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POPULATION MONITORING OF JAVAN LEOPARD AND JAVAN GIBBON IN POTENTIAL AREAS IN MOUNT HALIMUN SALAK NATIONAL PARK

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ABSTRACT

Mount Halimun Salak National Park (MHSNP) is one of tropical forest area in West Java which has the potential for a high diversity of flora and fauna species. One of them is an important habitat for the Javan leopard and Javan gibbon. The existence of these two species is so important that the monitoring towards those two are necessary. This study aims to analyze the population density of the Javan leopard and Javan gibbon. Based on the result of this study information on the population condition of the Javan leopard and Javan gibbon in MHSNP. The data collection was conducted in February – April 2021 in Cikaniki area, Citalahab, corridor, and MHSNP Star Energy by installing camera traps and line transect method. The results of the camera trap installation could detected 12 species of mammals and 5 species of birds. There are four Javan leopard identified in this study with a sex ratio of 3 males and 1 famale (3:1) and only had one age class (adult). The estimated density of the Javan leopard by SECR is 11.19 ind/100km^2. There were at least 11 javan leopards in an area 100 km2. The population density of javan gibbon in Cikaniki is 26.67 ind/km2, Citalahab is 16.67 ind/km2, and Star Energy is 8.33 ind/km^2.

Key words: *camera trap, javan gibbon, javan leopard, population density*

INTRODUCTION

Mount Halimun Salak National Park (MHSNP) is one of the tropical forest areas in West Java which has a high potential for diversity of flora and fauna and has a function as a life sup port system for living things (Carolyn et al., 2013). MHSNP is an important habitat for the Javan leopard (*Panthera pardus melas*) and Javan gibbon (*Hylobates moloch*) which are the main icons in this area. The existence of the Javan leopard plays an important role in the ecosystem because this species is a keystone species (Gunawan, 2019) and the highest level predator in food chain cycle (Nugroho, 2013). Lost or extinct key species lead to significant changes in other species population. Key species are the main predators because they play a role in controlling the herbivorous animal population (Buchori, 2014). The conservation status of the javan leopard was evaluated as an Endangered species in the IUCN Redlist in 2021 (IUCN, 2021), and included in Appendix I CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) (IUCN, 2012). This protected animal is listed in the KSDAE Law Number 5 in 1990, Government Regulation Number 7 in 1999, and Regulation of the Minister of Environment and Forestry Number 106 in 2018. The condition of the preservation of this animal is quite worrying. The remaining population size of the Javan leopard is estimated to be only around 191,3 to 546,2 individuals based on estimates of the remaining conservation forest on the island of Java which is only less than 5% or around 327.733 ha (3.277 km^2) (KLHK, 2016). The population size of the Javan leopard is estimated to continue to decline drastically and its distribution to continue to narrow due to habitat loss and fragmentation (Gunawan, 2019, Wilting et al., 2016). Ario (2010) stated that this degression happened along with the shrinking of natural forest which is the habitat of javan leopards and also followed by the decline of predatory animal and the increase in poaching.

Javan gibbons are also one of the endemic species in MHSNP which have an important role in the ecosystem as seed dispersal agents, so that their existence can help forest sustainability and regeneration (Widyastuti, 2016). The Javan gibbon is included in the '*Endangered*' category in the IUCN Redlist (IUCN, 2014), which means that it faces a high risk of extinction in the wild. The existence of the Javan gibbon is estimated to be increasingly threatened due to forest fragmentation and deforestation which has caused the loss of natural habitat for the Javan gibbon more than 96% (Dewi, 2016). This indicates that the existence of the Javan gibbon in this area is increasingly pressing (Yumarni et al., 2011). The high level of threat to the Javan leopard and Javan gibbon causes the need for appropriate management based on complete data on both populations. This management can be done by monitoring these two species to support the condition of their populations in MHSNP.

Wildlife monitoring is an important aspect of biodiversity conservation efforts. Effective and systematic monitoring of populations of known species is considered a top priority for species conservation management, understanding individual and group movements, habitat use and social dynamics, and detecting the possible presence of solitary individuals (Turvey et al., 2015). Javan leopard species is one species of mammal that has a behavior to avoid human so that it is difficult to monitor and observe them directly (Mustari et al., 2015). Monitoring the Javan leopard using the help of a camera trap is known to provide convenience, because this tool works without disturbing the activities of the Javan leopard and the chances of being caught are greater if the monitoring is carried out using a camera trap (O'Connell et al., 2011). Camera traps are able to record all passing animals so that the diversity of animals in the study area can also be known (Ario, 2010). Javan gibbon monitoring was carried out by direct observation in the field. This study aims to estimate the population density of the Javan leopard and Javan gibbon in several potential areas of MHSNP which will be used as a determination of population policy for both in MHSNP.

