The variation of bird diversity in different land cover at oil palm plantation: case study at Asm Oil Palm Estate in Central Kalimantan, Indonesia

Yanto Santosa[1*], *Windi* Sugiharti[2], and *Erniwati* [3]

[1]Ecology and Wildlife Management Division, Department of Forest Resource Conservation and Ecotourism, Faculty of Forestry, Bogor Agricultural University. Jl. Raya Dramaga, Bogor 16680, West Java, Indonesia.
[2]Department of Forest Resource Conservation and Ecotourism, Faculty of Forestry, Bogor Agricultural University. Jl. Raya Dramaga, Bogor 16680, West Java, Indonesia.
[3]Department of Forestry, Faculty of Agriculture, Universitas Bengkulu. Jl. W.R. Supratman, Kota Bengkulu 38371A, Bengkulu, Indonesia. Tel.: +62-73621170.

Abstract. The expansion of oil palm plantation has been claimed as a major driver of biodiversity loss in the tropics, including birds. To date, only a few studies have been conducted to document the variation of bird diversity in different land cover within oil palm plantation. Therefore, it is necessary to conduct the research to investigate the variation of bird diversity. The objective of this study to identify the diversity of bird in different land cover within oil palm plantation. The observation of bird diversity was done in young stand of oil palm, old stand of oil palm, smallholder oil palm and in secondary forest as high stock carbon as natural reference before converting in to oil palm. The survey was done in August 2017 in Central Kalimantan, Indonesia. Data of bird species were recorded by direct observation using transect method. To calculate the diversity value of birds at different land cover, we used Margalef Index (Dmg) and Comunity similarity (IS). The result showed that the number of species and species diversity was highest at high carbon stock area which the number of species was 25 species and Margalef Index was 5.99. The young stand of oil palm have the highest evenness index (0.93), while the highest similarity index was observed in old stand of oil palm and in smallholder oil palm. Our study concludes that the existence of high carbon stock areas within oil palm plantation had a positive influence in increasing bird diversity. From a conservation perspective, retaining of natural habitat such as high carbon stock within oil palm plantation is one strategy to conserve biodiversity.

1 Background

[*]Corresponding author : yantohaurjaya@yahoo.co.id

Oil palm plantations cover large areas and dominate plantations in Indonesia, especially in Kalimantan and Sumatra. Oil palm is one of the plantation crops that have an important role for the national economy. In 2017, palm oil became Indonesia's largest foreign exchange contributor (US$ 17.8 billion) and it became a source of income for approximately 2.2 million farm households (1).

The development of oil palm plantations has caused a number of problems. Conversion of forest areas into agricultural land has resulted in decreased soil fertility, increased levels of soil erosion, frequent floods, prolonged droughts, local extinction and declining diversity of flora and fauna species, including birds (2).

Birds are wildlife that has the ability to live in almost all habitat types. Birds can occupy a variety of habitat types, both forest habitat and non-forest habitat (3). Birds have high mobility and adaptability to a wide variety of habitat types. According Darmawan (4), birds are one type of wild animal that has many functions and is often used by humans. Birds have important role in the ecosystems for pollination, seed dispersal, and the control of crop pest (5). Hence, the need for research on the diversity of bird species in oil palm plantations. This study aims to identify the diversity of bird species before and after oil palm plantation is established by calculating the similarity of bird communities.

2 Material and Method

2.1. Study Area

This research was conducted in August 2017 in six different land cover namely; young palm oil (planted in 2016), old palm oil (planted in 2013), shrubs, High Carbon Stock area (HCS), and two smallholding oil palm plantations (planted in 2013) at Andalan Sukses Makmur (ASM) Plantation estate in Central Kalimantan. The tools used in this research are binoculars, digital cameras, timers, stationery, tally sheets, Global Positioning System (GPS) and a MacKinnon and Philips bird field guide in Sumatra, Java, Bali and Kalimantan (6). The observed objects include birds located in various land cover and habitat conditions in observation location in PT Andalan Sukses Makmur (ASM) palm oil plantation area.

2.2 Procedure

Primary data were collected through direct observation of bird species diversity and habitat conditions in oil palm plantations. Data were observed using transect method, each land cover had one transect line with 1 km long with 50 m to the left and the right side of the transect line. Observation were conducted in the morning at 06.00 - 09.00 and afternoon at 16.00 - 18.00. The data collection was repeated five times to maximise the total bird recorded. The observation included bird species, number of bird of species, time of encounter and bird activity. To describe the habitat condition, the characteristic of each land cover was recorded during the observation.

