Available online at www.sciencedirect.com

ScienceDirect

Procedia Environmental Sciences 33 (2016) 340 – 353

Procedia Environmental Sciences

The 2nd International Symposium on LAPAN-IPB Satellite for Food Security and Environmental Monitoring 2015, LISAT-FSEM 2015

Spatial distribution and habitat use of Javan Langur (*Presbytis comata*): case study in District of Kuningan

Toto Supartono[a,*], Lilik Budi Prasetyo[b], Agus Hikmat[b], Agus Priyono Kartono[b]

[a] *Department of Tropical Biodiversity Conservation, Faculty of Forestry, Bogor Agricultural University, Darmaga, Bogor 16680, Indonesia*
[b] *Department of Forest Resources Conservation and Ecotourism, Faculty of Forestry, Bogor Agricultural University, Darmaga, Bogor 16680, Indonesia*

Abstract

Javan langur (*Presbytis comata*) is grouped into one of priority species for conservation. However, little is known about the distribution of the population that can support conservation effort. The research is identify the distribution of Javan langur based on village administrative area, distance of group encounter to nearest settlement and roadway, and altitude, as well as habitat types used in Kuningan District, West Java Provinces. We interviewed residents of forest villages to gather information on population occurrence, followed by making line transects in each village based on the result of the interviews, then noted habitat type every 100 m along the transect and encountering point of group of Javan langur as well as the coordinates of encountering. The data obtained were analyzed descriptively and by using both chi-square test and Bonferroni's procedure to determine the preferences of habitat types used. The study found that Javan langur populations are distributed in 34 forest villages. The closest distance Javan langur were recorded at 9.32 meters from the settlement and 3.24 meters from the road. Its distribution ranging from 255-1254 meters asl. Land cover types used were natural forest, mixed-garden, homogenous timber plantation (pine, teak, mahagoni and rosewood forest), and transition areas (natural forest to mixed garden and pine forest to natural forest or mixed garden), but natural forest was preferred. We conclude that Javan langur population can still be found in several locations in lowland, hills, natural forest and plantation forest that have diverse vegetation, including those adjacent to settlement.

Peer-review under responsibility of the organizing committee of LISAT-FSEM2015

Keywords: distribution; Kuningan District; land cover; Javan langur; grizzled leaf monkey; *Presbytis comata;* conservation.

* Corresponding author. Tel.: +62-852-1936-3919.
E-mail address: macaca_fsc@yahoo.com.

Peer-review under responsibility of the organizing committee of LISAT-FSEM2015
doi:10.1016/j.proenv.2016.03.085

1. Introduction

Javan langur (*Presbytis comata*) is grouped into a very high conservation rating species [1] because the condition is endangered due to the reduction of most (96%) of its natural habitat [2]. In addition, Javan langur also has limited natural distribution [3], and since 1988 it was categorized by the IUCN as an endangered species [4]. The Government of the Republic of Indonesia stated that Javan langur is a protected species [5] and is one of a number of conservation priority species in Indonesia [6]. However, efforts of conservation of Javan langur have some constraints. One of the constraints is that there is still little information about the distribution of the species [7].

Nijman [8] had studied and published a map of population distribution of *P. comata* in Java. Nijman's research result showed that the population of *P. comata* was distributed in 34 forest areas, which are mostly located in the western part of Java Island (covering West Java Provinces and Banten Provinces) and some locations are in Central Java Provinces within the altitude of up to 2500 meters above sea level. Considering that the population that distributed in central and eastern parts of Java has now been known as a distinct species, namely *P. fredericae* [9], then the distribution areas of *P. comata* are mostly limited in the western part of Java. The results of previous studies could also complete information of the distribution of the Javan langur population in West Java [e.g., 10, 11, 12, 13]. However, the results of these studies only provided information about the distribution of the population in the conservation areas where the level of security and the region existence were more guaranteed. In fact, apart from in the conservation area, Javan langur also are distributed outside conservation areas [2]. MacKinnon also said that most of the population number of Javan langur are outside the conservation areas.

Information availability of Javan langur population distribution more detailed that includes conservation areas and non conservation areas in each region is necessary for the conservation of the population [6]. In addition, the conservation of populations also need information of habitat preferences [8], but the information is little known [7]. District of Kuningan is an area of distribution of Javan langur, but it is not included in the distribution map of Nijman [8], except Mount Ciremai which was since 2004 has been changed into a national park. The distribution locations that have not been listed in the map are located outside the conservation area, and still have not been enough studied, in terms of distribution patterns and habitat. The research is aimed to identify the distribution of Javan langur based on village administrative area, distance of group encountering to nearest settlement and roadway, and altitude, as well as habitat types used in Kuningan District, West Java Provinces. Results of this study are expected to support the Government in conservation efforts of *P. comata*.

2. Method

2.1. Research location

The research location is forest areas in Kuningan District, West Java Province, Indonesia. The Kuningan District is located at 108º23'-108º47'E and 6º47'-7º12'S and has area 1,195.71 km^2. Total forest area is 583.31 km^2: production forest is 256.44 km^2, conservation forest is 86.99 km^2, and community forest (mixed-garden) is 239.79 km^2 [14]. Javan langur population distribution data was collected between April 2014 and March 2015. Location of the study did not include conservation areas. The study was conducted in two forest blocks, i.e. Gunung Subang (GS) forest block and Bukit Pembarisan (BP) forest block. The GS forest block is a forest area bordering with Central Java Province. This block is in the form of lowland and hilly forest which is dominated by secondary natural forest cover (Figure 1), at the edge, this area is mainly surrounded by community mixed-forest covers. Natural forests in some locations have been replaced by young and old coffee plants. Pine forests, in general, exist between the community mixed-forests and secondary forests. Pine forest and natural forest are managed by Perum Perhutani Forest Management Unit (FMU) of Kuningan. Those forests serve as, respectively, production forest and local protected areas. Based on the government administration, this forest block is included in 11 village administrative areas.