RESEARCH METHOD

The tools used are a set of camera traps (camera traps, memory cards, camera guards, chains, banji ropes, padlocks), GPS, cellphones, meters, compasses, laptops and stationery. The devices used for data processing and presentation are Arcgis software, Microsoft Office software, and R software for SECR. The materials used in this study were tally sheets, alkaline batteries, and work maps. The objects observed in this study were the Javan leopard, Javan gibbon and other animals recorded by camera traps.

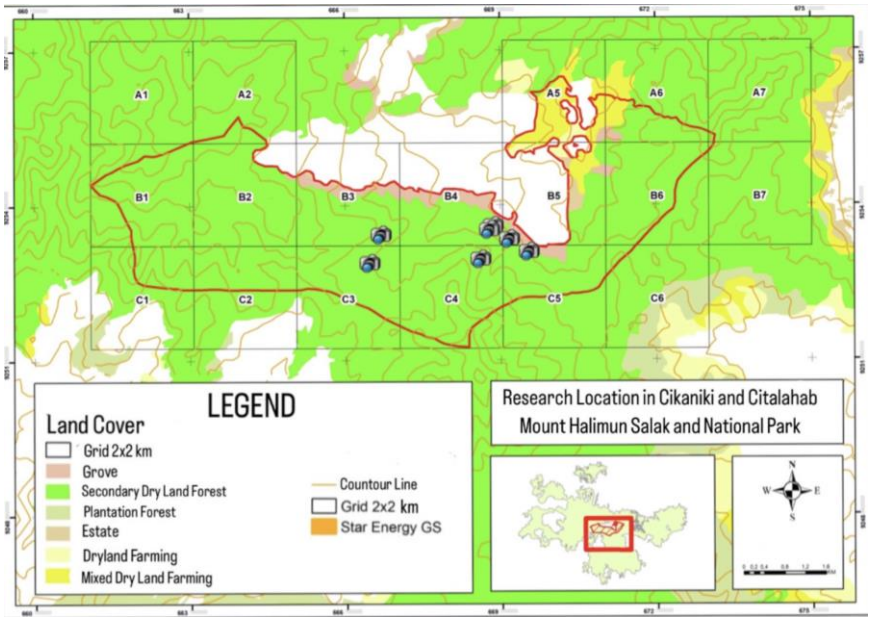
This research was conducted in the Mount Halimun Salak National Park area (Figure 1) for two months (February – April) 2021. This area is included in the classification of the most extensive tropical mountain forest on the island of Java (Hilwan dan Rahman, 2021). Geographically, it is located between 6º37′ – 6º53′ south latitude and 106º21' – 106º38' east longitude. Forest cover in MHSNP reaches around 60.000 Ha (Prasetyo, 2008). The shape of the MHSNP area is irregular. The MHSNP area is limited by smallholder agricultural lands managed by villagers, production forest areas and protected forests that were once managed by villagers, production and protected forest areas that were once managed by Perhutani, and tea plantations managed by private companies (Hakim et al., 2016). Geological history reveals that the MHSNP area is part of a volcanic belt that extends from the Bukit Barisan Mountains of Sumatra to Mount Hinje in Ujung Kulon National Park and so on to Mount Halimun-Salak (BTNGHS, 2010). The soil map of West Java Province with a scale of 1: 250.000 from the Bogor Soil Research Institute in 1966 shows that some soil types in the MHSNP area consist of associations of brown andosol and brown regosol, as well as other rocks (BTNGHS, 2012). The variation of average rainfall in the MHSNP area ranges from 4.000 mm-6.000 mm/year, where the rainy season between 400 mm- 600 mm/month occurs in October-April and the dry season around 200mm/month occurs in May-September (Zulkarnaen et al., 2020).

Alhamd and Polosakan (2011) stated that this area has several functions, including storing biodiversity, regulating water systems, education, research, germplasm sources, cultivation development, recreation and tourism. The biodiversity in this area has long attracted the attention of researchers from both home and abroad. Overall, the important values contained in MHSNP include the potential for biodiversity protection of hydro-orological functions, the potential for natural tourism and a strategic location reflecting the existence of MHSNP as a source of world biodiversity (BTNGHS, 2012). Forest cover in the MHSNP area can be classified into 3 vegetation zones, namely the hilly zone (colline) lowland forest found up to an altitude of 900-1.150 m above sea level, the lower mountain forest zone (submontane forest) between 1.050-1.400 m above sea level, and the submontane forest zone. Upper mountain forest (montane forest) above an elevation of 1.500 m above sea level (GHSNMP-JICA 2007). The MHSNP area is also a habitat for unique animals such as the Javan gibbon, Javan eagle, and Javan leopard. Several types of plants that dominate the MHSNP area include Puspa (*Schima wallichii*), Rasamala (*Altingia excelsa*), Saninten (*Castanopsis javanica*), and Pasang (*Quercus gemelilflora*) (Purwaningsih, 2012).

