Impact of oil palm plantation on mammal and herpetofauna species diversity

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Abstract. Since 2008, Indonesia has succeeded in becoming the largest palm oil producer in the world. However, this success has drawn some accusations that oil palm plantations cause deforestation and decreasing biodiversity. The research has been carried out in the topic of “the origin of the status and type of land cover and variations in the wildlife species diversity in oil palm plantations” in Province of Riau, South Sumatra, Central Kalimantan and West Kalimantan. The results of the interpretation of Landsat imagery coverage of 1 year before being oil palm plantation and interviews with resource persons showed that the type of land cover of the 8 study locations was 5 in the form of secondary forest, 2 bushes and the rest in the form of rubber plantations. The status of the land as a whole APL or customary land. Furthermore, the results of the comparison of the number and composition of species of mammals and herpetofauna before and after being oil palm plantations show that the impact of oil palm plantations on these two variables of diversity species according to the origin of land cover types. For the origin of the type of land cover in the form of bushes or rubber plantations, the impact of oil palm plantations is positive because it increases the number of species both mammals and herpetofauna before and after being oil palm plantations show that the impact of oil palm plantations on these two variables of diversity species according to the origin of land cover types. As for the origin of the type of land cover in the form of secondary forest, the existence of oil palm plantations increase the number of mamalia in 2 locations and herpetofauna in 4 locations The presence of oil palm plantations is thought to have caused changes in the composition of species with a range of 50 to 100% for mammals and 23 to 76% for herpetofauna.

1. Introduction
The expansion of oil palm plantations in developing countries is carried out as one of the economic development policies [1]. In 2017, palm oil has become the main product and play a role in the Indonesian economy from the plantation sector [2]. The area of oil palm plantation in Indonesia reaches 12.31 million ha in 2017 [3]. The expansion of oil palm plantation is thought to be a trigger for deforestation because it has rapid expansive properties in a short time [4]. This is also reinforced by a statement [5] that the conversion of forest areas in Indonesia is the largest allocated for oil palm plantations.

Deforestation has caused a diversity of wildlife species such as mammals and herpetofauna to decline. Mammals and herpetofauna are important components in maintaining ecosystem balance.
Mammals play a role in pest control, seed spreaders, predators, and pollinators for plants [6]. In addition, mammals also act as level I and II consumers and top predators in the food chain [7]. Meanwhile, Herpetofauna is a combination of reptiles and amphibians which are used as bioindicators of environmental change. This is because herpetofauna is very susceptible to environmental changes [8] and all aspects of life are affected by the climate in these habitats [9].

This research was carried out because there was still a lack of knowledge about the impact of the establishment of oil palm plantations on mammals and herpetofauna in various land coverings. The purpose of this study was to identify palm oil plantations, species of palm plantations, and plant oil palm oil. Estimate the impact of oil palm plantations on species of mammals and herpetofauna and Estimate the impact of oil palm plantations on loss/gain in species of mammals and herpetofauna.

2. Materials and methods
The impact of oil palm plantation mammals and herpetofauna diversity was known by comparing the types covered in land cover before and after oil palm plantation (OPP) establishment. Landsat imagery was interpretation to find out the history of land cover change for two years coverage before OPP establishment since it is not possible to find the exact land cover type as those before the conversion to oil palm. The present land cover type is assumed to represent the past land cover before the oil palm plantations establishment. In the same line, it is assumed that the mammal and herpetofauna diversity would also be similar.

2.1. Study area
The study was conducted on 8 large-scale oil palm plantations (PSB) located in the Riau (PT KPR, PT SAR, PT AMA, PT GDH and KJNPE), South Sumatera (PT WMA), Central Kalimantan (PT BLP) and West Kalimantan (PKWE) Province on two types area (baseline area and oil palm plantations area). Data collection was conducted out in 2016-2018.