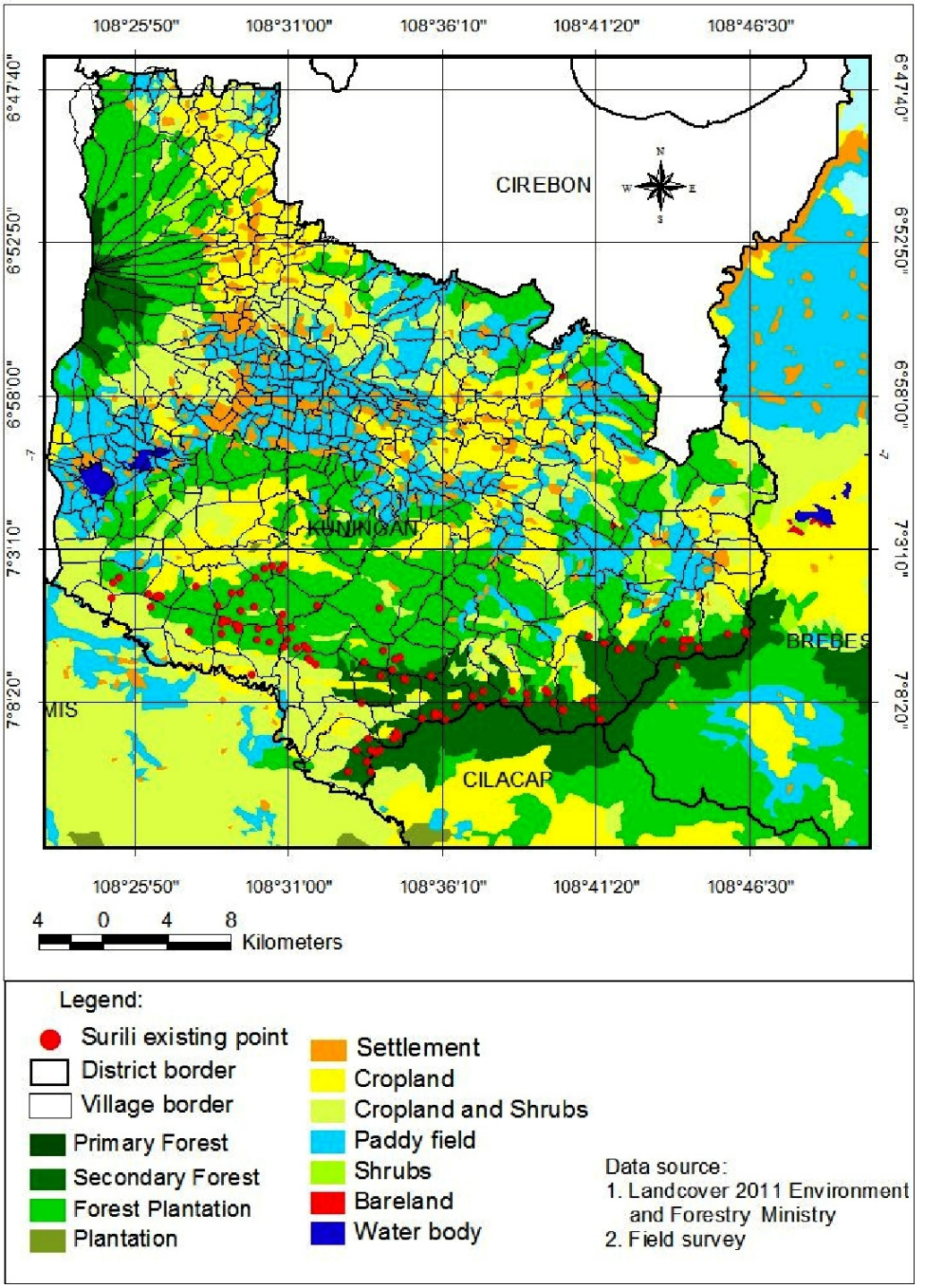

Fig. 1. Land cover type and distribution of Javan langur populations outside conservation areas in the District of Kuningan.

The land cover in the study site of BP forest block is classified by the Ministry of Environment and Forestry as industrial timber plantation and secondary forest (Fig. 1). The forest block consists of pine forest, teak forest, mahogany forest, remnants of natural forest and community mixed-forest. The pine forest is a plantation that

produces sap. The natural forest is a part of production forest which is designated as local protected area, generally narrow, and scattered among forests of pine and other tree plantations. The natural forest and the pine forest in the forest block are located on state land and are managed by Perum Perhutani Forest Management Unit (FMU) of Kuningan. As it was in the GS forest group, in some areas coffee plantations have replaced the natural forest and pine forest. The community mixed-forests are generally scattered with varied sizes. They are located on privately-owned land and bordered by natural forest or pine forest. Furthermore, on the vicinity of the community mixed-forest in general there is a mixture of rice fields and settlements. The community mixed-forest is also known as amixed-garden because it is planted with various types of commercial timber trees and fruit-bearing plants [15]. The community mixed-forest that becomes the location of this study henceforth will be referred to as mixed-garden.

2.2. Survey of Javan langur population

The research was conducted in two phases. In the first phase, we visited villages that have forest where there were indications of the presence of Javan langur population. Then we conducted interviews with local villagers [16] to collect information about the existence of Javan langur in the forest that belongs to the administrative areas of the villages. Because the villagers already familiar with this species of Javan langur, during the interview they could provide accurate information and would not confused the Javan langur in question with other species of monkeys which also existed in the District of Kuningan (long-tailed macaque and langur). At this stage we collected information that Javan langur existed in 34 villages.

In the second phase, a survey was conducted in villages which were suspected as habitats of the Javan langur based on results of the first phase. In the villages observation paths were established in forest areas. Total transects in each village varied from 5 km to 6 km, and the length of each transect varied from 1 km to 3 km, depended on the area of the forest blocks. Transect length was measured by using hipchain. Transects in several places used footpath and other situation used new trail [17]. The forest areas where the research was conducted have many ravines with a very steep topography. Therefore, the transect was turned if there was a cliff as a result the shape of the transects in several places was not a straight lined. The existing of the cliff was one of the reason why the transects used the footpath. To get the proportions of land cover types in the path traversed, we recorded the type of land cover every 100 meters along the transect [18] based on the plant species composition. The grouping of types of land cover were in the forms of natural forest, mix of natural forest and crops, mixed-garden, pine forest, mixed pine forest, teak forest, mahogany forest, rosewood forest, coffee plantation, and shrubs. At the time of meeting Javan langur on the transect, we recorded the coordinates of encounter location by using a GPSmap 62sc receiver and landcover type to know the habitat types used. Observations generally began at 07.00 to 11.00 am. However, during rainy morning, the survey was postponed for a while, and then we started when the rain stopped.

Javan langur distribution information, which is based on the distance from nearest settlements and roads, was obtained by entering the coordinates of each location of encounter with Javan langur groups on map by Google Earth tool, then measure the distance to the nearest settlements and roads. Data of distribution by altitude was also obtained by observing each point of Javan langur encounter which had been entered into the Google Earth map, so that the elevation data was obtained.