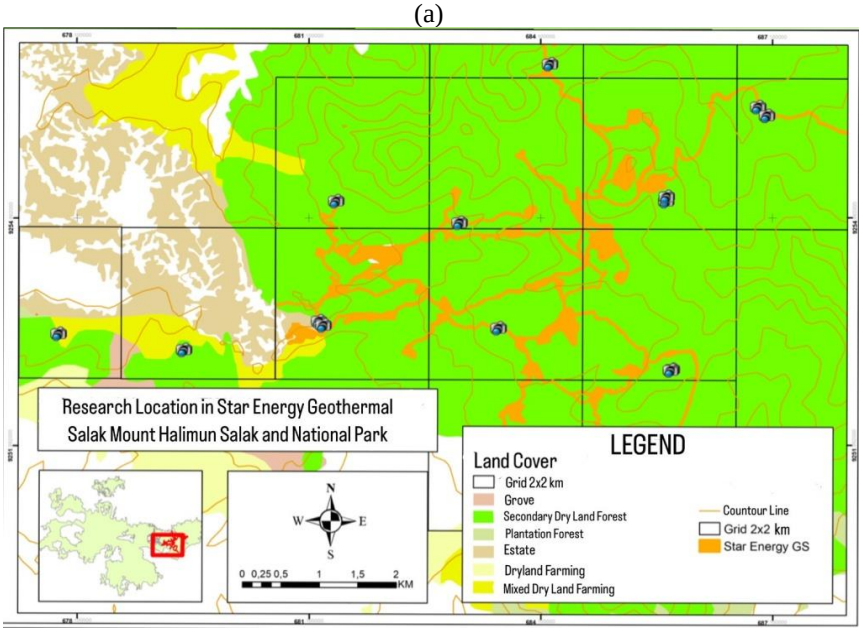
a. Camera traps installation

Camera trap is a common technique used in last few decades to observe the presence of rare and difficult species to catch and find in person (Rahman et al., 2016). Moreover, camera trap play a significant role in recording the data of animals with low population density, especially in the area where the pattern of movement is still unknown (Kawanishi et al., 2010) and it also used to predict number of individuals in certain areas (O'Connell et al., 2011).

Javan leopard data collection was carried out by installing a camera trap for two months. There are 32 camera traps installed and worked in pairs representing each grid that has been determined in the Cikaniki, Citalahab, Corridor and Star Energy MHSNP areas. There are 16 camera trapping points in MHSNP which have been determined based on careful consideration of potential areas and discussions with field officers. Each grid is installed as many as 2 camera traps (pairs). The grid size used is 2x2 km^2 which is determined based on the consideration of the number of camera traps. The smaller the specified grid size, the higher the potential results obtained.



(a)



(b)

Figure 1 Research Location (a) Cikaniki and (b) Star Energy Geothermal

The camera trap is mounted on a relatively straight tree trunk with an average height of 40 to 45 cm from the ground or adjusted to the surrounding conditions, the position of the camera trap is facing the animal trajectory at a distance of 2 to 3 meters in order to obtain a complete image (Paiman et al., 2021). Determination of the location of the camera trapping installation is based on consideration of the presence of indirect traces, as well as the relatively flat topography and higher than the surrounding area so that better results are expected to be obtained. Camera trap installed in potential locations where javan leopards might do daily activities, mountain area (general mountain rain), human track (animal often used human path), near river or pond (animal tends to approach water during drought season), area with animal traces (feces, urine smell, scratch, footprint and food leftovers), also areas frequente (Andriana, 2011). Recording the animal pictures is deeply influenced by installing camera trap strategically in an area where trace, feces, scratch, and water source can be found near the location (Mustari et al., 2015)

The location of the installation of each camera trap is recorded at the coordinates. Setting the date, time, recording mode, photo and video resolution, length of time, and recording interval is done on each camera trap that will be installed. The installation time of the camera

trap is approximately two months with picture and video modes. All animal data captured by the trapping camera is selected and selected to be an independent image. Data were collected in albums to differentiate between one species and another, including the Javan leopard. The captured Javan leopard was visually distinguished based on differences in morphological characteristics, body dimensions, spotted patterns, and individual specific signs. The identification of the Javan leopard is done by determining the special characteristics that distinguish each individual, so that the chance for recalculation is getting smaller (Ario, 2014).

The pictures of the Javan leopard recorded by the camera trap are selected with good quality, so that by the pictures, Javan leopard could be identified from the right, left, front and back side as well as a timer. Individual analysis of the Javan leopard is different in order to determine the sex ratio and age structure. After the individual Javan leopard is clearly identified, all individual pictures of the Javan leopard can be classified correctly. The Javan leopard identification data that has been obtained were analyzed using R software with the Spatial Explicit Capture Recapture (SECR) model to estimate population density of the Javan leopard. The encounter rate of the Javan leopard and all recorded animals was calculated by dividing the total number of photos divided by the total number of days the camera was active multiplied by one hundred (number of photos/number of days), where the divisor factor was the number of days to equalize the time of the effort used (O'Brien et al., 2013).

