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Oil palm plantations versus mammals and birds conservation: a case study in two oil palm plantations in West Kalimantan Province

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Abstract*. The assessment of the oil palm plantations impact on biodiversity mostly compares oil palm plantations to natural forests. However, in reality, most land cover types before oil palm plantation establishment are no longer primary forests. Observations were made on two oil palm plantations (2 companies) in the West Kalimantan Province. Tracking data on the origin of land cover types was carried out using an interview method and analysis of the interpretation of land satellite imagery. The results showed that the baseline of oil palm plantations studied were shrubs/fields and secondary forests. The number of species (mammals and birds) in the oil palm area was higher than in the baseline area. The establishment of oil palm plantations originally in the form of shrubs or fields has affected the increasing diversity of mammals (3 species) and birds (11 species). The same results were also observed in areas that were originally in the form of secondary fields and forests, which also increased the number of species of mammals (5 species) and birds (18 species). Thus, it can be concluded that the land cover changes in 2 oil palm plantations studied has a positive impact on the mammals and birds' species diversity.*

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INTRODUCTION

Palm oil's production efficiency, cost-effectiveness, and product stability make it the most attractive and widely used vegetable oil in the world (Petrenko et al. 2016). As one of the palm oil producing country, Indonesia has supplied half of the global demand for palm oil commodity (FAOSTAT 2015). This supports the statement that oil palm plantations has a variety of positive impacts, including generating the national income up to IDR 200 trillion/year (Pardamean 2017), reviving the regional economy, reducing social disparities and even reducing interest in migrating to neighboring countries for people in border areas (Ngadi and Noveria 2017), opening employment opportunities and absorbing around 21.49 million workers (Ditjenbun 2014), as well as various other positive effects. Even in 2017–2018, palm oil succeeded in providing a real contribution as Indonesia's largest export earnings with a value of USD 22.97 billion (IPOA 2018). West Kalimantan is one of the provinces with the largest palm oil plantation area, positioned at second largest after Riau Province.

However, this success has reaped negative accusations (since 1980 until now) so that it has become polemic in the public space: that oil palm causes the extinction of orangutans and the loss of biodiversity; that oil palm originates from primary or secondary forest that has caused deforestation (Vijay et al. 2016). Changes

in land use due to agricultural land clearing are known to be one of the causes of declining biodiversity in tropical areas (Laurance et al. 2014; Newbold et al. 2015). Mammals, herpetofauna, birds and insects are animals that are affected by the expansion of oil palm plantations, while their role is very large in the ecosystem (Kwatrina et al. 2018). The conversion of land cover has the potential to result in habitat damage that threatens the lives of mammals (Azhar et al. 2014; Kartono 2015). On the other hand, several other studies also show that oil palm affescts the diversity of butterfly and bird species (Edwards et al. 2013; Hamer et al. 2015; Yudea and Santosa 2019; Reiss-woolever et al. 2023). Another impact is changes in temperature which then affect biodiversity (Sabajo et al. 2017).

The assessment of the impact of palm oil plantations on biodiversity so far has been more about comparing palm oil plantations with primary forests. This unequal comparison can lead to bias in assessing its impact on the diversity of wildlife species because, in reality, the land cover type before becoming a plantation is no longer primary forest. In connection with this, comparative studies have been carried out between species diversity data of mammals and birds which carried out simultaneously in the baseline area (the land cover type before oil palm plantation establishment) and in the oil palm plantations themselves (including HCV).

METHOD

Assumptions

The impact of palm oil plantations on species diversity is the difference between the bird species diversity encountered in palm oil plantations and in the land cover before being turned into palm oil plantations. The results of a search of the origin of land cover types before being turned into palm oil plantations through the Landsat imagery interpretation of a year before becoming palm oil plantations show that the land under study was shrub land cover. Those considered as land cover after becoming palm oil plantations are the various ages of plantation area (young, middle, old) and High Conservation Value (HCV).