2.3 Data analysis

To estimate species richness, we used the Margalef Index (Dmg) which has the ability to respond to differences in species and has high sensitivity (7). The formula used is:

$$\mathbf{Dmg} = \frac{\boldsymbol{S-1}}{\mathbf{ln}(\boldsymbol{N})} \quad \text{..... (1)}$$

Dmg : Species richness index
S : The number of species
ln : Logarithm
N : The total number of individual of species

To determine the evenness of species richness between site types, we used an Evenness Index:

$$\mathbf{E} = \frac{\boldsymbol{H'}}{\mathbf{ln}\,\boldsymbol{S}} \quad \text{..... (2)}$$

E : Evenness index
S : The number of species
ln: Logarithm
H': Species diversity index

The similarity of bird communities among different sites was estimated using the Sørensen Index, using the formula :

$$\mathbf{IS} = \frac{2c}{a+b} \quad \text{.....(3)}$$

IS : The similarity Sorensen Index
a : The number of species found in location 1
b : The number of species found in location 2
c : The number of species found in both location

Moreover, we also categorized the conservation status of bird. The conservation status of the birds found in this research is referred to based on the Indonesia regulation about the preservation on wildlife, IUCN criteria and Appendix CITES.

3 Result and Discussion

3.1 Species Bird Composition

Our result showed that there were 39 species of birds from 26 families in all land cover. The highest number of bird species was found at the HCS area with 25 species. A total of 8 species were found at the young stand of oil palm, 13 species at both the smallholder oil palm area and shrub, and 10 species found in the old stand of oil palm and another smallholder oil palm area. Some bird species can be found in all types of land cover (Table 1).

Table 1. List of bird species found in different land cover in the study site

No	Scientific Name (Common name)	Family	SM	ST	KR1	KR2	HCS	SB
1	*Centropus bengalensis* (Lesser coucal)	Cuculidae	√	√	√	√	-	-
2	*Rhipidura javanica* (Sunda pied fantail)	Rhipiduridae	√	-	√	√	√	√
3	*Pycnonotus plumosus* (Olive-winged bulbul)	Pycnonotidae	√	-	-	√	√	√
4	*Pycnonotus goiavier* (Yellow-vented bulbul)	Pycnonotidae	√	√	√	√	√	√
5	*Streptopelia chinensis* (Spotted dove)	Columbidae	√	√	√	√	-	√

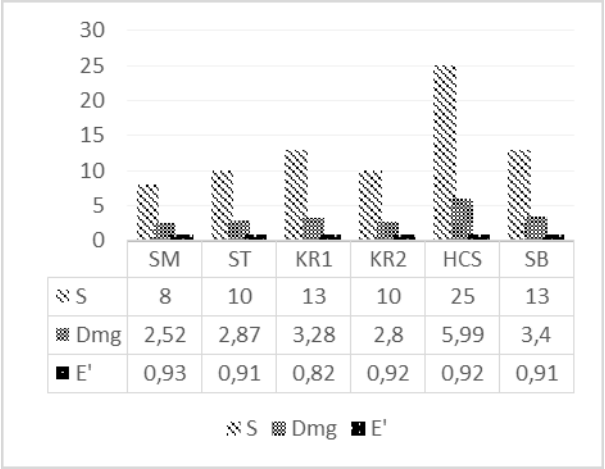
Noted: SM= young stand of oil palm, ST= old stand of oil palm, KR=Smallholder oil palm, HCS=High Carbon Stock area, SB=Shrub area

Pycnonotus plumosus and *Pycnonotus goiavier* are birds of the Pycnonotidae family. According to Partasasmita (8), bird species of the Pycnonotidae family have high adaptability in various types of vegetation, and are highly tolerant of vegetation changes. These bird species can be found in secondary forest habitat types, shrubs, farmland and even rural and urban environments. *Centropus bengalensis* are almost found in all land cover types. Sopiyandi (9) and Permana (10) stated that *Centropus bengalensis* is a type of bird that prefer to be in the open area habitat such as oil palm plantations.

Rhipidura javanica is a type of bird that is active in secondary forest, yard and mangrove forests. Therefore, it is common to find this bird species in almost all land cover in oil palm plantations. The bird species found mostly were insectivorous. The large number of insectivorous birds might be because the of the abundant ground cover as source of food (insects) for the birds. The shrub areas had higher insect diversity compared to other types of land cover (11). *Centropus bengalensis* are insectivorous bird species. Therefore, this bird plays a role as a natural enemy of insects in oil palm plantations.

The comparison of Number of species, species richness and the similarity of bird species

Our result showed that High Conservation Stock area had the highest number of species (25 species) and species richness (Dmg;5.99) compared to other land covers, while the lowest number of species and species richness was at young stand of oil palm with 8 species and the index of species richness was recorded at 2.52. (Figure 1). The highest similarity index (0.93) were recorded in young stand of oil palm.