b. Animal Identification with Camera Trap

Identification of animals through camera trap pictures is done by collecting all recording data on each camera in one folder according to the date of capture. The data obtained were observed directly using a laptop or PC with the stages of sorting the images obtained in the form of: selecting pictures containing animals, and selecting picture of animals that can be identified individually (Paiman et al., 2021). All animal pictures collected were observed for body characteristics, body size, morphological shape and special signs used to identify animal species. Mammals can generally be recognized directly by the type when viewing pictures. Bird species need to be observed more deeply by zooming in and out of the picture because of the small size of the bird's body so that these bird species can be obtained. The results of pictures that are clear, not cropped, and the right position is the key in identifying animals accurately and quickly. After all pictures of animals are identified, the Relative Abundance Index will be calculated with the following formula (O'Brien et al., 2003):

$$\text{RAI} = \frac{\Sigma f}{\Sigma d} x\ 100$$

Description:

RAI = Relative Abundance Index
Σf = All detection for each species are summed for all camera traps over all days
Σd = Total number of camera trap nights

c. Line transect

Javan gibbon data was collected using the line transect method in the Citalahab, Cikaniki, and Star Energy areas. Determination of the length of the observation path is adjusted to the consideration of time and energy in limited field activities (Ismail et al., 2015). Observation lines in each area start from the boundary of each area with a length of each observation line is 2 km and a total line width is 0.1 km to the both sides of the track or adjusting to field conditions. The forest area in GHSNP is a heterogeneous forest area (BTNGHS, 2012), so not all locations can use the same length and width of the track. Observations were made at three times (morning, afternoon, and evening) three times. Estimated population density of Javan gibbons in each region was calculated by the number of individuals divided by the total area of the transect observed (Bismark, 2011).

RESULT AND DISCUSSION

1. Result of camera traps installation

Camera traps were installed in various locations where the Javan leopard was researched, namely in the area of Mount Halimun Salak National Park covering the Cikaniki area, corridors, and Star Energy. The selection of these three areas as the location for camera trap installation was based on information from local managers and the results of previous research on Javan leopards. Researchers also conducted a preliminary survey in locations where the Javan leopard could be found in GHSNP. According to Ario (2010), the opportunity to capture pictures and videos of Javan leopards is even greater if the location of camera trap installation is done at locations that have been installed previously as well. The camera traps installation period is from February 1, 2021 to April 21, 2021 with four repetitions (data collection period). Data collection activities are carried out once every 15 days during the installation period of the camera trap because based on the data obtained within 15 days the Javan leopard has been successfully recorded by the camera traps. This result is in line with the data obtained by Martinyani (2020) where within 15 days, Javan Leopard had been successfully recorded by a camera trap.

The total number of camera traps that were successfully installed in this study were 32 units which were installed in pairs at 16 different points in 3 areas in MHSNP. Camera traps were installed in the Cikaniki area as many as 12 units at 6 points, in the corridor area as many as 4 units at 2 points, and in the Star Energy area as many as 16 units at 8 points. The division of the number of camera traps in each region is different based on considerations of regional access, weather, number of

manpower, and the chance of finding a Javan leopard based on information from field officers. Camera traps are installed in habitats with an altitude between 950 meters above sea level - 1500 meters above sea level. Gunawan et al., (2009) stated that there is a relationship between the presence of leopards and altitude, where this species prefers habitats with an altitude above 100 meters above sea level compared to habitats with an altitude below it. The grid size used is 2x2 km2 which is determined based on the consideration of the number of camera traps. Nugroho (2013) stated that the smaller the grid size used for feeding, the higher the potential for animal picture acquisition.

The total installation time of the camera trap is 1.250 days (trap days). The total number of photos and videos recorded during the camera trapping period was 13.537 images with the composition of the number of photos and videos capturing 792 images of animals (5,85%), the number of photos and videos that were empty or damaged as many as 4.778 images (35,30%), and the number of photos and videos that capture images of non-animals (humans, motorcycles, cars, and others) is 7.967 (58,85%). Most camera traps capture images of non-animals (humans, motorbikes, cars, etc.) with a percentage of more than 50%. This happens because most of the camera trapping installations are carried out in human traffic lanes, especially in the Star Energy area which is full of human activities. The percentage of camera traps capturing blank images is also higher than capturing images of animals. Many factors cause this to happen, including the camera being exposed to excessive sunlight and rainwater that interferes with the working sensor, as well as strong winds that cause the grass/plants to sway, which triggers the camera to record and capture blank images.

All images of Javan leopards and other animals recorded by camera traps are identified for each photo. Identification of javan leopard individuals carried out by referring to the right and left side of the body as how it was seen in the pictures. Therefore, identifying the right and left side of the body is important to be done in order to know the individuals of javan leopard that was recorded by the camera. Javan leopard individuals identified based on morphology characteristic differences, body dimensions, spot patterns, and individual specific signs (Ario, 2014).

