JMHT Vol. XIV (1): 1-8, April 2008 Artikel Ilmiah
ISSN: 0215 – 157X

Habitat Suitability of Javan Gibbon in Gunung Salak, West Java
(Kesesuaian Habitat Owa Jawa di Gunung Salak, Jawa Barat)

Wim Ikbal[1], Lilik Budi Prasetyo[2*], and Idung Risdiyanto[3]
[1]SEAMEO BIOTROP Campus, Jalan Raya Tajur, Bogor
[2,3]Faculty of Forestry, Bogor Agricultural University, Darmaga Campus, Bogor

Abstract

Objective of this study was to provide spatial information of Javan gibbon habitat suitability and distribution in Gunung (Mt.) Salak area for Management Authority of Mt. Halimun-Salak National Park. Informations on Javan gibbon distribution was collected through a number of survey during December 2005–June 2006 in Kawah Ratu (Parakan Salak, Sukabumi), Pondok Wisata Cangkuang (Cidahu, Sukabumi), and Bobojong Village (Bogor). Twenty two groups were identified using direct count and triangle count method from over 47 identified positions. Habitat suitability was formulated based on10 ecogeographical variables (criteria), consisting of forest type (primary forest, secondary forest, low-land forest, and submontane forest), slope (0–15%, 15–45%, >45%), and distance to non-forested land, river/water body, and road/tracks. The result showed that Mt. Salak consisted of 13.20% (17.53 km^2), 26.25% (34.86 km^2), 19.40% (25.77 km^2), 4.16% (5.53 km^2), and 20.17% (26.78 km^2) of high-suitable, suitable, moderate suitable, less and low suitable level subsequently, and 12.69 km^2 or 9.56% was not suitable for Javan gibbon habitat. It was also revealed that that 3 and 9 groups were living in high suitable and suitable habitat respectively; 13 groups in moderate suitable, while for each less and low suitable habitat, 2Javan gibbon groups lived in.

Keywords: GIS, wildlife, habitat suitability, Javan gibbon, Mt. Salak

Introduction

One well-known approach to conserve the remaining land on the earth, especially on area containing high biodiversity is conservation area establishment (Primack *et al*., 1998). Wildlife information, constitutes of habitat and population aspects are often used as standard criteria to select certain land to be assigned as conservation areas. Every park in Indonesia has to complementarily acquire this framework to determine management zonation (Republik Indonesia, 1998).

A synthesis on wildlife-habitat relationship knowledge, multivariate habitat analysis, with wildlife mapping techniques (which primarily done with certain GIS software) is known as a very promising method to produce efficient wildlife information in which providing a consistent basis for impact assessment, mitigation, baseline, conservation and monitoring studies (Morrison *et al*., 1992).

**Penulis untuk korespondensi,*
e-mail: lbpras@indo.net.id

In contrary, case studies concerning to this synthesis is still rarely done in Indonesia. The need of the study is obvious, considering that Indonesia has a lot of protected areas. In this context, developing such GIS application which carrying this wildlife-habitat relationship could be useful to support designing park zones and management plan in spatial basis.

This study focused on Javan gibbon (*Hylobates moloch*) in Mt. Salak. Conservation status of Javan gibbon is critically endangered (Eudey and MPSG2000, 2004), means that without proper management, it could go extinct in the immediate times. Therefore, urgent action is required to inhibit extinction process and promote its survivalness. Reintroduction was arising for one option and hence need assessment to the relatively large habitat such as Mt. Salak (Supriatna *et al*., 1994; LIPI *et al*., 2003).

The objective of this study was to provide spatial information of Javan gibbon distribution and its suitable habitat in Mt. Salak.

JMHT Vol. XIV (1): 1–8, April 2008 **Artikel Ilmiah**
ISSN: 0215 – 157X

Methodology

Habitat Suitability Model Formulation

Habitat suitability shows the affordability of a unit of land to support species survivalness. The affordability is determined the spatial properties and not just resources inside it. In the geographic scale, habitat resources could be represented by smaller scale features (spatial features) as indirect variables (Guisan and Zimmermann, 2000). The habitat resources can be represented spatially either in raster or vector data. Basically, vector data can be classified into three feature types that are point, line, and polygon. The table below shows the example resources and representation. The resources or spatial features is numerous than provided by the Table 1 as well as the spatial properties.