Data Collections

This study was conducted between July and August 2018 at two companies (Company A and Company B) in the West Kalimantan Province. The list of species and number of individuals of birds and mammals were collected through direct observation using the transect method (with 1 km length and 75 m left and right width) simultaneously on several land cover types: shrubs, secondary forests, oil palm plantations (with various age classes), and HCV areas. Data were collected in the morning (06.00–08.00) and afternoon (16.00–18.00) with three replications. For mammals, data were obtained using camera traps (installed for 3 × 24 hours).

Data Analysis

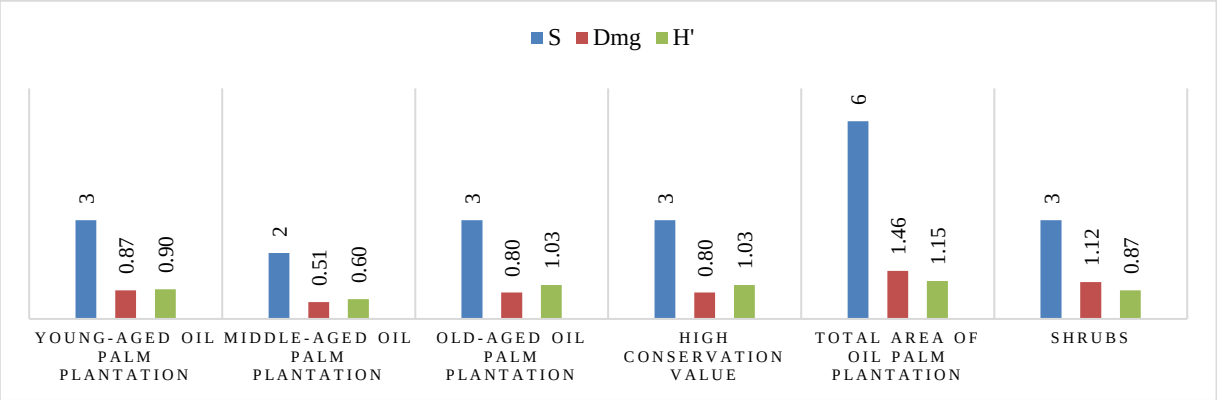
Some variables of the bird/mammal diversity used in this study were the number of species, species richness index (Dmg), and species diversity index (H’). The Sorensen community similarity index was used to estimate the effect on species composition.

RESULTS AND DISCUSSION

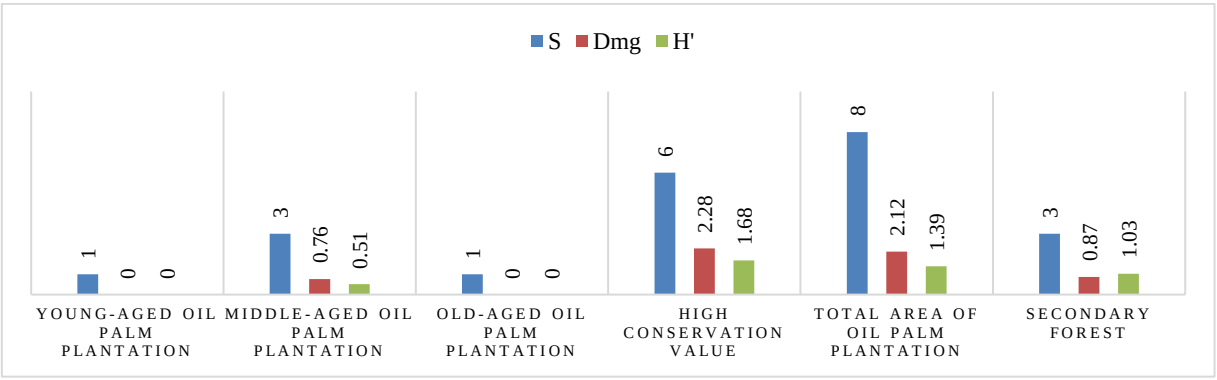
The Impact of Oil Palm Plantations on the Diversity of Mammals and Birds

Data collected from the observation and calculation of the species diversity index of mammals in the two PSBs are presented in Figure 1. The number of mammalian species which appear in the oil palm plantation area (both at Company A and at Company B) was greater than the number of mammalian species found in the baseline area which was in the form of shrubs (SB) at Company A and secondary forests (SF) at Company B. This shows that there has been an increase in the number of species of mammals due to land cover changes from shrubs and secondary forests to palm oil plantations. When comparing the types of land cover in Figure 1, it appears that shrubs (baseline area at Company A) had the highest species richness index and species

diversity index compared to the entire observation area at Company A. However, the index of species richness and species diversity in the total area of palm oil plantations was higher than that in the SB area. Unlike the conditions in Company B, where HCV in palm oil plantations had the highest species richness and diversity index of mammals compared to other types of cover, including the SF area. If seen as a whole, the value of mammals' species richness index and species diversity index in oil palm plantations area is also higher than the SF area.



