Response in bird community to a forest fire: Does bird population recover after several years?

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Abstract. Fires occur almost every year in Sumatra Indonesia and have impacted on biodiversity. As a part of the ecosystem, birds play an essential role in the food chain and have a function as specific indicators of the ecosystem. Despite its important role, the response of the bird community to forest fires is not yet completely understood. To improve the understanding of the recovery of bird community after the forest fire, especially in Indonesia, we conducted a study in 2017 and 2019 at a sago plantation forest in Riau Province, Sumatra. We used the combination of point count method, transect method, and exploration to observe the bird community for 40 days at the burned area and unburned area. We estimated the response of birds on forest fire by quantifying and assess the level of species richness, species evenness, similarity, and feeding group of species. We found that bird communities are starting being recovery four years after the forest fire. Even though the value varies among sites, the species richness and evenness in the burned area are increasing in two years, as much as 28.56%, and 6.52%, respectively. In the fourth year, this recovery was also indicated by the higher number of individuals in the burned area than in the unburned area. In the functional diversity, insectivore is the dominant feeding group. This study revealed that the burned are, that impact on food source regimes, may sustain the existence and recovery of bird community in the post-fire area.

Keywords: forest fire, species diversity, feeding group, point count method, Riau

1. Introduction

Today, forest and land fires are a part of global phenomenon. The World Meteorological Organization states that 2019 is one of the hottest year on record, and the 2015-2019 is the hottest period of 5 years in history [1]. Indonesia is one of a high-risk country to forest fire as it occurs almost every year [2]. The high frequency of fire is feared to have an impact on the loss of biodiversity. Many studies show that fires affect various bio-ecological components of plants and animals including; abundance, diversity, and the succession or recovery process of communities and populations [3-6].

Fire management to minimize impacts on biodiversity requires a good understanding of biodiversity's response to fires. Birds are often used as objects in assessing the impact of environmental damage on biodiversity [7-9].Interestingly, some studies suggest birds have a diverse response to fires [5]. Like an animal that functioned as a key component of the food web and the essential role in the ecosystem, it is very important to know the response of bird populations after a forest fire event. This is very important because
the data available in Indonesia as a fire-prone area is very limited. An understanding of the conditions after a forest fire event will illustrate the survival rate of birds in restoring their population. The question we want to answer is; can the birds recover soon after fire disturbance? To answer this we assess the level of species diversity and functional diversity of bird communities several years after the forest fire.

2. Methods
2.1 Data collection.
This research was conducted at sago plantation in Meranti District, Riau Province in 2017 and 2019. This area has been in a fire in 2015. We observe the difference of bird diversity at difference types of habitat i.e. burned area, unburned area. Birds data were collected using combining of transect methods and point count methods (Figure 1). Total of 15 transects were develop in the three habitat. Each transect has 1 km long and 100 m width. We observed the birds two times a day at 08.00-09.00 WIB in the morning and 15.00-18.00 WIB in the afternoon and repeated the observation four times in each transect.

Birds are directly observed using binoculars. The species and number of birds found in the field are recorded on a tally sheet and identified using Sumatran, Javanese, Balinese, and Kalimantan bird field guides [10]. In addition, identification is assisted with documentation as supporting data using pro summer type cameras.

2.2. Data Analysis.
The total of birds diversity at the three types of habitat was calculated by using the index of diversity (H’), Margalef Index (Dmg) [11]. The similarity of birds species community in 2 time periods (2017 and 2019) was expressed by the Sorensen index. We also assess the functional diversity by classifying birds according to feeding guild [12].

3. Results and Discussions
3.1. Results.
After the forest fire, the bird species found in both of habitat show variability in a total of species and total of the individual. In 2017 or two years after the fire, number of species in the unburned area is higher than burned area, but it is inversely in 2019. Two years later or four years after the fire, there was an increase in species numbers in both of the habitat types. Number of species in the burned area turned to be higher than unburned area. Inversely, the number of individuals shows a decrease from 2017 to 2019 (Table 1).
An increase in the number of species in burned areas from 2017 to 2019 followed by the level of species diversity. The species richness and evenness in the burned area are increasing in two years, as much as 28.56%, and 6.52%, respectively. But, the level of diversity in unburned areas is still higher than in burned areas. This can be understood because the species diversity index is not only determined by the number of species but also by the number of individuals. However, all of the species found at each site are distributed in equal numbers. This is evidenced by the similarity index which is close to 1 in all of the sites (Figure 2.).

