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A Preliminary Study on Factors Determining the Success of High Conservation Value Area in Oil Palm Plantations

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***Abstract*—**High Conservation Value (HCV) is an area with conservation function within oil palm plantation. Despite the important role of HCV area in biodiversity conservation and various studies on HCV, there was a lack of research studying the factors determining its success. A preliminary study was conducted to identify the determinant factor of HCV that affected the diversity. Line transect method was used to calculate the species diversity of butterfly, birds, mammals, and herpetofauna species as well as their richness. Specifically for mammals, camera traps were also used. The research sites comprised of 12 HCV areas in 3 provinces of Indonesia (Central Kalimantan, Riau, and Palembang). The relationship between the HCV biophysical factor with the species number and species diversity for each wildlife class was identified using Chi-Square analysis with Cross tab (contingency table). Results of the study revealed that species diversity varied by research locations. Four factors determining the success of HCV area in relations to the number and diversity of wildlife species are land cover types for mammals, the width of area and distance to rivers for birds, and distance to settlements for butterflies.

***Keywords*—**Ecological factors, high conservation value area, oil palm plantation, wildlife diversity.

I. Introduction

DEVELOPMENT of oil palm plantations in Indonesia has grown rapidly during the last decade. Since 2008, Indonesia has placed itself as the greatest producer of palm oil in the world [1]. The total value of Indonesia's palm oil production in 2017 was more than 35 million tons, with its contribution to the national income of US $ 22.97 billion [2]. The high economic value prompted extensive expansion of oil palm plantations. These conditions gave rise to the lawsuit regarding its impact on deforestation and environmental changes [3] and are considered as a contributor to biodiversity loss in tropical Southeast Asia region [4]-[7].

One of the biodiversity impacts of oil palm plantation development is on the wildlife. The results show that forest conversion to oil palm plantations negatively impacts wildlife [5], [8]-[16], while its role in ecosystems is very important. Some animal groups have high sensitivity to environmental changes such as birds and butterflies, and are indicators of ecological change [17], [18]. Other groups such as mammals and herpetofauna have close links with certain habitat types or micro-climatic conditions of habitats, and have an important role in preserving the sustainability of ecological processes [16].

In accordance with the Indonesian Palm Oil Certification System (ISPO) and Roundtable Sustainable Palm Oil (RSPO) consensus, biodiversity protection in oil palm plantations is conducted in HCV areas, especially on HCV Forest. HCV itself is an area of forests, oil palm plantations or mine areas) intended to protect aspects of biodiversity, environmental services, social, economic and cultural communities [19]. In its development, the effectiveness of HCVs and the success of biodiversity conservation have been widely questioned and criticized [20], [21], while justification has not been adequately addressed due to the very limited scientific basis [22]. So far there is limited information on the characteristics of HCV areas and their relation to physical factors that determine the value of species diversity, thus contributing to the successful management of HCV areas cannot be formulated. Therefore, the study aims to quantify the extent of wildlife species diversity and identify its relation to the physical factors of the HCV area. The results can serve as a basis for further analysis and management of HCV areas for biodiversity conservation.

II. Method

A. Data Collection

The study was conducted in two stages: 1) quantifying the number and diversity of wildlife species (mammals, herpetofauna, birds and butterflies), and 2) identifying the relationship between the diversity of the species and the ecological physical factors in the HCV area. The data used were obtained from field surveys and literature studies on publications and research reports on the diversity of wildlife species, conducted by the same methods.

Field surveys to quantify the number and diversity of animals are done through an inventory simultaneously on any type of land cover found in each habitat. For each land cover type, one plot was selected to represent a specific land cover type. Inventory was repeated for three days at each track to maximize the number of species recorded. Mammals' inventory using line transect method with a length of 1 km and a width of 100 m was visited twice each morning (06:00 - 08:00) and afternoon (15:30 - 17:30 GMT). Seven camera traps were used to record indirect observation. Inventory on herpetofauna was conducted using Visual Encounter Survey method on a transect of 1 km by 100 m. Data collection was performed at night from 19:00 until

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21:00 pm.

