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Habitat and behavior of javan hawk-eagle (*Nisaetus bartelsi*) in SPTN 2 Majelengka Gunung Ciremai National Park, West Java

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Abstract. *The javan hawk-eagle is a bird species endemic to Java, so the distribution area is limited in Java. The javan hawk-eagle is one of the indicators of environmental health in Gunung Ciremai National Park (TNGC). This study aims to analyze the habitat of the javan hawk-eagle and the behavior of the Javan hawk-eagle in Gunung Ciremai National Park. Observations focused on the area of direct encounter with the Javan hawk-eagle and were selected intentionally (purposive sampling). The habitat analysis was approached with vegetation analysis and habitat used method. The behavior of the javan hawk-eagle was observed by focal animal sampling to describe its daily activities. The results showed that habitat use during the javan hawk-eagle nesting season used plantation forest types (83.14%), natural forest (14.12%), and shrubs (2.75%). The characteristics of the javan hawk-eagle's resting place are strata A trees or strata B trees, which have horizontal and strong branches. The javan hawk-eagle chooses a tree to nest on an emergent tree, namely a pine tree (Pinus merkusii). The characteristics of the Javan hawk-eagle hunting area are natural forests with diverse and abundant potential for prey such as spotted doves and squirrels. The behavior of the javan hawk-eagle observed included resting 3 times, meeting for a total of 79 minutes, hunting 2 times for a total of 11 minutes, flying 8 times and meeting for a total of 48 minutes, and social interaction 5 times between 08.00 am and 11.00 am, with a total time of 108 minutes.*

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INTRODUCTION

The Javan hawk-eagle is a bird species endemic to Java, so the distribution area is limited in Java in lowland rain forests, hills, and mountains, with an altitude of 500 m to 2000 m above sea level (Sözer and Nijman 1995). Based on population data, the Javan hawk-eagle ranges from 300 to 500 adult individuals, so the Javan hawk-eagle is listed on the IUCN (International Union for Conservation of Nature) Red List with an endangered (critical) category (Birdlife International 2017). Factors influencing this threat are the decreasing population size, decreasing habitat, forest fragmentation, and illegal hunting of the Javan hawk-eagle (Birdlife International 2017). The main habitat of the Javan hawk-eagle is the natural forest, but the Javan hawk-eagle is also found in various habitat types, but still connected with natural forest; the types of habitat outside the

natural forest that can be found are secondary forest, plantation forest, and areas of agricultural land or plantations. This location is almost always close to the natural forest (Rakhman 2012). This condition is in line with the observations of Gjershaug et al. (2004), which show that the Javan hawk-eagle utilizes secondary forests for hunting and nesting.

Gunung Ciremai National Park (TNGC) has three key animal species, namely the Javan leopard (*Panthera pardus* melas), surili (*Presbytis comata*), and the Javan hawk-eagle (*Nisaetus bartelsi*) (Kuswandono et al. 2018). The Javan hawk-eagle is an indicator of environmental health, and it can be seen from the selection of nesting areas, namely in water catchment areas or upstream rivers; the presence of prey or feed influences this to meet the needs of eagle mates and chicks during the breeding period (Rakhman 2012). Therefore, it is important to conduct research related to the habitat of the Javan hawk-eagle and its behavior. This study aims to: (1) analyze the habitat of the Javan hawk-eagle in Gunung Ciremai National Park, and (2) analyze the behavior of the Javan hawk-eagle in Gunung Ciremai National Park.

METHODS

Study Area and Time

This research was conducted at the National Park Management Section (SPTN) 2 Majalengka TNGC, West Java, in March–May 2022. Vegetation measurement plots were placed in Plantation Forests and Natural Forest to get an overview of the vegetation in the two types of forest, which are the locations for Javan hawk-eagle encounters. The research location can be seen in Figure 1.

