heron (*Ardeola bacchus*), Brown shrike (*Lanius cristatus*), Long-tailed shrike (*Lanius schach*), Javan myna (*Acridotheres javanicus*), Yellow-bellied prinia (*Prinia flaviventris*), and Lesser coucal (*Centropus bengalensis*). This is in accordance with the opinion that the types of birds are birds that like open habitats, such as shrubs, open grasslands and rice fields. These species like a fairly open habitat because the bird species has a type of feed in the form of insects which are mostly found in shrub habitat that supports its presence in post-burnt locations [24]. There are 34 of the same bird species on post-burnt and unburnt land (Table 1). Factors that can affect several species of birds in certain areas are habitat variation. Yoza [25] states that the availability of habitat variation greatly affects the high diversity of species.

| No | Survive  | No | Gain  | No | Loss  |
|----|---------|----|------|----|-------|
| 1  | Ardea purpurea | 1 | Picoides moluccensis | 1 | Spizaetus cirrhatus |
| 2  | Ardeola bacchus | 2 | Lanius cristatus | 2 | Dendrocopos macei |
| 3  | Ixobrychus eurhythmus | 3 | Passer montanus | |
| 4  | Ixobrychus cinnamomeus | 4 | Rhipidura javanica | |
| 5  | Dupetor flavicollis | 5 | Aegithina tiphia | |
For example, the varying habitat can affect the species of birds found drawn on post-burnt land that has more open environmental conditions and is dominated by understorey and staple plants that are not too high. There is also a dry tree that has been used as a fire to perch birds that like open areas such as brown shrike and pied fantail [24]. This condition is also in accordance with [26] opinion which states that canopy openness can affect the number of bird species found, the more canopy cover is opened, the more birds will be found when compared to habitats that have closed and canopy cover. The existence of five new species found and many species that survive indicates that the post-burnt land is undergoing a process of recovery after burning marked by the number of surviving species and the presence of new species.

4. Conclusion
The number of species and species richness of birds on land four years after burning is higher when compared to unburned land, which is 39 species of birds, while there are 36 species of birds on unburned land. The highest richness index is also found in post-burnt land at 6.37. The evenness index value in all locations is close to 1, which means it is spread evenly.

The composition of bird species between land four years after burning and not burning was almost the same, with a species similarity index value of 0.90, so that the similarity of bird communities in the study site was high, with only 7 different bird species. There are 34 species of birds found in post-burnt and unburned land. And found 5 species of birds obtained and 2 species that are loss. 13 species of bird included into protected species.

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