The results of manual inspection of camera traps obtained as many as 792 photos of animals with the composition of images of Javan leopards totaling 63 photos, and images of other animals totaling 729 photos. The results of animal identification showed that there were 12 species of mammals and 5 species of birds that were successfully recorded during the camera trapping period. The highest number of animal photos recorded was the palm civet with a total of 241 photos and 233 independent photos with a percentage of 31,1%, followed by the common quail barking with a total of 122 photos and 118 independent photos with a percentage of 15,7%. The species of animals that have the lowest number of photos recorded are the Javanese surili, biul, and garangan with a total of 1 photo each with the same percentage of 0,13% each.

The number of species recorded in this research period was less than the number of species recorded in the MHSNP area based on field surveys. According to Qodri (2020) the number of mammal species in MHSNP is 83 species and bird species are 271 species. The number of animal species found in this study period was less than the number of animal species in MHSNP because the sampling period was only carried out in areas of potential presence of Javan gibbons and Javan leopards which did not cover the entire TNHGS area. In addition, the sampling period was only carried out for two months. The longer the sampling period, the more species of animals might be obtained. The species of animals recorded during the study period are presented in Table 1.

2. Javan Leopard Density

a. Population Size

Estimation of the population size of the Javan leopard in the MHSNP area was carried out using 32 camera traps installed in pairs at 16 potential locations for the Javan leopard to pass. The population size of the Javan leopard at the study site was determined based on the number of individual Javan leopards recorded by camera traps during the study period. Analysis of photos and videos is done by making an album first, making a database of Javan leopards that have been caught by camera traps. The photos of the Javan leopard are selected with good quality so as to facilitate the identification process based on the characteristics of the body found on the right or left side of the body, and front or back. According to Ario (2009) the individual identification process is carried out by looking at the unique spotted pattern on the Javan leopard's body to ease individual marking. A unique spotted pattern is found on the body of the Javan leopard in the form of a dice-shaped pattern that is used as an individual identification mark for the Javan leopard as found by Martiyani (2020) in Gunung Sawal.

The results of the visual analysis of photos and videos of the Javan leopard showed that there were four different individuals of the Javan leopard in the study area. It is known that there is 1 individual panther and 3 individuals leopard. The panther is the same species as the leopard, but the panther has melanism, namely the presence of a black base color on its body. The panther also has a spotted pattern on its body if you look thoroughly, but the spots are disguised with black on the panther's body (Rustiadi and Prihatini, 2015).Each individual Javan leopard was given an identity with the each of names such as JD1, JD2, JD3, and BD1. This study only covers 16 different points in three areas, namely Cikaniki, corridor, and Star Energy, not cover the entire MHSNP area. Consideration of the very wide area of MHSNP, access, and the time they have, the

researchers can only carry out sampling in a few areas, so the data produced is also limited. The results of this study are also different from the research conducted by Rahman et al., (2018) where in Ujung Kulon National Park, the estimated number of Javan leopard individuals ranges from 35,23 to 41,37 individuals.

The presence of the Javan leopard can be detected by the signs left by the Javan leopard such as footprints on the ground and scratches on trees. Gymnastiar (2019) mentioned that the Javan leopard usually leaves signs of its presence through sound, feces and urine, tree scratches and footprints. Signs of the javan leopard found in this study consisted of footprints and sounds. While the other signs such as scratches on trees, traces of dirt, and other signs have not been found. Javan leopard footprints were found at the research site, two of which were found in Cikaniki and the corridor which can be seen in Figure 3.

The footprints found are almost all clearly imprinted on the ground with condition that is clean of leaves. The footprints found are still relatively new, indicating that the Javan leopard has not been active in the vicinity of the camera trapping location. The number of Javan leopard footprints found during the study period indicates that the Javan leopard individuals were active during the study period. The footprints found at Cikaniki were 7,5 cm long and 6 cm wide (Figure 3a), while the footprints found in the corridor were 6 cm long and 5,7 cm wide (Figure 3b). The footprints found can be used to determine the direction of movement of the Javan leopard in the location, but these footprints cannot be used to identify the individual Javan leopard because it depends on soil conditions. Soil conditions that are too wet make the size of the footprints not the same as the actual size (Ardiansyah, 2019).

b. Sex Ratio

The results of the visual analysis of photos and videos of the Javan leopard showed that the sex ratio of the Javan leopard at the study site consisted of 3 males and 1 female (3:1). These results were obtained by identifying individual Javan leopards from the right and left sides of the Javan leopard's body, as well as based on photos from the side and rear (Ario, 2009). The sex of the Javan leopard can be identified from the external genitalia of the individual, especially the male leopard. Comparison of sex ratios obtained in this study showed that the number of male Javan leopard individuals was higher than that of female individuals. This can lead to competition between individuals of Javan leopards, because according to Friedmann (2008) the ideal sex ratio of leopards is 1 male and 1,8 female (1: 1,8). The Javan leopard is an animal that has a social structure in limited mating, namely polygamy where one male can mate with many females. The sex comparison of the Javan leopard in 2021 at the study site is presented in Table 2.

