Does oil palm plantation establishment cause loss/gain of bird species? (Case study: KGP oil palm plantation, West Kalimantan)

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Abstract. Oil palm plantation expansion in Indonesia always been associated as the cause of deforestation and loss of biodiversity. This research was conducted aiming to verify that allegation. The study was conducted from July to August 2018 and carried out in an independent oil palm plantation company, KGP in West Kalimantan. To identify the loss and gain of the bird species, an observation about the bird diversity was conducted. Five transects were laid out in each land covers (4 in the oil palm plantation and 1 in the shrub [baseline]). The analysis showed that the bird species found in the shrub was slightly smaller (22 species) then the species found in the oil palm plantation land covers (27 species). A total of 3 species were found only in shrubland cover which later is assumed as the loss. On the other side, 18 species were only found in the oil palm plantation assumed as a gain. These could be happening as 60% of the bird species composition found in shrub were almost the same as those in the High Conservation Value (HCV) land covers which belong to oil palm plantation land cover. Hence, the existence of oil palm plantation did cause a loss to the bird species but also happen to gain some other new species.

1. Introduction
Oil palm plantation has been covering large scale of areas in Indonesia plantation history [1]. This has been led oil palm plantation as one of the most promising sources of Indonesia’s economic growth as it has been contributing being a source of income for 2.2 million farm households [2] which lead to more land expansion of some plantation companies.

Although this growth giving a positive effect on our economic sector, the expansion itself has been assumed to cause some matters such as deforestation [3]. Land covers changes can cause some problems related to environmental stabilities. The conversion can cause soil fertility decrease, frequent floods, local extinction and even flora and fauna diversity loss [4], [5] which happened especially in bird species diversity. As birds are very sensitive to changes in the ecosystem which makes them as a strong bio-indicator for environmental changes resulting from land use changes [6]. Hence, it is necessary to identify the bird species diversity loss or gain by comparing the oil palm plantation land covers es to its origin land cover.
2. Methods

2.1. Study area
The study was conducted in the West Kalimantan Province, Indonesia, particularly in the Ketapang district. This province lies in the 2°08 LU - 3°05 LS and between 108°0 BT - 114°10 BT and has rainfall average of 397.0 mm maximum and 34.3 mm minimum. Whereas the rainy season falls on October – March and dry season falls on April – September. This research was focusing on wildlife diversity loss and gain as a cause of the oil palm plantation establishment. The study area comprised of oil palm plantation and shrub land covers. The oil palm plantation land cover divided into 4 land covers which were young-aged, middle-aged, old-aged oil palm plantation and high conservation value forest (HCV).

2.2. Procedures
Data were collected through July to August 2018 using line transect method. The transects were 1 km length and 100 m width. Each land covers were placed one transect. To record the bird diversity, the transects were visited in the morning from 6.00 to 9.00 and from 16.00 to 18.00 in the afternoon. Each transect were repeated for 3 times, but not in the rainy day. While to identify the bird species we used [7] field guide. Camera and binoculars were also used to make the observation easier.

There were 5 transects in total, whereas 4 transects lied in the oil palm plantation management land and 1 transect lied outside the plantation, the shrubland cover. The palm oil plantation was classified into 3 age classes: young (1-8 years old), middle (9-10 years old), old (more than 10 years old). Physically, each class was recognized by its height and front coverage. Young-aged oil palm plantation tends to have an open canopy covers. While shrubland cover was covered by undergrowth and few of vegetation species. The bird diversity survey was using visual and acoustic to identify species, count the numbers and determine the locations of the birds. Meanwhile, to describe the characteristic of the HCV, we assessed the vegetation using single plots measurement 113x100 m. The plants were classified into the growth stage of tree, sapling, pole, and seedling.

