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The impacts of oil palm plantation establishment on the habitat type, species diversity, and feeding guild of mammals and herpetofauna

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Abstract. *Kwatrina RT, Santosa Y, Bismark M, Santoso N. 2018. The impacts of oil palm plantation establishment on the habitat type, species diversity, and feeding guild of mammals and herpetofauna. Biodiversitas 19: 1213-1219.* Indonesia is the world's largest producer of palm oil. Contributing 2.14% to the country's gross domestic product, palm oil plays an important role in the national economy from plantation sector. However, the expansion of oil palm plantations has brought negative impacts to forests and wildlife. Little is known to what extent these negative impacts on mammals and reptiles can be reduced through better management. To address this knowledge gap, the current study assessed species diversity as affected by the establishment of the oil palm plantation in Central Kalimantan, a tropical biodiversity hotspot in Asia. We conducted 25 line transect surveys and visual encounter surveys in oil palm areas, shrubs and secondary forests in these landscapes. The results indicated that the establishment of oil palm plantation negatively impacted species abundance and diversity, and changed the mammal and reptile species composition, by favoring ecologically generalist species. For forest specialist species, forested areas like HCV and HCS, play an important role in maintaining habitat heterogeneity in oil palm landscapes. Mammal species found in habitat conditions following oil palm plantations belong to some feeding groups, whereas all species of herpetofauna have terrestrial habitat types. These mammal and herpetofauna species can live and function in the food chain in the oil palm plantation ecosystem.

Keywords: Borneo, high conservation value, habitat heterogeneity, oil palm plantation, species diversity

INTRODUCTION

Indonesia is the world's largest producer and exporter of crude palm oil with a total area of 12.3 million ha and produces 35.4 million tons by 2017 (Dirjenbun 2016). Together with Malaysia, Indonesia controls almost 85% of the world's palm oil production. With its contribution to the national income of approximately 18.1 billion dollars in 2016 and soared by 26% to US $ 22.97 billion in 2017 (GAPKI 2017) or 2.31% of total national GDP, palm oil has become a mainstay product and play a leading role in the Indonesian economy from plantation sector.

The expansion of oil palm (*Elaeis guineensis*) plantations also creates a negative perception of the loss of biodiversity. For the Southeast Asian region, oil palm plantations in Indonesia are often blamed for the destruction of tropical biodiversity (Fitzherbert et al. 2008; Koh and Wilcove 2008; Sodhi et al. 2008; Colchester et al. 2011). The characteristics of oil palm plantations are considered to greatly reduce the functioning of species diversity and support only a few forest-dependent species (Aratrakorn et al. 2006; Edwards et al. 2013). Mammals and herpetofauna are animals that are affected by the expansion of oil palm plantations. Mammals play an important role in maintaining and preserving the continuity of ecological processes (Kartono 2015), while herpetofauna is a part of the environmental biological indicators. Although the number of mammal species that can survive in the oil palm plantations is relatively small (Yasuma 1994), the available information on the impact of oil palm plantation establishment on species diversity is limited (Sodhi et al. 2010). Several studies have examined the impact of forest change on the tropical herpetofauna community (Vitt and Caldwell 2001, Wanger et al. 2010), and the effects of oil palm plantation establishments on mammals (Maddox et al. 2007; Bernard et al. 2009; Nantha and Tisdell 2009; Azhar et al. 2014; Kartono 2015). However, up to now, studies related to mammal and herpetofauna diversity based on changes in land cover in oil palm plantations have not been widely implemented. It is important to know the implementation of those studies because Indonesian oil palm plantations come in various types of land cover such as shrubs, forests, fields, or other plantations.

Kalimantan is an important region of tropical biodiversity in Indonesia and is often the object of biodiversity and deforestation studies. The growth trend of oil palm plantations in Indonesia has also contributed to the expansion of these plantations in Kalimantan. In 2016, the total area of oil palm plantations in this region ranked second after Sumatra. The largest area is located in Central Kalimantan Province with about 38.4% of the total area of Kalimantan (Dirjenbun 2016). So far, there are still some questions about how biodiversity in Borneo is affected by the establishment of oil palm plantations. To address the knowledge gaps and obtain the accurate information on species diversity and composition, a study of mammals and herpetofauna in oil palm plantations was conducted by comparing the conditions of habitat prior to the oil palm plantation development and subsequent habitat conditions. This research will help our understanding of the impacts of the establishment of oil palm plantations on the diversity of mammals and herpetofauna on a land cover.