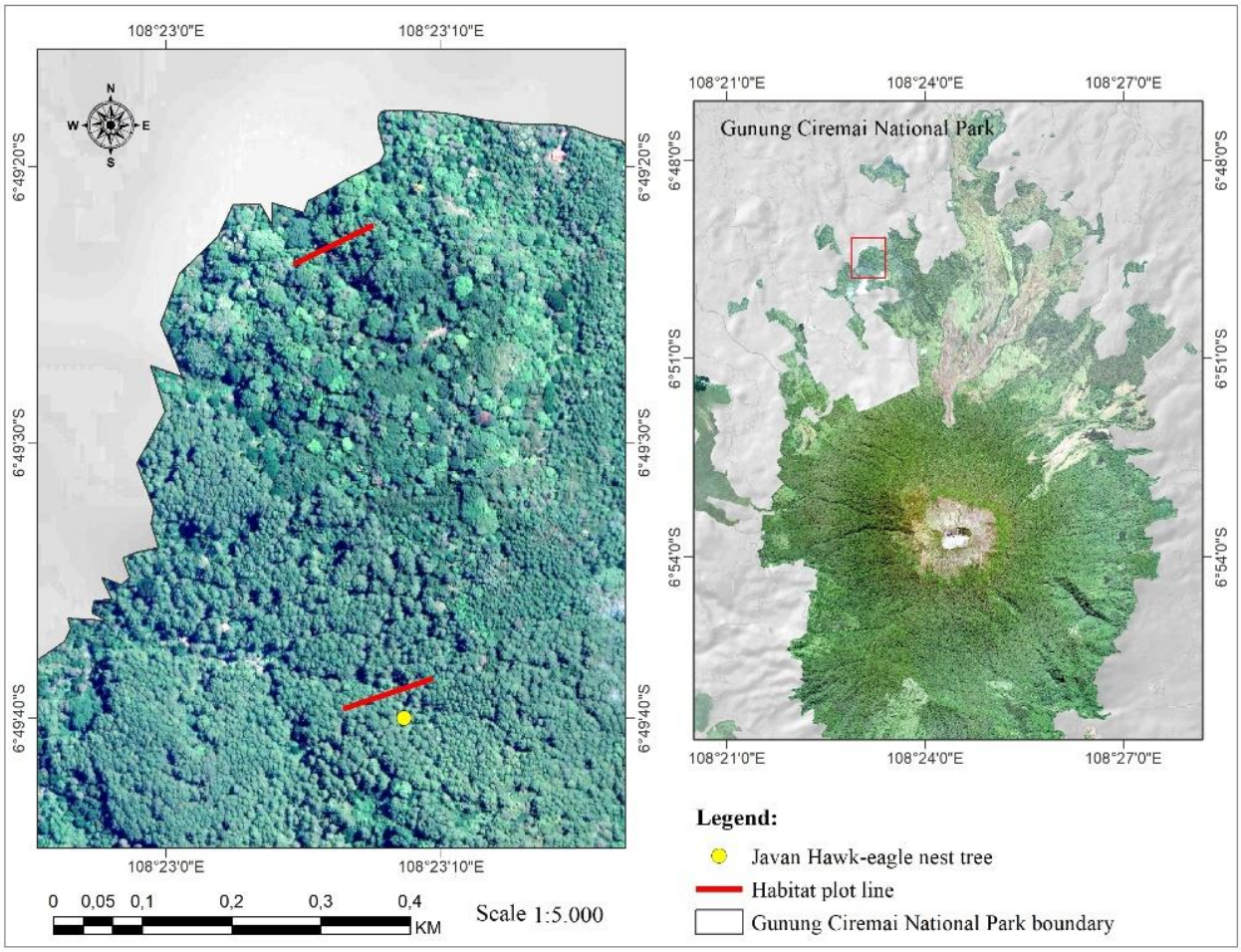

Figure 1 Study area

Data Collection Methods

The type of data regarding the habitat of the Javan hawk-eagle collected is primary data in the form of habitat characteristics, including resting areas, hunting areas, and nesting sites obtained from direct observations in the field. Secondary data in the form of supporting information about the habitat of the Javan hawk-eagle was obtained from interviews and literature studies. Observation plots were determined using a purposive sampling method. The location designated as the observation plot is the selected area, namely the places where the Javan hawk-eagle is found directly. The sampling plots were placed in 10 plots of natural forest and plantation forest. Observation of the daily behavior of the Javan hawk-eagle is carried out using the focal animal sampling method. This method is a way of observing the behavior the Javan hawk-eagle in a certain time interval. This technique is used to find out all types of behavior carried out by the observed individual (Altmann 1974). Observations were made from 06.00 am to 05.00 pm for 14 days at the observation site.

Data Analysis Methods

Vegetation analysis was carried out to identify the composition of vegetation in the habitat of the javan hawk-eagle. The vegetation composition obtained will be analyzed to obtain the Important Value Index (INP). The INP is used to express the level of dominance of a species or provide an overview of the role of the species concerned in the community (Soegianto 1994), with the formula:

$$\text{INP} = \text{KR} + \text{FR} + \text{DR}$$

$$\text{Density (K)} = \frac{\text{Number of individuals of a species (N)}}{\text{Sampling plot area (ha)}}$$

$$\text{Relative Density (KR)} = \frac{\text{Density of a species (N/ha)}}{\text{Total density (N/ha)}} \times 100\%$$