Table 1 List of animal types captured by camera trap along the research period

Local Name	Scientific Name	Total Photos	IDP Photos	%	RAI-1	RAI-2
Mammals						
Javan leopard	*Panthera pardus melas*	63	48	6,4	26	3,84
Wild boar	*Sus scrofa*	9	7	0,93	179	0,56
Mouse deer	*Tragulus javanicus*	66	61	8,14	20,5	4,88
Linsang	*Prionodon linsang*	6	6	0,8	208	0,48
Palm civet	*Paradoxurus hermaphroditus*	241	233	31,1	5,36	18,64
Deer	*Muntiacus muntjak*	116	116	15,5	10,8	9,28
Rat	*Rattus sp.*	34	32	4,27	39,1	2,56
Squirrel	*Tupaia sp.*	73	68	9,07	18,4	5,44
Surili	*Presbytis comata*	1	1	0,13	1.250	0,08
Biul	*Melogale orientalis*	1	1	0,13	1.250	0,08
Javan garangan	*Herpestes javanicus*	1	1	0,13	1.250	0,08
Common dog	*Canis familiaris*	25	25	3,33	50	2
Local Name	Scientific Name	Total Photos	IDP Photos	%	RA1-1	RAI-2
Aves						
Small quirk	*Enicurus velatus*	2	2	0,27	625	0,16
Delimukan emerald	*Chalcophaps indica*	4	4	0,53	313	0,32
Common barking quail	*Abrophila javanica*	12	118	15,7	10,6	9,44
Wild red chicken	*Gallus gallus*	14	13	1,73	96,2	1,04
Black punglor	*Zoothera sibirica*	14	14	1,87	89,3	1,12
Total		792	750	100		

Note : IDP Photos= independent photo, RAI-1= relative abundance index-1, RAI-2= relative abundance index-2

Figure 2 Javan leopard individuals (a= BD1, b=JD2, c= JD4, d=JD3)

(a) (b)

Figure 3 (a) Javan leopard's footprint in Cikaniki, (b) Javan leopard's footprint in corridor

Table 2 Sex ratio of Javan leopard in 2021

No.	Individual ID	Sex	Type	Location Found
1.	JD1	Male	Leopard	Cikaniki
2.	JD2	Male	Black Panther	Star Energy
3.	JD3	Male	Leopard	Koridor
4.	BD1	Female	Leopard	Star Energy

Note : JD = adult male, BD = adult famale

c. Age Structure

Nugroho (2013) explained that the age structure is one aspect that is used to review the breeding success of the Javan leopard which can later be used to estimate the prospects for the preservation of this animal. Visual analysis of photos and videos of Javan leopards that have been carried out leads to the assumption where all recorded Javan leopard individuals have the same age class, which is adults. The identification results can be seen from the spotted pattern of the Javan leopard with a clear rosette, the age is more than 2,5 years, the male leopard body size is larger than the female, and already has its own territory (Rustiadi and Prihantini, 2015). The cub (infant) and juvenile (sub-adult) of the Javan leopard were not captured by the camera trap at all. The absence of individual Javan leopards in the age class of cub and juvenile makes the population of this animal even more worrying.

The existence of individual Javan leopards in the age class of cub and juvenile is a very important factor for the Javan leopard population in an area. Javan leopard individuals in the age class of cub and juvenile are individuals who can maintain the animal population. If the number of individuals is too small to grow and develop into adults in order to meet the needs of replacement, then the structure of a population is a declining population condition (Wirakusumah, 2003). The results of this study are similar to research conducted by Nugroho (2013) in the Mount Ciremai National Park area which only found one age structure of the Javan leopard, namely adult. These studies are much different from overseas research conducted by Friedmann (2008) in Kruger National Park, South Africa which found three age structures of leopards, namely cubs, juveniles, and adults with a ratio of 454 cubs: 243 juveniles: 135 adult tail.

d. Population density

Estimation of the estimated density of the Javan leopard is carried out with the assumption that the estimated animal population is a closed population,

which means that there is no change in the number of individuals from birth, death, emigration, and immigration of population members during data collection (Ancrenaz et al., 2012). The results of the individual identification of the Javan leopard were made in Ms. Excel along with the grid name, date and coordinates of the photo. Efford (2013) stated in data analysis using SECR, there are three files that need to be prepared, namely Traps.txt, Capture.txt, and Habitat Mask created in Ms. Excel and saved in tab delimited Text format. These three files are then inputted into the R Studio program to estimate the population density of the Javan leopard. The estimated density of the Javan leopard using the SECR model can be seen in Table 3.

The number of individuals of the Javan leopard that was identified was four individuals, consisting of three adult males and one adult female. The sampling area in this study is 64 km^2. Based on density analysis using the Spatial Explicit Capture Recapture (SECR) model, the population density of the Javan leopard in three areas of MHSNP is 11,19 ind/100 km^2. There are at least 11 individual Javan leopards in an area of 100 km^2 or 0,011 ind/km^2. Potential habitat that can be used (mask area) is 100 km^2. The mask area is an alternative way in the SECR model to define the integration region, if no mask is specified then a "trapbuffer" type of mask will be built automatically using the buffer width specified in meters (Borchers and Efford, 2008) .