Company A



Company B

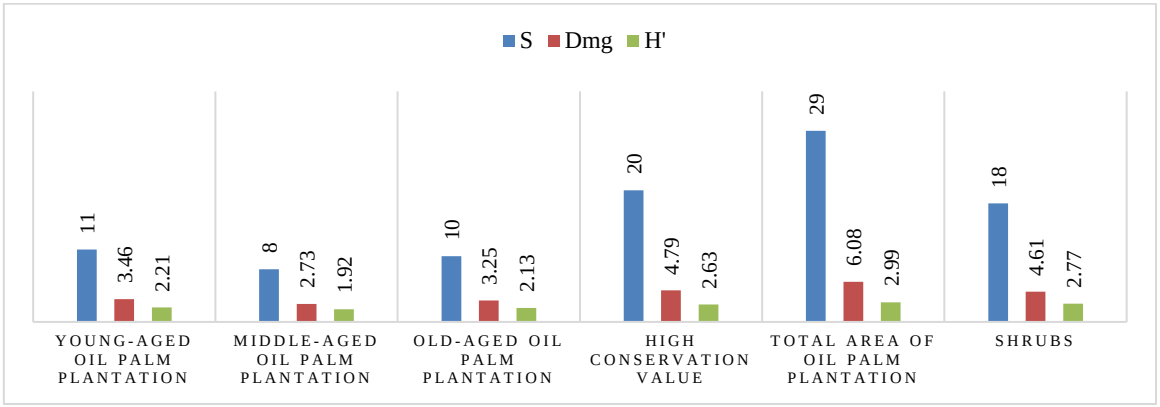
Figure 1 Comparison of the number of species, species richness index, and diversity index of mammals on each land cover type at Company A and Company B

The high diversity of mammals in the oil palm plantations area is due to the availability of mammalian feed, namely palm fruit, particularly for squirrels and rats. The plantain squirrel is a type of mammal found in almost all types of land cover (both at Company A and at Company B), except for the young oil palm plantations. These results are in accordance with Harich and Treydte (2016) who stated that squirrels are found in plantation areas and eat palm fruit. Based on interviews with plantation managers, this species is a pest of palm oil plants. Squirrels use palm fruit as a source of food. This is thought to be the cause of the absence of squirrels in the young (not yet bearing fruit) oil palm areas. Santosa et al. (2017) also encountered plantain squirrels in various land cover types in palm oil plantations. According to Krisanti et al. (2017), plantain squirrels are species that are tolerant to change and can survive and thrive at locations, assuming the availability of feed. According to Rupert et al. (2015), plantain squirrels are opportunistic species that are commonly found on plantation lands because they offer opportunities for additional food.