$$\text{Frequency (F)} = \frac{\text{Number of plots found of a type}}{\text{Number of all plots}}$$

$$\text{Relative Frequency (FR)} = \frac{\text{Frequency of a type}}{\text{Frequency of all types}} \times 100\%$$

$$\text{Dominance (D)} = \frac{\text{Number of base area of a type } (m^2)}{\text{Sample plot area (ha)}}$$

$$\text{Relative Dominance (DR)} = \frac{\text{Dominance of a species } (m^2/ha)}{\text{Dominance of all species } (m^2/ha)} \times 100\%$$

The vegetation used by the Javan hawk-eagle was analyzed based on Soerianegara and Indrawan (1978) who divided the forest strata into five strata, namely strata A (> 30 m), B (20–30 m), C (4–20 m), D (1–4 m) and E (0–1 m). The tree used by the Javan hawk-eagle was analyzed for its use of canopy space based on Putri (2009) Illustration of the use of tree canopy space by the Javan hawk-eagle can be seen in Figure 2, who divided the canopy space horizontally into spaces A, B, and C while vertically divided into spaces I, II, and III. The tree architecture used by the Javan hawk-eagle was analyzed based on Hasanuddin (2013). The calculation of the proportion of habitat use is based on the formula for the level of use of the type of habitat (Hernowo 1985), and the percentage of the Javan hawk-eagle activity:

$$\text{PHC} = \frac{\text{FPi}}{\text{TP}} \times 100\%$$

Information:
PHC : The rate of use of each habitat type
FPi : Length of time used in habitat type-i
TP : Total time spent on each habitat type

Analysis for the percentage of Javan hawk-eagle activity with the following formula:

$$\% \text{ Behavior} = \frac{X}{Y} \text{ X } 100$$

Information:
X: frequency of one observed behavior in observation)
Y: the frequency of all behaviors observed in the observation)

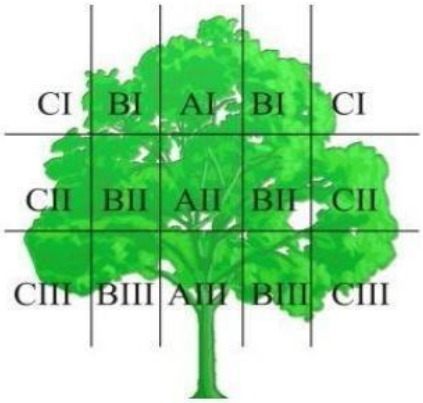

Figure 2 Use of tree canopy space (Putri 2009)