2.3. Data analysis

The picture of Javan langur distribution by areas of the village administration was made by mapping the coordinates of locations of Javan langur encounters into the administrative maps of the villages combined with maps of landcover types. The distribution of groups at various distances from nearest settlements and roads, and various altitudes were analyzed descriptively (mean, standart deviation). Pearson's correlation coefficient test was used to measure relationship between distance from a group meeting point to the nearest village and that to the nearest road. Furthermore, the chi-square goodness-of-fit test was used to determine whether the number of group observed are distributed proportionately to the number of the transect of distance categories [19]. The formula used in chi-square test is:

$$\lambda^2 = \Sigma(O_i - E_i)^2/E_i \quad (1)$$

Where O_i is the number of group observed in the *i*th distance category and E_i is the number of group expected in the *i*th distance category. The expected number of group in each distance (E_i) is obtained by multiplying the total number of group observed from all transect with the proportion of the number of the transects of each categories.

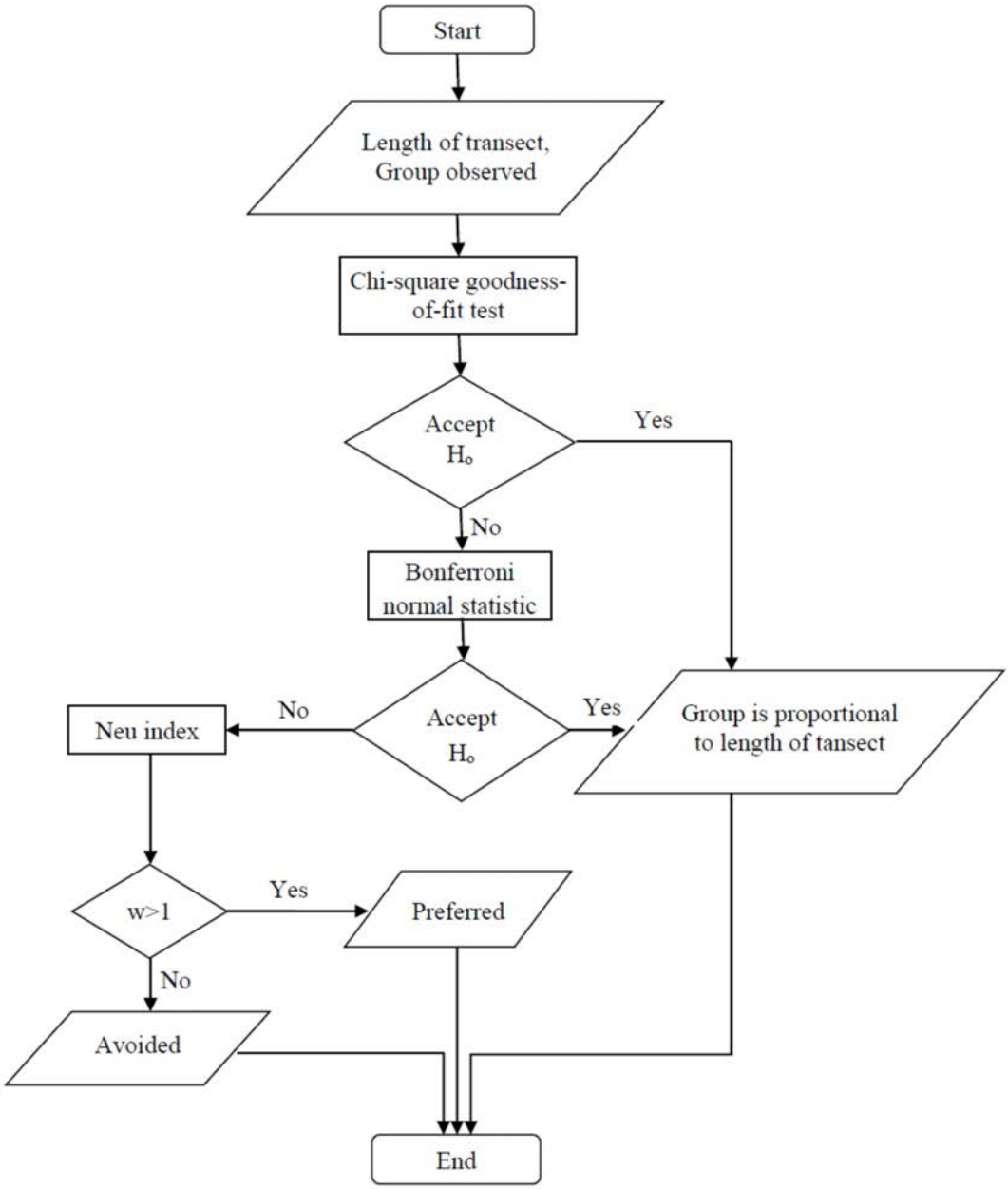

Fig. 2. Steps of determination of land cover type preferred by *Presbytis comate.*

To know the types of land cover preferred by Javan langur population, we also done steps used by Neu et al.[19] (Fig. 2). First was identifying whether the number of group observed are distributed proportionately to the total length of transect of land cover types. The formula used was the same as the formula above, but the value of O_i and

E_i is different. The value of O_i is the number of group observed in the *i*th land cover type and E_i is the number of group expected in the *i*th land cover type. The expected value (E_i) is obtained by multiplying the total number group observed from all land cover types with the proportion of transect length of the *i*th land cover type. In this study, there are seven land cover types where transects were placed. The number of group observed is proportional to the number transect if value $\lambda^2 > \lambda^2_{tabel}$ with level of significance *(α) 0.05*, but if value $\lambda^2 < \lambda^2_{tabel}$, then the number of group observed is not proportional. Next step was using the Bonferroni procedure [20]. This prosedure was conducted if based on the result of the chi-square test, the number of group was not proportional to the total transect length of land cover types and aimed to determine the interval of probability of land cover types. The estimating of the interval of probability used the following formula [19, 20]:

$$\bar{p}_i - Z_{\alpha/2k}\sqrt{\bar{p}_i(1-\bar{p}_i)/n} \leq p_i \leq \bar{p}_i + Z_{\alpha/2k}\sqrt{\bar{p}_i(1-\bar{p}_i)/n} \quad (2)$$

where $\bar{p}_i$ is the proportion of transect length in the *i*th land cover type, *k* is the number of land cover type tested, and *n* is the total number of group observed. The level of significance used was 0.05. The third step was counting the Neu index. To get this index, the group proportion found in each land cover type was divided with the transect lenght proprotion from the same each land cover type [21]. The final step was identifying the land cover type preferred by Javan langur groups. A land cover types is preferred by groups if the Neu Index of the land cover type is more than 1 [21] and between the proportion of transect length and the proportion of group observed is diferent.