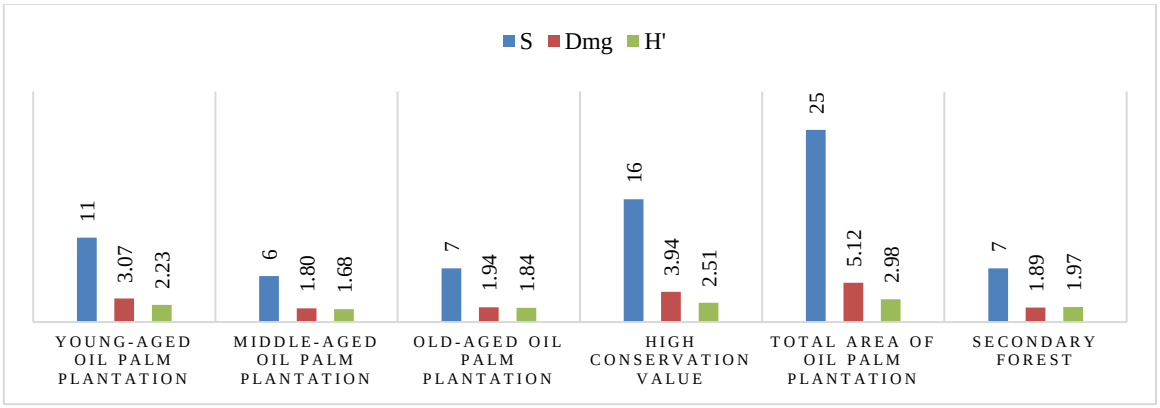
Meanwhile, the presence of rats in the oil palm plantation area acts as a predator of arthropods, such as grasshoppers, beetles, ants, moths, and cockroaches (Upa et al. 2017). Furthermore, Susanto and Ngabekti (2014) stated that these rats have benefits such as detritivores, insectivores, and granivores. In line with the

results of this study, Sasidhran et al. (2016) stated that palm oil plantations decrease herbivorous activity, but increase omnivorous activity. However, the presence of rats in the plantation area is also a pest for palm oil plantations because they eat plant roots and palm fruits (Harich and Treydte 2016; Santosa et al. 2016). However, the large number of rat encounters in the plantation area is a factor in the presence of leopard cats in that area. Leopard cat is a protected species by the government. According to Mohamed et al. (2013), leopard cats often look for feed from Rodentia orders. This result is in accordance with the research of Yue et al. (2015), who found leopard cats only in plantations and not in forests because Rodentia as their prey source is more numerous than in forests.

Similar results were obtained for bird taxa, where the number of bird species in the plantation area was higher than that in the baseline area (both shrubs and secondary forest). The comparative values of bird species in each land cover type in the two companies are shown in Figure 2.



Company A



Company B

Figure 2 Comparison of the number of species, species richness, and diversity of birds on each land cover type at Company A and Company B

The HCV area had the highest diversity of bird species compared with the other observation areas. This means that the presence of HCV areas positively affects the number of bird species in palm oil plantations. Kwatrina et al. (2018) stated that the high number of species in oil palm plantation areas is thought to also be related to the presence of forests such as HCV areas within plantations and forests around plantations. Apart from that, the HCV area profile which has plant age strata also supports the formation of vegetation heterogeneity which contributes to microclimate, light penetration for lower vegetation, and certain species including birds. HCV areas at Company A had the highest number of plant species (87 species) compared to the shrub areas (36 species), thus providing more habitat structure. The composition, structure of vegetation,

and complex form of HCV habitats tend to favour the presence of birds. In addition, the presence of water sources in the HCV areas as well as in other palm oil plantations is also considered to affect the diversity of animals when compared to the condition of shrub areas where no water source is found. Different results are shown at the location of the Company B, where SF had a higher number of plant species than the HCV area (48 species versus 34 species), but the highest number of bird species appeared in the HCV area. This is presumably due to the location of the HCV area surrounded by oil palm plantations where water sources are available in the form of a trench that forms a boundary between oil palm plantations, so the factor of water availability also determines the presence of animals in an area.

When viewed as a whole, oil palm plantation areas had a larger number of species compared to the baseline areas (29 species versus 18 species in Company A, and 25 species versus 7 species at Company B). This shows that land cover changes to palm oil plantations have an effect on bird species diversity increase in these two plantation areas. This result is in line with Kwatrina et al. (2018) where the development of oil palm plantations which provide new habitat for certain types of animals, has an impact on species diversity and composition. Kwatrina et al. (2018) further explained revealed that the change of habitat after the oil palm plantation establishment in Central Kalimantan increased the diversity of birds.

The Impact of Oil Palm Plantations on Mammal and Bird Species Composition

By comparing using the the Sorensen index of similarity (IS), the IS value approaching 1 shows the similarity in species composition between the two communities being compared. The results of this study (Table 1) show that the IS value for each land cover compared to the previous land cover (shrubs) has a similarity value of less than 1. This result shows that although the number of species found between the two types of land cover is relatively the same, they have different species composition.