RESULTS AND DISCUSSIONS

Habitat

Natural Forest

The Bantar Agung site is at an altitude of about 670 meters above sea level. Natural forest habitat is dominated by trees Hantap heulang (*Sterculia macrophylla*; 67.18%), Ki calung (*Diospyros macrophylla*; 60.14%), Salam (*Syzygium polyanthum*; 49.80%), Saninten (*Castanopsis argentea*; 28.35%), and Benda (*Artocarpus elasticus*; 21.55%), the Javan hawk-eagle often use strata B (tree height 20–30 m) to strata A (tree height > 30 m). The existence of various types of trees in natural forests is able to provide the needs of the Javan hawk-eagle as a nesting place, a place to rest, and provide food for the Javan hawk-eagle (Cahyana et al. 2016). The tree used by the Javan hawk-eagle to rest is an object tree (*Artocarpus elasticus*) with strata A, which has branching solid characteristics, and a crown that is not too thick.

Plantation Forest

The type of tree found in the plantation forest is Pinus (*Pinus merkusii*) with strata A and B, which has a spacing of 2.5 m and a density of 1,363 stems/ha. In addition to Pine Trees in the plantation forest, coffee plants can also be found planted on the sidelines of the plantation forest. Between pines and become a source of food for animals such as long-tailed monkeys, squirrels, and birds. The Javan hawk-eagle builds its nest on a pine tree which is an emergent tree. The tree is not too close to other trees and is located on a ridge close to a valley with a water source. This is in line with the statement of Afianto (1999), which states that the characteristics of the javan hawk-eagle's nest are valley areas with a slope of up to 86^0. This pine plantation forest is also close to a natural forest that can support the javan hawk-eagle's food needs.

Rest Area

The resting tree was chosen by prioritizing the criteria of a strong branch, as evidenced by its ability to support the weight of the Javan hawk-eagle. Another choice of branches that are perpendicular to the main trunk is to be able to stand upright. The branch chosen by the eagle is, on average, perpendicular to the trunk for perching and resting (Widodo 2004). Perched locations on trees are required to have a broad view and can observe both prey and threats around, in accordance with the behavior of the Javan eagle looking around the area when perched. This is in line with Afianto (1999), who stated that the Javan hawk-eagle uses an area on a tree branch with a minimal canopy. To be able to monitor the surroundings. The Javan hawk-eagle was observed using pine trees on the hillside to perch, and the tree height is 32 meters.

Hunting Area

The hunting area for the Javan hawk-eagle is a habitat where good food sources are available (Utami 2002). The Javan hawk-eagle hunting areas are divided into open and closed areas; closed areas are in natural forest habitats and plantation forests, while open areas are in shrubs. The diversity of habitat types affects the diversity of a species (Huzni 2017). The plantation forest, a nesting place for the Javan hawk-eagle, also contains coffee plants that are food for langurs, squirrels, long-tailed macaques, and birds. Hence, the abundance of Javan hawk-eagle feed in the plantation area is also sufficient. The characteristics of birds that become potential food for the Javan hawk-eagle have several criteria: body size ranging from 20–35 cm, living in an open canopy, and not being agile (Utami 2002), according to the results of observations of bird species in the plantation forest, namely the Spotted dove (*Spilopelia chinensis*).

The Javan hawk-eagle uses perch hunting techniques to catch its prey by hunting from branch to branch, and this is possible if the area's condition is closed, with many trees. In natural forests can be found various types of animals feed the javan hawk-eagle, including; Surili (*Presbytis comata*), Javan langur (*Trachypithecus auratus*), Long-tailed macaque (*Macaca fascicularis*), Plaintive Squirrel (*Callosciurus notatus*), Green lizard (*Desia olivacea*), Collared Kingfisher (*Todirhamphus chloris*), Spotted dove (*Spilopelia chinensis*), and Sooty-headed Bulbul (*Pycnonotus aurigaster*). Species of mammals such as Surili, Javan langur, and Long-tailed macaques are more often found on *Salam* trees (*Syzygium polyanthum*) and *Hantap heulang* (*Sterculia macrophylla*).

