The Habitat Suitability of Javan Langur (*Trachypithecus auratus* E. Geoffroy Saint-Hilaire, 1812) in Kucur Resort at Alas Purwo National Park, Indonesia

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Abstract. The population of Javan Langur is continuous decline as the habitat decreases. One of the remaining protected areas of the Javan Langur is Kucur Resort Alas Purwo National Park (APNP). However, the condition of its habitat is still unclear. This study was conducted to predict the distribution and habitat suitability of Javan Langur. Data for the Javan Langur encounter points was obtained by a two-way sampling of five transect lines along 0.5–2.5 km. The habitat variable e.g., Normalized Difference Vegetation Index (NDVI), altitude, river distance, settlement distance, and tourist distance downloaded from the geographic information database websites. Furthermore, all data were analyzed using Microsoft Excel 2019 and ArcGIS 10.1. The group of Javan Langurs are distributed at medium density vegetation cover (NDVI 0.1–0.5), low altitude (<100 masl), and areas that are far from rivers (<300 m), settlements, and tourism (<750 m). The habitat of Javan Langur is categorized as excellent (1456.25 ha) and high (898.89 ha). It shows that Kucur Resort can provide a good carrying capacity for Javan Langurs to survive.

Keywords: Spangled ebony langur · Habitat suitability · Kucur resort · Alas Purwo National Park

1 Introduction

The Javan Langur (*Trachypithecus auratus* E. Geoffroy Saint-Hilaire, 1812) is one of the Indonesia endemic primates that is categorized as vulnerable and appendix II by IUCN and CITES, respectively [1, 2]. Indonesian Government protected the Javan Langur by the Regulation of Minister of the Environment and Forestry Number P.106/MENLHK/SETJEN/KUM.1/ 12/2018. It is due to the declining population and the habitat decreased. One of the remained habitats for Javan Langurs is the Kucur Resort in the Alas Purwo National Park (APNP). The langurs are found in the lowland forests with varied vegetation structures e.g. teak forests and jungle forests. However, the condition of the Javan Langur habitat in this resort is unclear.

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The existence of the Javan Langur depends on the preferences and conditions of its habitat [3]. It can affect the distribution and habitat suitability which can be predicted by some habitat factors e.g., food sources, cover, water, and topographic [4, 5]. The availability of food sources is represented through the condition of the vegetation. It is because the Javan Langur feeds young leaves, seeds, flowers, and fruit [6]. Moreover, the condition of the vegetation represents Javan Langur protection to avoid predators and anthropogenic disturbances [3]. Water sources provide the main metabolism material for the primate. In addition, the Javan Langur was found to occupy habitats with varying altitudes from the lowland forest to the highland forest [7].

All of the habitat factors can be analyzed with a Geographic Information System (GIS) [8] based on the Normalized Difference Vegetation Index (NDVI), altitude, distance to water sources, settlements, and tourism. The analysis of vegetation conditions as a representative of food sources and protection through NDVI parameters from satellite imagery [9]. Meanwhile, the Javan Langur distance from water sources, settlements, and tourism is analyzed with Euclidean distance which measures the distance of an object from other objects in vector mapping [10].

The Javan Langur distribution and habitat suitability are important to study. The available information will be the basis for the APNP management to plan development around the Javan Langur habitat conservation. Therefore, this research was conducted to obtain information concerning the Javan Langur distribution and habitat suitability in Resort Kucur APNP. The results can be used to minimize threats to the Javan Langur population as a species endemic.

2 Materials and Methods

2.1 Data Collections

2.1.1 Line Transect Sampling

Data were collected in October and November 2020 at Kucur Resort APNP that was carried out using a transect line according to Peres et al., Buckland et al., and Hillario et al. (Fig. 1) [11–13]. Three people walked (two-way sampling) on a transect line of about 0.5–2.5 km with 20 m of visibility at 07.00–12.00 and 13.00–16.30 that following the daily activity of the Javan Langur. We stop about 30 min to observe the encounter of Javan Langur [3]. The encounter points of Javan Langur were recorded using a Garmin 64s.