MATERIALS AND METHODS

Study area

The study was conducted in Kotawaringin Barat District, Central Kalimantan Province, Indonesia (Figure 1). Four oil palm plantation companies (Site A, Site B, Site C and Site D) and seven smallholder plantations located in three Sub-districts of Kumai, Arut Selatan, and Pangkalan Lada were used as the study sites. The oil palm plantations were established between 1993 and 2015. The observed smallholder plantations are located around the companies' plantation area.

Each plantation has different types and characteristics of land cover. Shrubs are present on Sites A, C, and D. These three sites are located in the areas adjacent to roads, HCV areas (High Conservation Value) and HCS (High Carbon Stock) areas, oil palm plantations, rubber plantations, and village forests. The ground cover consists of dense shrubs, and in the shrub area, *Mucuna* spp are also found. The secondary forests are found outside the plantation sites B, C, and D adjacent to oil palm plantations area, open land, lakes, or riparian areas.

The companies' oil palm plantations (large scale plantation) consist of several age classes. The first class is young palm plantation, planted in 2013, 2015, 2016 or one to four years old at the time of the study, and located adjacent to oil palm plantations, community forests, secondary forests, and HCV areas. The area of the young palm plant is characterized by 2-3 m tall plants, and groundcover with shrubs, grasses, *Mucuna bracteata*, sintrong (*Crassocephalum crepidioides*) and fern (*Stenochlaena palustris*). The second class is middle-aged palm plantation, grown in 1998, 2005, and 2006 or 11 to 19 years old when the research was conducted, and located on the main roadside adjacent to oil palm plantations. Most have fairly wide canopy covers and groundcover with fern (*S. palustris*). The third is old palm plantation, grown in 1993, 1994, 1997 or aged up to 24 years and located adjacent to rivers, oil palm plantations, and HCV areas. Oil palm in this category is characterized by closed canopy cover and groundcover with shrub species such as sintrong (*C. crepidioides*) and fern (*S. palustris*).