The estimated population density of the Javan leopard in this study is high, this is assumed due to the placement of the camera trap in an area that is indeed the territory of the Javan leopard so that the higher the number of Javan leopards detected. The total detection in this study was 33 times detection with 80 times a day (occasion). The number is quite large and it is also possible that the detected individual is the same individual, causing overlate estimation. In addition, the placement of camera traps in this study is also not spread throughout the MHSNP area, namely only in a few potential areas (Cikaniki, corridors, Star Energy). The distance between camera traps is also close/short and the installation is done in pairs which causes the level of animal detection to be higher by camera traps.

Population density analysis of the Javan leopard using the Spatial Explicit Capture Recapture model can also show the active movements of the Javan leopard during the study period based on the detection of each individual by camera traps. Figure 4 shows (for example) individual JD1 captured in any of the mounting regions, and applies to other individuals as well. Based on this figure, it can be seen that the Javan leopard individuals recorded the most by camera traps, namely BD1 in Star Energy, followed by JD2 in Star Energy, and JD3 in the corridor and JD1 in Cikaniki. The results were obtained allegedly because in the Cikaniki area camera traps were only installed at six points, while in the corridor area camera traps were only installed at two points, and in the Star Energy area camera traps were installed at eight points.

The imbalance in the number of camera traps installed occurs due to the limitations of researchers in installing camera traps in the MHSNP area which has a broad and hilly topography so that it is difficult to reach. The weather factor at the time of camera trap installation which tends to rain continuously is also become consideration for researchers in its placement. When installing camera traps in the Cikaniki area, researchers were only accompanied by one field officer so that with the steep topography the researchers were only able to install camera traps at six points. Meanwhile, during the installation in the Star Energy area, the researchers were accompanied by three field officers so that the number of camera traps installed in this area was quite a lot compared to Cikaniki. The limited number of camera traps also causes the installation cannot be done thoroughly. The area chosen for the installation of camera traps is a potential area for the presence of the Javan leopard based on discussions with the management team. According to the researchers themselves, with forest conditions in the MHSNP area which is still good, if more camera traps could be installed and more comprehensive, the number of individual detections of Javan leopards would be high as well. However, the complete installation of camera traps in the MHSNP area requires careful preparation, starting from the availability of tools, time, and energy. This is necessary considering the size of this area.

Figure 5 shows the detection probability and the distance of Javan leopard in research site which explain how far the researcher can detect Javan leopard individual from its homerange. At 0 distance, the probability of researcher can detect Javan leopard picture is 0,04. This can lead to assumption where the further researcher install the camera trap from location A, the smaller the probability of researcher can record the animal picture. Otherwise, in this study, researcher installed the camera traps near the homerange so that the level of detection and density of Javan leopard is high.

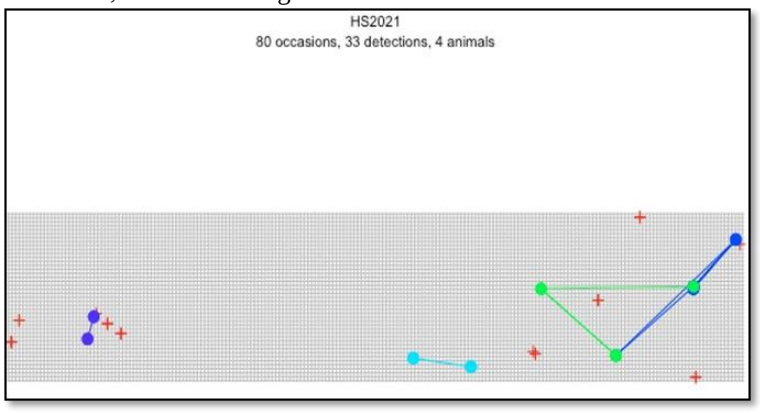
Table 3 Estimation of Javan leopard population density with SECR model

Assumption	D (ind/km^2)	SE	g0	Sigma
With "buffer/habitat mask" 36 km wide	0,011	0,005	0,04	1.469

3.
Javan Gibbon Density

Observations of the Javan gibbon were carried out at three locations in MHSNP which are Cikaniki, Citalahab, and Star Energy with each transect line length of 2 km and a width of 0,1 km (total area of observation track is 0,6 km^2). Observations were made with three repetitions at each location. The three locations were chosen based on careful consideration regarding access and discussion with field officers regarding the high potential for encounters with Javan gibbons. The results of Supriatna's research (2006) estimated that the population of Javan gibbons in Mount Halimun and Mount Salak was 900 – 1.221 individuals. Nijman (2004) estimated the gibbon population on Mount Halimun as many as 850-1.320 individuals and on Mount Salak as many as 140 individuals. Observations made by researchers by making three transect lines found as many as 31 individual Javan gibbons in Cikaniki, Citalahab, and Star Energy. Javan gibbons found at the research site can be seen in Figure 6.