	SM	ST	KR1	KR2	HCS	SB
S	8	10	13	10	25	13
Dmg	2,52	2,87	3,28	2,8	5,99	3,4
E'	0,93	0,91	0,82	0,92	0,92	0,91

Noted : SM= young stand of oil palm, ST= old stand of oil palm,
KR=Smallholder oil palm, HCS=high carbon stock, SB=Shrubs area
Fig. 1. Number of species (S), species richness (Dmg) and Evenness Index (E') in each land cover.

High conservation stock area had the highest number of bird species and species richness due to its complex vegetation or habitat structure compared to oil palm plantations. The habitat diversity affects bird species diversity. The more diverse the habitat structure the greater the diversity of species (4). These results are similar to studies conducted by Erniwati *et al* in Riau Province (12) which showed that secondary forests had higher number of bird species compared to oil palm plantations. The number of species and species richness found at shrubs and smallholder oil palm mostly were mainly open habitat species. The existence of those species was influenced by condition of the area and the proximity to the to HCS areas. Yoza (13) stated that forests have more complex stratification, thus providing strata variation for bird habitats, as well as relatively heterogeneous composition of vegetation creating varied ecological niches. The types of birds in the young palm are open bird species (*C. bengalensis*, *P. goiavier*, *R. javanica* and insect-feeders) which have adapted to oil palm areas having overgrown shrubs as a source of food.

The Evenness Index in each site ranged from 0.82-0.93 (Figure 1). According to the concept of evenness, if the index of evenness is close to 1, the species are distributed evenly. The data in Figure 1 indicates that the bird species were distributed almost evenly among sites. The highest Evenness Index was found in young age of oil palm (E'=0.93), whereas the lowest Evenness Index was found insmallholder oil palm (E'=0.82). According to Ludwig and Reynolds (14), the value of evenness is influenced by the number of individuals. Santosa (15) stated that if each species has the same number of individuals, it indicates that the evenness of the community has a maximum value, but if the number of individuals in each species is much different, it shows that the evenness of the species have a minimum value.

The similarity of bird community in different site

The index of bird community similarity assesses the similarity in species composition between habitats. The results show that the highest similarity found between old stand of oil palm (ST) and smallholder (KR) oil palm about 0.61. This could be influenced by the presence of old stand of oil palm adjacent to smallholder oil palm and the age of oil palm is the same from both location. Keindeigh (16) said that the factors causing the similarity of

species between the two habitats are the distance of adjacent habitat, the similar vegetation composition and other environmental factors.

While the lowest level of similarity found between old stand of oil palm and HCS area is about 0.23, it might be due to differences in vegetation structure, therefore the types of birds found are very different. Ganevan (17) stated that the similarity of bird communities is caused by the same characteristic of vegetation composition and altitudes. (Table 2)

Table 2. The similarity index of bird community in the study site

Land cover	SM	ST	KR1	KR2	HCS	SB
SM	1	0.44	0.48	0.56	0.24	0.57
ST		1	0.61	0.3	0.23	0.43
KR1			1	0.43	0.42	0.38
KR2				1	0.34	0.35
HCS					1	0.32
SB						1

Noted : SM= young stand of oil palm, ST= old stand of oil palm, KR1&2=Smallholder oil palm, HCS=High Carbon Stock, SB=Shrub area

Using the IUCN criteria, there was one species that is classified as Endangered (EN), one species classified as Vulnerable (VU) and two species categorized as Near Threatened (NT). There were a total of ten different bird species that are protected by Indonesian law and five different species listed in Appendix II of CITES. The protected bird species such as hawk eagle (*Elanus caeruleus*) and Buccane eagle (*Spilornis cheela*) from the family of Accipitridae play a role in the ecosystem as bird of prey. According to Sozer *et al.* (5) several species of bird of prey has a function to maintain the balance of ecosystems of pest populations of rats and populations of snakes. Furthermore, the bird species of the Alcedinidae family are protected because they belong to fish-eating birds.The Alcedinidae family itself is used as an indicator of a habitat (4). The bird species along with their conservation status and their distribution by habitat are presented in Table 3.