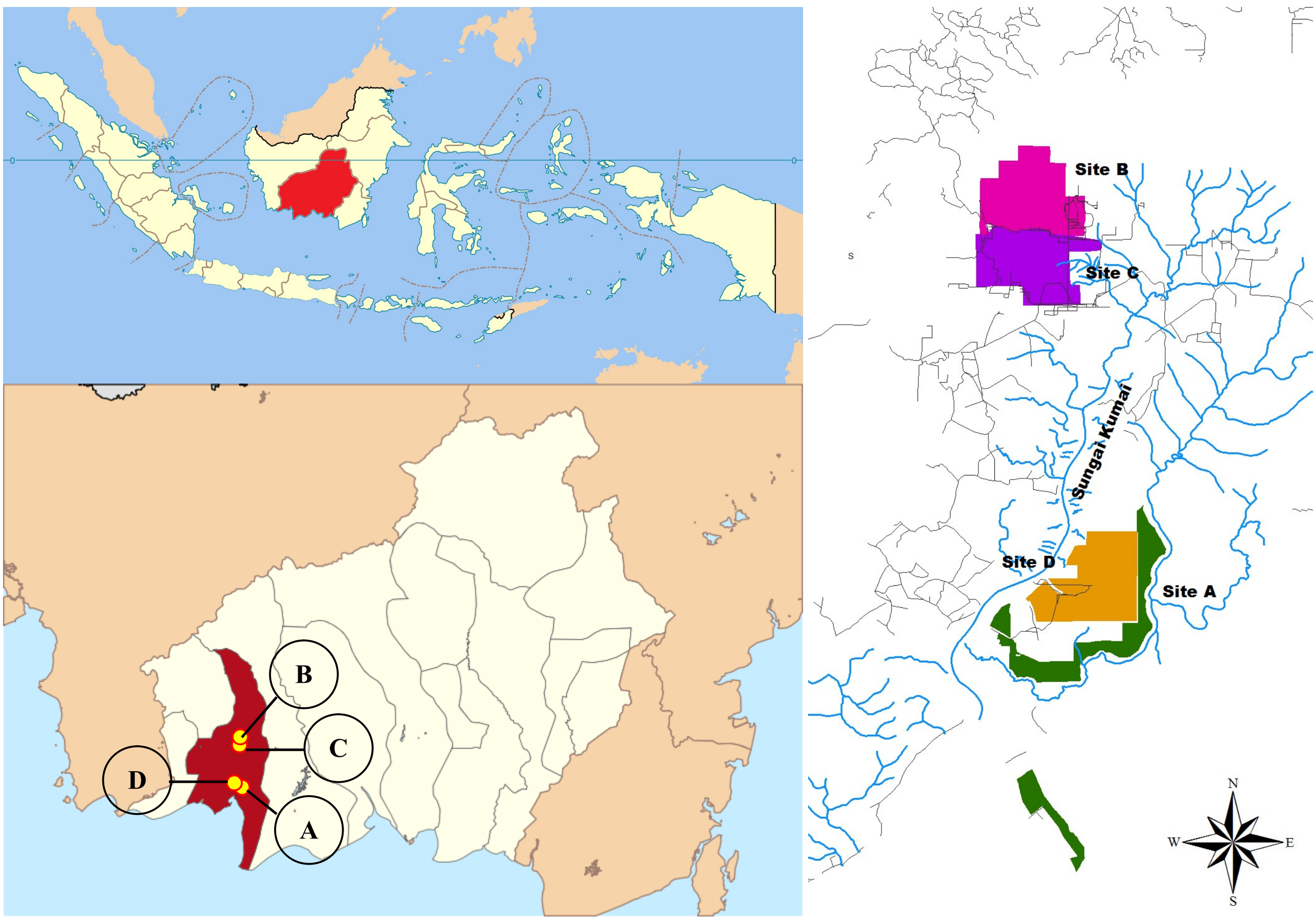

Figure 1. Map of research location at four large-scale plantations in Kotawaringin Barat District, Central Kalimantan Province, Indonesia

The HCV area is an area of secondary forest inside the oil palm plantation area. Its location is surrounded by community forests, oil palm plantations, shrubs, lakes, and parts of riparian areas. The land cover is quite dense dominated by big trees such as Mahang (*Macaranga* sp.), *S. leprosula*, *S. pervifolia*, and *D. comutus*. In addition to large plantations, there are community plantations called smallholder plantations planted in 2009 and 2013 or aged four to eight years when the research was conducted. The species of plants in this plantation include harendong (*Melastoma malabathricum*), fern (*S. palustris*) and sintrong (*C. crepidioide*s).

Procedures

This study was conducted in two types of habitats, i.e., habitat before the oil palm plantation establishment (hereafter referred to as BPE), and habitat after the oil palm plantation establishment (hereafter referred to as APE). 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 to the development of oil palm plantations. Based on the satellite imagery interpretation, there are two types of land cover that dominate the area prior to the development of oil palm plantations, namely shrubs and secondary forest. Both were then used as sampling sites for the BPE habitat. The APE habitat is all large-scale plantation areas and smallholder existing after oil palm plantation development, covering all age classes of oil palm plantations on the large plantations of young palm, middle-aged palm, old palm, including HCV and HCS areas, and people's oil palm plantation. The data on the diversity of mammals and herpetofauna were obtained through a survey of each type of land cover found in each habitat type (BPE and APE) (Terlizzi et al. 2005; Smiley et al. 2009; Santosa et al. 2016; Erniwati et al. 2016). This study used the assumption that the species found in each type of BPE land cover were similar to those prior to the establishment of oil palm plantations.

Animal inventory was carried out simultaneously on each type of land cover present in each habitat (BPE and APE). In each type of land cover, one observation line was made considering the relatively small area and based on the assumption that mammal and herpetofauna species in each of the same habitat types were homogeneous. The inventory of mammals was done using the Line Transect Method with the length of 1 km and the width of 100 m. In total there were 25 transects in all types of land cover visited twice daily, in the morning (06.00-08.00 WIB) and afternoon (15.30-17.30 WIB) for each transect. Seven camera traps were used to record observations indirectly. Herpetofauna inventory was done by using Visual Encounter Survey method. The data collection was done at night from 19.00 to 21.00 WIB. Mammal and herpetofauna inventories were repeated for three days in each transect to maximize the number of species recorded.