2.1.2 Habitat Variable

The four main factors e.g., vegetation, topography, water resources, and anthropogenic disturbances are determined as habitat variables [14]. It is represented in five variables: (1) NDVI, (2) altitude, (3) river, (4) settlement areas, and (5) tourist areas. The NDVI and Altitude variables were downloaded from Landsat 8 image from the Earth Explorer website (https://earthdata.nasa.gov/). The river and settlement variables were downloaded from the Indonesian Earth Map (https http://portal.inasdi.or.id/). Meanwhile. the tourism variable was obtained from Google Earth Pro.

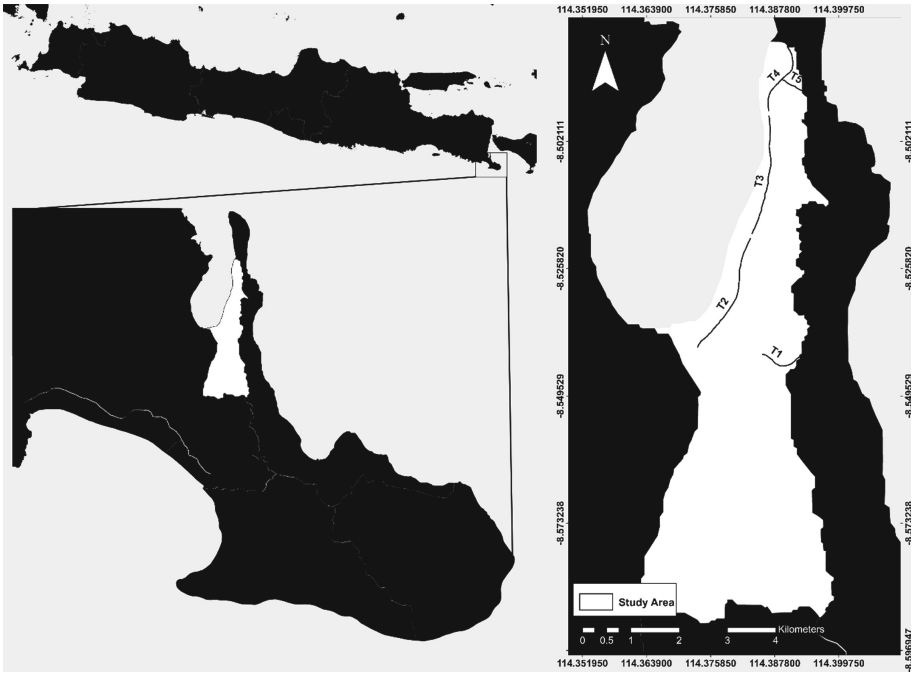

Fig. 1. Kucur Resort (2.355,14 Ha) TNAP is the study area located in Banyuwangi, East Java, Indonesia (base map: http://portal.ina). Five transects were conducted in this study i.e., T1, T2, T3, T4, and T5.

2.2 Data Analysis

2.2.1 Javan Langur Distribution

The data are grouped in Microsoft Excel 2019 and analyzed spatially with ArcGIS 10.1. The spatial analysis was performed with the following stages:

a. NDVI Map

NDVI map of Resort Kucur APNP processed with the Javan Langur encounter coordinates. The Eq. (1) is used to determine NDVI values based on Landsat 8 bands (NIR = Near-Infrared; Red = Infrared) [15].

$$\text{NDVI} = \frac{\text{NIR} - \text{RED}}{\text{NIR} + \text{RED}} \tag{1}$$

b. Altitude Map

The Javan Langur altitude distribution is determined on an altitude map. The map was processed together with the Javan Langur encounters coordinates with the spatial analysis tools.

c. River, Settlements, and Tourism Distance Map

The map is processed respectively with the Javan Langur encounter coordinates. The Euclidean distance from spatial analysis tools is used. The distance between the Javan Langur and the river is determined.

Table 1. The rank score of the Javan Langur habitat variables

Habitat variables	Classification	Rank Score
NDVI	< -0,5	1
	-0,5 – 0,0	2
	0,0 – 0,5	3
	> 0,5	4
Altitude (masl)	0–100	4
	100–200	3
	200–300	2
	> 300	1
River Distance (m)	0–100	4
	100–200	3
	200–300	2
	> 300	1
Settlement Distance (m)	0–250	1
	250–500	2
	500–750	3
	> 750	4
Tourism Distance (m)	0–250	1
	250–500	2
	500–750	3
	> 750	4

2.2.2 Habitat Suitability Level

The five habitat variable maps were analyzed simultaneously with the scoring overlay method in ArcGIS 10.1. Each habitat variable was classified and scored based on the Javan Langur habitat preferences. Thmost favored condition of the habitat variable is given the highest score of four, while the less favored condition is given the lowest score of one (Table 1).