Inventory of butterfly uses time search method which is a modification of line transect method where observation plots are not limited by distance, but limited by time (minutes). Observations were conducted using three repetitions, in the morning when the air was starting to warm (at 08.00 - 11.00 GMT). The butterfly captured (specimen), were then inserted into an envelope or a paper triangle. Data obtained then are recorded on the tally sheet. The object was identified using a butterfly field guide. Inventory of bird species diversity was conducted using a combination of line transect method (line transect) and observation point method. The transect is 1 km in length and 100 m in width. Observations were carried out in the morning (06:00 - 08:00 pm) and afternoon (15:30 - 17:30 pm) with 3 times repetition.

Data recorded include hour encounter, found species, number of individuals of each species found and traces of animals such as voice. In addition, we observe environmental conditions, such as plants in the plantation floor, scrub and forest. Observations were carried out with the aid of binoculars to assist in clarifying the type of species. Data are recorded in structured tally sheets.

The identification of biophysical factors within an HCV area is conducted through a map analysis of five major factors found in HCV areas in 12 companies in Central Kalimantan, Riau, and Palembang provinces. The five factors are land cover type, area, distance from river, distance from road, and distance from settlement. The distance was measured using Proximity Analysis through spatial analysis. Geoprocessing tools used are Point Distance and Multiple Ring Buffer.

B. Data Analysis

The species diversity of mammals, herpetofauna, birds and butterflies is quantified through the number and abundance of species in each type of habitat in oil palm plantations. Variations in species abundance were calculated using the Margalef species richness index [23]. The relationship between the HCV biophysical factor with the species number and species diversity for each wildlife class was identified using Chi-Square analysis with Cross tab (contingency table). Factors tested were land cover type, total area, distance from river, distance from road, and distance from settlement. The hypothesis tested is H0 = there is no relationship between a biophysical factor with the number of species or species diversity, and Ha = there is a relationship between a biophysical factor with the number of species or species diversity. H0 is rejected if the p-value significance < 0.05. Analysis was done using SPSS statistical analysis program version 17.

III. Results and Discussion

A. Results

The number of species and the diversity of wildlife species in HCV areas vary by the location of the study (Table I). The number of mammalian species ranges from 2 to 6 species, herpetofauna range from 2 to 15 species, birds range from 10 to 55 species, and butterflies range from 9 to 37 species. The level of species diversity is 0.51-1.85 in mammals, 1.44-4.08 in herpetofauna, 2.6-7.17 in birds, and 2.91-9.3 in butterflies. The results of this study indicate that birds have the highest number of species, while butterflies have the highest species diversity among other animals. In contrast, the number and extent of mammalian species diversity is the lowest among all groups of animals.

Spatial analysis of five physical factors found in the landscape of oil palm plantations shows that there are two categories of land cover that are found, namely forest and non-forest. Forest cover type is the boundary area of the river. The total area of HCV ranges from 21.5 to 6,800 ha. Distance to the river ranges from 200-25,000 m, the distance to the road is between 10 and 10,000 m, and the distance to the settlement is between 98 and 16,700 m (Table II).

TABLE I
Number of Species and Species Diversity of Mammals, Herpetofauna, Butterflies, Birds in HCV Areas at Each Study Site

Site Locations	Mammals		Herpetofauna		Birds		Butterflies	
	S	DMg	S	DMg	S	DMg	S	DMg
A	6	1.61	9	2.46	25	5.99	15	4.75
B	5	1.85	15	4.08	55	7.17	37	9.3
C	3	0.83	14	3.72	21	4.55	26	6.21
D	4	1.37	12	3.05	17	4.23	13	4.33
E	6	1.36	9	2.35	16	3.68	13	4.33
F	2	0.91	9	2.67	19	4.81	11	2.91
G	2	0.48	9	2.77	16	4.43	18	4.02
H	2	0.51	6	1.95	17	4.15	14	3.63
I	2	0.72	2	1.44	16	3.78	9	3.47
J	2	0.56	11	3.4	10	2.6	17	4.16
K	4	1.44	8	2.04	20	4.85	14	4.09
L	4	0.84	6	1.59	33	7.69	12	2.98

S = number of species, DMg = index of Margalef species diversity

TABLE II
Biophysical Factors of HCV Areas and Their Categories

Physical factors	Category
Land cover type	Forest; Nonforest
Width of area (ha)	0 - 2,500; 2,500 - 5,000; > 5,000
Distance to the river (m)	0 - 8,500; 8,500 - 17,000; > 17,000
Distance to the road (m)	0 – 3,500; 3,500 – 7,000; > 7,000
Distance to the settlement (m)	0 – 5,500; 5,500 – 11,000; > 11.000

Based on the identification of five biophysical factors, in relation to the number and diversity of species, Chi-square test showed that there was no significant relationship between the distance of the road to the number and variety of species for all wildlife classes. However, there was a relationship between land cover type with the number of mammal species (p-value = 0.015), bird species diversity with p-value = 0.004) and distance from the river (p-value = 0.040), and diversity of butterfly species were related to the distance from settlement (p-value = 0.022). Herpetofauna is the only wildlife class that has no significant relationship with all the factors (Table III).