Suitability model was estimated using GIS-based decision rules, *i.e.*: *Simple Additive Weighting* (SAW) method. In general, SAW is formulated by the following formula:

$$S = \sum_{i}^{N} w_i x_i$$

S : suitability score
w : weight of i-th criterion
x : the *i*-th criterion (*i*=1, 2, .., N)

The model considers habitat factors, such as biotic, abiotic and human factor as decision criteria. The decision criteria are comprises of chosen eco-geographical variables (EGVs) that is spatial properties of a unit of area based on the arrangement of corresponding habitat factor. The variables were determined based on the available knowledge on Javan gibbon behavior and survivalness. Specifically, the considered EGVs are area of primary and secondary forest, area that containing 0–15% slope, area that containing 15–45% slope, area that containing more than 45% slope, area that containing lowland and submontane forest, and distance to river, road, and non-habitat area.

The decision constraints were also considered due to the existence of a factor in the land entity that is not livable for gibbons. Non-forested area (such as tea plantation, bushes, open land, and settlement) and area on which road trespassed were considered as constraints. As was observed by Tobing (1999), Javan gibbon could detect human existence in 20 m (flash distance). Therefore, the area within the distance of 20 m from anthropogenic area (such as roads and non-forested area) was also considered as a constraint.

Table 1. The example of spatial properties, resources and data representation

Spatial properties	Resources/spatial features	Type
Area of forest	Forest Type	Polygon
Area of slope in certain	Slope	Polygon
Intensity of rainfall	Rainfall	Polygon
Frequency of soil type	Soil	Polygon
Average of temperatures	Temperatures	Polygon
Distance to settlement	Settlement	Point/polygon
Distance to settlement	Open land	Polygon
Distance to non-forested area	Non-forested	Polygon
Distance to river	River	Line/polygon
Number of predator	Predator	Point
Number of competitor	Competitor	Point
Number of disturbances	Small disturbance	Point

The occurrence of gibbon group was meant as proxy (indication) of their habitat suitability. The influence level of each EGV corresponds to the occurrence reflects the weight of each variable in the model. This weight was obtained by examining the loading factors value from *Principal Component Analysis*.

Generally, the available data only describes the spatial feature of certain land, but not its spatial properties. Therefore, spatial properties extraction process is needed before conducting suitability score calculation. A certain land, the area of interest upon which the habitat suitability was described, and were divided into smaller grids. Then, the spatial properties in each grid were examined. The extraction process would need special function to create grids.

The process of GIS-Based SAW method was performed by special application (namely SUITSTAT, developed by the author) including the calculation of weight and suitability score, which adopted Malczewski's (1999) procedure.

Equipment

Some equipment were used for collecting field data, such as hand-held GPS, compass, and analog map covering the study area. ERDAS Imagine 8.x and ESRI 3.2 software were used to prepared intermediate data (the license belongs to Environmental Spatial Analysis Laboratory, Environmental Research Centre, Bogor Agricultural University). The special software namely SUITSTAT was used (previously developed by the author) to calculate the suitability score on the intermediate data.

Data Input

The data that were used as a test case of this application were:

1). Digital topographic map of Mt Halimun Salak National Park on scale 1:25.000. This map was special and the newest version of topographical situation on Mt Halimun Salak National Park, produced by the National Coordinating Agency on Survey and Mapping (BAKOSURTANAL) consultant for Mt. Halimun Salak National Park Management.
2). Javan gibbon distribution data in Mt Salak. The data were collected during field survey and some data came from previous research (Djanubudiman *et al*., 2004). This data was also used by this system to determine Javan gibbon habitat suitability.

Field Data Collection Method

Javan gibbon distribution data were collected by using triangle count and direct count along the available track in the study area. Triangle count method is appropriate to be applied on gibbon population counting and positioning (Rinaldi, 1992). The method is working based on the intersection between two (imaginary) lines, which each line was created by observer position (measured by GPS) and the measured compass bearing (azimuth) of observer to the source of sound. The observers should be in a quite distant to prevent the occurrence of parallel lines. After the species position was determined by drawing lines upon the map, the observer went to that position to verify the species existence.