The sum of the rank score is converted into a habitat suitability index (HSI) (2) and the overall habitat suitability level of Javan Langur at Kucur Resort APNP is determined [17]. The Suitability level is based on four classifications e.g., excellent, high, average, and below-average (Table 2).

$$\text{HSI} = \frac{\text{Output rank for the Area of Interest}}{20} \tag{2}$$

Table 2. The classification level of the Javan Langur habitat suitability

Habitat Suitability Level	Habitat Suitability Index (HSI)
Excellent	0.76–1.0
High	0.51–0.75
Average	0.26–0.50
Below-average	0.0–0.25

3 Results and Discussion

3.1 Javan Langur Distribution

The observations were carried out in three repetitions on each transect line because of time and cost limitations. There are only three groups of Javan Langurs were found that are identified in the T1, T2, and T3 transect lines (Fig. 1). The total number of encounter point for the three groups are seven (Table 3). We suggested that habitat variables influence the distribution of the Javan Langur.

3.1.1 Ndvi

The Kucur Resort is dominated by areas with NDVI values of 0.0 - 0.5 (Table 3). It is revealed that the most of Kucur resort areas indicate a fairly dense canopy as described by Zaitunah et al. [18]. All Javan Langur encounter points were distributed in medium vegetation density areas (Fig. 3.A). We assume that the fairly dense vegetation will provide many branches of the tree and high biomass leaf for the Javan Langur activity and food sources.

The fairly dense canopy and branches provide benefits for the Javan Langur activity. It is because Javan Langur utilizes the canopy and tree branches as much as 20–40% for all its activities e.g., resting, mobilizing, socializing, and sheltering [19, 20]. In addition, Javan Langurs are folivorous primates that use leaves as their main food source [21]. Some food Plant species e.g., kepuh (*Sterculia foetida*), bendo (*Artocarpus elastica*),

Table 3. The number of Javan Langur groups encounter Points in T1-T5

Transect Line	Group	Number of Encounter Points	Number of Individual
T1	I	2	10; 3
T2	II	3	3; 6; 5
T3	III	2	7; 9
T4	-	-	-
T5	-	-	-

kedawung (*Parkia roxburghii*), and kedodong (*Spondias pinnata*) that consumed by Javan Langurs were found in the Kucur resort [22].

3.1.2 Altitude

The altitude of Kucur Resort is categorized as lowland (0–300 masl) (Fig. 3.B). The six encounter points are located at 0–100 masl and one encounter point at 100–200 masl (Table 3). The Javan Langur distribution has the lowest and highest altitude at 13 masl and 120 masl, respectively. However, the Javan Langurs can utilize habitats with varied altitudes until 3000 masl [7].

We assume the structure of vegetation and physical factors of the environment at different altitudes affect Javan Langur distribution. Lowlands have a more diverse vegetation structure compared to the highland [23, 24]. The highest plant diversity allows the Javan Langur able to have more variant food sources. The vegetation in the highlands is also mostly dominated by coniferous that have a small number, size, and form of branches. It affects the arboreal primates to optimally use the branches for their activities.

The other assumption is that environmental physical factors are correlated to altitude. The lowland has warm temperatures and humid air conditions that are suitable for the activities of Javan Langur [25, 26]. Moreover. lowland has a low UV radiation exposure that influences the susceptibility of parasites and the productivity and quality of the food plant [27].

3.1.3 River Distance

All of the Javan Langurs are distributed at >300 m from the river (Table 3). The farthest and closest encounter point to the river is at 2227 m and 469 m, respectively (Fig. 3.C). It is similar to the report of the other Cercopitecidae in Kucur Resort which found long-tailed macaques (*Macaca fascicularis*) in habitats far from the river [28] but in contrast with two previous studies on *Trachypithecus* [16, 29]. However, the contradiction shows that the Javan Langur is not fully dependent on the existence of the river.