3. Result

3.1. Spatial distribution

Based on information collected from local residents, as many as 34 villages were suspected to be the location of distribution of Javan langur, however, based on the line transect the Javan langur population were found only in 31 villages (Figure 1). Figure 1 also shows that the locations of distribution of Javan langur is connected with one to another and the forest areas that was not used by Javan langur is the fragmented areas.

3.2. Distance from human activities

The characteristic of habitat of the existence of Javan langur is specified in more detail by considering: a) location of nearest settlement, and b) nearest road. Results of measurements showed that Javan langur groups were found within the distance of 9.32 to 3022.23 meters ($\bar{x}$ = 1002.08; *n* = 92; *SD* = 604.56) to the nearest settlement and within the distance of 3.24 to 3104.26 meters ($\bar{x}$ = 984.09; *n* = 92; *SD* = 667.02) to the nearest road. There was a significant correlation between the distance from the point of the encounter of Javan langur group to nearest settlements and to nearest road (*r* = 0.963; *n* = 92; *p* = 0.000). To determine group distribution based on distance from nearest settlement to the meeting point and the nearest road, the distance was divided into six classes (Figure 3). Although the number of Javan langur groups that were encountered in each distance class was varied, the number of the groups was proportional to the number of transects (the location of Javan langur – nearest settlement: λ^2 = 6.251; *df* = 4, *p* > 0.05 and the location of Javan langur – nearest road: λ^2 = 4.663; *df* = 4; *p* > 0.05). In other words, the number of groups that were found was related to the number of transects: the more the transects were made, the more the number of groups that were found (Table 1). Furthermore, by Kruskall Wallis test, the average of transect lengths between each distance class were not significantly different (transect to nearest settlement: λ^2 = 2.584; *df* = 4;*p* = 0.630, and transect to nearest road: λ^2 = 2.217; *df* = 4; *p* = 0.696).

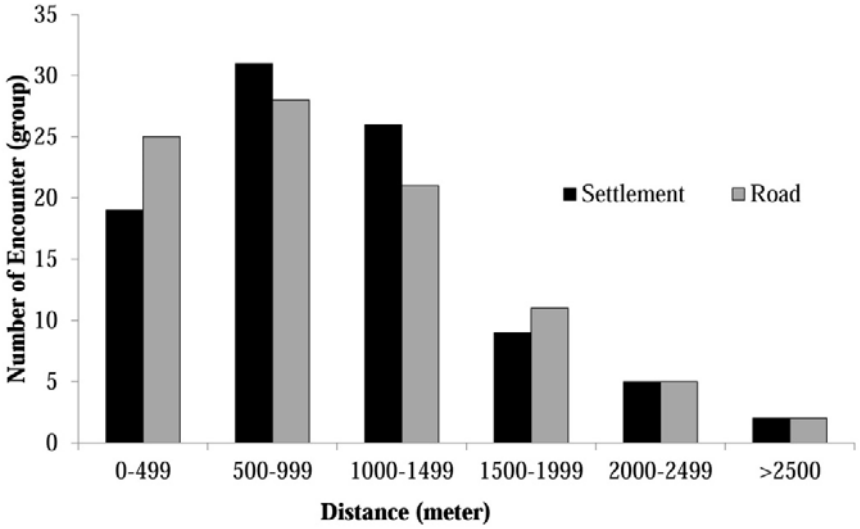

Fig. 3. Javan langur population distribution based on distance from point of group encounter to nearest settlement and nearest road.

Table 1. Number of transects and numbers of Javan langur groups on each distance class from transect which their starting points were made at certain distance from nearest settlement and nearest road.

Distance (m)	Number of Transect	Prop. (1)	Obs. (2)	Prop. (3)	E (4)	$(O-E)^2/(E)$
Starting point to settlement						
0 – 499	57	0.475	41	0.446	43.70	0.167
500 – 999	37	0.308	35	0.380	28.37	1.551
1000 – 1499	16	0.133	6	0.065	12.27	3.201
1500 – 1999	7	0.058	8	0.087	5.37	1.292
>2000	3	0.025	2	0.022	2.30	0.039
Total	120	1.000	92	1.000	92.00	6.251
Starting point to road						
0 – 499	63	0.525	41	0.446	48.30	1.103
500 – 999	27	0.225	28	0.304	20.70	2.574
1000 – 1499	18	0.150	13	0.141	13.80	0.046
1500 – 1999	8	0.067	8	0.087	6.13	0.568
>2000	4	0.033	2	0.022	3.07	0.371
Total	120	1.000	92	1.000	92.00	4.663

Note: (1) Proportion of total of transects; (2) Number of groups encountered; (3) Proportion of number of groups encountered; (4) Expected number of groups encountered

3.3. Land cover

The study also noted the type of land cover at each point of encounter with Javan langur groups. Results of this study showed that land cover types at locations of Javan langur encounter were natural forest, mixed garden, timber

plantations, area of transition between natural forest with mixed garden, and area of transition between pine forest with natural forest and mixed garden (Table 2). However, this study did not find Javan langur groups at coffee plantations and shrubs (Table 2).

Table 2. Length of observation transects, number of groups, and Neu index on each vegetation type.