2.2. Study methods
Animal inventory was carried out simultaneously on each type of land cover present in each habitat. The inventory of mammals was done using the list transect method with three repetitions. There 15 camera traps were used to record observation indirectly. The observation was done in the morning (06:00-08:00 WIB) and afternoon (15:30-17:30 WIB). Herpetofauna inventory was done by using Visual Encounter Survey method for 3 hours starting from 19:00 to 22:00 with three repetitions.

2.3. Data analysis
To find out the impact of oil palm plantation on mammals and herpetofauna species diversity, the calculation of number of species, evenness index and species richness index are calculated as follows:

- **Species richness index (Dmg)**
  Margalef Index (species richness) used to determine the species richness of each species in the community that found in the field, the formula is:
  \[ Dmg = \frac{S - 1}{\ln N} \]
  Information:
  
  | Symbol | Description |
  |--------|-------------|
  | Dmg    | species richness index |
  | S      | number of species |
  | N      | total number of individuals of all species |

- **Evenness index (E)**
  Evenness Index has a function to determine the evenness of each type in every community.
  \[ E = \frac{H'}{\ln(S)} \]
Inform
ation:
E = evenness index (a value between 0-1)
H' = diversity
ln = natural logarithm
S = number of species

Whereas to determine the impact of oil palm plantation on species composition, a number of mammals and herpetofauna diversity loss and gain in all location, the following formula is used:

- Dissimilarity index (ID)
  Dissimilarity index is used to determine the dissimilarity between the observation location based on the species mammals and herpetofauna found

\[ ID = 1 - IS, \text{ where } IS = \frac{2c}{(A+b)} \]

Information:
ID = Dissimilarity indeks
IS = similarity index
a = the number of species that are only found in community A
b = the number of species that are only found in community B
c = the number of species found in community A and B

3. Results and discussion

3.1. History of land cover types and status
The type of land cover of the 8 study locations was no longer in the form of primary forest, but 5 of them were in the form of secondary forest (PT KPR, PT SAR, PT AMA, PT GDH and PT BLP), 2 shrubs (KJNP Estate and PKWE) and the rest in the form of rubber plantations (PT WMA). Table 1 presents data on the type and status of land cover before the oil palm plantation establishment.

| Study location | Land cover types before oil palm plantation established | Land status before oil palm plantation established |
|----------------|--------------------------------------------------------|--------------------------------------------------|
| Riau           | PT. KPR Secondary forest                               | Others land use                                  |
|                | PT. SAR Secondary forest                               | Others land use and Transmigration area          |
|                | PT. AMA Secondary forest                               | Others land use                                  |
|                | PT. GDH Secondary forest                               | Others land use                                  |
|                | KJNP Estate Shrub                                     | Others land use                                  |
| South Sumatera | PT. WMA Rubber plantation                             | Others land use                                  |
| Central Kalimantan | PT. BLP Secondary forest                       | Others land use                                  |
| West Kalimantan | PKW Estate Shrub                                      | Others land use                                  |

Besides that, the status of the land as a whole is not a forest area but APL, customary land and transmigration area. Transmigration policy (1905-1940/ Dutch colonial period; and 1969- present) – around 8.94 million land (Most of the part of the forest) were conversed into crops plantation, especially in order to increase rice production. Meanwhile, Forest use rights (HPH) using its systematic logging as it was started since the 1970s (1985 – 1997 as the peak) with degradation rate around 1.26 million per year which made it as a major acceleration of the deforestation as it turned out to be an access for the newcomers. The policy about increasing deforested forest production which allowing investors to open the land (especially for the degraded land) to open oil palm plantation and industrial forest started in the late 1980s).

3.2. Impact on diversity of species
There are 11 species of mammals found in the baseline area of each location. The highest number of species mammals is found in PT KPR with five species, and the lowest is in PT KJNP (S = 0). PT
KPR also has the highest species richness index compared to the other locations (Dmg = 2.23). Three locations have zero of species richness index, namely PT GDH, KJNPE and PKWE. All species of mammals are shown in table 2.

