How does oil palm plantation impact bird species diversity? a case study from PKWE Estate, West Kalimantan

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Abstract. The prospect of Indonesian palm oil industry nowadays tends positive and shows an increasing trend. This matter also caused many negative responses to the presence of environmental damage and biodiversity loss, including bird species diversity. Since there are only a few researches related to oil palm plantation impact on bird species diversity, this research is necessary to enrich the data related. Data retrieval was carried out on March 2018, in PKWE Estate, West Kalimantan, using strip transect method in six different types of habitat/land cover. Two types of land cover which are secondary forest and shrubs considered as land cover before the establishment of oil palm plantation (baseline), while the others are habitat types that exist in oil palm plantation. The result shows that both baselines have the highest number of species among all habitat types, with a total of 26 species were found in each baseline. However, as a unity, turn out that the level of bird species diversity in oil palm plantation area is higher than the baseline area, where 33 species of bird were found (Dmg= 6.98). The existence of oil palm plantation also has changed the composition of bird species, the highest similarity index with both baselines is showed by old growth of oil palm. The change of species composition caused ten birds species lost and 17 species were gained on the secondary forest cover, meanwhile, 11 species lost and 18 species were gained in shrubs.

1. Introduction
Palm oil is known as the most widely consumed vegetable oil in the world that used in many packaged products sold in the market. At present, the palm oil mill industry being dominated by the Southeast Asia region, where Indonesia is the world’s biggest producer of palm oil [1]. The prospect of Indonesian palm oil industry seems positive and keep shows an increasing trend. According to the FAO and IndexMundi [2], there were 18 million ha planted with oil palm in 2013, with a total production volume of 55 million tons of CPO during the same year, in 2015 the production increased to 62 million tons and this increased projected to continuously improve. This has an impact on the increasing level of land requirements resulting in land cover conversion, while the production of palm oil continues to grow, its expansion also increased rapidly [3]. The establishment of oil palm plantation certainly has changed the type of land cover. Based on several references oil palm rapid expansion claimed as one of the major drivers for the land-use change in Indonesia and has been spotlighted internationally of this dramatic land-use change [4], [5]. This conversion activity causes habitat destruction, degradation and fragmentation, and changes in species that are sensitive to
migratory species. If this continues, biodiversity will threatened. Biodiversity that continues to decline shows enormous costs if many irreplaceable species begin to become extinct. Habitat loss is one of the important factors that caused a global biodiversity crisis, and the existence of land management can affect biodiversity needs. Several studies have shown that changes in land use-land cover are one of the main causes of biodiversity loss [6], [7].

This matter also caused negative responses on oil palm plantation establishment, said that the expansion connected to the environmental damage, destruction of habitat, and biodiversity loss, including the loss of bird species diversity. NGOs and researchers often declared that the conversion of forest to oil palm has led to a major threat to biodiversity and environmental problems [8], [9]. Indonesia is one of the most cost-efficient countries in the world for oil palm agriculture due to the environment suitability [10] and also a home of many wildlife species because located in a hotspot biodiversity area [11], including birds. Bird is one of the biodiversity that commonly found in oil palm plantation. Its species presence was affected by environmental factors; climatology and topography, vegetation structure, and human disturbance. It has an important role in nature and has high sensitivity on the surroundings changes. That is why birds often used widely for environmental changes indicators and included in evaluation studies for overall biodiversity conservation [12]. However, this is also made a concern on bird conservation, threatened by the habitat disturbances and loss, especially by the establishment of oil palm plantation. Therefore, we conduct this research with an intention to estimate the impact of oil palm plantations on bird species diversity.

2. Methods
2.1. Study site
Data retrieval was held on March 2018, in PKWE Estate, Ketapang District (0°19’26,51’’ LS – 3°4’16,59’’ LS and 109° 47’36,55’’ BT – 111°21’37,36’’ BT), West Kalimantan Province. We chose six plots for counting birds, divided in six sites, secondary forest, shrubs, High Conservation Value area (HCV), young, intermediate, and old growth of oil palm plantation. The oil palm plantations area consists of several age classes. Each age classes have different types and characteristics of land cover. The first class is young palm plantation, where the observation plot took place in the palm plantation planted in 2016 or two years old at the time of the study and located adjacent to shrubs land cover. The young palm characterized by 2-3 m tall plants, no canopy covers and groundcover with shrubs and grasses. The second class is middle-aged oil palm plantation, the plot took in palm plantation grown in 2011 or seven years old when the research was conducted. Most have fairly wide canopy covers and groundcover with fern, shrubs and grasses. The third is old palm plantation, the observation plot took in palm plantation grown in 2006 or aged 12 years. Oil palm in this category is characterized by closed canopy cover, the groundcover only slightly covered with fern, shrubs and grasses. The HCV area is an area that looks like secondary forest inside the oil palm plantation area. This land cover is quite dense dominated by big trees, surrounded by community of the oil palm plantations and parts of riparian areas.