Vegetation Type	Transect (1)	Prop. (2)	Group (3)	Prop. (4)	E (5)	Interval prop. (6)	Neu
Natural Forest (HA)	60.30	0.333	47	0.511	30.616	$0.371 \leq P \leq 0.651$*	1.535
Mixed Garden (KC)	71.90	0.397	22	0.239	36.506	$0.120 \leq P \leq 0.359$*	0.603
Homogenous timber plantation							
Pine forest	11.30	0.062	1	0.011	5.737	$0 \leq P \leq 0.040$*	0.174
Teak, mahogany and rosewood forests	7.60	0.042	2	0.022	3.859	$0 \leq P \leq 0.063$	0.518
Areas of transition							
HA to KC	14.70	0.081	15	0.163	7.464	$0.059 \leq P \leq 0.267$	2.010
Pine forest to HA&KC	11.80	0.065	5	0.054	5.991	$0 \leq P \leq 0.118$	0.835
Coffee plantation and shrubs	3.60	0.020	0	0	1.828	0	0
Total	181.20	1	92	1	92		5.675

Note: (1) Total length of observation transect (km); (2) Proportion of length of observation transect; (3) Number of groups observed; (4) Proportion of number of groups observed; (5) Expected number of groups; (6) Interval of proportion of observed groups at significant level of α = 0,05; and*shows difference at significant level of 0.05

Total of groups of Javan langur found on all transects were 92 groups. The groups were mostly found in natural forest, followed by mixed garden, area of transition between natural forest and mixed garden, area of transition between pine forest and natural forest and mixed garden, and homogenous timber plantation (Table 2). The distribution of Javan langur groups on the various types of vegetation was significantly different or was not proportionate to the total length of transect on any type of land cover (λ^2= 28.94; $p < 0.01$). Based on Neu Index (Table 2), Javan langur groups liked natural forest. Although it was not significant, the groups also liked the transition area between forest and mixed garden. Pine forests that mixed with natural forest plant species and mixed garden were preferred over pure stands of pine forest (Table 2).

Based on results of interviews with local people, Javan langur frequently visited gardens bordering settlements to take food in forms of fruit crops such as banana and papaya. Although annoying, the local villagers did not hunt or kill these animals, they just repelled them away or protected their crops, such as by wrapping the banana fruits with plastic bags while they were still on the tree.

3.4. Elevation

To determine the distribution of Javan langur based on altitude, the research has measured altitudes at every point of encounter with Javan langur groups. The results showed that Javan langur groups were encountered within the altitudes of 255 to 1254 meters above sea level ($\bar{x}$=671.78; n=92; SD=187.92), or from the lowland forest ecosystem up to hilly area. Javan langur groups were often found at an altitude of 400 – 1000m asl, and were rarely encountered at elevations below 400 m asl or above 1000 m asl (Fig. 4).

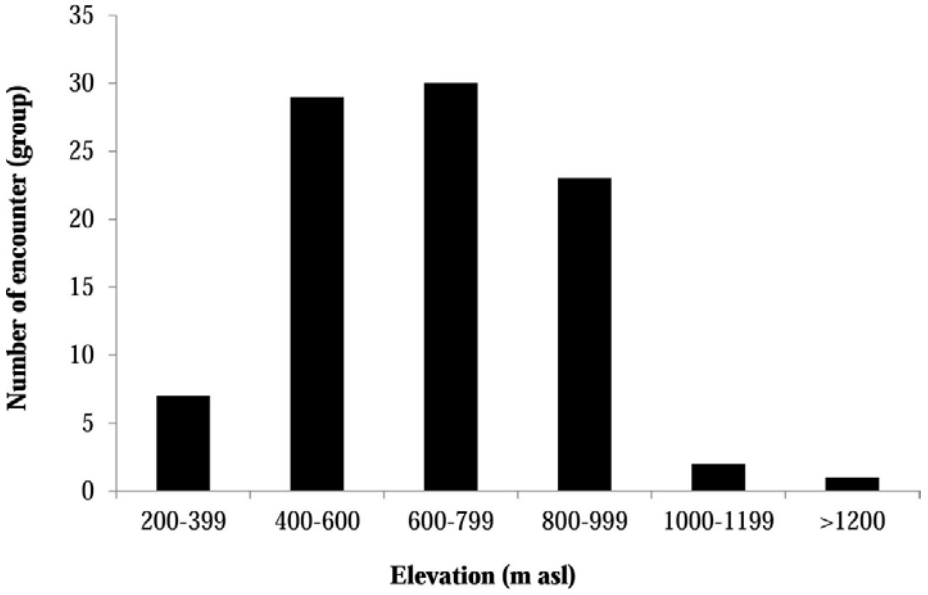

Fig. 4. Distribution of Javan langur based on elevation of location of encounter.

4. Discussion

4.1. Spatial distribution

To know the distribution of Javan langur population outside the conservation areas in Kuningan District, we collected information from villages that have forest areas, then proved the information on field. The study results showed that Javan langur population, based on information collected from local community, was distributed in 34 forest villages, while based on direct field survey they were distributed in 31 villages. The study suggested that the Javan langur population in Kuningan District still survived outside the conservation areas. Although there were 3 locations where Javan langur groups were not encountered during direct field observations, we still assume that the Javan langur groups were there at those locations. This is because based on re-interviews with some members of the local community, they have encountered Javan langur groups at the three locations. Regarding the absence of Javan langur groups that were not encountered at the three locations at the time of the survey, we assumed that the population density in those areas was very low, so the probability to be encountered was small.

The locations of the Javan langur distribution were interconnected one to another by forest cover and those were located within two blocks of forest, i.e. the Bukit Pembarisan forest block and the Gunung Subang forest block (Fig. 1). On the contrary, the forest areas that is not used by Javan langur population is isolated from those forest blocks. This result indicate that the connection among habitat is needed by the population. The interconnectedness allowed the Javan langur groups to move from one location to another. Bukit Pembarisan forest block is located in the southern part of Kuningan District, stretching from west to east. Gunung Subang forest block is located in the eastern part of the Kuningan District (extending from the northeast to the southwest), bordering the Central Java Province (Fig. 1). Given this part of the Central Java Province is also a forest, and then the Javan langur distribution also included the western part of the province. Therefore, both forest blocks are the important areas for the Javan langur population outside the conservation areas.

The map of Javan langur population distribution in Kuningan District from Nijman [8] only covered Gunung Ciremai National Park. Because the study of Javan langur population in the outside conservation areas have not been done, the result of this study could also complement the study results of Nijman [8] in Kuningan District. The study locations and Gunung Ciremai National Park are fragmented by settlements, paddy fields and croplands (Figure 1). By combining the results of both studies, the picture of Javan langur population distribution in Kuningan District

became more complete, specifically that it spreaded in three forest blocks: Ciremai Mountain National Park, Bukit Pembarisan, and Gunung Subang.