Table 3. Conservation status of birds in the study area

No	Scientific Name	Indonesian Law	IUCN	CITES
1	*Microhierax fringillarius*	**D**	LC	-
2	*Ciconia stormi*	**D**	**EN**	-
3	*Leptoptilos javanicus*	**D**	**VU**	-
4	*Psittacula longicauda*	TD	**NT**	**II**
5	*Halcyon smyrnensis*	**D**	LC	-
6	*Elanus caeruleus*	**D**	LC	**II**
7	*Spilornis cheela*	**D**	LC	**II**
8	*Rhipidura javanica*	**D**	LC	-
9	*Arachnothera longirostra*	**D**	LC	-
10	*Pericrocotus igneus*	TD	**NT**	-
11	*Loriculus galgulus*	TD	LC	**II**
12	*Gracula religiosa*	**D**	LC	**II**
13	*Anthracoceros albirostris*	**D**	LC	-

Note: Indonesian law number 7 year 1999 about preserving planta and animal species. IUCN = International Union for Conservation of Nature, CITES = The Convention on International Trade

in Endangered Species of Wild Fauna dan Flora. D = Protected, TD = Not Protected , LC = Least Concern, EN = Endangered, VU = Vulnerable, NT = Near Threatened

4 Conclusion

The number of spesies and species diversity was highest at HCS area with 25 species recorded with Margalef Index 5.99. The young stand of oil palm have the highest Evenness Index (0.93), while the highest similarity index is in old stand of oil palm and in smallholder oil palm. Our study concluded that oil palm establishment have reduced the bird species diversity. However, the existence of HCS area within oil palm plantations have increased the bird diversity. From a conservation perspective, retaining natural habitats such as high carbon stock areas within oil palm plantation is one strategy to conserve biodiversity. Moreover, the plantation estate should understand the importance of bird species diversity for ecosystem in plantations, especially bird species which are useful as natural pesticides, thereby reducing costs incurred to eradicate oil palm pests.

References

1. Directorate generale of plantations. Tree Crop Estate Statistic of Indonesia 2015-2017. Central Bureau of Statistic, Jakarta.(2016).
2. E. Ruswenti, W. Novarino, Rizaldi. Jenis-jenis burung di perkebunan kelapa sawit PT. Andalas Wahana Berjaya (AWB), Kabupaten Dharmasraya, Sumatera Barat. *Jurnal Biologi Universitas Andalas*. Vol **3**(3) : 219-226 (2014)
3. H.S. Alikodra, *Pengelolaan Satwaliar*. Forestry Faculty Bogor Agricultural University (2002).
4. M.P. Darmawan, Keanekaragaman Jenis Burung Pada Beberapa Tipe Habitat Di Hutan Lindung Gunung Lumut Kalimantan Timur. Forestry Faculty Bogor Agricultural University (2006)
5. R. Sozer, Y. Saaroni, P.F. Nurwatha, *Jenis-jenis burung dilindungi yang sering diperdagangkan* (Yayasan Pribumi Alam Lestari, Bandung, 1999)
6. J. MacKinnon, K. Phillipps, B. van Balen, *Burung-burung di Sumatra, Jawa, Bali dan Kalimantan*. Bogor (ID): Burung Indonesia. (2010).
7. A. Magurran, *Ecological Diversity and Its Measurement*, (Croom Helmed Limited, London, 1988)
8. R. Partasasmita, Komunitas Burung Pemakan Buah Di Panaruban, Subang : Ekologi Makan dan Penyebaran Biji Tumbuhan Semak, Bogor Agricultural University (2009).
9. S. Sopiyandi, Keanekaragaman Burung Pada Berbagai Tipe Tutupan Lahan Di Perkebunan Kelapa Sawit PT Mitra Unggul Pusaka Kabupaten Pelawanan, Riau. Bogor Agricultural University (2016).
10. M.F. Permana, Keanekaragaman jenis burung pada beberapa tipe habitat di hutan Lambusango, pulau Buton, Sulawesi Tenggara, Bogor Agricultural University (2016).
11. J. Setiawan, Keanekaragaman Jenis Burung di Areal PT Indocement Tunggal Prakarsa Tbk. Pabrik Palimanan. Bogor Agricultural University (2013).

12. Erniwati, E.A.M. Zuhud, Y. Santosa, I. Anas, The value of secondary forest patches for bird conservation in palm oil landscapes of Riau, Sumatra, *Biodiversitas* (**17**). (2016)

13. D. Yoza, Keanekaragaman jenis burung di berbagai tipe daerah tepi *(edge)* Taman Hutan Raya Sultan Syarif Hasyim Propinsi Riau. [Tesis]. Bogor Agricultural University (2006).

14. J.A. Ludwig, J.F. Reynolds, *Statistical Ecology: A Primer on Methods and Computing*, (John Wily and Sons, New York, 1988).

15. Y. Santosa, *Teknik Pengukuran Keanekaragaman Satwaliar*. Jurusan Konservasi Sumberdaya Hutan Fakultas Kehutanan-Institut Pertanian Bogor, Bogor. (Unpublished). (1995)

16. S.C. Kendeigh, *Ecology with Special Reference to Animal and Men,* (Prentice Hall of India Private Limited, New Delhi,1980).

17. G. Ganevan, Keanekaragaman jenis burung pada lima ketinggian tempat di Resort Gunung Putri Taman Nasional Gunung Gede Pangrango Bogor Agricultural University (2016).