2.2. Data collection
This study defines the habitat into two types, i.e., habitat before the oil palm plantation establishment and habitat after the oil palm plantation establishment. We used Landsat image analysis of each site within one to two years before plantation land clearance to determine the type of land cover prior. Based on the satellite imagery interpretation, secondary forest and shrubs representing the baseline or the land cover before the establishment of oil palm plantation, and the rest of land cover are habitat after the oil palm plantation establishment. In each type of land cover, one observation track was made considering the relatively small area and based on the assumption that bird species in each of the same habitat types were homogeneous.

The inventory of birds was carried out with strip transect method (Figure 1), with total length of the track is 2 km, by making a straight line as far as one kilometre to the north/south/west/east, then turn approximately 150 m (distance between lines), and go back as far as one kilometre in the opposite
direction to the start line. This inventory is carried out simultaneously on each type of land cover, in the morning (06.00-08.00 WIB) and afternoon (16.00-18.00 WIB) for each transect, repeated for three times in each transect to maximize the number of species recorded. Observer walks along the track by noting the type species and a number of birds seen or heard, the time encounter and the place where birds are found.

![Figure 1. The illustration of strip transect method](image)

2.3. *Data analysis*

Impacts of oil palm plantations on bird diversity were determined by comparing the current biodiversity found on each plantation covers, with those found on the current baseline (with an assumption that the current baseline resembles the previous land cover before the plantation establishment). To measure and compare the diversity of birds in all habitat conditions number of species that found on each land covers in PKWE estate is counted. Also Margalef species Richness index [13] was used to simply count the number of different species in a given area. The evenness index was used to determine the evenness of the species in each land cover and the similarity index was used to determine the similarity of bird species between the baseline and each of oil palm plantation covers [14], and used as the basis for assessing the impact of oil palm plantation establishment on the diversity of birds, number of bird diversity loss and gain.

3. **Results and discussion**

3.1. *Comparison of bird species diversity*

Based on observation data in all types of land cover, 49 species of bird were recorded. Compared to all existing land cover types, secondary forest and shrubs cover have the highest bird encounter with total 26 species were found in each cover. Although both land covers have the same number of species, but the value of species richness indices shows a differ, the secondary forest has a higher value (6.01) rather than shrubs cover (5.48). The difference is due evenness factor, where evenness indices on shrubs is lower than secondary forest, this indicates a high dominance or abundance in certain species on the site. Species richness not only takes into account the number of species, but also the number of individuals, so the abundance of a species will affect the value of the index [13]. Meanwhile, the lowest bird species encounter and species richness indices was found on old growth oil palm, only 4 species of bird were found, with species richness value of 1.44. Overall the results of observations on the bird diversity in the study sites are shown in table 1 and figure 2.

| Table 1. Comparison of ecological variable values of bird species diversity in each land cover of PKWE estate |
|---------------------------------------------------------------|
|                  | OG   | IG   | YG   | HCV  | Secondary forest | Shrubs |
| Number of species | 4    | 9    | 16   | 15   | 26               | 26     |
| Species richness  | 1.44 | 3.12 | 3.99 | 4    | 6.01             | 5.48   |
| Evenness indices  | 0.95 | 0.95 | 0.9  | 0.87 | 0.88             | 0.85   |

*where: YG= young growth oil palm, IG= intermediate growth oil palm, OG= old growth oil palm, HCV= high conservation value area
This study has a different result with another similar study, conducted by [15], where the results represent that bird diversity affected by plantation age, in the early establishment of oil palm plantation, the diversity of birds tends to be lower and show an increasing number along with the older age of plantation. This study shows the opposite result, the oldest growth oil palm has the lowest species diversity instead, intermediate growth oil palm has a higher number, and the young growth oil palm has the highest number. In old growth oil palm cover, the state of the plantation’s undergrowth was less dense than the other types of the plantation, this is due to the harvesting activities in the surrounding block area. In addition to the harvesting activities, the area was frequently visited by humans, so the environment tends to have a high level of human disturbance [16]. Remarked by reference [17], [18], human activities and presence caused a disturbance that can affect species diversity in a given area or habitat. A better habitat is a place where far from human disturbances and there is enough source of food, this kind area is likely to have many bird species [19]. Both baselines (secondary forest and shrubs) have the highest number of species because of almost no disturbance from humans.

