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DETERMINING FACTORS OF THE SPATIAL DISTRIBUTION OF SUMATRAN ELEPHANT TRACK ACTIVITIES IN PEMERIHAN RESORT BUKIT BARISAN SELATAN NATIONAL PARK

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ABSTRACT

The movement of Sumatran elephants from forests to villages and agricultural lands triggers elephant-human conflicts. The increase in conflict between Sumatran elephants and humans has caused a drastic decline in the Sumatran elephant population. The decline in the Sumatran elephant population indicates the importance of the conservation efforts carried out on the results of research studies related to the traces of Sumatran elephant activities. This study aims to analyze the relationship between activity traces and the characteristics of the Sumatran elephant habitat at Pemerihan Resort. The research was carried out from July 2021 to January 2022. The direct observation carried out in the observation line is 1 km long and 250 m wide (4 transect lines) with 4 repetitions. The results showed that the spatial distribution of Sumatran elephant activity traces is related to habitat characteristics, namely land cover type (secondary forest), topographic class (flat), distance from water sources (<1000 m), and distance from settlements (1000-2000 m). Traces of activity can be interpreted as an indicator of knowing the presence of Sumatran elephants that can prevent and minimize conflict levels. Management of the habitat and population of Sumatran elephants through enrichment of feed and captive activities is needed as a form of Sumatran elephant conservation efforts.

Key words: *activity traces, habitat, Pemerihan Resort, Sumatran elephant*

INTRODUCTION

The conflict between Sumatran elephants (*Elephas maximus sumatranus* Temminck, 1847) and humans continues to increase and causes a decline in the Sumatran elephant population. The release of elephants from the forest into villages and agricultural land by destroying crops is a human-elephant conflict that continues until this day. Utami *et al.* (2015) stated that the case of elephant-human conflicts in BBSNP had caused crop failures up to 29.58% because plants were damaged, trampled, and knocked down. The population of Sumatran elephants in 1985 was 2,400-4,800 individuals and spread over 44 populations (Blouch and Simbolon 1985). The estimated population of Sumatran elephants in 2007 was reduced by almost 50%, amounting to 2,400-2,800 individuals (Azmi and Gunaryadi 2011). The Sumatran elephant population is declared to have declined again, leaving only 1,694-2,038 individuals in 36 populations (Dirjen KSDAE 2020). Hedges *et al.* (2005) stated that as many as 12 populations of Sumatran elephants were found in Lampung Province, namely in Bukit Barisan Selatan National Park and Way Kambas National Park. The estimated population of Sumatran elephants in Lampung Province is 550–900 individuals, with 498 in the Bukit Barisan Selatan National Park (BBSNP). Pemerihan Resort is one of the areas in BBSNP, which is the habitat of Sumatran elephants.

Forest encroachment and habitat fragmentation are factors in the decline in the Sumatran elephant population. Deforestation in BBSNP occurred in various types of forests, including primary and secondary forests, which are Sumatran elephant habitats. According to Gaveau *et al.* (2007), in the period 1972-2002, forest cover

BBSNP has lost an area of 57,344 ha with an average of deforestation rate 367 ha/year. Suyadi (2011) too stated that BBSNP had an average rate of deforestation worth 0.64% per year from 1972-2006. The Sumatran elephant habitat is fragmented into habitats that have narrow space and hinder mobility, causing the Sumatran elephant population to be isolated and their numbers to decline. Habitat fragmentation also results in the increasingly limited availability of feed, water, and cover resources (Mustafa *et al.* 2018). The limited availability of resources triggers conflicts between elephants and humans.

Sumatran elephants are susceptible mammals and have specific preferences for habitat use. It is feared that habitat problems will affect the pattern Sumatran elephants use space and cause population decline. Studies on habitat preferences are still very limited, especially in analyzing environmental factors that influence the selection of Sumatran elephant habitat. Research related to activity traces (feces, puddles, footprints) can be used as an alternative in monitoring Sumatran elephants considering that Sumatran elephants are difficult to find directly. Information on the distribution of activity traces can indicate the distribution of individual Sumatran elephants which will facilitate the management and mitigation of conflicts with humans.

The purpose of this study was to analyze the relationship between activity traces and the characteristics of the Sumatran elephant habitat at Pemerihan Resort.

RESEARCH METHOD

This research was carried out at Pemerihan Resort Bukit Barisan Selatan National Park, Lampung Province on three land cover types (primary forest, secondary forest, and shrubs) (Figure 1). The research was carried out from July 2021 to January 2022, with data collection carried out from October 2021 to November 2021.