Spatial Data Input Processing

The spatial data processing was taken in two steps, i.e. preliminary processing and main processing. The preliminary processing was used for three aims; firstly, to generate needed spatial data, such as elevation class, slope class and forest ecosystem. DEM (*Digital Elevation Model*) data that represented by contour lines was used to generate these data using ERDAS Imagine software. The generated elevation class data was used to produce elevation-based forest ecosystem data. Secondly, it was aimed to adjust the attribute (especially on categorical spatial data, such as land cover, forest ecosystem, and so forth) in order to provide coding system which represents the available feature class in the data using ArcView 3.2. Thirdly, SUITSTAT was used to prepare vector-grid data containing chosen spatial properties based on selected data. The data used by SUITSTAT was the intermediate data gained from previous processing. Lastly, the main processing that used to calculate suitability score was carried out in SUITSTAT.

Time and Location

The study was started in September 2005 to December 2006. The field survey was done in December 2005, January to February 2006 and May to June 2006 at several places in Mt. Salak, West Java.

Result and Discussion

Javan Gibbon Distribution and Habitat Suitability in Mt. Salak

Javan Gibbon Distribution

Field survey successfully recorded 47 positions of identified Javan gibbon through direct count method (visually) and triangle count method from whole study location. From these recorded locations, only 22 groups were identified as distinct groups. Specifically 10, 8, and 4 distinct groups were found in Bobojong, Cangkuang, and Kawah Ratu.

Most of the distinct groups were recorded through visual count method. However, triangle count method was helpful to be applied in gibbon count, which 13 points were recorded, and the rest was recorded visually. The extreme topographic condition was very challenging for verification of some positions which identified by triangle count method. Nevertheless, both methods were useful to be used concurrently by moving observer.

The number of groups identified through this survey was quite small, but it was successful to identified distinct group. Some positions which relatively close to its nearest position were determined as similar group. By using this procedure, distinct group misinterpretation was found to the previous study by Djanubudiman *et al*. (2004). Additionally, consider to the forest damage around Kawah Ratu and extreme topographical condition which limiting the forest exploration in Bobojong, the number of identified groups was optimal.

The distribution data obtained by this survey enrich the information of Javan gibbon distribution data upon Mt. Salak. Previous research conducted by Djanubudiman *et al*. (2004) was focusing in western part of Mt. Salak, whereas this survey provides data from central and north-eastern parts.

Javan Gibbon Habitat Suitability in Mt. Salak

The whole spatial variables were analyzed using PCA, except for the variable of montane forest area. This variable was omitted from calculation, because it has zero value for the entire samples which could not be used in PCA.

Only two principal components (PCs) were interpretable based on broken stick distribution, i.e. PC I and II. Each component had a percentage variance of 37.80 % and 24.03 % subsequently. Table 6 shows the loadings, percent variance and broken stick distribution value.

The weight of each variable was further transformed into the range of value 0–1. The final weight calculation result can be seen in Table 2. The weight of each variable given by the PCA shows the influence level to determine habitat suitability.

Table 2. Principal component loadings and weight for each spatial variable

Variable	PC I	PC II	Weight
HSE	0.244	-0.486	0.130(2)
HPRI	-0.180	0.522	0.140(1)
HDR	0.367	-0.254	0.098(4)
HGB	-0.345	0.297	0.093(6)
SL1	0.361	0.319	0.097(5)
SL2	-0.247	-0.303	0.081(7)
SL3	-0.361	-0.259	0.097(5)
RIV	-0.240	-0.110	0.065(8)
NONFOR	-0.345	0.009	0.093(6)
JL	-0.394	-0.257	0.106(3)
Eigen values	3.780	2.40277	
Percent variance (%)	37.80	24.03	
Broken stick distibution (%)	29.29	19.29	

Note:
- HPR: area of primary forest; HSE: area of secondary forest; HDR: area of low-land forest; HGB: area of submontane forest contained in; SL1: area of slope 0–15%; SL2: area of slope 15–45%; SL3: area of slope >45%; NFOR: distance to non-forested land; RIV: distance to river/water body; JL: distance to road/tracks.
- The shaded shows the maximum loading of correspond variable and the bracket beside the weight value shows the rank of the weight.