Data analysis

The number of mammal and herpetofauna species found in each habitat condition at each study site was calculated. To measure and compare the abundance of mammals and herpetofauna in habitat conditions, BPE and APE, Margalef species Richness index (Magurran 1998) was used. The Evenness Index was used to determine the evenness of the species in each habitat type and the Similarity index was used to determine the degree of similarity of mammals and herpetofauna between the BPE and APE habitats (Krebs 1985). The comparison of species number, species richness, and species composition in BPE and APE habitats was used as the basis for assessing the impact of oil palm plantation establishment on the diversity of mammals and herpetofauna. Mammals based on feeding guilds were categorized into carnivores, herbivores, and omnivores (Azhar et al. 2014). An insectivorous animal was classified as a carnivore, whereas folivorous and frugivorous animals were classified as herbivores. Herpetofauna based on habitat types were categorized into three types: terrestrial, aquatic, and arboreal.

RESULTS AND DISCUSSION

Comparison of species richness

Overall comparisons between habitats (BPE and APE) showed changes in species numbers, indexes of species richness and evenness. The results of observations on the diversity of mammals and herpetofauna in the study sites are shown in Table 1 and 2. Overall, the number of individuals and the number of mammals and herpetofauna species in APE were higher than those in BPE. The increase in number of individuals ranged from 66.67 to 540% in mammals and 58.8-367.86% in herpetofauna. The number of species increased in the range of 16.67-166.67% and 20-250% for mammals and herpetofauna respectively.

The diversity index of species also showed an increase in both groups of species. The decrease in value occurred only in site B for mammals and site D for herpetofauna. This can be seen as a response to the high number of individuals versus the number of species affecting the value of the Margalef index. The Margalef index is an index of species richness and diversity that 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. Magurran (1988) states that the Margalef index has a high sensitivity and ability to respond to differences in species so that the dominance of a species will affect the value of the index.

Evenness is generally defined as the ratio between observational diversity and maximum diversity. The diversity of mammal species showed various values (0.2-0.93). The lowest evenness value was in Site C. This indicates a high dominance or abundance in certain species on the site. For herpetofauna, the species evenness values ranged from 0.65 to 0.96. Compared with mammals, the herpetofauna species tended to be more evenly distributed in BPE habitat than in APE habitat. Pielou (1996) states that the evenness value will reach maximum if the observed species have the same abundance.

Table 1. Comparison of ecological variable values of mammals' species diversity in BPE and APE habitats

Variables	Site A		Site B		Site C		Site D	
	BPE	APE	BPE	APE	BPE	APE	BPE	APE
Number of individual	15	25	23	78	11	56	5	32
Number of species	6	8	6	7	3	5	3	6
Species Richness indices	1.85	2.17	1.59	1.38	0.83	0.99	1.24	1.44
Evenness indices	0.9	0.93	0.84	0.73	0.2	0.22	0.86	0.64

Note: BPE = before plantation establishment, APE = after plantation establishment

Table 2. Comparison of ecological variable values of herpetofauna's species diversity in BPE and APE habitats

Variables	Site A		Site B		Site C		Site D	
	BPE	APE	BPE	APE	BPE	APE	BPE	APE
Number of individual	47	99	31	138	51	81	28	131
Number of species	10	14	15	22	17	22	12	15
Species Richness indices	2.34	2.83	4.08	4.26	4.07	4.78	3.3	2.87
Evenness indices	0.7	0.65	0.9	0.82	0.87	0.85	0.95	0.86

Note: BPE = before plantation establishment, APE = after plantation establishment

Impacts on composition, feeding guild, and habitat type

The establishment of oil palm plantations also have an impact on species composition. In all the study sites, 15 mammal species belonging to nine families were found. Six of them were primates from the families Cercopithecidae, Pongidae and Lorisidae (Table 3). Plantain squirrel (*Callosciurus notatus*) was the only species found consistently in all study sites in both BPE and APE habitats. The dominance of *C. notatus* is thought to be linked to ecological factors such as its high adaptability, wide distribution, large population, and tolerance to varying levels of habitat modification. This species can be found in secondary forests, plantations, and all types of habitats (Duckworth 2016). *Pongo pygmaeus* was the only animal not found at Site D of APE habitat, but was still found in Site A. Most primate species, especially orangutans, are arboreal animals that need trees for activity, but they also have the ability to adapt to certain circumstances in foraging activity (Ancrenaz et al. 2004).