The data used in this study consisted of primary data and secondary data. Primary data includes data on the traces of Sumatran elephant activity along the observation path and habitat characteristics of Sumatran elephants at Pemerihan Resort BBSNP. Sources of literature used as supporting data can be in the form of publications of previous studies in articles, journals, books, or other documents. The tools used in the research are tape measure, stationery, Global Garmin 60 CSX Positioning System (GPS), tool timer (clock), and digital camera. The instrument used is a tally sheet, BBSNP area, land cover, and topographic map. In addition, this study uses Garmin BaseCamp, ArcGIS, and Microsoft Excel software to process and analyze data research results.

Data was collected through direct observation at the research site using the transect method. Direct observations were made to find secondary signs of the presence of Sumatran elephants, such as footprints, food residue, feces, puddles, and body friction. Observations on the type and distribution of activity traces were carried out in an observation plot of 100 ha with a plot size of 1000 m × 1000 m. The sample area was selected based on stratified sampling. The observation plot includes the size of each transect line, which is 1 km long and 250 m wide, so that four transect lines are obtained (Figure 2). Activity traces were observed in the morning (08.00 WIB - 10.00 WIB) and in the afternoon (11.00 WIB - 13.00 WIB). Repetition is carried out 4 times on each line in parallel and simultaneously. The shift in each repetition has a distance of 5-10 m. All direct and indirect encounters (through activity traces), including type, number, size, location (coordinate points), and habitat characteristics found in traces of activity are recorded in tally sheets and documented.

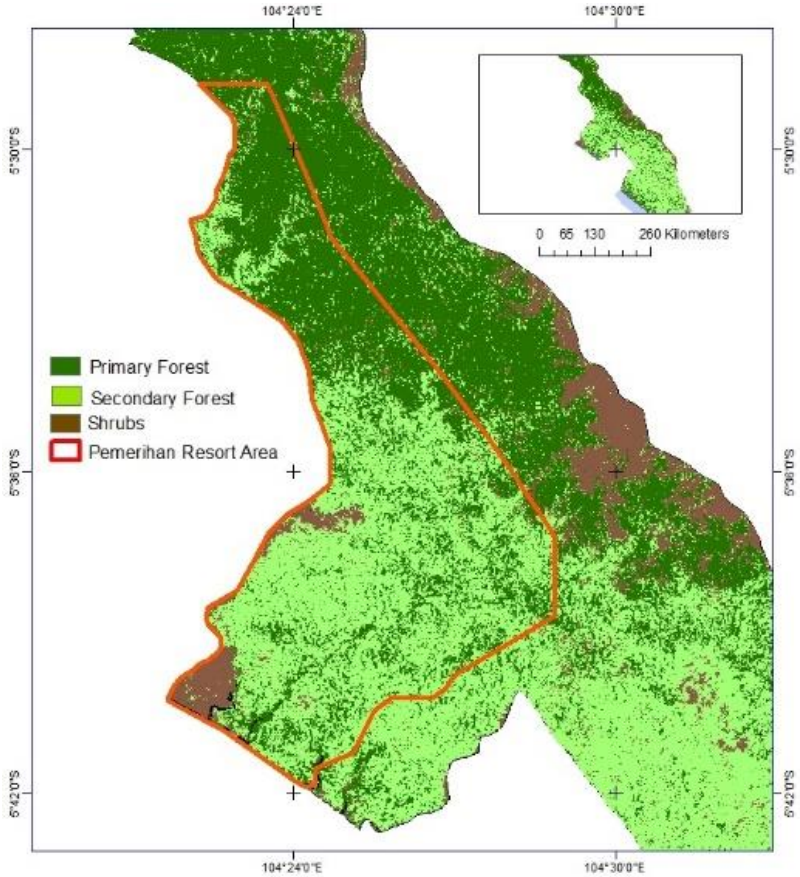

Figure 1 Research location map.

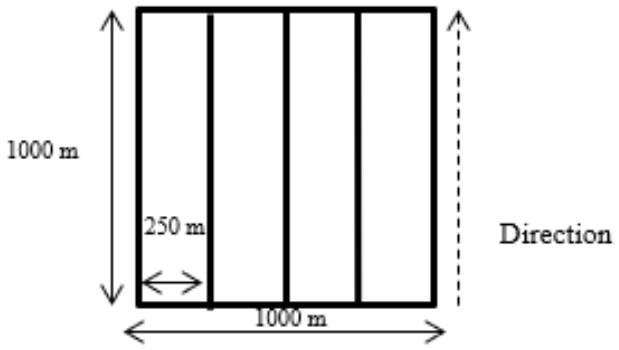

Figure 2 Illustration of the line transect method.