2.3. Data analysis
The total number of species that was actually recorded then being analyzed using Margalef Index (Dmg) to determine the richness of each species in each land cover. This index has the ability to respond to differences in species and is highly sensitive [8].

\[
Dmg = \frac{S-1}{\ln N}
\]  

While to analyze the gain or loss of the species, we estimated the species proportion in the area (Faculty of Forestry IPB – SMARTRI 2018). In some cases, the survival of some certain species will increase their species richness and the homogenization of the species origin in a long period of time (Mc Cune and Vellend, 2013). Therefore, this relation can be applied to estimate the species proportion which will survive in a certain period of time in an area when the habitat experiencing proportion decrease from its own origin area [9]:

\[
\frac{S_{\text{survived}}}{S_{\text{initial}}} = \left(\frac{A_{\text{survived}}}{A_{\text{initial}}}\right)^Z
\]

3. Results and discussions

3.1. Bird species diversity amongst land covers
There are 30 bird species recorded from all land covers. The highest number of species found in the HCV land cover which has 17 species (table 1). While the lowest number of species found in the middle-aged palm oil land cover. The highest number of individuals found in the oil palm plantation
land cover was Long-tailed parakeet (*Psittacula longicauda*). This happened as lots of this species of bird flying across the land covers area, as they were on their way out for foraging and back to their own nests. However, the highest individuals number found in the bushes land cover was yellow-vented bulbul (*Pycnonotus goiavier*). This species found in all over land cover areas.

Yellow-vented bulbul is one of the insectivorous bird species that have a high tolerance to environmental change as it can found in every land cover [6]. The study conducted by [6] shows the same result as this species found being the most abundant species amongst the land covers. These insectivore birds could perform the role of natural pest control in the oil palm plantation land area [10]. Meanwhile, other land covers showed a variety of species which had the highest abundant. In the young-aged oil palm land cover, Long-tailed parakeet showing the highest number individuals compared to other bird species found in the land covers. While in the middle-aged oil palm plantation, the highest species abundant is Pacific swallow (*Hirundo tahitica*). The bird species found in the old-aged oil palm plantation showed that none of the species being dominant. Almost all of the species shared the same number of individuals. This condition also happened in the HCV forest, almost all of the species shared the same number of individuals, although there was one species which had a slightly higher number of species which is yellow-vented bulbul. This species categorized as a generalist species [11] which is not dependent on forest existence [6], [12].

However, the differences between each land cover resulting in richness varieties of richness value. The highest value of richness resulted in HCV land cover (Dmg= 4.16). Compared to other bushland cover, that value is different significantly. However, the bushland cover has higher richness value compared to other land covers other than HCV land cover. The lowest value of richness found in the middle-aged land cover which has more than 1 value gap from bushland cover as shown in figure 1. The variation in height of oil palm also affecting the existence of the bird species as it created a microhabitat which suited well for bird-nesting places, foraging or physiology activities for particular species [13].

![Figure 1. Species richness index values in each land covers](image)

YOP: Young-aged Oil Palm Plantation; MOP: Middle-aged Oil Palm Plantation; OOP: Old-aged Oil Palm Plantation; HCV: High Conservation Value Forest, BS: Bushes

Nevertheless, compared to bushland cover, HCV forest has more heterogenous bird species. Almost all of the bird species found in the bushland covers were insectivorous species. While the bird species found in the HCV forest were varied from predator such as Black-winged kite (*Elanus Caeruleus*), frugivore and insectivore bird species. This study shows the same result as [14] which also showed that forest area has more heterogeneous species. The existence of the heterogenous bird species can be affected by the vegetation condition in the land cover itself [15]. As HCV forest has a more heterogenous vegetation composition compared to bushland cover. Bushland cover was dominated by undergrowth and only few vegetation found in the land cover. The abundance of
epiphytes and fruits [16], openness of forest floor, composition of tree species could also affect the diversity of birds [15]. Overall, bush land cover species composition has the highest similarity to the HCV forest compared to other land covers.