4.2. Distance from human activities

Javan langur was classified into species that is sensitive and timid to the presence of humans [13]. Furthermore, the occupancy of primates in an area was affected by settlement existing; primate occupied forest areas far away from settlements [22]. Therefore, we assumed that the locations of Javan langur population distribution would be far away from settlements and places where people do many activities such as road. However, the results of the study indicated that the Javan langur groups did not only occupy locations far away from settlements and roads, but also those that were close to those features. This study also obtained information that the Javan langur group often came to the gardens close to houses to"steal" food, especially bananas, but the residents did not bother the Javan langur groups. These cases were common in regard to populations of *M. fascicularis* as reported by Munsha and Hanya [23] in Central Catchment Nature Reserves in Singapore and by Marchal and Hill [24] in North Sumatra, Indonesia. Marchal and Hill also reported crop-riding by monkeys from the subfamilly of colobine (e.g., *Presbytis thomasi* and *Trachypithecus villosus villosus*). The crop-riding by others primates have also been reported by previous researchers [such as 25, 26, 27]. However, the crop-riding by Javan langur was little studied and published, except the study of Melisch and Dirgayusa [28].

Some other primates such as *M. fuscata* will also enter the area around the settlement when there is a shortage of feed in their natural habitat [27]. However, the probability of such scarcity of food sources of Javan langur in its natural habitat is small because Javan langur is a leaf-eating monkey [13] and leaves are the abundance resources of food. Therefore, we assumed that the Javan langur groups that could occupy locations close to settlements and highways were not related to the scarcity of food resources in their natural habitat. According to Saj et al. [29], generally, the food plants cultivated by farmers have higer quality and energy per unit than the food plants in the wild. Therefore, the Javan langur group frequent entered mixed-gardens near settlements because of several factors such as the availability of preferred feed sources [29, 30] and area was also safe from disturbance; or even though there was disturbance, it was still below the tolerance limit of the Javan langur population.

4.3. Land cover types

Based on the types of habitats that were used, we found that the population of Javan langur in Kuningan District used not only natural forest, but also used mixed-gardens and several places in the form of a pine forest. The natural forests where Javan langur populations were found in this study were in the form of secondary natural forests (Fig. 1). Our study results that showed that Javan langur occupied a secondary natural forest had also been widely reported by previous researchers, such as, MacKinnon [2], Nijman [8], Hidayat [12]. By calculating the Neu Index, it can be known that the Javan langur group preferred habitats in form of secondary natural forest compared to other forest types. This result supports the assuming of Supriatna et al. [7] that Javan langur species preferred younger forest stands rather than mature ones. The availability of preferred food was suspected to be the reason why Javan langur chose the forest stands [7]. However, undisturbed primary forest is an optimal habitat for a population of Javan langur [8] because primary forest is a high quality and more secure habitat [31]. Primary forests have trees larger than other habitat types so that primates that use the trees in the primary forest would have a lower risk of predation [31]. Although habitat preferred by Javan langur in this study was not a primary forest, but secondary forest (Fig. 1), habitat quality and security conditions supposed to be some of the factors that cause Javan langur prefers natural forests.

In addition to occupying the interior of the natural forest, Javan langur also occupied areas of transition between natural forest and mixed-gardens. This finding was in accordance with the publication of Supriatna et al. [7] and the study results of Melisch and Dirgayusa [28] around Nature Reserve of Mount Tukung Gede. Ecotone area can experience a merging of species from two types of adjacent habitats so that it has a higher species diversity [32, 33]. A high plant diversity has a great possibility to increase the diversity of feeds. The condition was thought to be one of the factors that attracted Javan langur to occupy the area. The result of the study, that informed that the population of Javan langur could also be found in the mixed-garden ecosystem, was in accordance with the results of research

of Melish and Dirgayusa [28] in Gunung Gede Tukung Nature Reserve. According to the two researchers, Javan langur often entered orchards and degraded forests bordering the Nature Reserve. Previous researchers also found evidence that some other primates, such as *P. fredericae* [34], *P. thomasi* [35], and *Nasalis larvatus* [36], also used the mixed-gardens as part of their habitats. The study result of Fashing et al. [37] in the africa monkey in mixed plantation forest area, Kenya, also supported this study. The primata group entered the mixed gardens and farm areas aimed to use cultivation plants as food sources [24, 25, 29, 38]. Species of plants that were common in the mixed-gardens of study locations were *Paraserianthes falcataria, Swietenia mahagoni, Anthocepalus cadamba, Tectona grandis, Maesopsis eminii, Bambusa* spp., *Mangifera indica, Durio zibethinus, Nephelium lappaceum, Parkia speciosa, Cocos nucifera, Arenga pinnata, Artocarpus heterophyllus* and *Gnetum gnemon* [15]. Some species of plants in the mixed-garden such as *N. lappaceum*, and *P. falcataria* are feed source for Javan langur [10, 28]. Therefore, the availability of food was thought to be one of the reasons of Javan langur group presence in mixed-gardens. In addition, the presence of Javan langur in the mixed-gardens in this study showed that mixed-gardens can be an alternative habitat for a population of Javan langur.

The study showing that Javan langur population was found in pine forest was consistent with the study result of Agostini et al. [39] in *Alouatta caraya* and *A. guariba clamitans* at Atlantic Forest of Misiones in Northeastern Argentina. Although Javan langur groups could be found in pine forests and other monoculture forests (*T. grandis, S. macrophylla*, and *D. latifolia*), but, the encounter frequency was lower than in other forest types. The condition was supported by results of research of Henzi et al. [40] in Mpumalanga Province, South Africa, which showed that baboons (*Papio hamadryas ursinus*) avoided stands of pine and choose small pockets that contained natural stands. Pine forests and other monoculture forests such as Agathis forest have availability of food for primates (such as *P. fredericae*) lower than natural forests [41]. *T. grandis, S. macrophylla*, and *D. latifolia* have never been reported eaten by Javan langur [10, 13]. Furthermore, Javan langur occupying plantations and degraded forests cannot survive for a long time [8]. Therefore, the low number of groups of Javan langur in both forest types was allegedly because of the low availability of feeds sources.

The result of the study that showed that Javan langur was not found in shrubs were allegedly linked to level of its ability to move and habitat quality. As an arboreal species [8], Javan langur needs canopies of trees that are closely connected to enable it to move, even though Ruhiyat [13] once found a Javan langur got down on to the ground. In addition, the shrubs were also a low-quality habitat [31]. The suspected reason that Javan langur was not found in coffee plantation was also that coffee plantations have low quality as habitat. However, this study is different from results of the research done by Gurmaya [35] on *P.thomasi*. The species used shrubs and cacao garden as part of its home range [35]. But, the difference of the results of the two studies has not been understood yet, whether it was because of the methods used, difference in species, or other factors. This needs to be studied further.