All sites received species additions following the establishment of palm plantations, including four species in Site A, a species in Site B, two species in site C, and four species in Site D. The low number of species additions in Site B is thought to be related to the conditions of trees and canopies especially for species of primate groups. In addition, the HCV area on Site B is a forest that is part of the riparian area as a specific mammalian habitat such as *Proboscis* monkey, pig-tailed macaque, and long-tailed macaque.

Based on feeding guild, mammals found in the study sites can be classified into three groups, namely herbivores, carnivores, and omnivores. The herbivore group was dominated by primates whose main meals are leaves and fruit. In the omnivore group, the species found were more diverse, such as small arboreal mammals (squirrel), rodents, wild boars, and monkeys. These animals have a broad spectrum of food types. They can be found in the BPE and APE habitats, except *Rattus* sp and *Sus barbatus* that found only in APE habitat. There were two carnivore species encountered during the study, namely Leopard cat (*Prionailurus bengalensis*) and Malay badger (*Mydaus javanensis*). The Leopard cats are known as small carnivorous mammals that eat rats, lizards, frogs, birds, and insects, while the Malay badger is known as an eater of bird eggs, carcasses, insects, worms, and plants. Forest cats and the Malay badger were found in APE habitat but not in BPE habitat. According to Ross et al. (2015) and Wilting et al. (2015), both species are common in oil palm plantations. This is allegedly related to the presence of species of food sources (prey) in more diverse palm plantations.

In addition to impacting mammals, the establishment of oil palm plantations also has an impact on the composition of herpetofauna. In all plantation sites, a total of 39 species of herpetofauna were found, consisting of 18 species of amphibians (413 individuals), and 21 species of reptiles (98 individuals) (Table 4). No species were missing in APE habitat at Sites B and C, whereas Sites A and D, each losing one or two species. In contrast, all plantations received species additions in APE habitat, ie 11, 7, and 5 species respectively for Sites A, B, and C and D. Some Herpetofauna species were found in almost all sites both in BPE and APE habitats, namely *Polypedates leucomystax*, *Fejervarya cancrivora*, *Hylarana erythraea*, *Pulchrana baramica*, *Eutrophic multifasciata*, and *Varanus salvator*. *Polypedates leucomystax* and *F. cancrivora* are non-forest species and adaptable opportunist species that can be found in almost all habitat types such as agricultural and artificial environments such as oil palm plantations (Diesmos 2004; Yuan et al. 2004). *Pulchrana baramica* is commonly found in swampy areas (Stuebing 2017) and lowland areas including peat swamp forests, primary forests of the plains, and swamp forests. High adaptability made this species found in all the observed locations and became the dominant species.

Table 3. Mammal species compositions and its feeding guild

Scientific name	Family	Feeding guild	Site A		Site B		Site C		Site D	
			BPE	APE	BPE	APE	BPE	APE	BPE	APE
Tupaia minor	Tupaiidae	Omnivore	√	√	√	√			√	√
Callosciurus notatus	Sciuridae	Omnivore	√	√	√	√	√	√	√	√
Callosciurus prevostii	Sciuridae	Herbivore					√	√		√
Rattus tiomanicus	Muridae	Omnivore	√	√						
Rattus tanezumi	Muridae	Omnivore			√	√		√		
Rattus sp	Muridae	Omnivore								√
Mydaus javanensis	Mephitidae	Carnivore		√						
Sus barbatus	Suidae	Omnivore				√				√
Prionailurus bengalensis	Felidae	Carnivore		√				√		√
Trachypithecus cristatus	Cercopithecidae	Herbivore	√	√						
Macaca fascicularis	Cercopithecidae	Omnivore	√	√	√	√				
Nasalis larvatus	Cercopithecidae	Herbivore			√	√				
Macaca nemestrina	Cercopithecidae	Omnivore			√	√				
Pongo pygmaeus	Pongidae	Herbivore	√	√					√	
Nycticebus coucang	Lorisidae	Herbivore					√	√		