Table 2. List of mammals species before OPP establishment

| No | Scientific name          | PT KPR | PT SAR | PT AMA | PT GDH | PT BLP | KJNPE | PKWE | PT WMA |
|----|--------------------------|--------|--------|--------|--------|--------|-------|------|--------|
| 1  | Callosciurus notatus      | 2      | 5      | 0      | 0      | 2      | 0     | 3    | 5      |
| 2  | Macaca fascicularis       | 1      | 0      | 6      | 25     | 0      | 0     | 0    | 0      |
| 3  | Macaca nemestrina         | 0      | 1      | 0      | 0      | 0      | 0     | 0    | 0      |
| 4  | Muntiacus muntjak         | 1      | 0      | 0      | 0      | 0      | 0     | 0    | 0      |
| 5  | Pongo pygmaeus            | 0      | 0      | 0      | 0      | 1      | 0     | 0    | 0      |
| 6  | Tracypithecus auratus     | 0      | 0      | 0      | 0      | 0      | 0     | 0    | 0      |
| 7  | Primatesia aurata         | 0      | 0      | 10     | 0      | 0      | 0     | 0    | 0      |
| 8  | Macaca nemestrina         | 0      | 0      | 0      | 0      | 0      | 0     | 0    | 0      |
| 9  | Sus scrofa                | 1      | 1      | 0      | 0      | 0      | 0     | 0    | 0      |
| 10 | Tupaia minor              | 0      | 0      | 0      | 0      | 1      | 0     | 0    | 0      |
| 11 | Tupaia splendidula        | 0      | 2      | 1      | 0      | 0      | 0     | 0    | 0      |

The species of mammals found in the OPP area are more than in the baseline area. There are 12 species of mammals are found in the OPP area. PT WMA and PT BLP have the most number of species, namely six species. While PT GDH has the least number of mammals which are two species, the highest species richness index was found in PT BLP (Dmg = 1.47) and the lowest in PT GDH (Dmg = 0.51). The species of mammals found can be seen in table 3.

Table 3. List of mammals species after OPP establishment

| No | Scientific Name          | PT KPR | PT SAR | PT AMA | PT GDH | PT BLP | KJNPE | PKWE | PT WMA |
|----|--------------------------|--------|--------|--------|--------|--------|-------|------|--------|
| 1  | Aonyx cinereus           | 0      | 0      | 0      | 0      | 0      | 0     | 8    | 1      |
| 2  | Callosciurus notatus      | 2      | 0      | 0      | 5      | 14     | 1     | 7    | 6      |
| 3  | Macaca nemestrina         | 0      | 0      | 0      | 0      | 1      | 0     | 0    | 0      |
| 4  | Macaca fascicularis       | 0      | 0      | 0      | 0      | 0      | 0     | 36   | 26     |
| 5  | Macaca nemestrina         | 0      | 1      | 0      | 0      | 0      | 0     | 0    | 0      |
| 6  | Paradoxus hermaphroditus  | 1      | 0      | 3      | 0      | 0      | 0     | 0    | 0      |
| 7  | Presbytis cristata       | 0      | 0      | 0      | 0      | 6      | 0     | 1    | 1      |
| 8  | Prionailurus bengalensis  | 0      | 3      | 0      | 1      | 1      | 0     | 1    | 1      |
| 9  | Rattus rioumania          | 0      | 9      | 11     | 0      | 12     | 0     | 4    | 17     |
| 10 | Sus barbatus             | 0      | 0      | 0      | 0      | 1      | 0     | 0    | 0      |
| 11 | Tupaia minor             | 0      | 0      | 0      | 0      | 0      | 0     | 0    | 0      |