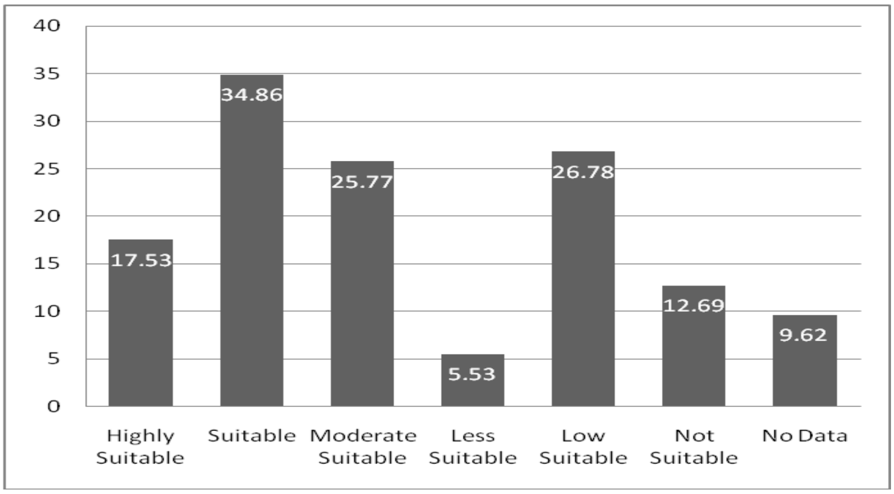

Figure 1. Area of each Javan Gibbon Habitat Suitability in Mt. Salak (in km^2)

Based on PC loadings, the first component is best describing the contained in lowland and submontane forest area, slope 0 to 15% and more than 45%, and distance to road and non-forested land. The second component is best describing primary and secondary forest and contained area with slope 15 to 45%. Weight calculation set the forest maturity (i.e. primary and secondary forest) and distance from road as the most influenced variable; followed by forest ecosystem, distance to non-forested area and river/water body.

The weights seem ecologically interpretable. The weight of forest maturity is highest on primary forest, which is already known that primary forest is containing richer gibbon diets (foods), providing more cover (structural properties in environment that used for certain activities, such as resting cover, sleeping cover, and so forth) than the secondary forest. The influence of water supply to the gibbons is small by the fact that gibbon are seldom to come down from the tree canopy. Even though, Hadi (2002) noted that communities near to the river have a high species biodiversity.

Based on the weight calculation, the suitability score was determined by the following formula:

$$S = 0.13X_1 + 0.14X_2 + 0.098X_3 + 0.093X_4 + 0.097X_5 + 0.081X_6 + 0.097X_7 + 0.065X_8 + 0.093X_9 + 0.106X_{10}$$

where:

X_1	:	area of secondary forest
X_2	:	area of primary forest
X_3	:	area of low-land forest
X_4	:	area of submontane forest
X_5	:	area which has slope 0–15%
X_6	:	area which has slope 15–45%
X_7	:	area which has slope more than 45%;
X_8	:	distance to river/water body
X_9	:	distance to non-forested land
X_{10}	:	distance to road/tracks

The result of model showed that habitat with a low suitability shared fairly extent on whole area of Mt. Salak. The largest portion of Mt. Salak was dominated by suitable, low suitable and moderate suitable respectively. Figure shows the extent of each habitat suitability level of Javan gibbon in Mt. Salak. The geographical position of suitability class based on their area can be seen in the Appendix 1.

According to the model outcome, the highly suitable habitat was mainly situated in the eastern and northern part of Mt Salak area, within Desa Tamansari, Gunung Malang, Tenjolaya, and also Pasirjaya, Sutajaya, Pasawahan, and Cisaat. Some part of this class was placed in the western parts, i.e. Parakansalak, Sukakersa, and Sukatani. Suitable habitat area was much more distributed following the orientation of the shape of Mt Salak area, as well as the moderate suitable area. The low suitable was mainly located at the periphery of Mt Salak, surrounds the suitable and highly suitable habitat. The smallest suitable class area (less suitable) was placed in the northern part.

Mostly the suitable and highly suitable habitat spread over the primary forest. In contrast, low suitable area was mainly placed over secondary forest. The distribution data was superimposed into the habitat suitability class map to know the condition of available gibbon distribution from field survey. Figure in Appendix 1 shows that from 29 gibbon identified groups, 3 and 9 groups were living in high suitable and suitable habitat respectively; 13 groups in moderate suitable, and for each less and low suitable habitat level was lived by 2 javan gibbon groups.

Two gibbon groups were living in low suitable habitat, instead of that small portion of the habitat is still supporting their lives. It showed the influence of geographical factors to the model, which were not only considered to biological or ecological factors. The suitability of the habitat entity was decreasing if located near to the inappropriate factors for survival (built up area, such as road, settlement, and so forth). Figure 1 shows a member of isolated gibbon near Cangkuang base.