Note: BPE= before plantation establishment, APE=after plantation establishment

Table 4. Species compositions of herpetofauna and its habitat types

Scientific name	Family	Habitat type	Site A		Site B		Site C		Site D	
			BPE	APE	BPE	APE	BPE	APE	BPE	APE
Amphibians										
Polypedates leucomystax	Rhacoporidae	Terrestrial, freshwater	√	√	√	√	√	√	√	√
Polypedates macrotis	Rhacoporidae	Terrestrial, freshwater				√			√	√
Rhacophorus appendiculatus	Rhacoporidae	Terrestrial, freshwater					√	√		
Fejervarya cancrivora	Dicroglossidae	Terrestrial, freshwater	√	√		√	√	√	√	√
Fejervarya limnocharis	Dicroglossidae	Terrestrial, freshwater		√		√	√	√	√	√
Limnonectes sp.	Dicroglossidae	Terrestrial, freshwater			√	√	√	√	√	√
Limnonectes sp.1	Dicroglossidae	Terrestrial, freshwater		√						
Limnonectes sp.2	Dicroglossidae	Terrestrial, freshwater		√						
Kalophrynus pleurostigma	Microhylidae	Terrestrial, freshwater					√	√		
Microhyla malang	Microhylidae	Terrestrial, freshwater					√	√		
Amnirana nicobariensis	Ranidae	Terrestrial, freshwater			√	√	√	√		√
Chalcorana chalconota	Ranidae	Terrestrial, freshwater						√		
Hylarana erythraea	Ranidae	Terrestrial, freshwater	√	√	√	√	√	√		√
Hylarana glandulosa	Ranidae	Terrestrial, freshwater			√	√				
Pulchrana baramica	Ranidae	Terrestrial, freshwater	√	√	√	√	√	√	√	√
Ingerophrynus biporcatus	Bufonidae	Terrestrial, freshwater				√	√	√	√	√
Pseudobufo subasper	Bufonidae	Terrestrial, freshwater	√	√						
Leptobrachium sp.	Megophrydae	Terrestrial, freshwater				√				
Reptiles										
Cyrtodactylus marmoratus	Geckonidae	Terrestrial		√						
Hemidactylus frenatus	Geckonidae	Terrestrial	√	√	√	√		√		√
Draco sp.	Agamidae	Terrestrial					√	√		
Bronchocela sp.	Agamidae	Terrestrial					√	√		
Eutropis rudis	Scincidae	Terrestrial	√	√	√	√	√	√	√	√
Eutropis multifasciata	Scincidae	Terrestrial			√	√		√	√	√
Lipinia vittigera	Scincidae	Terrestrial			√	√				
Dasia vittata	Scincidae	Terrestrial			√	√			√	
Takydromus sexlineatus	Lacertidae	Terrestrial			√	√				√
Malayopython reticulatus	Pythonidae	Terrestrial	√	√	√	√				√
Python breitensteini	Pythonidae	Terrestrial				√				
Naja sumatrana	Elapidae	Terrestrial		√		√				
Bungarus candidus	Elapidae	Terrestrial			√	√				
Lycodon subcintus	Colubridae	Terrestrial						√		
Dendrelaphis caudolineatus	Colubridae	Terrestrial						√		
Pseudorabdion albonuchalis	Colubridae	Terrestrial							√	
Xenopeltis unicolor	Xenopeltidae	Terrestrial					√	√		
Rhabdophis conspicillatus	Natricidae	Terrestrial, freshwater					√	√		
Varanus salvator	Varanidae	Terrestrial	√	√	√	√	√	√	√	√
Siebenrockiella clasicollis	Geomydae	Terrestrial	√							

Note: BPE= before plantation establishment, APE=after plantation establishment

Based on the habitat type, all herpetofauna of all amphibian and reptile groups in BPE or APE habitats have terrestrial habitat types. Although there are no changes in habitat types, some species such as *Limnonectes*, *Leptobrachium*, *Cyrtodactylus marmoratus*, *Lycodon subcintus*, and *Dendrelaphis caudolineatus* are found only in APE habitat.