The origin of land cover types in the form of shrubs or rubber plantations, the impact of oil palm plantations is positive because it increases the number of mammal species. Whereas for the origin of land cover types in the form of secondary forests, the existence of oil palm plantations has caused unchanged (2 locations), increased (2 locations) and decreased (1 location) number of mammals. Seen from species richness index, the highest change in value is found in PKWE with Dmg = +1.04. Changes in the number and value of mammal species can be seen in table 4.
Table 4. Comparison of ecological variable value of mammal species diversity

| Types of Land Cover Before Oil Palm Plantations Establish | Study Location | Impact Of Oil Palm Plantations on Mammals Species Diversity |
|---------------------------------------------------------|----------------|------------------------------------------------------------|
| Secondary forest                                       | Riau PT. KPR   | S= Decreasing 2 species (from 5 to 3 species) Dmg= -0.79   |
|                                                         | Riau PT. SAR   | S= Does not changes (4 species) Dmg= -0.39                 |
|                                                         | Riau PT. AMA   | S= Does not changes (3 species) Dmg= +0.03                 |
|                                                         | Central Kalimantan PT. BLP | S= Increasing 3 species (from 3 to 6 species) Dmg= +0.03 |
| Shrub                                                  | Riau KJNP Estate | S= Increasing 3 species (from 0 to 3 species) Dmg= +0.53  |
| West Kalimantan                                        | PKW Estate     | S= Increasing 4 species (from 1 to 5 species) Dmg= +1.04   |
| Rubber plantations                                     | South Sumatera PT. WMA | S= Increasing 4 species (from 2 to 6 species) Dmg= +0.70 |

There are two areas that have declining species richness index (PT KPR and PT SAR) (table 4). Both locations have a baseline in the form of a secondary forest. Similar to the research of [7] who also found that changes from secondary forest to oil palm plantations had a negative impact than shrub or rubber plantation areas. One of the factors that influence the decline in the species richness index is the difference in habitat structure. As stated by [10] that the high diversity of mammal species influenced by the high diversity of vegetation species. Secondary forest areas have more diverse species of vegetation and more complex strata than OPP area. This is similar to [11] statement that forested areas have a high diversity of vegetation. Variations in strata and the number of species of vegetation greatly affect the presence of mammals because mammals need trees that can be used as a place of refuge and become a source of food. According to [12] each stratum can support the life of a certain species of wildlife. [13] stated an increase in the number of different habitats led to an increase in species diversity.

The expansion of this large-scale crop monoculture has provided an unnatural environment in which many animals have rapidly adapted and become pests. One of them is the rat that is adaptable, aggressive, highly competitive, fierce and difficult to control [14]. Based on Tables 2 and 3, *Rattus tiomanicus* is gained after OPP established in 4 areas (SAR, PT AMA, PT BLP and PKWE). Research by [15] also found that *Rattus tiomanicus* dominated 68% in 28 oil palm plantations that researched. [16] explained that habitat change had occurred in *Rattus tiomanicus* which is currently rarely found in mature forests. Habitation of this biome appears to have effectively ‘pre-adapted’ the species for life in oil palm plantation [17]. [18] also stated that rats tend to increase in the plantation area. One of the factors that make *Rattus tiomanicus* increase in oil palm plantations is the abundance of feed. [19] explained that the uncontrolled population of *Rattus tiomanicus* reached 600 individuals per hectare and caused damage to oil palm plantations. The study of [20] states that many adult *Rattus tiomanicus* forage oil palm fruit. Another study of *Rattus tiomanicus* in an oil palm plantation also revealed that on average about 96% of their stomach contents was made up of oil palm fruit [21]. Besides, *Rattus tiomanicus* also forage for insect, molluscs and other invertebrates among the ground vegetations of oil palm plantation fields [22]. [23] stated that rodent relations and the abundance of oil palm fruit were considered as numerical responses, which meant that the more the number of oil palm fruits, the more the number of rats. Furthermore, the study also presents correlative evidence that at least 1 species rats in oil palm plantations increase in abundance with food availability in a number of circumstances.