![Figure 2](image-url)

**Figure 2.** Changes in the richness and evenness index of birds in the 2 periods after the fire

Another indication in valuing the response of a bird to forest fire after several years is the similarity of species found in the burned and unburned areas. The study indicated an increase in variability of species on both habitat type from 2017 to 2019, that expressed in Sorensen index 0.38 in 2017 to 0.27 in 2019 (Figure 3). The higher index implicates a higher level of similarity. It means many similar species found in two years after the fire than four years after the fire.

Birds response to fire may also assess by functional diversity based on its feeding guild. Nine category of feeding group found on both location (Figure 4 and 5). Several species found were *Hirundo* spp (Insectivore), *Pycnonotus* spp (Omnivore), *Lonchura striata* (Gravivore), *Clamator coromandus* (Insectivore-frugivore), *Leptocoma calcostetha* (Nectarivore), Columbidae (Frugivore), *Aethopyga siparaja* (Insectivore-nectarivore), *Egretta garzetta* (Piscivore), and *Tyto alba* (Carnivore). Insectivore birds dominated on both of habitat type at the two time periods, followed by Frugivore, Omnivore, and Granivore.

As dominant group, insectivore birds were increasing from 2017 to 2019 at burned area, indicated a good response after four years after the forest fire.
Figure 3. The level of similarity in birds species community in 2 time periods after the fire.

Figure 4. Composition of bird community based on feeding guild at two years after the fire.
3.2. Discussion.

This study shows that birds represent a positive response to wildlife after the forest fire. Although species abundance is lower than unburned areas, there is a variety of bird species since 2 years after the fire and continues to increase 2 years later. The distribution of species in the community in the burned area is also almost the same as the unburned area. That is, birds can restore their existence in the form of the presence of species in equal numbers in a community. This study confirms some research results which state that bird diversity may increase at a particular level of succession after the fire [13], [14].

Bird response to forest fire is also indicated in its functional diversity. The variability of feeding group assemblages at the burned area represents the survival condition of species after the forest fire. In this study, the fire changes the sago forest plantation to open habitat and the succession running for years. Vegetation types that develop along the succession process can support different feed sources so that certain feeding groups can benefit from this condition, or conversely. Post-burning habitat conditions having different food sources than before, like insects and seeds that are more accessible because of changes in vegetation [15]. That is one of the reasons why insectivore abundance tends to increase after four years. Although not all studies showed the same results, the results of this study show the kind of bird responses based on feeding groups to fires and their ecological attributes. A study [16] report that species response to fire predicted to be independent of functional groups as several groups showed both positive and negative relationships with increasing total fire frequency. Many factors influence the response of birds in many kinds of habitat after the fire but mainly determined by the change in food availability and habitat structure [17].

Studying the response of birds to fire is an interesting topic, but unfortunately, it is still limited study in the tropics especially in Indonesia. One of them is a study to assess the impact of fire on the avian community after the fire event in 1997 [5]. The study conducted in Sumatra conclude that fire has an impact on bird composition and the degree of impact was both taxon and guild specific. Those findings are in line with this study, with a little exception in the response of the insectivorous group. But another study which summarizes fifteen studies related to the response of birds mainly at woodland in Australia, revealed that there is a variety in the response of birds to fire [18]. Most of those studies (60%) imply no significant response for species richness and abundance, where bird species may show a positive or negative response according to its characteristics. Therefore, based on that literature, the result of this study reveals that the bird positive response indicated that the bird community begins to recover.
4. Conclusions
Since two years after fires, the bird community begins to recover, including the population from a variety of feeding groups. Fires do not cause the extinction all of bird species but have an impact on the number of species, level of species richness, and functional diversity. The species richness and evenness in the burned area are increasing in two years, as much as 28.56%, and 6.52%, respectively, and insectivore is the dominant feeding group.

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