Discussion

The results of this study revealed that oil palm plantations developed on land cover from secondary forest or shrubs had an impact on the number of species and the diversity of mammals and herpetofauna. The comparisons between the BPE and APE habitats showed no decrease in the number of mammal and herpetofauna species. Overall, the total number of species found in the APE habitat was higher than that in the BPE habitat. This result is in line with that of the research conducted by Azhar et al. (2014) who found more species of small mammals in oil palm planting areas than in natural forests. The presence of mammals in a particular habitat is influenced by the availability of feed, water, and shelter (Steinmetz et al. 2010). This suggests that some species of mammals can live and are able to adapt to habitats in relatively small plantations (Yasuma 2004). The changes of shrubs and forests into oil palm plantations change the environment. However, these environmental conditions still provide a source of food derived from vegetation, water flow, and plant stands as cover. For some species of mammals, the standing structure of various classes of oil palm is thought to provide better protection than shrubs. Some mammals are well adapted to oil palm plantation landscape such as squirrels, rats, wild pigs, and some primates. Most of them are generalist species. Yaap et al. (2010) suggest that generalist species have a positive response and can thrive in secondary forest or plantation habitats.

This study also showed that land conversion to oil palm plantations does not eliminate the ecological process of energy transfer in the food chain in the oil palm plantation landscape. In the mammal group, this is indicated by the presence of a forest cat (*Prionailurus bengalensis*) as a carnivore at the plantation site. This result is in accordance with the research conducted by Yue et al. (2015) who found forest cats and skunks only in the plantation area because of large number of prey from the rodents group in the plantation area. This suggests that the presence of these species is influenced by the availability of food sources (prey) in oil palm plantations as a foraging area. In addition to carnivorous animals, other mammal groups were also found, namely omnivorous mammals such as *Sus barbatus*, *Rattus* spp., and *M. fascicularis*; fruiting and leaf mammals (foliovores and fruityvores) such as *P. pygmaeus* and *Nasalis larvatus*; omnivore and insectivorous mammals such as *Mydaus javanensis*. Oil palm plantations provide a wide range of food resources compared to forests and shrubs to certain mammals, such as *S. barbatus*, and *M. fascularis* that can feed on young palm kernels as feed sources. The diverse ages of oil palm plants with different structures form spatial and temporal variations in microclimate and heterogeneity (Luskin and Potts 2011), and influences the diversity of feed sources.

The number of individuals of herpetofauna in APE habitat was higher than that in BPE habitat. In addition, the number of individual amphibians was higher than that of reptiles. Muslim (2017) states that some reptile species play a predatory role for most amphibians, and healthy ecosystems are shown by higher amphibian counts than reptiles. The dominant reptile species found in plantation areas included *Eutrophic rudis*, *E. mulifasciata*, and *Varanus salvator* known as predators for several species of amphibians such as *P. leucomystax* and *F. cancrivora*.

The study also revealed that HCV and HCS areas that are part of APE habitat play an important role in supporting the diversity of mammal and herpetofauna species. Oil palm plantations with heavily forested HCV and HCS areas serve as a refuge for wildlife and contribute to the habitat of arboreal primate supporters. This result is in line with that of Azhar et al. (2014) who suggests that a number of species of forest animals (especially mammals) are able to utilize the oil palm-planted environment as their habitat, although not as a primary habitat. Therefore, forest patches are essential for maintaining mammal diversity (Yue et al. 2015).

For herpetofauna, its presence in certain habitat is strongly influenced by environmental quality. Low environmental quality can result in low number of species in certain habitats (Denoël 2012). Forested areas such as HCV and HCS are thought to provide suitable microhabitats for herpetofauna as evidenced by the increasing number of herpetofauna species in APE habitat. Opportunistic species with good adaptability have a higher chance of survival and development in oil palm plantations. Some species are tolerant to environmental changes and can live in the human environment (Gillespie et al. 2005). Water is very important for some species especially amphibians (Vitt and Caldwell 2009) such as *Polypedates leucomystax* as a species of tree frog (arboreal) that is positively associated with aquatic vegetation and trees (Gunzburger and Travis 2004). In addition, several herpetofauna species that have the primary habitat type of forest were also found in APE habitat, such as *Limnonectes* and *Chalcorana chalconota*. This suggests that HCV areas with forest cover contribute to the presence of specialist species in the oil palm plantation landscape.

Through this research, it can be concluded that the establishment of oil palm plantations has increased the number of species and the index of species richness and changed the species composition of mammals and herpetofauna in the study sites, where most of these species have high adaptability or are classified as generalist species. For some specialist species that depend on tree and forest existence, the HCV and HCS areas play an important role in creating habitat heterogeneity. Mammal species found in APE habitat belong to some feeding groups, whereas all species of herpetofauna have terrestrial habitat types. These mammal and herpetofauna species can live and function in the food chain in the oil palm plantation ecosystem.

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