Based on table 5, the total number of herpetofauna found before OPP was 29 species (16 amphibians and 13 reptiles). PT BLP has the highest number of species (S = 12) and the highest
species richness index (Dmg = 3.88). The lowest number of species and species richness index in PT GDH (S = 0; Dmg = 0).

| Table 5. List of herpetofauna species before OPP establishment |
|----------------------|--------------------|----------------|-------------------|-------------------|----------------|----------------|----------------|
| N o | Scientific name | PT KPR SAR | PT AMA | PT GDH | PT BLP | KJNP E PKW E | PT WMA |
| --- | -----------------| ------------|--------|--------|--------|-------------|--------|
| Amphibi | | | | | | | |
| 1 | Ingerophrynus biporactus | 0 0 0 0 | 1 0 0 0 | 1 | 0 | 0 | 1 |
| 2 | Pseudobofo subasper | 0 0 0 0 | 1 0 | 0 | 0 | 0 | 0 |
| 3 | Fejervarya cancrivora | 0 0 1 0 | 1 4 | 0 | 3 | 0 | 0 |
| 4 | Fejervarya limnocharis | 0 0 0 0 | 5 | 7 | 2 | 2 | 0 |
| 5 | Microhyla achatina | 1 0 0 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | Microhyla heyromysi | 1 0 0 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | Microhyla sp | 0 0 0 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Amnirana nicobariensis | 0 0 0 0 | 0 1 | 0 | 0 | 0 | 0 |
| 9 | Chalcophorus raniceps | 0 1 | 1 0 | 0 0 | 0 | 0 | 0 |
| 10 | Huia sumatranus | 0 0 0 0 | 0 | 1 | 0 | 0 | 0 |
| 11 | Hylarana erythraea | 3 0 2 | 0 | 0 | 0 0 | 0 | 0 |
| 12 | Limnonectes paramacrodon | 0 0 0 0 | 0 0 | 0 | 0 0 | 0 | 0 |
| 13 | Limnonectes sp | 0 0 0 0 | 3 0 | 0 | 0 | 0 | 0 |
| 14 | Pulchrana baramica | 0 0 0 0 | 1 1 | 0 | 0 | 0 | 0 |
| 15 | Pulchrana glandulosa | 0 0 1 | 0 | 1 | 5 | 0 | 0 |
| 16 | Polypedates leucomystax | 0 1 1 | 0 | 2 | 4 | 0 | 0 |
| 17 | Polypedates macrotis | 0 0 0 0 | 1 0 | 0 | 0 | 0 | 0 |
| Reptile | | | | | | | |
| 18 | Boiga dendrophila | 0 0 1 | 0 | 0 | 0 | 0 | 0 |
| 19 | Dendrelaphis caudolineatus | 0 1 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | Dendrelaphis pictus | 0 0 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | Bungarus pictus | 0 0 0 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | Crotodactylus marmoratus | 0 0 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | Hemithectus frenatus | 0 0 0 0 | 1 0 | 0 | 1 | 0 | 0 |
| 24 | Dasia viitata | 0 0 0 | 0 | 1 | 0 | 0 | 0 |
| 25 | Eutropis multifasciata | 0 0 0 0 | 2 | 0 | 0 | 0 | 0 |
| 26 | Eutropis radis | 0 0 0 | 0 | 2 | 0 | 1 | 2 |
| 27 | Eutropis sp | 0 0 0 | 0 | 0 | 0 | 0 | 0 |
| 28 | Takydromus sexlineatus | 0 0 0 | 1 | 0 | 0 | 0 | 0 |
| 29 | Varanus salvator | 0 0 0 | 0 | 1 | 0 | 0 | 0 |
| Number of individuals | 5 3 7 | 0 | 22 33 | 8 17 |
| Number of species | 3 3 7 | 0 | 12 12 | 3 10 |

There is number of herpetofauna found in OPP area than baseline area. As seen in table 6, there are 16 species of reptiles and 24 species of amphibians. The highest number of species was found in KJNP, and PT WMA (S = 19) and the highest species richness index was found at PT WMA (Dmg = 3.83). PT AMA has the lowest number of species (S = 12) and the lowest species richness index (Dmg = 2.62).