Shrub is a good habitat for some species of birds to perch and look for food on the shrubs or bushes area. The denser the cover of the undergrowth, birds will be easier in hiding and looking for food, this condition can increase bird diversity. As been stated in reference [20] when the undergrowth removed experimentally, the bird species richness was declined. As stated by reference [21] and [22], the increase in ground vegetation cover can marginally increase bird and butterfly diversity in plantations. Among all habitat types in oil palm, young growth oil palm cover has a high number of species because in this area the undergrowth is denser. Other factors known to affect the responses of birds to oil palm include the age and size of the plantation trees, percentage of canopy cover [23], the presence of epiphytic ferns on oil palm trees, and human disturbance such as weeding or harvesting [18]. The results obtained show that the way of managing and maintaining oil palm plantations greatly affects the diversity of bird species.

As a whole management unit, oil palm plantation has a higher number of species and species richness indices compared to the two baselines, where 33 species of birds recorded with richness indices value of 6.98. Bird densities, domination, species occurrence, and turnover rate depend mainly on area and structure variables [24]. The characteristics and habitat types affect the diversity of bird species, the more diverse habitat the higher bird species diversity tends to get [25]. The difference on the oil palm plantation which does not only consist of oil palm monoculture plantation but also HCV areas whose resembles a secondary forest, while each baseline formed only from one characteristic habitat, has caused a decrease in the number of species and species diversity value.

**Figure 2.** Comparison of ecological variable values of bird species before and after oil palm Establishment
3.2. Comparison of bird species composition

Each type of land cover has a different number of species and species composition. Changes in land cover that occur not only caused a differ in the value of the diversity of bird species but also changed the composition of the bird species. An indication of differences in species composition can be found based on the composition and feeding guild of bird species before and after the establishment of oil palm in table 2 and comparison of the Sorensen similarity indices that can be seen in figure 3.

Table 2. Composition and feeding guild of bird species before and after the establishment of oil palm plantation