Habitat characteristics observed included land cover type, topography, distance from water sources, and settlements. The distance of each trace found to water sources and settlements is measured via Garmin BaseCamp software. The types of land cover analyzed are divided into three types of land cover, namely primary forest, secondary forest, and shrubs. The topographic class is divided into flat (0-8%), gentle (8-15%), wavy (15-25%), steep (25-40%), and very steep (>40%) (Basuki *et al.* 2020). The grouping of distance data from water sources consists of distances 0-1000 m, 1000-2000 m, and > 2000 m. The grouping of distance data from settlements consists of a distance of 0-1000 m, 1000-2000 m, and >2000 m.

The relationship between activity traces and habitat characteristics was analyzed using a non-parametric statistical test called the chi-square test. The chi-square test will compare the calculated x^2 count with the x^2 table with a value of $\alpha = 0.05$ or $\alpha = 5\%$. Calculation of the value of x^2 count on the chi-square test can be done with the following formula (Pandis 2016):

$$X^2 count = \frac{(\Sigma f_o - f_e)^2}{fe}$$

Description:

f_0 = Frequency of encounters obtained

f_e = Expected frequency value

Based on the chi-square test, two conclusions will be formed, namely:

If the value of x^2 count > x^2 table, then reject H_0

If the value of x^2count < x^2 table, then accept H_0

RESULT AND DISCUSSION

1. Activity trace type

Based on the results of research on all transect lines, two types of traces of Sumatran elephant activity were found, namely feces and footprints. Feces is the most common type of traces of Sumatran elephant activity. Types of traces of activity in the form of feces were found as many as 160 feces (98%). In contrast to Abdullah and Japisa (2013) who found other types of activity traces in the form of body rubbing marks on < 3 trees. The absence of scrubbing marks for the Sumatran elephant at the Pemerihan Resort BBSNP could be due to the lack of availability of scrubbing trees, especially in shrubs and secondary forests frequented by Sumatran elephants. The size of the Sumatran elephant feces diameter that was found was in the range of 8-29 cm. The types of traces of Sumatran elephant activity in the form of footprints were found at the study site as many as 3 (2%). Based on the results of observations, it was found that there were two footprint sizes, one measuring 30×31 cm and two other footprints measuring 40×41 cm.

The results of the observations show that the traces of activity spread in groups. The distribution of activity traces in groups can be influenced by biological and physical habitat characteristics. Habitat characteristics that will be explained include land cover type, topography type, distance from rivers, and settlement distance.

2. Relationship of Activity Trace with Land Cover Type

Pemerihan Resort is part of the Bukit Barisan Selatan National Park with three types of land cover based on satellite image (primary forest, secondary forest, and shrubs) (Figure 1). Based on the data found in the feces in Figure 3, it can be seen that the highest number of activity traces was found in secondary forest, which was 91. These results are in accordance with the research results of Sabri et al. (2014), which stated that the highest traces found, as many as 296, were in secondary forests. Mahanani (2012) stated that Sumatran elephants would generally move in groups towards the type of land cover of shrubs and secondary forest. This movement is caused by the availability of various types of feed and shade in shrubs and secondary forests compared to primary forests. Abdullah et al. (2009) stated that the productivity of forage plants in the secondary forest was higher than that of the primary forest.

In contrast to fecal traces, traces of site activity were more commonly found in shrub land cover types. Based on the observations, there are two footprints of the Sumatran elephant on the bushland cover type and one

footprint on the secondary forest land cover type. Sumatran elephant footprints are mostly found in shrubs because the location of the bushland cover type is close to the river. According to Mahanani (2012), elephant footprints are often found on the outskirts of creeks because there are many types of natural food and vegetation suitable for resting.

Based on the results of the chi-square test, the value of x^2 count (70,245) > x^2 table (5,991) means that there is a relationship between the traces of Sumatran elephant activity and the type of land cover. The traces of Sumatran elephant activity in the form of feces were found in all types of land cover, while the footprints of the Sumatran elephant were only found in secondary forests and shrubs.

During the day, Sumatran elephants spend more time looking for food or just sitting around in secondary forests. According to Abdullah *et al.* (2012), in addition to the availability of food, the presence of Sumatran elephants is also influenced by the availability of mineral source trees often found in secondary forests. Sumatran elephants prefer shrubs when the sun is not too hot, and the temperature is not too high. Elephants will move to more closed forests, such as secondary and primary forests to escape the sun's heat. There are 6 feces in the primary forest. Sumatran elephants need primary forests for shelter, rest, and reproduction.