| Table 6. List of herpetofauna species after OPP establishment |
|----------------------|-----------------|----------------|-------------------|-------------------|----------------|----------------|----------------|
| No | Scientific name | PT KPR SAR | PT AMA | PT GDH | PT BLP | KJNP E PKW E | PT WMA |
| --- | -----------------| ------------|--------|--------|--------|-------------|--------|
| Amphibi | | | | | | | |
| 1 | Duttaphrynus melanostictus | 2 6 10 | 3 0 | 5 | 0 | 4 | 0 |
| 2 | Ingerophrynus biporactus | 1 1 0 | 1 7 | 0 | 0 | 5 | 0 |
| 3 | Phrynoidea aspera | 7 0 0 | 1 0 | 1 0 | 0 | 0 | 0 |
| 4 | Pseudobofo subasper | 0 0 0 | 1 0 | 0 | 0 | 0 | 0 |
| 5 | Fejervarya cancivora | 0 2 4 | 0 | 19 | 6 | 4 | 34 |
| 6 | Fejervarya limnocharis | 9 8 | 21 44 | 12 | 18 | 30 | 21 |
| 7 | Leptobrachium abotti | 0 0 0 | 0 | 0 | 1 | 1 | 0 |
Similar to changes in the number and species richness index of mammal species, the amount and species richness index of herpetofauna also have positive changes in the area of Shrub and Rubber plantation. Unlike the case with the secondary forest area, the comparison between positive and negative changes are balance (2 location positive and 2 location negative). Seen in table 7, the highest change in value is found in PT KPR with Dmg = +1.95.

**Table 7.** Comparison of ecological variable value of herpetofauna species diversity

| Types of Land Cover Before Oil Palm Plantations Establish | Study Location | Impact of Oil Palm Plantations on Herpetofauna Species Diversity |
|----------------------------------------------------------|----------------|-----------------------------------------------------------------|
| Secondary forest                                         | Riau           | **PT. KPR**<br>$S =$ Increasing 9 species (from 4 to 13 species)<br>Dmg = +1.95 |
|                                                          | PT. SAR        | **S =$ Increasing 11 species (from 3 to 14 species)<br>Dmg = +1.76 |
|                                                          | PT. AMA        | **S =$ Increasing 10 species (from 3 to 13 species)<br>Dmg = -0.47 |
| Central Kalimantan                                        | PT. BLP        | **S =$ Increasing 3 species (from 12 to 15)<br>Dmg = -1.01 |

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The change from rubber plantation and shrub to OPP has a positive impact, namely an increase in the value of species diversity. PT AMA and PT BLP (secondary forest) have a decrease in the species richness index when the number of species increases (Table 7). This can be caused by the influence of the number of individuals. Similarly, the study of [24] also found a decrease in species richness index when the number of species increased. [24] also noted that the margalef index was not only influenced by the number of species but also by the number of individuals. Reference [25] explains that the margalef index has high sensitivity and the ability to respond to the difference in species so that the dominance of species will affect the values of the index. The existence of sources of water and canopy cover are the factors that most influence the presence of herpetofauna, because both of these affect the humidity in a habitat. According to [26] the existence of water sources is a limiting factor for animals that are dependent on water, such as herpetofauna. Secondary forest areas in PT AMA and PT BLP have very abundant water sources because they are close to the river flow. It is different from the condition of secondary forests in PT KPR and PT SAR which only have water sources from the trench.

### 3.3. Impact on community of species

The presence of oil palm plantations has a change in species composition with a range of 50 to 100% for mammals and 23 to 76% for herpetofauna. PT AMA, PT GDH and KJNPE had the highest of dissimilarity value of 100%, meaning that all species found in the baseline area were not found in the OPP area. While the highest dissimilarity value for herpetofauna is found in PT SAR, all dissimilarity values can be seen in table 8.

| Types of land cover before oil palm plantations established. | Study location | Impact of Oil Palm Plantation on Mammal and Herpetofauna Species Composition (Dissimilarity) |
|--------------------------------------------------------------|----------------|---------------------------------------------------------------------------------------------|
| Secondary forest                                             | Riau           |                                                                                             |
|                                                              | PT. KPR        | 50 %                                                                                       |
|                                                              | PT. SAR        | 50 %                                                                                       |
|                                                              | PT. AMA        | 100 %                                                                                      |
|                                                              | PT. GDH        | 100 %                                                                                      |
| Central Kalimantan                                           | PT. BLP        | 56 %                                                                                       |
|                                                              |                | 26 %                                                                                       |
| Shrub                                                        | Riau           |                                                                                             |
|                                                              | KJNP Estate    | 100%                                                                                       |
|                                                              |                | 23 %                                                                                       |
| West Kalimantan                                              | PKW Estate     | 67%                                                                                         |
|                                                              |                | 62.5%                                                                                      |
| Rubber plantations                                           | South Sumatera |                                                                                             |
|                                                              | PT. WMA        | 50%                                                                                         |
|                                                              |                | 27%                                                                                         |