| No | Scientific name       | Family | Feeding guilds                  | Area before oil palm plantation | Oil palm plantation area |
|----|-----------------------|--------|---------------------------------|---------------------------------|--------------------------|
| 1  | Microhierax fringillarius | Falconidae | Insectivorous, carnivorous     | V                               | V                        |
| 2  | Isorhynchus cinnamomeus | Ardeidae | Carnivorous                     | V                               | V                        |
| 3  | Lanius schach         | Laniidae | Insectivorous                   | V                               | V                        |
| 4  | Psittacula longicauda | Psittacidae | Frugivorous, granivorous       | V                               | V                        |
| 5  | Lonchura fuscans      | Estrildidae | Granivorous                   | V                               | V                        |
| 6  | Centropus bengalensis | Cuculidae | Insectivorous                   | V                               | V                        |
| 7  | Centropus sinensis    | Cuculidae | Insectivorous                   | V                               | V                        |
| 8  | Chalcoparia singalensis | Nectarinidae | Nectivorous                   | V                               | V                        |
| 9  | Dicaeum cruentatum    | Dicaeidae | Insectivorous                   | V                               | V                        |
| 10 | Ardea purpurea        | Ardeidae | Carnivorous                     | V                               | V                        |
| 11 | Halcayan smyrnensis   | Alcedinidae | Insectivorous                   | V                               | V                        |
| 12 | Todiramphus chloris   | Alcedinidae | Carnivorous                   | V                               | V                        |
| 13 | Orthotomus ruficeps   | Sylviidae | Insectivorous                   | V                               | V                        |
| 14 | Aegithina tajia        | Aegithinidae | Insectivorous                   | V                               | V                        |
| 15 | Pycnonotus aurigaster | Pycnonotidae | Omnivorous                   | V                               | V                        |
| 16 | Ichthyophaga ichthyaetus | Accipitridae | Carnivorous                   | V                               | V                        |
| 17 | Batistur indicus      | Accipitridae | Carnivorous                   | V                               | V                        |
| 18 | Elanus caeruleus      | Accipitridae | Carnivorous                   | V                               | V                        |
| 19 | Corvus enca           | Corvidae | Omnivorous                     | V                               | V                        |
| 20 | Hemipus hirundinaceus | Campephagidae | Insectivorous                   | V                               | V                        |
| 21 | Copyrhyb us saulaitis | Muscicapidae | Insectivorous                   | V                               | V                        |
| 22 | Anthracoceros malayanus | Bucerotidae | Frugivorous, carnivorous       | V                               | V                        |
| 23 | Anthracoceros albicollis | Bucerotidae | Frugivorous, carnivorous       | V                               | V                        |
| 24 | Amaurornis phoenicurus | Rallidae | Carnivorous                     | V                               | V                        |
| 25 | Acridotheres cristatellus | Sturnidae | Omnivorous                     | V                               | V                        |
| 26 | Rhipidura javanica | Rhipiduridae | Insectivorous                   | V                               | V                        |
| 27 | Merops viridis        | Meropidae | Insectivorous                   | V                               | V                        |
| 28 | Egretta eolophotes    | Ardeidae | Carnivorous                     | V                               | V                        |
| 29 | Bubulcus ibis         | Ardeidae | Carnivorous                     | V                               | V                        |
| 30 | Hirundo tahitica      | Hirundinidae | Insectivorous                   | V                               | V                        |
| 31 | Pycnonotus plumsus    | Pycnonotidae | Omnivorous                   | V                               | V                        |
| 32 | Pycnonotus goisier    | Pycnonotidae | Omnivorous                   | V                               | V                        |
| 33 | Pycnonotus simplex    | Pycnonotidae | Omnivorous                   | V                               | V                        |
| 34 | Pycnonotus brunnene   | Pycnonotidae | Omnivorous                   | V                               | V                        |
| 35 | Chrysophlegma miniaceum | Picidae | Insectivorous                   | V                               | V                        |
| 36 | Prinia flavigularis   | Cisticolidae | Insectivorous                   | V                               | V                        |
| 37 | Ducula aenea          | Columbidae | Frugivorous                    | V                               | V                        |
| 38 | Treron vernans        | Columbidae | Frugivorous                    | V                               | V                        |
| 39 | Treron olax           | Columbidae | Frugivorous                    | V                               | V                        |
| 40 | Alcedo meninting      | Alcedinidae | Carnivorous                   | V                               | V                        |
| 41 | Loriculus galgalus    | Psittacidae | Frugivorous                    | V                               | V                        |
| 42 | Dicrurus paradiseus   | Dicruridae | Insectivorous                   | V                               | V                        |
| 43 | Dicrurus macrourus    | Dicruridae | Insectivorous                   | V                               | V                        |
| 44 | Psilopogon australis  | Megalaimidae | Frugivorous                   | V                               | V                        |
| 45 | Spilopelia chimensis  | Columbidae | Granivorous                    | V                               | V                        |
| 46 | Euryzostoma orientalis | Corvidae | Omnivorous                     | V                               | V                        |
| 47 | Gracula religiosa     | Sturnidae | Omnivorous                     | V                               | V                        |
| 48 | Collocalia esculenta  | Apodidae | Insectivorous                   | V                               | V                        |
| 49 | Isorhynchus flavicollis | Ardeidae | Carnivorous                     | V                               | V                        |

*where: SF = secondary Forest, SB = shrubs, YG = young growth oil palm, IG = intermediate growth oil palm, OG = old growth, HCV = high conservation value area
Figure 3. Comparison of Sorensen similarity indices between (a) each type of land covers in oil palm plantation with the baseline (b) overall oil palm plantation and the baseline

Table 2 shows that predators and carnivores can be more commonly found in SB areal, while in other types of land cover there are fewer or even only one predator species. One type of feed such as small birds exists in all locations. Vegetation structure can influence the ability to detect prey. As SB is an open habitat, make predators tend to perch and find prey more easily. Besides that, some locations within the SB area are submerged by water, which can be a place to find prey for several species of carnivores.