3. **Relationship of Activity Trace with Topography**

Topography is a habitat component that affects the existence of traces of Sumatran elephant activity. The topographic class consists of flat, gentle, wavy, steep, and very steep. Figure 4 shows that the dominance of the discovery of activity traces is in the flat topography class (0-8%). The traces of activity found in the flat topography class consisted of 131 feces and 3 footprints, while the sloping topography class consisted of 16 feces, and in the wavy topography class 13 feces. The chi-square test results are x^2 count is 335,634, and the x^2 table is 9.487. The value of x^2 count > x^2 table indicates a relationship between traces of Sumatran elephant activity and topographic class. The results showed 3 topographical classes where the Sumatran elephant traces were found, namely flat, sloping, and wavy. The number of activity traces by topographic class is presented in Figure 3.

According to the results of previous studies, namely Rohman *et al.* (2019) which show that the Sumatran elephant's space use preference in Bukit Barisan Selatan National Park to land slopes is in areas with flat and gentle slopes. According to Abdullah *et al.* (2012), the Sumatran elephant will be easier to move in the flat topographic class. The daily activities of Sumatran elephants such as reproductive behavior and protecting their young from predators will be easier in the flat and sloping topography class compared to the wavy and steep topography class. Sumatran elephants have a large body size and weight. This causes the Sumatran elephant difficulty holding and supporting its body in a bumpy and steep topography class.

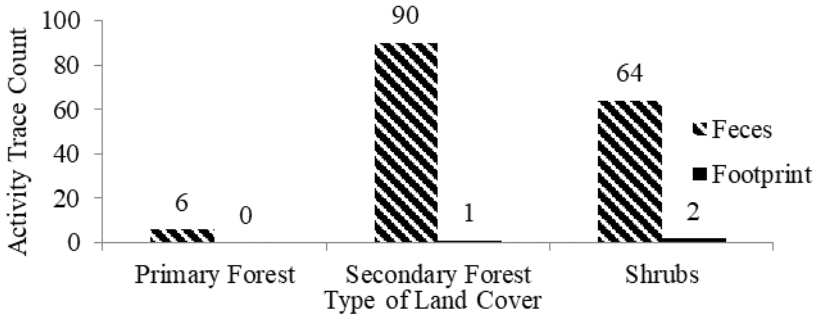

Figure 3 Number of activity traces according to land cover type.

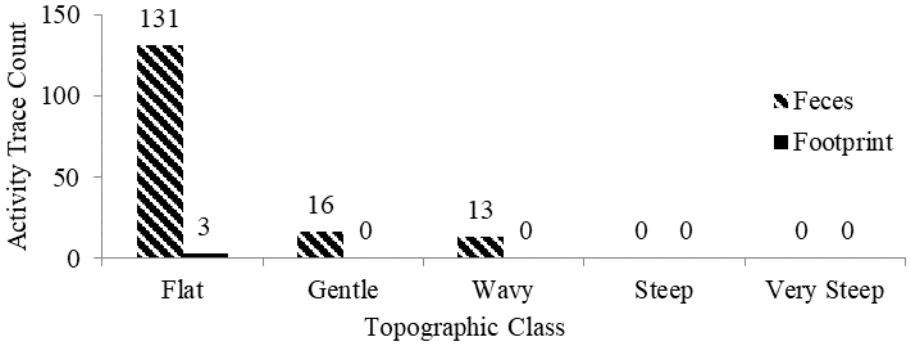

Figure 4 Number of traces of activity according to topographic class

4. Relationship of Activity Trace with Water Sources Distance

The analysis results show that the highest number of activity traces found at a distance of < 1000 m is 135 tracks. There were only 24 traces of Sumatran elephant activity at a distance of 1000-2000 m, while at a distance of >2,000 m no traces were found. (Figure 5). This result shows that Sumatran elephants are dependent on water. Based on the value from the chi-square test (x^2 count 186.859 and x^2 table 5.991), it can be interpreted that there is a relationship between the traces of Sumatran elephant activity and the distance from the water source. Abdullah *et al.* (2012) state that most activity traces are found in areas close to water sources with a distance of 0-500 m. The research of Rohman *et al.* (2019) also showed the same results, traces of elephant activity were found in the very close category with a distance interval of 0-100 m as much as 83.5%. Abdullah and Japisa (2013) stated that the habitat conditions frequented by Sumatran elephants were 0-250 m from a water source. The concordance between the results obtained with other studies shows that water is the primary need to be met to support the life of the Sumatran elephant.