The location of secondary forest in PT KPR and rubber plantation of PT WMA has a distance that is very close or adjacent to the OPP area. This is thought to be one of the factors affecting the similarity between the two habitats. [27] said that the similarity index is influenced by the distance between habitat. Besides distance, [28] explain the same vegetation composition and other environmental factors also affect the similarity index. In addition, the presence of HCV areas can also increase the number of mammal and herpetofauna species. Based on [29] who found that similarity
between baseline and OPP was influenced by the presence of HCV that was part of the OPP. PT WMA has a similarity value of 50%, and 4 of 6 species of mammals are found in the HCV area. The presence of HCV in oil palm plantations has an important role in maintaining and increasing the diversity of mammal and herpetofauna species. [27] said that HCV is a place of refuge especially for arboreal animals such as primates. As stated in [7] found the HCV area had a high variation of vegetation and that the vegetation was used as a shelter and feed source for mammals. Similar to the location of KJNPE which has the lowest dissimilarity value of 23% or 77% types of herpetofauna can be found in the shrub and OPP area. In general, the number of species found in the baseline area can still be found in the OPP area, and even there are some new species found in the OPP area. This proves that the OPP area can still be a suitable habitat for herpetofauna.

3.4. Impact on loss/gain of species
Figure 1 presents data on the number of species loss and gain due to the conversion of secondary forest to oil palm plantations. The highest species of losses are found in PT KPR and PT AMA with a total loss of 3 species mammals, while the highest number of gains is in PT BLP with a total gain of 4 species. In PT KPR, there are three loss species (Macaca fascicularis, Muntiacus muntjak and Prionailurus bengalensis). Meanwhile, the species loss in PT AMA are Macaca fascicularis, Trachypithecus auratus and Tupaia spendidula. Similar to the research of [30] who found Mutiacus muntjak only in wooded areas and did not find it in the OPP area. [31] explained that Mutiacus muntjak is one species of mammal that is negatively affected by forest fragmentation or conversion. This mammals is a diurnal active [32], so that M. muntjak activity must be disrupted by the activities of employees working in oil palm plantations. Naturally, wildlife will avoid if there is human activity [33].

![Figure 1. Comparison of mammal species loss and gain percentage from secondary forest](image)

In addition, the species loss is caused in the secondary forest area has a variety of vegetation and more food sources. Reference [34] cites that low biodiversity in oil palm plantation area is caused by monoculture and there are not major components of forest vegetation. Research [35] proved that mammals of primates such as Macaca fascicularis were more commonly found in secondary forests because they had abundant feed sources. Artocarpus interget is one species that dominated in secondary forest PT KPR and PT AMA. According to the results of [36] cempedak is one of 9 types of primate feed.
Figure 2. Comparison of mammals species loss and gain percentage from shrubs

The conversion from shrub into OPP does not cause loss of mammal species (figure 2). In KJNPE, there are three species gain, namely Callosciurus notatus, M. fascicularis and T. auratus. While in PKWE there are four species gain, namely Prionailurus bengalensis, M. fascicularis, Rattus tiomanicus and Aonyx cinerus. Plantain squirrel or Callosciurus notatus is a species of mammal that has high adaptability, wide distribution and tolerance to habitat changes [7] so that this species can be found in the OPP area. Furthermore, the discovery of P. bengalensis was caused because R. tiomanicus was found in the OPP area which is the main food P. bengalensis. This type of mammal is often used as a biocontrol in rat pests on oil palm plantations [37], [38] said carnivorous species like a P. bengalensis have a role a balancing ecosystem mainly as a predator of a small animal such as R. tiomanicus and C. notatus.