Based on figure 3 we can see that bird communities differed greatly between the two baselines (secondary forest and shrubs) compared with all types of covers in oil palm plantation. From 33 species recorded in the oil palm plantation area, insectivorous birds dominated the number of bird species (42.42%), followed by carnivorous bird (24.24%), omnivorous and frugivorous bird (15.15%), and granivorous (3.03%). No nectivorous bird was found in oil palm plantation. The most significant species composition changes in both baselines occurred in old-growth oil palm, marked by the lowest value of similarity indices, 0.27 in the secondary forest and 0.13 in shrubs. Shown by figure 3 that young growth oil palm and shrubs have the highest similarity indices with value > 0.5 and became the highest similarity with the shrubs baseline, meanwhile, the highest similarity with the secondary forest is HCV area with a value of only 0.39. The rate of species similarity indices affected by the characteristic in both habitats, the more similar both habitats, the higher species similarity will obtain [26].

HCV area in oil palm plantations is an area that intended for the protection of riparian and all waterways and restoration of buffer zones. This area function toward providing a relatively healthy habitat for wildlife species, this area has a similar habitat characteristic with secondary forest, there is still dense trees cover, which is not found in other types of oil palm plantation cover. Young growth oil palm has the highest similarity with shrubs, there are entirely no tree types on both land covers, the height of the oil palm is still short, no canopy tree is formed, and most of the vegetation that exists is in the form of undergrowth or shrubs. On the other side, old growth oil palm has the most significant difference in both baselines, due to the lack of habitat characteristics. Its habitat condition has been disturbed, only slightly covered by undergrowth and shrubs (low density of undergrowth) so that the acquisition of the species is the least. With the existence of the undergrowth or shrubs in this area, there is still a similarity between old growth oil palm and the baseline.

Overall, the comparison of similarity indices between oil palm plantation with each baseline show almost the same value in the range 0.52-0.55. This indicates that land cover changes in the form of secondary forest or even shrubs cover have a pretty significant difference, where almost half of the total bird species, with 16 species of birds in the secondary forest are similar, and 15 species in shrubs are similar. Different species in each baseline lead the assumption of the loss and gain of bird species. Figure 4 shows the assumption of loss and gain from both baselines with each land cover types that exist in an oil palm plantation, meanwhile, table 2 and 3 shows result between overall oil palm plantation and the baseline.
*where: SF= secondary Forest, SB= shrubs, YG= young growth oil palm, IG= intermediate growth oil palm, OG= old growth oil palm, HCV= high conservation value area

**Figure 4.** Comparison assumption of bird species loss and gain in each type of land covers (a) from secondary forest baseline (b) from shrubs baseline

The comparison of loss and gain estimation from both baseline (figure 4a and 4b), shows that each type covers of oil palm plantation have a higher number in the species lost than the species gained. Old growth oil palm cover has the highest number of species lost, also the lowest number of species gained from even both baseline type. From the secondary forest baseline, 22 species are lost and there are no species gained, from the shrubs baseline 24 are lost and 2 are gained. This represents the lowest value in similarity indices between old growth oil palm cover with the baseline. This loss and gain data show that the new appearance or loss of certain species of bird is caused by the selection of habitat based on the compatibility of the bird with the habitat and the availability of resources for the birds to sustain their life [17].

Birds found in oil palm cover type (young, intermediate and old growth oil palm) tend to be simple communities of generalists and non-forest species and they tend to dominate [27], frugivorous birds also rarely recorded in the oil palm, due to the lack of fruiting trees and dominated only oil palm monoculture. Vegetation on the baseline found to be more diverse. Vegetation plays an important role in bird survival and supports birdlife, including species diversity, structure, population density, and density of the canopy [28]. It provides the availability of food, cover, and other psychological conditions [17]. The more diverse and abundant of the vegetation compositions, including the abundance of epiphytes and fruits, the larger number of bird species [29], [30]. In the secondary forest, the main vegetation types are ranging from the undergrowth, seedlings, saplings, and tall trees that are not owned by other land covers, the presence of trees cause canopy stratification also more diverse in this land cover. Vertical distribution of leaf or canopy stratification diversity also affects the diversity of bird species [31]. This makes the species found on the baseline more diverse, thus causing each oil palm covers to lose much more. While the list of bird species that considered lost and gained from the baseline into oil palm plantation is shown in table 3, table 4 and figure 5.