TABLE III
P-VALUE IN CHI-SQUARE ANALYSIS FOR THE RELATIONSHIP BETWEEN BIOPHYSICAL FACTOR OF HCV AREA WITH SPECIES NUMBER AND SPECIES DIVERSITY

Wildlife class	Species number and species diversity	Physical factors of HCV area				
		Land cover type	Width of area	Distance to the river	Distance to the road	Distance to the settlement
Butterflies	S	0.368	0.618	0.240	0.814	0.022*
	DMg	0.083	0.780	0.308	0.165	0.077
Birds	S	0.519	0.102	0.097	0.73	0.525
	DMg	0.140	0.004*	0.040*	0.74	0.730
Mammals	S	0.015*	0.251	0.542	0.231	0.434
	DMg	0.072	0.312	0.800	0.517	0.484
Herpetofauna	S	0.368	0.470	0.102	0.814	0.670
	DMg	0.368	0.837	0.415	0.621	0.497

S = number of species, DMg = index of Margalef species diversity, *p-value < 0.05

B. Discussion

The relationship between the number of Mammal species and the forest can be affected by several factors such as varying tropical levels, home range, as well as the characteristics of terrestrial or arboreal animals that require trees and forests. This causes Mammals, especially terrestrial mammals, to be an important component in the forest ecosystem [24]. Oil palm plantations with forested HCV areas serve as a refuge for wildlife and contribute as a support habitat for arboreal Mammals. This result is in line with [15] indicating that a number of species of forest animals (especially Mammals) are able to utilize the oil palm-planted environment as its habitat, although not as a primary habitat. Therefore, forest patches are essential for maintaining Mammalian diversity [25].

Significant relation of diversity Birds with rivers can be caused by various food sources and biological characteristics of several species of birds belonging to aquatic birds [26], or microclimate influences from the *ecotone* region. In Birds, the high number of species in oil palm plantations is also suspected to be related to the existence of forests such as HCV areas in plantations and forests around the plantation. According to [11] secondary forests play an important role in increasing the abundance of bird species in oil palm plantations. These areas can serve as a matrix for the movement of animals in plantation areas that have spatial heterogeneity [15].

For butterflies, most of the species are known to have a wider range of food in modified areas such as settlements with many plant sources of feed or host plants for butterfly larvae [27], so distances with settlements provide significant value to number of species. Opportunistic species with good adaptability has a higher chance of survival and development in oil palm plantations. Some species are tolerant of environmental changes and can live in the human environment [28]. In case of Herpetofauna, its presence in certain habitat conditions is strongly influenced by environmental quality. Low environmental quality can result in low numbers of species in certain habitats [29]. Water is very important for some species, especially amphibians [30], so that HCV areas can provide suitable microhabitats for Herpetofauna. The absence of factors closely related to the number and diversity of Herpetofauna species can be attributed to the relatively well adapted adaptation of Herpetofauna species to all HCV area habitat conditions. The impact is that all these factors do not significantly affect the amount and its diversity.

The results of preliminary identification in this study indicate that physical factors are linked to species and species diversity. Thus, the determination of HCV areas in large-scale oil palm plantations should take these factors into consideration with the dominant animal classes. Such scientific considerations will contribute to the success of the HCV area in the conservation of biodiversity in oil palm plantations.

IV. CONCLUSION

The diversity of Mammal species, Herpetofauna, Birds, and Butterflies in the HCV area shows variations based on the location of the study. The physical condition of the HCV area as part of the palm oil plantation landscape has been identified as having links to the diversity of wildlife species. Therefore, further analysis of the characteristics and roles of the physical factors of the area, i.e. vegetation type or land cover, the width of area, distance from the river, and distance from the settlement, to achieve the success of HCV areas in the conservation of wildlife species in the landscape of oil palm plantations.

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