Figure 3. Comparison of mammals species loss and gain percentage from rubber plantation

As with shrub, the conversion from rubber plantation to OPP does not cause loss of species (figure 3). There are three species of mammals found in OPP PT WMA (P. bengalensis, T. auratus, M. fascicularis and Aonyx cinerus). Like PKWE, Aonyx cinerus was also found in the PT WMA OPP area. Large and deep canals surround the PT WMA OPP area. This canal contains peat water which lives in various kinds of fish such as Clarias nieuhofii, Mystus sp, Channa striata and Channa pleurophthalma. [39] stated the food composition of small claw otters is Pisces and Mollusca as the main food, Insecta and Amphibians as the second food, Crustacea and Mammals as complementary foods. The study of [40] and [41] also found that A. cinereus was only found in oil palm plantation areas and nesting inside of the canal.

The effect of conversion from secondary forest to OPP area tends to have a positive impact. All locations that have higher number of species gain than the number of species loss (figure 4). PT SAR has the highest number of species gain which is 12 species. While the lowest is PT BLP with four species gain. PT KPR and PT BLP have not a loss species. Different from PT SAR and PT AMA which have one species loss.
The secondary forest of PT SAR only found three species of herpetofauna, while the OPP area had 15 species of herpetofauna. The small amount of herpetofauna found in the secondary forest of PT KPR because this area has a water source with a low pH which is 4. According to [42] amphibians will grow optimally if the support has a pH of 6-8. In contrast to [43] states that Anura can tolerate a pH range of water from 4.3 to 7.5. Physical factors such as pH influence anura growth [44] The only loss species in OPP PT AMA is Boiga dendrophila. Gold ringed cat snakes or B. dendrophila are an arboreal snake. This snake commonly found in habitat dominated by trees with lots of twigs [45]. This is related to the conditions of secondary forest of PT AMA which are dominated by Dipterocarpacea and Anacardiaceae (Shorea pauciflora, Shorea teysmanniana and Gluta renghas). It is different with the condition in HCV PT AMA which is dominated by shrubs and does not have strata such as the secondary forest area. This was one of the factors not found in B. dendrophila in the PT AMA OPP area.

Figure 5. Comparison of herpetofauna species loss and gain percentage from shrub

Similar to the secondary forest area, the shrub area also has a high number of species gain (8 species in the KJNPE and ten species in the PKWE). The factors that affect loss and gain species in KJNPE and PKWE are canopy cover conditions. Shrub has a canopy cover, and OPP has a canopy cover. This can affect the humidity and temperature in the area. The same thing was also explained by [46] that canopy cover affects the temperature and humidity of a habitat. Herpetofauna is a poikilotherm whose body temperature depends on the temperature of the environment [47]. Research by [48] states that herpetofauna prefers habitat with a closed canopy because it has high humidity. [43] in his research obtained the optimal humidity range for herpetofauna between 84% and 99%.
Figure 6. Comparison of herpetofauna species loss and gain percentage from shrub

Conversion from rubber plantation to oil palm plantations also have a positive impact. PT WMA has eight species gain and no one species loss due to land conversion. Species gain are *Duttaphrynus melanostictus*, *Pulchrana baramica*, *Chalcorana chalconota*, *Polypedates leucomystax*, *Leptobrachium hasseltii*, *Naja sumatrana* and *Cancridus bungarus*. The number of species gains of amphibians is many because the OPP area has more water sources than the rubber plantation area. Anura is always associated with water and anura requires water to lay eggs or breed [49]. In addition, [50] amphibians are always associated with water, because water can maintain changes in body temperature.

4. Conclusion
All the oil palm plantations being studied was converted from the secondary forest with non-forest area status. The presence of oil palm plantations does not always cause a decline in the diversity of species of mammals and herpetofauna. Oil palm plantations in all study areas resulted in a change in the species composition of both mammals and herpetofauna.

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