4.4. Elevation

The fact that Javan langur were found in the lowland forest ecosystems was in accordance with reports of previous researchers that said that the lowland primary forests were the main habitat of Javan langur [2, 42, 43]. Melisch and Dirgayusa [21] in their study also found Javan langur population in lowland forest and hills with an altitude below 700 meters above sea level. However, the reduction of habitat due to conversion of natural forest into, for example, agricultural area and timber plantation [28] has resulted in Javan langur nowadays often found in mountain ecosystems [4, 40], such as in the Gunung Halimun National Park [10]. At Mount Slamet, *P. fredericae*, which was known formerly as a subspecies of *P. comata frederiace* [9], was distributed at an altitude of 750 meters to 2500 m asl [41]. Not much different from situation in Dieng Mountains, the species was found at an altitude of 650-2565 m asl [45, 46]. In Situ Patenggang Nature Reserve and in Kamojang, respectively, Javan langur found at an altitude of 1600-1775 m asl and 1390-1625 m asl [13]. The study that found evidence of Javan langur existence at an altitude of 255-1254 m asl showed that Javan langur in several places in Kuningan District was still survived in forest ecosystem at the lowland and on hills.

4.5. Implications for conservation

The result of the study creates some implications on the conservation of Javan langur, particularly in the lowland forest ecosystems in the District of Kuningan. This research obtained results that locations of distribution of Javan langur were 34 forest areas and interconnected by forest cover, which indicated that the making of corridor that connects other forest locations need to be done to facilitate the distribution and expansion of habitat. The result of the research that showed that the population of Javan langur could be found in mixed-gardens and pine forests that mixed with other plant species indicated that the conservation of Javan langur can be done in man-made forest which is a combination of crops plants and other plants either natural or crop plants that can provide resources for Javan langur population. Our study which obtained results that Javan langur population can be found in gardens or forests that were close to settlements indicated that Javan langur conservation can be done near settlements by keeping the security of those forests and gardens.

4.6. Limitation of study

Although this study could be considered as covering almost all locations (village administrative area) outside conservation area in District of Kuningan, where Javan langur population was distributed, this study had its limitations. The placement and length of transects were not based on the proportion of the total area of each land cover types. The consideration of determination of transect starting point was based on accessibility. Eventhough it was not proportional, the transect was placed in several land cover types where the Javan langur population was indicated inhabit the types. Therefore, the future work needed is reseach with the length of transect which is proportional to the total area of various of land cover types so that the result will be more representative.

5. Conclusion

The study concluded that Javan langur population in District of Kuningan were still distributed in 34 forest areas, from lowland to hilly forest ecosystems. Javan langur distribution locations were not only in form of natural forests and located far away from settlements and roads, but also in man-made forests which have diverse plant species and forests which were close to settlements. Secondary natural forest is the ecosystem preferred by Javan langur population. Overall, this result has the value for Javan langur population conservation outside the conservation areas dominated by production activity. The conservation of Javan langur population can be done in production forests that have many tree species that can provide food sources for the Javan langur population. Even though the transect have covered all village forests inhabited by the Javan langur population, the lenght of transect made in this study was not proportional to forest types in the research location. Therefore, the length of transect which is proportional to the area of each forest type is needed for future research.

Acknowledgements

We thank Dirjen Dikti of Ministry of Research, Technology and Higher Education, Republic of Indonesia for providing the fund of this research, Perum Perhutani Unit III West Java and Banten Province and Agency of Forestry Kuningan District for accessing to the state forest (production forest) and privat forest (mixed-garden). We also thank Rohman, Syahman, Amir, and Didi for helping the data collecting during the research.

References

1. Eudey AA. Priorities in Asian primate conservation. *Primate Conservation* 1987; **8**:172-4.
2. MacKinnon K. Conservation status of primates in Malesia, with special reference to Indonesia. *Primate Conservation* 1987; **8**:175-83.
3. Kool KM. The status of endangered primates in Gunung Halimun Reserve, Indonesia. *Oryx* 1992; **26**:29-33.
4. IUCN. IUCN Red List of Threatened Species. Version 2012.2. www.iucnredlist.org. [downloaded at 05 April 2013].
5. Government Regulation Number 7 of 1999 about Preservation of Plants and Animals. Jakarta: Indonesia Government; 1999.