We assume three other factors that influence the Javan Langur to stay away from the river, (1) *the use of preformed water*, in the captive *Trachypithecus delacouri* known to utilize the young leaves as food as well as a water source to supply 60% water of the body [30, 31]. Furthermore, it is also possible for free-ranging Javan Langur to use trees hollows and dew on leaves as water sources. (2) *to avoid predation*, the river is an open area for wildlife to drink e.g., leopard (*Panthera pardus melas*) as a predator of Javan Langur. If the Javan Langur directly uses the river water, it increases the risk of predation. (3) *the arboreal behavior*, Javan Langur spend more time in the trees to eat, move, groom, or rest with the ground activity infrequently occurs e.g., picking up fallen food and geophagy, not for use water [32, 33].

3.1.4 Settlements Distance

The distribution of Javan Langur is found away from the settlement at >750 m (Table 3). The nearest and farthest habitats with human settlements are at 3,107 m and 4,130 m, respectively (Fig. 3.D). The high intensity of human activity in residential areas prevents

Javan Langur to the area. It is due to low protection for the Javan Langur to avoid anthropogenic disturbance. However, settlements in Tegaldlimo District are close and accessible to Kucur Resort. It is proven by several community activities around this resort e.g. fishing and searching clams. The increased human activity possibly influences the distribution of Javan Langur in this resort [34].

3.1.5 Tourism Distance

The Javan Langur is distributed at >750 m from the tourist areas (Table 3). The nearest and farthest distribution at 1371 m and 3900 m, respectively (Fig. 3.E). However, Javan Langurs usually use mangrove forests as one of their habitats [35], but There were no encounters with Javan Langurs that approached the mangroves around tourism in this study. The Javan Langurs observed approach the mangrove between the T2 line and the T3 line. We assume the high intensity of tourists in the mangrove jungle track affects Javan Langur to avoid mangrove around tourism. The highly human presence indirectly causes stress in primates. The Russon & Wallis [36] study revealed that tourism can cause stress and in severe conditions, it can change primate's behavior, and reduce the mortality of the juvenile (Table 5).

3.2 Habitat Suitability Level

The HSI value of Kucur Resort is at 0.60–0.95 and is classified as an excellent and high level of suitability. The HSI value of excellent level habitat is at 0.80–0.95 (1456.5 Ha). While the high-level habitat is at 0.6–0.75 (898.89 Ha) (Table 4). It showed that habitats with excellent levels of suitability are dominant in Kucur Resort. We assumed several habitat variable influences and determined the level of habitat suitability e.g., NDVI. altitude. and Settlement distance.

The NDVI value affects those suitability level because most of the Kucur Resort areas have NDVI values which indicate medium density and vegetation cover. Meanwhile. The Javan Langur distribution in Kucur Resort is lowland and away from settlements that are suitable and avoid anthropogenic disturbances. These results are consistent with Dong et al. [37] which revealed that altitude and settlement are key factors in determining habitat suitability. However. the most influential habitat variables for habitat suitability of Javan Langur are not ensured in this study and need more study in the future.

Furthermore. the six encounter points were distributed at an excellent level habitat [Fig. 2.F]. Javan Langur groups II and III were found in habitats at 0.8 HSI values. While group I was distributed at 0.8 and 0.75 HSI values. The high number of encounters in excellent level habitats indicated good carrying capacity for Javan Langurs to survive. The availability of vegetation as a source of food and shelter. suitable altitude. and minimal anthropogenic disturbance is beneficial for Javan Langurs. The wide and good-quality habitat will certainly attract the presence of wild animals to inhabit the habitat [38].