Table 1 Comparison of species similarity in mammals on each land covers

Company A					**Company B**				
Land cover type	**MOP**	**OOP**	**HCV**	**SB (Baseline area)**	**Land cover type**	**MOP**	**OOP**	**HCV**	**SF (baseline area)**
YOP	0.8	0.67	0.33	0.67	YOP	0.50	0.00	0.00	0.00
MOP		0.80	0.40	0.40	MOP		0.50	0.22	0.33
OOP			0.33	0.33	OOP			0.29	0.50
HCV				0.33	HCV				0.44
TOPP				0.44	TOPP				0.36

Note: YOP: young-aged oil palm plantations; MOP: middle-aged oil palm plantation; OOP: old-aged oil palm plantation; HCV: high conservation value; TOPP: total area of oil palm plantation; SB: shurbs; SF: secondary forest.

Table 1 shows that the highest value of the species similarity index was found in the two oil palm plantation areas (especially in the MOP-OOP area). This is allegedly due to the similarity of habitat types in vegetation structure, water availability, and the condition of the canopy cover of the two locations which are not much different, so it is possible to have high species similarity. There is a difference between plantation land cover and forest land cover (HCV area or SF area) which has a tendency to differ in mammal species composition by more than 50% in those two land covers.

When comparing palm oil plantations and baseline areas, there were differences in the composition of mammal species by 56% at Company A and 64% at Company B. In other words, the change in land cover from shrubs to palm oil plantations of the Company A affected the composition of mammal species by 56%, while the change in secondary forest land cover into palm oil plantations of Company B caused a 64% change

in the composition of mammals. However, the number of mammals found in the palm oil plantation area is greater than the number of mammals found in the baseline area (both SB and SF).

In contrast to bird taxa, the species similarity index between oil palm land cover types tends to be small (below 50%). This indicates that the difference in each land cover habitat condition affects the composition of bird species. A comparison of bird species similarity indices is shown in Table 2.

Table 2 Comparison of bird species similarity in each land cover

Company A					Company B				
Land cover type	**MOP**	**OOP**	**HCV**	**SB (baseline area)**	**Land cover type**	**MOP**	**OOP**	**HCV**	**SF (baseline area)**
YOP	0.42	0.48	0.32	0.41	YOP	0.24	0.17	0.30	0.33
MOP		0.44	0.43	0.45	MOP		0.31	0.27	0.46
OOP			0.40	0.36	OOP			0.17	0.00
HCV				0.53	HCV				0.35
TOPP				0.60	TOPP				0.30

Note: YOP: young-aged oil palm plantations; MOP: middle-aged oil palm plantation; OOP: old-aged oil palm plantation; HCV: high conservation value; TOPP: total area of oil palm plantation; SB: shurbs; SF: secondary forest.

The highest value of bird species similarity was found between HCV and the SB area (53%) in Company A, while in Company B, the highest value of bird species similarity was found between MOP and the SF area (46%). If seen as a whole, the total bird species found in all land cover types in Company A had a similarity of 60% with the shrub area. This means that the land cover change of shrubs into palm oil plantations has resulted in a 40% change in the composition of bird species. Unlike the case at Company B, the land cover change in secondary forest to palm oil plantations has resulted in changes in the composition of larger bird species, which is 70%. This result is in line with Muin (2013), who states that the change in land cover (forests and shrubs) to palm oil plantations will also affect changing conditions and the potential for biodiversity. Changes in the composition of these species can not only lead to allegations of decline or loss of species but also to allegations regarding the acquisition of species or biodiversity gain on each land cover. Figure 3 shows the impact of forests and shrub conversion into palm oil plantations on the loss and gain of mammals and birds that occurred at Company A and Company B.