Table 1. Bird species list found in the whole sample of the study area

| No. | Common Name                  | Scientific Name                  | Land Covers |
|-----|------------------------------|----------------------------------|-------------|
|     |                              |                                  | Bushes      | YOP | MOP | OOP | HCV |
| 1   | White-breasted Woodswallow   | Artamus leucorhynchus            | v           |     |     |     |     |
| 2   | Ashy Tailorbird              | Orthotomus ruficeps              | v           | v   | v   | V   | v   |
| 3   | Barn Swallow                 | Hirundorustica                   | V           |     |     |     |     |
| 4   | Black-winged Kite            | Elanus caeruleus                 | v           |     |     |     |     |
| 5   | Brown-throated Sunbird       | Anthreptes malacensis            | v           |     |     |     |     |
| 6   | Common Emerald Dove          | Chalcophapsindica                | v           | v   | V   | v   | v   |
| 7   | Crimson Sunbird              | Aethopygas paraja                | v           |     |     |     |     |
| 8   | Dusky Munia                  | Lonchurafuscans                  | v           |     |     |     |     |
| 9   | Green Iora                   | Aegithina viridissima            | v           |     |     |     |     |
| 10  | Large Green Pigeon           | Treron capellei                  | v           |     |     |     |     |
| 11  | Lesser Coucal                | Centropus bengalensis            | v           | v   |     | V   |     |
| 12  | Little Spiderhunter          | Arachnotheral longirostra        | v           |     |     |     |     |
| 13  | Long-tailed Parakeet         | Psittaculalongicauda             | v           |     |     |     |     |
| 14  | Long-tailed Shrike           | Lanius schach                    | v           |     |     | V   |
| 15  | Olive-backed Sunbird         | Cinnyris jugularis               | v           | v   | v   |     |     |
| 16  | Olive-winged Bulbul          | Pycnonotus plumosus              | v           |     |     |     |     |
| 17  | Orange-bellied Flowerpecker  | Dicaeum trignonostigma           | v           |     |     |     |     |
| 18  | Pacific Swallow              | Hirundotahitica                  | v           | v   |     |     |     |
| 19  | Pied Fantail                 | Rhipidurajavanica                | v           |     |     |     |     |
| 20  | Pink-necked Green Pigeon     | Treron vernans                   | v           |     |     |     |     |
| 21  | Rufous-tailed Tailorbird     | Orthotomus sericeus              | v           | v   | v   | V   |
| 22  | Rusty-breasted Cuckoo        | Cacomantis sepulcralis           | v           |     |     |     |     |
| 23  | Scarlet Minivet              | Pericrocotus flavissimus         | V           |     |     |     |     |
| 24  | Sooty-headed Bulbul          | Pycnonotus aurigaster            | v           | v   | v   |     |     |
| 25  | Spotted Dove                 | Streptopelia chinensis           | v           | v   | v   | v   |     |
| 26  | Swallows                     | Callocaliasp.                    | v           |     |     |     |     |
| 27  | White-breasted Waterhen      | Amaurornis phoenicurus           | v           | v   |     |     |     |
| 28  | White-throated Kingfisher    | Halcyon smyrensis                | v           |     |     |     |     |
| 29  | Yellow-bellied Prinia        | Prinia flaviventris              | v           | v   |     | V   |
| 30  | Yellow-vented Bulbul         | Pycnonotus goiavier              | v           | v   | v   | V   |

Species Total 13 11 7 12 17
The similarities happened as there are some sources which support some species found in both areas. The species such as the sunbirds species which dieting on nectar. However, in other land covers, only a few species found in both bush and other land covers which allow more difference between the land covers. The value of the similarity index as shown in figure 2 tells that the establishment of oil palm plantation changes the composition of the bird species. Only 30% - 33% of the species found in oil palm land covers are similar to the species found in bushland cover.

![Figure 2. Index similarity between each land cover and bushland cover](image)

3.2. Bird species gain and loss

The varieties of species through all over the land covers led to a composition difference between each land cover. The composition of bird species change comprises both species gain and loss as shown in table 2. Some land covers experiencing higher loss than gain species. The proportion of loss and gain (figure 3) showing that young-aged and middle-aged oil palm plantation has a higher loss species proportion compared to other land covers. While old-aged oil palm plantation shows the same proportion of gain and loss species. However, HCV forest land cover experiencing higher gain species than the loss species.

![Figure 3. Gain and loss of bird species proportion](image)
Table 2. Species gain and loss in each land covers

| Young-aged Oil Palm Plantation | Medium-aged Oil Palm Plantation |
|--------------------------------|---------------------------------|
| **Loss**                       | **Gain**                        | **Loss**               | **Gain**                           |
| Long-tailed Shrike             | Long-tailed Parakeet            | Long-tailed Shrike     | Lesser Coucal                      |
| Brown-throated Sunbird         | Lesser Coucal                   | Brown-throated Sunbird | Rufous-tailed Tailorbird           |
| White-throated Kingfisher      | Rufous-tailed Tailorbird        | Olive-backed Sunbird   | White-breasted Waterhen            |
| Ashy Tailorbird                | Common Emerald Dove             | White-throated Kingfisher | Pacific Swallow                    |
| Pied Fantail                   | White-breasted wood swallow     | Sooty-headed Bulbul    | Rusty-breasted Cuckoo              |
| Olive-winged Bulbul            | Large Green Pigeon              |                         |                                   |
| Yellow-bellied Prinia          | Swallows                        |                         |                                   |
| Pink-necked Green Pigeon       |                                 |                         |                                   |