6. Regulation of Ministry of Forestry Number P.57/Menhut-II/2008 about Strategic Plan for National Animals Conservation 2008-2018. Jakarta: Minister of Forestry; 2008.
7. Supriatna J, Tilson JR, Gurmaya KJ, Manangsang J, Wardojo W, Sriyanto A, Teare A, Castle K, Seal U. *Javan Gibbon and Javan Langur Population and Habitat Viability Analysis*. Bogor: Safari Indonesia; 1994.
8. Nijman V. On the occurrence and distribution of *Presbytis comata* (Desmarest, 1822) (Mammalia: Primates: Cercopithecidae) in Java, Indonesia. *Contributions to Zoology* 1997; **66**:247-256.
9. Brandon-Jones D, Eudey AA, Geissmann T, Groves CV, Melnick DJ, Morales JC, Shekelle M,Stewart CB. Asian primate classification. *International Journal of Primatology* 2003; **27**:97-164.
10. Farida WR, Harun. The diversity of plants as feed resources for the java gibbon (*Hylobates moloch*), grizzled langur (*Presbytis comata*), and silver langur (*Trachypithecus auratus*) in Gunung Halimun National Park. *Jurnal Primatologi Indonesia* 2000; **3**:55-61.
11. Heriyanto NM, Iskandar S. The population status and habitat of grizzled-leaf monkey *Presbytis comata* Desmarest in Kalajeten-Karangranjang Forest Complek, Ujung Kulon National Park. *Jurnal Penelitian Hutan dan Konservasi* 2004;**1:**89-98.
12. Hidayat R. *Pendugaan parameter demografi dan pola pendugaan ruang surili (Presbytis comata) di Taman Nasional Gunung Ciremai*. Bogor: Sekolah Pascasarjana Institut Pertanian Bogor; 2013. *In Bahasa.*
13. Ruhiyat Y. Socio-ecological study of *Presbytis aygula* in West Java. *Primates* 1983; **24**:344-359.
14. Kuningan District Government. http://www.kuningankab.go.id/sumber-daya-alam/kehutanan. [Downloaded at17 January 2016]. *In Bahasa.*
15. Prasetyo LB, Damayanti EK, Masuda M. Land cover changes before and after implementation of the PHBM program in Kuningan District, West Java, Indonesia. *Tropics* 2012; **21**:47-57.
16. Setchell JM, Curtis DJ. Field and Laboratory Methods in Primatology: A Practical Guide. Cambridge: Cambridge University Press; 2003.
17. Estrada A, Coates-Estrada R. Tropical rain forest fragmentation and wild populations of primates at Los Tuxtlas, Mexic. *International Journal of Primatology* 1996; **17**:759-783.
18. Morgan D, Sanz C, Onononga JR, Stindberg S. Ape abundance and habitat use in the Goualougo Triangle, Republic of Congo. *International Journal of Primatology* 2006; **27**:147-179.
19. Neu CW, Byers CR, Peek JM. A technique for analysis of utilization-availability data. *The Journal of Wildlife Management* 1974; **38**:541-545.
20. Byers CR, Steinhorst RK, Krausman PR. Clarification of a technique for analysis of utilization-availability data. *The Journal of Wildlife Management* 1984; **48**:1050-1053.
21. Bibby C, Marsden S, Fielding A. Bird-Habitat Studies. In: Colin B, Jones M, Marsden S, editors. *Expedition Field Techniques: Bird survey.* London: Expedition Advisory Centre; 1998. p. 103-117.
22. Arroyo-Rodriguez V, Mandujano S, Benitez-Malvido J. Landscape attributes affecting patch occupancy by howler monkey (*Alouatta palliata mexicana*) at Los Tuxtlas, Mexico. *American Journal of Primatology* 2008; **70**:69-77.
23. Munsha JCM, Hanya G. Diet, activity, habitat use, and ranging of two neighboring groups of food-enhanced long-tailed macaques (*Macaca fascicularis*). *American Journal of Primatology* 2013; **75**:581 – 592.
24. Marchal V, Hill C. Primate crop-raiding: a study of local perception in four villages in North Sumatra, Indonesia. *Primate Conservation* 2009; **24**:107-116.
25. Boulton AM, Horrocks JA, Baulu J. The barbados vervet monkey (*Cercopithecus aethiops sabaeus*): change in population size and crop damage, 1980-1994. *International Journal of Primatology* 1996; **17**:831-844.
26. Hockings KJ, Anderson JR, Matsuzawa T. Use of wild and cultivated foods by chimpanzees at Bossou, Republic of Guinea: feeding dynamics in a human-influenced environment. *American Journal of Primatology* 2009; **71**:636-646.
27. Yamada A, Muroyama Y. Effects of vegetation type on habitat use by crop-raiding Japanese macaques during a food-scarce season. *Primates* 2010; **51**:159-166.
28. Melisch R, Dirgayusa IWA. Notes on the grizzled leaf monkey (*Presbytis comata*) from two nature reserves in the West Java, Indonesia. *Asian Primates* 1996; **6**:5-11.
29. Saj T, Sicotte P, Paterson JD. Influence of human food consumption on the time budged of vervets. *International Journal of Primatology* 1999; **20**: 977-994.
30. Altmann J, Muruthi P. Differences in daily life between semi provisioned and wild-feeding baboons. *American Journal of Primatology* 1988; **15**:213-221.
31. Li Y. The effect of forest clear-cutting on habitat use in Sichuan snub-nosed monkey (*Rhinopithecus roxellana*) in Shennongjia Nature Reserve, China. *Primates* 2004; **45**:69-72.
32. Whittaker RJ, Fernandez-Palacios JM. *Island Biogeography: Ecology, evolution, and conservation*. New York: Oxford University Press; 2007.
33. Senft AR. *Species diversity patterns at ecotones*. Chapel Hill: University of North Carolina; 2009.
34. Suryana D. *Studi perilaku makan dan palatabilitas rekrekan (Presbytis fredericae Sody, 1930) di kawasan hutan dan perkebunan karet Desa Gutomo Kabupaten Pekalongan Provinsi Jawa Tengah*. Bogor: Forest Resources Conservation and Ecotourism, Bogor Agricultural University; 2010. *In Bahasa.*
35. Gurmaya KJ. Ecology and behavior of *Presbytis thomasi* in Northern Sumatra. *Primates* 1986; **27**:151-72.
36. Salter RE, Mackenzie NA, Nightingale N, Aken KM, Chai PKP. Habitat use, ranging behaviour, and good habits of the proboscis monkey, *Nasalis larvatus* (van Wurmb), in Sarawak. *Primates* 1985; **26**: 436–51.
37. Fashing PJ, Nguyen N, Luteshi P, Opondo W, Cash JF, Cords M. Evaluating the suitability of planted forests for african forest monkey: a case study from Kakamega Forest, Kenya. *American Journal of Primatology* 2012; **74**:77-90.

38. Naughton-Treves L. Predicting patterns of crop damage by wildlife around Kibale National Park, Uganda. *Conservation Biology* 1998; **12**:156-68.
39. Agostini I, Holzmann I, Bitetti MSD. Are howler monkey species ecologically equivalent? trophic niche overlap in syntopic *Alouatta guariba clamitans* and *Alouatta caraya*. *American Journal of Primatology* 2010; **72**:173–186.
40. Henzi SP, Brown LR, Barrett L, Marais AJ. Troop size, habitat use, and diet of chacma baboons (*Papio hamadryasursinus*) in commercial pine plantations: implications for management. *International Journal of Primatology* 2011; **32**:1020-32.
41. Setiawan A, Wibisono Y, Nugroho TS, Agustin IY, Imron MA, Pudyatmoko S, Djuwantoko. Javan surili: a survey population and distribution in Mt. Slamet Central Java, Indonesia. *Jurnal Primatologi Indonesia* 2010; **7**:51–4.
42. Hoogerwerf AA.*Udjung Kulon: The land of the last javan rhinoceros*. Netherlands: E.J. Brill; 1970.
43. Napier JR, Napier PH. *The natural history of primates*. Cambridge: The MIT Pr.; 1985.
44. Roland, Seitre J. Recent sightings of rare primates on Java. *Primate Conservation* 1990;**11**:18.
45. Nijman V, Sozer R. Recent observations of the grizzled leaf monkey (*Presbytis comata*) and an extension of the range of the Javan gibbon (*Hylobates moloch*) in Central Jawa. *Tropical Biodiversity* 1995;**3**:45-8.
46. Nijman V, van Balen SB. A faunal survey of the Dieng Mountains, Central Java, Indonesia: distribution and conservation of endemic primate taxa. *Oryx* 1998; **32**:145-56.