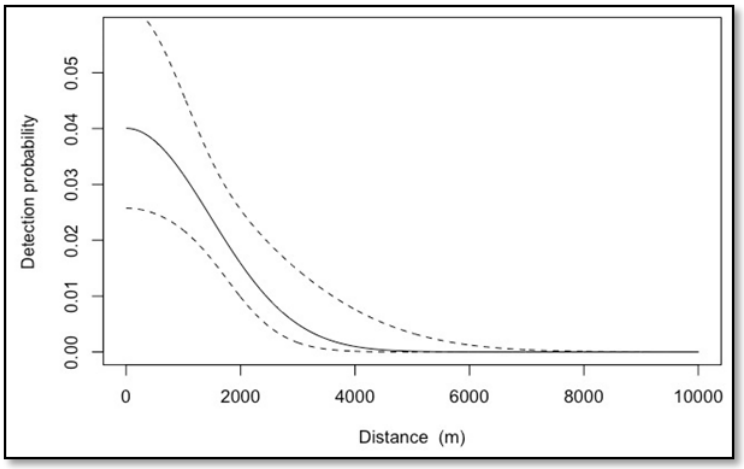
The total density of individual Javan gibbons in the three locations was 51,67 ind/km^2, with the largest population density in Cikaniki at 26,67 ind/km^2, followed by Citalahab at 16,67 ind/km^2, and Star Energy at 8,33 ind/km^2 (Table 4). The high density of individual Javan gibbons in the Cikaniki and Citalahab areas is due to habitat conditions that are generally stable and rarely hampered, despite small-scale habitat destruction (1,83%) such as tree felling for honey harvesting and bird traps where trees are felled they may serve as forage and sleeping trees for the Javan gibbon (Dewi et al., 2016). On the other hand, in Star Energy where there's only a small population density of Javan gibbons. This is because this area is a cluster of active volcanoes (Global Volcanism Program, 2007) which stores geothermal energy potential and is used as a power plant. The existence of geothermal utilization in Mount Salak is feared to cause the wildlife ecosystem to be disrupted due to the construction of supporting infrastructure for power plants and other management activities. There are two things that can affect the diversity and abundance of wildlife including habitat structure and human interference (Pyritz et al., 2010).



.

Note : Purple line = JD1 in Cikaniki, Turqoise line = JD2 in corridor, Green line = JD3 in Star Energy, Blue line = BD1 in Star Energy

Figure 4 Movement detection result of Javan leopard in research location



Note: sigma = distance parameter, full line = detection probability, dotted line = convidence interval from sigma

Figure 5 Java leopard sigma chart at the research location

(a)

(b)

Figure 6 Javan gibbons found in (a) Cikaniki and (b) Citalahab

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Table 4 Result of Javan gibbon observation in Citalahab, Cikaniki, and Star Energy

Location	Number of individuals	Number of groups	Transect wide (km^2)	Repitition (times)	Individual density (ind/km^2)	Group Density (grp/km^2)
Citalahab	10	2	0,2	3	16,67	3,33
Cikaniki	16	4	0,2	3	26,67	6,67
Star Energy	5	2	0,2	3	8,33	3,33
Total	31	8	0,6	9	51,67	13,3

The population density in this study is different from the results of research by Iskandar (2007) which stated that the population density of the Javan gibbon in Citarik, Cikaniki, Cibereum, and Cisalimar MHSNP is 8,2 ind/km^2. The large population density in this study when compared to Iskandar's (2007) study was caused by the high number of Javan gibbons encountered during observation with a small study area. The high number of encounters with Javan gibbons in this study is also because the Citalahab and Cikaniki areas are known as habitats for Javan gibbons. In addition to differences in research locations, the methods used, forest characteristics and altitude of the location are also predicted to be the cause of differences in population density of the Javan gibbon. According to Maulana (2019), a higher observation location allows for a sufficient number of forage trees and sleeping trees. Alikodra (2002) stated that population density varies based on location and forest type, so the results of population density analysis from one location cannot be directly implemented for other locations. In this area there are also groups of habituated Javan gibbons observed by the Javan Gibbon Research and Conservation Project (JGRCP) team in Citalahab Central Village, where there are group A, B, C, D, O and S whose presence is routinely observed by the JGRCP team. The habituated Javanese gibbon group had different responses from the unhabituated group. The habituated type of Javan gibbon is already accustomed to the presence of humans so that its presence is easier to find so that the population density of the Javan gibbon in the research location is quite high.

CONCLUSION

The results of the camera trap installation can detect 12 species of mammals and 5 species of birds. There were four individuals of Javan leopard identified with a sex ratio of three males to one female (3:1) and only had one age class, which is adults. The estimated density of the Javan leopard by SECR is 11,19 $ind/100\ km^2$. There are at least 11 individual Javan leopards in an area of 100 km^2 or 0,011 ind/km^2. The population density of the Javan gibbon in Cikaniki is 26,67 ind/km^2, Citalahab is 16,67 ind/km^2, and Star Energy is 8,33 ind/km^2.

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