Nest Area

The Javan hawk-eagle nest tree was found about 450 meters from the natural forest; according to (Sözer and Nijman 1995), the Javan hawk-eagle nest location remains close to the extensive primary forest for hunting needs. The nest tree has a Rauh tree architecture, which is a tree with monopodial and orthotropic branching patterns. The Rauh Architectural Model can provide a suitable resting place for the Javan hawk-eagle to support the nest and has a strong branching pattern perpendicular to the main trunk with a nest height of 26 meters from the ground.

Use of Tree Canopy Space

The Javan hawk-eagle uses the canopy space close to the main stem, namely A (I and II), for resting behavior, stalking prey, and building nests, with an illustration of the division of the tree canopy as shown in Figure 3. In the canopy space, the Javan hawk-eagle is more comfortable resting and has a wide view, making it easier to move. Branches close to the main trunk are horizontal $\pm 90^0$, shaded by a canopy; branches are not tightly closed by leaves, and strong branches support the body of the javan hawk-eagle. Widodo (2004) stated that the Javan hawk-eagle perches in the middle of the tree because it provides strong branches to support the Javan hawk-eagle body.

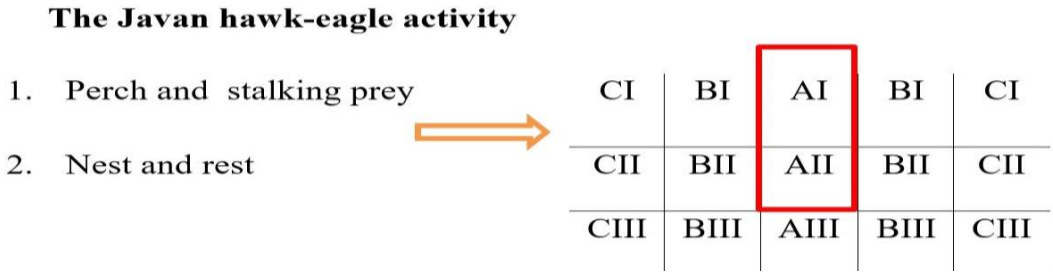

Figure 3 The Javan hawk-eagle uses the tree canopy space

Habitat Type Use Rate

The results showed that habitat use during the Javan hawk-eagle nesting season used plantation forest types (83.14%), natural forest (14.12%), and shrubs (2.75%) was obtained from activity encounters, and the length of time from encounters with the Javan hawk-eagle in different forest types. Habitat use by Javan hawk-eagle in plantation forests is higher than in natural forests because Javan hawk-eagle are found nesting in plantation forests. The natural forest remains the main habitat for the Javan hawk-eagle because plantation forests and natural forests complement each other in providing resources, especially diverse and abundant feed.

Javan Hawk-eagle Behavior

Based on the behavior of the Javan hawk-eagle observed, among others, resting, hunting, flying, and social interaction. The limitation of the Javan hawk-eagle resting activity is perching on a tree, taking care of oneself such as examining feathers, and monitoring the surroundings, such as turning left and right. Hunting activities start with Javan hawk-eagles targeting prey, catching, tearing, and eating prey with Perch hunting or Ambush hunting techniques. The limitation of flight activity starts with the Javan hawk-eagle leaving the perch to the next perch. While social interaction is an activity between the Javan hawk-eagle and its cubs or other eagle species. The frequency of behavior of the Javan hawk-eagle in natural forests, plantation forests, and shrubs is presented in Figures 4, 5, and 6, respectively.