Some limitations were identified in this research. The outcome of suitability model depended on the samples (unit sampling size and quantity) and habitat factors as model input. It was expected that sampling units large enough and taken from more systematic way. Samples data was not sufficient to do sensitivity analysis, therefore the model consistency was not known. The input of habitat factors was also limited. More likely the model much more legitimates if it considered landscape theory/concepts, such as the edge effect and contiguity concepts.

Conclusion and Recommendation

Conclusion

1. Based on habitat suitability model which grouped into 5 classes, Mt. Salak area was dominated by suitable class. The area with score more than the moderate suitable class covered 52.39 km^2 or 39.5% from total area 132.78 km^2.
2. Two Javan gibbon groups were located for each low and less and suitable habitat, 13 groups in moderate suitable, 9 groups in the suitable habitat, and 3 groups were living in the high suitable habitat.

Recommendation

This study promotes recommendations for javan gibbon conservation:

1. providing spatial database for gibbon distribution data for easier to monitor this species in Mt. Salak;
2. management authority was suggested to begin developing monitoring plan for javan gibbon groups which living in low suitable areas.

References

Djanubudiman, G., Setiadi, M. I., Wibisono, F., Arisona, J., Mulcahy, G. and Indrawan, M. 2004. Current Distribution and Conservation Priorities for the Javan-Gibbon (*Hylobates moloch*). Project Report. Yayasan Bina Sains Hayati Indonesia (YABSHI) dan Pusat Studi Biologi Konservasi (PSBK) Universitas Indonesia.

Eudey, A. and Members of the Primate Specialist Group 2000 (MPSG2000). 2004. *Hylobates moloch*. *In*: IUCN Red List of Threatened Species. http://www.redlist.org. December 17th, 2004.

Guisan, A. and Zimmermann, N. E. 2000. Predictive Habitat Distribution Models in Ecology. Ecological Modelling 135: 147–186.

Hadi, A. N. 2002. Studi Karakteristik Wilayah Jelajah Owa Jawa (*Hylobates moloch* Audebert, 1798) di Taman Nasional Gunung Halimun (Studi Kasus di Resort Cikaniki). [Under Graduate Thesis]. Bogor Agricultural University.

Lembaga Ilmu Pengetahuan Indonesia (LIPI), Biodiversity Conservation Programme-Japan International Cooperation Agency (BCP-JICA), and Balai Taman Nasional Gunung Halimun (BTNGH). 2003. *Action Plan for Endangered Species in Gunung Halimun National Park*. BCP-JICA. Bogor.

Malczewski, J. 1999. GIS and Multicriteria Decision Analysis. John Wiley and Sons. New York. 414pp.

Morrison, M.L., Marcott, B. G., and Mannan, R.W. 1992. Wildlife Habitat Relationship. The University of Wisconsin Press. Wisconsin. 364pp.

Primack, R., Supriatna, J., Indrawan, M., and Kramadibrata, P. 1998. Biologi Konservasi. Yayasan Obor Indonesia. Jakarta. 345pp.

Rinaldi, D. 1992. The Use of Triangle and Concentration Count Methods in the Investigation of Gibbon Distribution and Population. Media Konservasi IV(1): 9–21.

ISSN: 0215 – 157X

Republik Indonesia. 1998. Peraturan Pemerintah No. 68 Tahun 1998 tentang Kawasan Suaka Alam dan Kawasan Pelestarian Alam. Lembaran Negara Republik Indonesia Tahun 1998, No. 132. Sekretariat Kabinet RI. Jakarta.

Supriatna, J., Tilson, R., Gurmaya, K. J., Manansang, J., Wardojo, W., Sriyanto, A., Teare, A., Castle, K. & Seal, U. (*eds*.). 1994. Javan Gibbon and Javan Langur: Population and Habitat Viability Analysis Report. IUCN/SSC Conservation Breeding Specialist Group. Minnesota.

Tobing, I.S.L. 1999. Pengaruh Perbedaan Kualitas Habitat Terhadap Perilaku dan Populasi Primata di Kawasan Cukaniki, Taman Nasional Gunung Halimun, Jawa Barat. [Thesis]. Bogor Agricultural University.

JMHT Vol. XIV (1): 1–8, April 2008
ISSN: 0215 – 157X

Appendix 1. Map of Javan bibbon habitat suitability in Mt. Salak