| Old-aged Oil Palm Plantation   | High Conservation Value Forest  |
|--------------------------------|---------------------------------|
| **Loss**                       | **Gain**                        | **Loss**               | **Gain**                           |
| Long-tailed Shrike             | Dusky Munia                     | White-throated Kingfisher | Crimson Sunbird                    |
| Brown-throated Sunbird         | Lesser Coucal                   | Pied Fantail           | Orange-bellied Flowerpecker        |
| Olive-backed Sunbird           | Rufous-tailed Tailorbird        | Pink-necked Green Pigeon | Rufous-tailed Tailorbird           |
| White-throated Kingfisher      | Common Emerald Dove             |                          | Green Iora                         |
| Pied Fantail                   | White-breasted Waterhen         |                          | Common Emerald Dove                |
| Olive-winged Bulbul            | Barn Swallow                    |                          | Black-winged Kite                  |
| Yellow-vented Bulbul           | Pacific Swallow                 |                          | Little Spiderhunter                |
| Pink-necked Green Pigeon       | Swallows                        |                          | Scarlet Minivet                    |

| Oil Palm Plantation            |                                  |
|--------------------------------|---------------------------------|
| **Loss**                       | **Gain**                        |
| Pied Fantail                   | White-breasted wood swallow      | Lesser Coucal           |
| Pink-necked Green Pigeon       | Barn Swallow                    | Little Spiderhunter     |
| White-throated Kingfisher      | Black-winged Kite               | Long-tailed Parakeet    |
| Common Emerald Dove            | Orange-bellied Flowerpecker     |
| Crimson Sunbird                | Pacific Swallow                 |
| Dusky Munia                    | Rufous-tailed Tailorbird        |
| Green Iora                     | Rusty-breasted Cuckoo           |
| Large Green Pigeon             | Scarlet Minivet                 |
| Swallows                       | White-breasted Waterhen         |
Nevertheless, the species gain from all land covers shows a higher gained species than the loss species (table 2). Most of the loss species are insectivore bird, however, there are some other bird species such as frugivore, nectarivore, and predator. The loss of certain bird species will result in species diversity and the loss of the role played by the species. Ashy tailorbird is one of the species which give a positive impact on oil palm plantation as it helps the oil palm during their reproduction as their pollinator [16]. However, this species loss in the young-aged oil palm will give some effects to the plantation itself where the pollination will run slower as there is no more natural supporter.

Nevertheless, the loss of this species does not happen in other land covers. This condition might happen as there is less supply of its diet. As stated in [6] that the presence of bird species is affected by the source of the species diet. However, most of the bird species which are classified as the loss species come from nectarivore species. [13] stated that this bird species are hard to be seen in the oil palm plantation as there is less source of its diet. While the predator bird which happens to be lost is White-throated kingfisher. However, the loss of this species will not affect greatly to the environment as the plantation area is not a swamp area.

Though the establishment of this plantation resulting in some loss species, this establishment also gain some new species. There were 18 species gained from all over the land covers. Most of the gained species were also insectivorous bird species. Higher species richness and gain were boosted by the presence of HCV forest as part of the plantation land cover. Due to some bird species are depended heavily on the presence of forest such as pigeons, the heterogeneity of the habitat needed [14]. Therefore, with the support of HCV forest, oil palm plantation may perform essential roles in conserving the biodiversity [14].

4. Conclusion

The oil palm plantation area experiencing more gain than the loss of bird species (gain: 138%; loss: 23%). Each land cover happened to have a variety of gain and loss percentage. In the young-aged oil palm plantation encounter higher loss than gain (gain: 54%; loss:62%), which also happened in the middle-aged oil palm plantation (gain: 38%; loss: 69%). While the old-aged oil palm plantation experiencing a balance loss and gain percentage in the number of 62%. The HCV forest experiencing a higher gain (62%) compared to its loss, 23%. Therefore, this establishment of the oil palm plantation provided new habitat for some particular bird species, though the richness of the bird species showing a variation. The oil palm plantation land cover which includes HCV forest giving essential support to the diversity and ecological role of each species.

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