In the natural forest habitat, only two activities of the Javan hawk-eagle were observed: hunting and flying (Figure 4). It can be seen that the Javan hawk-eagle's flight activity in the natural forest is six times, with the highest frequency of 2 encounters between 09.00 am and 10.00 am. While in the pine plantation forest habitat, four activities of the Javan hawk-eagle were found, namely, resting, hunting, flying, and social interaction (Figure 5). Hunting activities for Javan hawk-eagles in plantation forests were three times, with the highest frequency of encounters two times between 08.00 am and 11.00 am. In the scrub habitat, only two activities of the Javan hawk-eagle were found: flying and social interaction (Figure 6). The flight activity and social interaction of the Javan hawk-eagle e in the bushes are only one encounter between 9.00 am and 10 am.

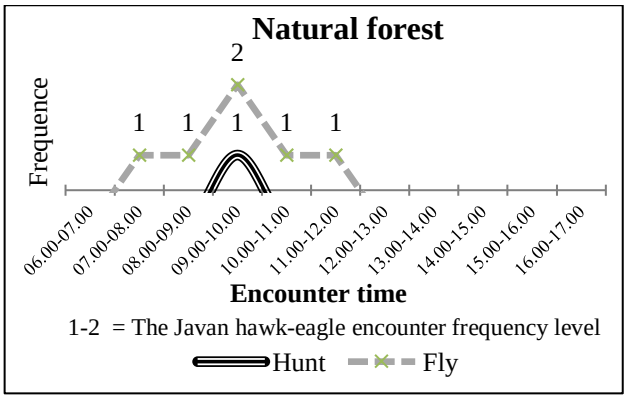

Figure 4 Frequency of the Javan hawk-eagle encounters in natural forest

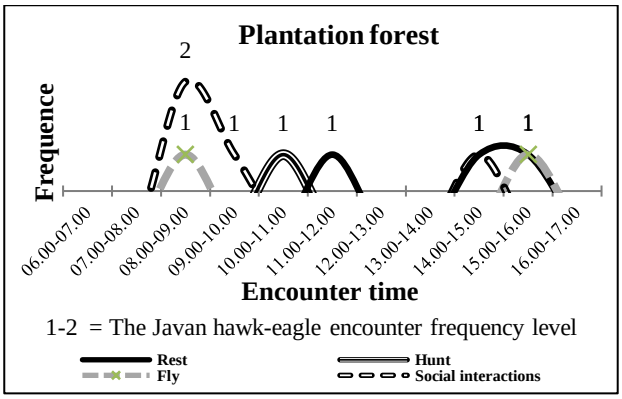

Figure 5 Frequency of eagle encounters in plantation forest

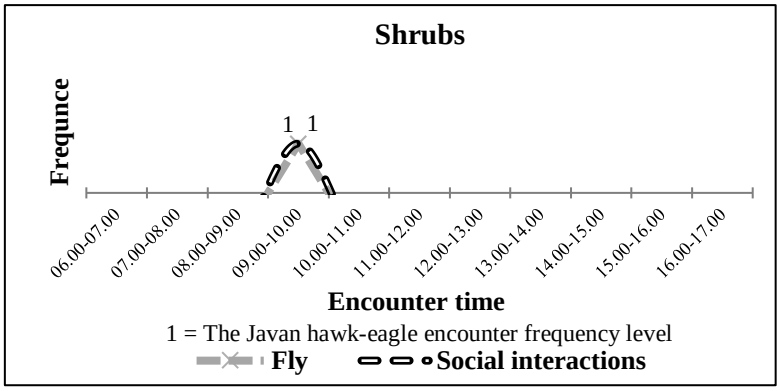

Figure 6 Frequency of eagle encounters in shrubs

Rest Behavior

The Javan hawk-eagle was found resting in pine plantation forests three times, namely at 11.03 am, 02.23 pm, and 04.45 pm, with a total time of 79 minutes. Based on the observations of the Javan hawk-eagle perching on a pine tree which is ± 50 meters from the nest, this is done to monitor the nest where there are eagle chicks. This is reinforced by Thiollay (1996) statement that while perching, the Javan hawk-eagle will pay attention to its territory while targeting prey.