**Table 3.** List of bird species contributed to the dissimilarity of species composition between oil palm plantations and the baseline

| Founded only in oil palm plantation | Founded only in secondary forest | Founded only in oil palm plantation | Founded only in shrubs |
|-----------------------------------|---------------------------------|------------------------------------|------------------------|
| Isobrychus cinnamomeus 1          | 1 Psilopogon australis          | 1 Isobrychus cinnamomeus 1         | 1 Microhierax fringillarius |
| Isobrychus flavicollis 2          | 2 Microhierax fringillarius     | 2 Isobrychus flavicollis 2         | 2 Treron olax           |
| Babuleus ibis 3                   | 3 Elanus caeruleus             | 3 Egretta garzetta 3               | 3 Butastur indicus      |
| Egretta garzetta 4                | 4 Chalcoparia singalensis       | 4 Alcedo meninting 4               | 4 Dicrurus macracercus  |
| Todiramphus chloris 5             | 5 Hemipus irundinaceus         | 5 Halcyon smyrnensis 5             | 5 Pycnonotus aurigaster |
| Amaurornis phoenicula 6           | 6 Merops viridis               | 6 Todiramphus chloris 6            | 6 Pycnonotus simplex    |
| Alcedo meninting 7                | 7 Lonchura fascans            | 7 Corvus enca                     | 7 Merops viridis       |
Table 4. List of bird species contributed to the dissimilarity of species composition between oil palm plantations (without HCV) and the baseline

| Oil palm without HCV | Secondary forest | Oil palm without HCV | Shrub | Oil palm without HCV | Secondary forest | Oil palm without HCV | Shrub |
|----------------------|------------------|----------------------|-------|----------------------|------------------|----------------------|-------|
| 1. Isabrychus cinnamomeus | 1. Microhierax fringillarius | 1. Isabrychus cinnamomeus | 1. Microhierax fringillarius | 1. Chalcoparia singalensis | 1. Microhierax fringillarius | 1. Chalcoparia singalensis | 1. Microhierax fringillarius |
| 2. Isabrychus flavicollis | 2. Lonchura fuscans | 2. Isabrychus flavicollis | 2. Chalcoparia singalensis | 2. Centropus chinensis | 2. Chalcoparia singalensis | 2. Chalcoparia singalensis | 2. Chalcoparia singalensis |
| 3. Lanius schach | 3. Chalcoparia singalensis | 3. Centropus chinensis | 3. Chalcoparia singalensis | 3. Ardea purpurea | 3. Ardea purpurea | 3. Ardea purpurea | 3. Ardea purpurea |
| 4. Psittacula longicauda | 4. Dicrurus cruentatum | 4. Halcyon smyrnensis | 4. Halcyon smyrnensis | 4. Aegithina tiphia | 4. Aegithina tiphia | 4. Aegithina tiphia | 4. Aegithina tiphia |
| 5. Todiramphus chloris | 5. Galopterus caeruleus | 5. Todiramphus chloris | 5. Todiramphus chloris | 5. Pycnonotus aurigaster | 5. Pycnonotus aurigaster | 5. Pycnonotus aurigaster | 5. Pycnonotus aurigaster |
| 6. Ichthyophaga ichthyaetus | 6. Hirundo tahitica | 6. Hirundo tahitica | 6. Hirundo tahitica | 6. Butastur indicus | 6. Butastur indicus | 6. Butastur indicus | 6. Butastur indicus |
| 7. Amasiamis phoenicurus | 7. Rhipidura javanica | 7. Rhipidura javanica | 7. Rhipidura javanica | 7. Hemipus hirundinaceus | 7. Hemipus hirundinaceus | 7. Hemipus hirundinaceus | 7. Hemipus hirundinaceus |
| 8. Egretta garzetta | 8. Merops viridis | 8. Orthotomus ruficeps | 8. Orthotomus ruficeps | 8. Acridotheres cristatellus | 8. Acridotheres cristatellus | 8. Acridotheres cristatellus | 8. Acridotheres cristatellus |
| 9. Babulcus ibis | 9. Pycnonotus plumosus | 9. Pycnonotus plumosus | 9. Pycnonotus plumosus | 9. Rhipidura javanica | 9. Rhipidura javanica | 9. Rhipidura javanica | 9. Rhipidura javanica |
| 10. Chrysophlegma miniaceum | 10. Dicrurus macracercus | 10. Dicrurus macracercus | 10. Dicrurus macracercus | 10. Merops viridis | 10. Merops viridis | 10. Merops viridis | 10. Merops viridis |
| 11. Ducula aenea | 11. Pycnonotus simplex | 11. Pycnonotus simplex | 11. Pycnonotus simplex | 11. Treron olax | 11. Treron olax | 11. Treron olax | 11. Treron olax |
| 12. Loriculus galgalus | 12. Treron olax | 12. Treron olax | 12. Treron olax | 12. Dicrurus macracercus | 12. Dicrurus macracercus | 12. Dicrurus macracercus | 12. Dicrurus macracercus |
| 13. Psilopogon australis | 13. Anthracoceros malayanus | 13. Anthracoceros malayanus | 13. Anthracoceros malayanus | 13. Dicrurus macracercus | 13. Dicrurus macracercus | 13. Dicrurus macracercus | 13. Dicrurus macracercus |
| 14. Gracula religiosa | 14. Anthracoceros malayanus | 14. Anthracoceros malayanus | 14. Anthracoceros malayanus | 14. Dicrurus macracercus | 14. Dicrurus macracercus | 14. Dicrurus macracercus | 14. Dicrurus macracercus |