Company A Company B

Figure 3 Comparison of the amount of species loss and gain in mammals and birds

Figure 3 shows that land cover change from shrubs to palm oil plantations has resulted in the loss of one mammal species and four bird species, but has brought four new mammal species and 15 new bird species. This is different from the impact of secondary forest conversion to palm oil plantations at Company B, which caused the loss of one mammal species and three bird species but resulted in six new mammal species and 20 new bird species. If we look at the conversion between land cover, the change in land cover from shrubs to palm oil plantations and HCV results in species gain and loss. The three oil palm land covers (young-age, middle-age, and old-age) have a higher loss than gain. Only one land cover after in oil palm, HCV, had a higher

gain amount than the amount of loss. Habitat conditions in HCV areas that have more diverse vegetation, Erniwati and Santosa (2019) stated the diversity of vegetation is an important factor affecting bird species diversity.

Human activity or disturbance is thought to affect the diversity of animal species. The results of research in Riau oil palm plantations by Santosa et al. (2016) show that there are differences in the diversity of animal species in HCV that are close to human activities (such as oil palm harvesting activities and settlements). Azhar et al. (2014) and Erniwati et al. (2016) which concluded that the conversion of secondary forest into oil palm plantation in Riau province reduced the bird species richness. However, when viewed as a whole, the conversion of land into palm oil plantations at Company A and Company B indicates that there was a higher gain in species for both mammalian and bird taxa. The gain of these species was obtained from several different land-cover types found in palm oil plantations A complete list of mammals and birds which were lost and gained is presented in Table 3.

Table 3 List of lost/gained mammal and bird species

Research location	**Taxa**	**Species lost**	**Species gained**	
Company A (shrubs-oil palm plantations)	Mammals	1. *Macaca nemestrina*	1. *Prionailurus bengalensis* 2. *Rattus tiomanicus*	3. *Nannosciurus melanotis* 4. *Callosciurus baluensis*
	Birds	1. *Rhipidura javanica* 2. *Treron vernans* 3. *Gerygone sulphurea* 4. *Tyto alba*	1. *Lonchura punctulata* 2. *Lonchura fuscans* 3. *Passer montanus* 4. *Dicaeum trigonostigma* 5. *Lacedo pulchella* 6. *Halcyon smyrnensis* 7. *Orthotomus sericeus* 8. *Macronus bornensis*	9. *Chalcophaps indica* 10. *Ictinaetus malaiensis* 11. *Spilornis cheela* 12. *Amaurornis phoenicurus* 13. *Hirundo tahitica* 14. *Pycnonotus goiavier* 15. *Prinia flaviventris*
Company B (secondary forests-oil palm plantations)	Mammals	1. *Macaca fascicularis*	1. *Prionailurus bengalensis* 2. *Rattus tiomanicus* 3. *Tupaia dorsalis*	4. *Sundasciurus tenuis* 5. *Callosciurus baluensis* 6. *Sundasciurus hippurus*
	Birds	1. *Macronus bornensis* 2. *Ictinaetus malaiensis* 3. *Dicrurus paradiseus*	1. *Ixobrychus cinnamomeus* 2. *Lanius schach* 3. *Lonchura fuscans* 4. *Centroopus bengalensis* 5. *Dicaeum trigonostigma* 6. *Caprimulgus concretus* 7. *Orthotomus sericeus* 8. *Aegithina Viridissima* 9. *Aegithina tiphia* 10. *Elanus caeruleus*	11. *Amaurornis phoenicurus* 12. *Chrysococcyx xanthorhynchus* 13. *Artamus leucorynchus* 14. *Rhipidura javanica* 15. *Hirundo rustica* 16. *Prinia flaviventris* 17. *Treron curvirostra* 18. *Psilopogon australis* 19. *Macropygia emiliana* 20. *Collocalia linchi*

CONCLUSION

The conclusion of this study is that land cover changes from shrubs to palm oil plantations as a whole have resulted in a) an increase in mammals (3 species) and birds (11 species); b) changes in the composition of mammals by 56% and birds by 40%; and c) loss of one mammal and 4 species of bird but has brought four new species of mammals and 15 new species of birds. Meanwhile, land cover changes from secondary forests to palm oil plantations as a whole have resulted in a) an increase in mammals (five species) and birds (18 species); b) change in species composition by 64% in mammals and 70% in birds; and c) loss of one species of mammal and three species of bird, bringing in six new species of mammals and 20 new bird species. In addition, HCV in the form of forest land cover plays a significant role in increasing the number of mammalian and bird species in palm oil plantations.

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