Figure 4 shows that Sumatran elephants really need water to support their survival. According to Harianto and Winarno (2018), the Sumatran elephant is an animal dependent on water and needs up to 160 liters of drinking water per day. The drinking behavior of the Sumatran elephant is sucking water with its trunk which then puts it in its mouth. In addition to drinking, Sumatran elephants need water to wallow. The Sumatran elephant wallows to protect the skin from insect and ectoparasite bites and maintain body temperature.

The water source used by the Sumatran elephants at the Pemerihan Resort BBSNP comes from rivers within the national park area. In addition, Sumatran elephants can also use puddles that form during the rainy season. When entering the dry season, the condition of the river in the area is not completely dry but only experiences a decrease in water discharge. This is because the Pemihan resort is located in the western area of BBSNP which has a higher rainfall of around 3000-3500 mm per year compared to the eastern area where rainfall is only 2500-3000 mm per year. Based on these conditions, it can be assumed that the Sumatran elephants at the Pemerihan Resort BBSNP do not lack water sources.

5. Relationship of Activity Trace with Distance from the Settlement

Human settlements and presence are the determining factors for the existence of the Sumatran elephant. Figure 6 shows that there are 51 traces at a distance of < 1000 m, 110 at a distance of 1000-2000 m, and 3 at a distance of > 2000 m. These data indicate that Sumatran elephants' existence is quite far from settlements. These results follow Rohman et al. (2019) who state that the daily range of the Sumatran elephant is more dominant at a distance of >1,000 m. Sabri et al. (2014) also showed that Sumatran elephants prefer habitats away from settlements. The Sumatran elephant is a type of animal that is sensitive to humans. Sumatran elephants will tend to avoid residential areas, especially during the day. This is because the intensity of human activity during the day is higher, so it can be a source of disturbance for the Sumatran elephant. These results are also reinforced by the chi-square value obtained. Based on the results of the chi-square test, it can be seen that the calculated x^2 count is 105.085 and the x^2 table is 5.991. This indicates a relationship between the traces of Sumatran elephant activity and the distance of settlements. The number of traces of Sumatran elephant activity based on settlement distance can be seen in Figure 5.

Mitigation efforts from various parties support the existence of Sumatran elephants far from settlements. The management and local residents carry Sumatran elephants' herding to the forest area. In addition, the management also partners with other officers such as the TNI or the National Police and NGOs such as WWF. Mitigation efforts are needed to minimize conflicts between elephants and humans.

People have different perceptions of the Sumatran elephant. Conflicts between Sumatran elephants and their respective communities often occur, especially in the hamlets of Kuyung Arang and Dusun Talang Sunda (Utami *et al.* 2015). Most people think the Sumatran elephant is a nuisance pest that can damage agricultural land and plantations. Sumatran elephants are seen as the cause of crop failure on their land because the crops on the land are damaged, trampled, and knocked down by Sumatran elephants. Such views usually come from people whose land is in a protected forest, so Sumatran elephants are accessible and often visited, especially at night. Not only causing crop failure, but several conflicts also show that Sumatran elephants damage the infrastructure of the BBSNP area such as rest stations. However, for some people whose agricultural land is on clan land, Sumatran elephants are considered not to disturb, and they respond positively to the presence of Sumatran elephants.

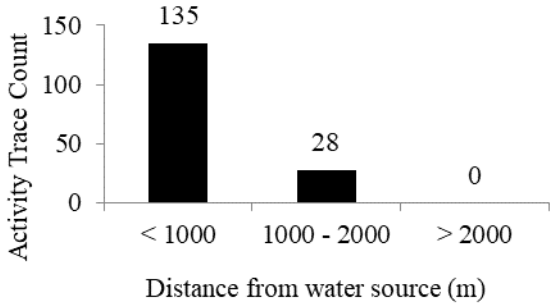

Figure 5 Number of traces of activity based on distance from the water source

Figure 6 Number of traces of activity based on distance from the settlement

CONCLUSION

The spatial distribution of Sumatran elephant activity traces relates to the type of land cover type, topography class, distance from water sources, and distance from settlements. The factor most related to the distribution of activity traces is the type of land cover. Traces of Sumatran elephant activity are mostly found in habitats with secondary forest land cover type, flat topography class, distance from water sources < 1000 m, and distance from settlements 1000-2000 m.

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