Figure 5. Comparison assumption of bird species loss and gain between whole oil palm plantations and plantation area without HCV with the baseline

All species that considered lost indicate that those species cannot fit in oil palm plantation habitat, meanwhile gained species or similar species that also recorded in oil palm plantation indicate that those species are capable of using oil palm plantations for their habitat, also indicates that oil palm plantation can be hospitable for some bird species. The total number of the gained species from both land cover show almost the same bird species composition. The bird community that found in the oil palm plantation is influenced by the relatively heterogeneous landscape, both within and surrounding
the oil palm plantation. HCV area in the oil palm plantations enrich heterogeneity, this area has a similar habitat characteristic to secondary forests. The crucial role of HCV area in the oil palm plantation shown by table 3 and figure 5, which indicate that without this area the presence oil palm plantation has caused the number of bird species lost is higher than the species that gained. This area has various types of trees, forest edge or border typical, therefore forest species birds can be found and recorded in oil palm plantation area, just like *Anthracoceros albirostris* and *Anthracoceros malayanus*

Meanwhile, in oil palm cover, trenches, shrubs and marshes become the typical characteristic of this habitat. Areas that close to water sources, just like swamp area has their own habitat characteristics and favored by certain types of birds, such as *Alcedo meninting*, *Ergetta garzetta*, *Bubulcus ibis*, *Ixobrychus cinnamomeus*, *Ixobrychus flavicollis*. Those species founded only in oil palm plantation areas, they found nesting on platforms of reeds in shrub, feed on insects, fish and amphibians [32]. The presence of oil palm plantation also increased and provided insects [15], this caused insectivorous birds gained, such as *Lanius schach*, *Copsychus saularis*, *Centropus chinensis*. The presence of insectivorous birds in oil palm plantation bring positive impacts, they can contribute in controlling the pest [33]. Some of the bird’s families that have been found only in oil palm cover, among others are alcedinidae and ardeidae. Its species, among others, *Halcyon smyrnensis*, *Todiramphus chloris*, *Ixobrychus cinnamomeus*, *Ixobrychus flavicollis* are species that common and have large range [32]. This shows that most species appear to be able adapt in the oil palm habitat, many species of birds are capable of using oil palm plantations but indicate that habitats supporting communities in oil palm plantation are dominated by a common and widespread species, but the presence of HCV area inside the plantation can bring more birds diversity. Reference [34], [35] remarked the importance of the surrounding forest area and by adjoining, higher species of birds obtained than plantations that lacked such connectivity.

4. Conclusion

The results indicate that conversion from secondary forest and shrubs oil plantation results in the change of bird number of species and bird species composition. Overall oil palm plantation has increased the bird species diversity, from 26 species on each baseline into 33 species. However, if we look based on the comparison of the baseline with all types of land covers on oil palm plantation, the result shows a decrease of species diversity in all oil palm land covers. The highest decreased from both baselines is shown by old growth oil palm.

The most significant change of species composition in each baseline, both shown by old growth oil palm with the lowest similarity value of 0.27 with secondary forest, and 0.13 with shrubs cover. The land cover change from the secondary forest into oil palm plantations led to the gain of 16 bird species and the loss of 10 species, while the change from shrubs led to the gain of 17 species and the loss of 11 species. Insectivorous bird is the most found species. Oil palm habitat tends to bring species that considered as species of lower conservation concern and with extensive ranges. The existence of HCV area in oil palm plantations is crucial because it brings more diverse, so that oil palm plantation area can has higher diversity.

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