The study shows that Kucur Resort is quite suitable for the Javan Langur. Wedana et al. [39] categorize the entire APNP area as one of the good habitats for Javan Langurs because it has a fairly low level of disturbance. However. the APNP management especially the Kucur Resort needs to maintain and improve its efforts for increases the

Table 4. The distribution of Javan Langur on habitat variable

Habitat variables	Classification	Areas (Ha)	The Number of Encounter points
NDVI	< -0,5	0	0
	-0,5 – 0,0	316,60	0
	0,0 – 0,5	2053,08	7
	> 0,5	0	0
Altitude (masl)	0–100	1402.02	6
	100–200	507.43	1
	200–300	463.22	0
	> 300	0	0
River Distance (m)	0–100	291.18	0
	100–200	261.71	0
	200–300	254.73	0
	> 300	1565.82	7
Settlement Distance (m)	0–250	0.00	0
	250–500	8.85	0
	500–750	38.72	0
	> 750	2325.12	7
Tourism Distance (m)	0–250	27.52	0
	250–500	57.07	0
	500–750	60.57	0
	> 750	2228.83	7

Table 5. The habitat suitability of Javan Langur

Habitat Suitability Level	Habitat Suitability Index (HSI)	Areas (Ha)	Proportion (%)
Excellent	0.76–1.0	1456.25	61.8
High	0.51–0.75	898.89	38.2
Average	0.26–0.50	0	-
Below-average	0.0–0.25	0	-

habitat quality of the Javan Langur. The APNP management can restore the teak forest area by increasing the density cover of vegetation which is a former Perhutani production area. In addition. The APNP might need to limit the number of visitors as tourists and fishermen to give a space for Javan Langur.

Fig. 2. The group of Javan Langur is only found in three transect lines i.e., T1. T2. and T3. The group found in T1 is the group I. T2 is group II. and T3 is group III.

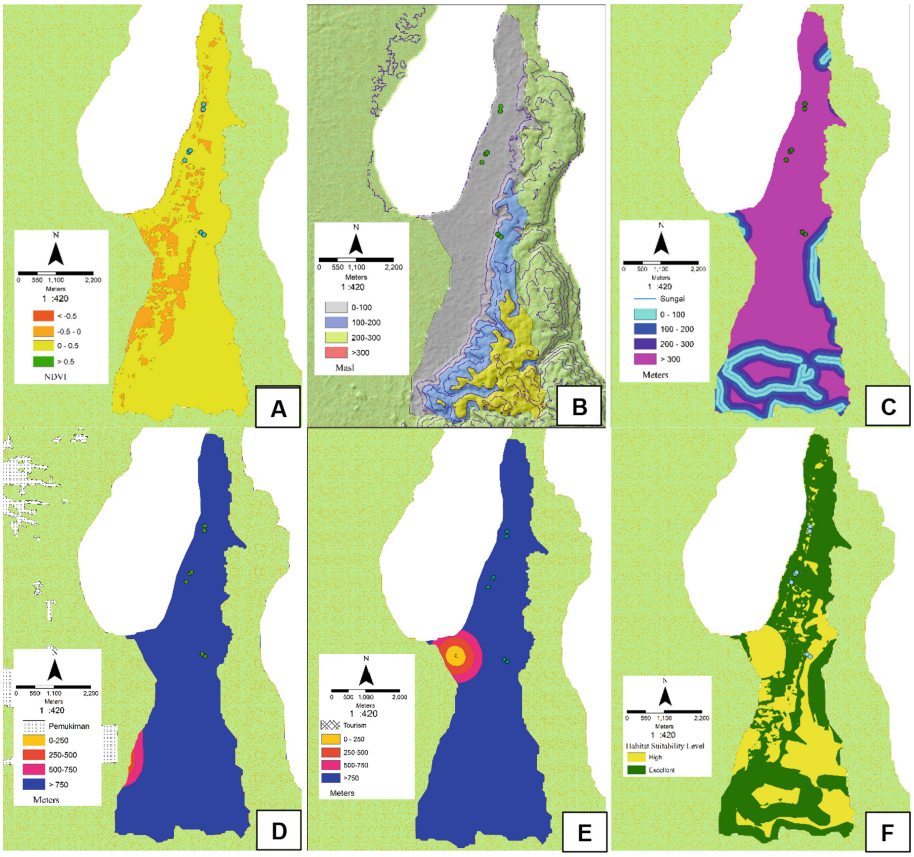

Fig. 3. Map of distribution and habitat suitability for Javan Langur in Kucur Resort Alas Purwo National Park: (A) NDVI. (B) altitude. (C) river distance. (D) settlements distance. (E) tourism distance. and (F) habitat suitability level. (Base map: https://earthdata.nasa.gov/. http://portal.ina. and google earth pro).

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