Hunt Behavior

Based on observations, it was found that the Javan hawk-eagle was hunting with the perch hunting technique, which is a hunting technique by monitoring its prey from branch to branch before grabbing its prey (Sitorus and Hernowo 2017). Furthermore, Prawiradilaga et al. (2003), that the Javan hawk-eagle likes Tupaiidae mammals, such as the black squirrel at the observation site. The Javan hawk-eagle hunting behavior is seen from 09.00 am to 11.00 am. In the natural forest, the Javan hawk-eagle hunts for one encounter with a total time of 5 minutes, and in the plantation forest, one encounter with a total time of 6 minutes.

Fly Behavior

The most frequently observed flying behavior is spinning upwards without flapping its wings (soaring) and gliding flying. The soaring flight behavior was carried out right above the nest tree between 02.00 pm to 03.00 pm with a total time of 9 minutes, and this was done to repel Crested Serpent Eagle (*Spilornis cheela*) and groups of long-tailed monkeys (*Macaca fascicularis*) that entered the territory of the javan hawk-eagle. The Javan hawk-eagle also occasionally makes a distinctive sound to warn of a threat. The gliding flight of the Javan hawk-eagle was found between 07.00 am and 11.00 am, with a total time of 17 minutes. Another activity when the Javan hawk-eagle flies is flying with materials to build a nest; this is found when the Javan hawk-eagle is breeding; this activity is carried out in order to keep the nest condition warm when incubating the eggs and when caring for the chicks of the javan hawk-eagle. The Javan hawk-eagle flight activity was recorded in as many as eight encounters with a total time of 48 minutes.

Social Interaction Behavior

The social interaction behavior of the Javan hawk-eagle that is most often observed is between the Javan hawk-eagle and its cubs in the nest, where the Javan hawk-eagle is often in the nest to guard and feed the chicks; this activity was recorded four times between 08.00 am to 11.00 am, with a total time of 105 minutes. Another activity seen is a pair of Javan hawk-eagle flying (soaring) together while making sounds when the Crested Serpent Eagle (*Spilornis cheela*) crosses the eagle's nest territory; this sound is usually issued when the Javan hawk-eagle feels threatened, and the Javan hawk-eagle often makes sounds during breeding and this

sound audible over long distances, this behavior also serves to alert the eagle to its territory and also functions in falconry and chicks (Sözer et al. 2012; Luthfi et al. 2020). This activity was recorded once at 09.00 am with a total time of 3 minutes. The Javan hawk-eagle pair forms a breeding territory that covers the location of nest trees in the home range, and the territory will disappear after breeding is complete (Azmi et al. 2016).

CONCLUSION

The Javan hawk-eagle main habitat is natural forest, but the Javan hawk-eagle also uses various types of forest for activities. The use of plantation forest types (83.14%), natural forest (14.12%), and shrubs (2.75%). Natural forest habitat is dominated by *Hantap heulang* (*Sterculia macrophylla*; 67.18%), *Ki calung* (*Diospyros macrophylla*; 60.14%), *Salam* (*Syzygium polyanthum*; 49.80%), *Saninten* (*Castanopsis argentea*; 28.35%), and *Benda* (*Artocarpus elasticus*; 21.55%). The type of tree found in the plantation forest is Pinus (*Pinus merkusii*) with strata A and B, which has a spacing of 2.5 m and a density of 1,363 stems/ha. There are three habitat functions for the javan hawk-eagle, namely nesting, resting, and hunting areas. The Javan hawk-eagle uses the canopy space close to the main trunk, A (I and II) for resting behavior, stalking prey and building nests.

The observed behavior of the Javan hawk-eagle included resting, hunting, flying, and social interaction. The Javan hawk-eagle was found resting in pine plantations three times with a total time of 79 minutes. In the natural and plantation forests, the Javan hawk-eagle hunted twice for a total of 11 minutes. The Javan hawk-eagle flight activity was recorded in as many as eight encounters within 48 minutes. The Javan hawk-eagle social interaction was recorded five times between 08.00 am to 11.00 am, with a total time of 108 minutes.

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