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A habitat selection model for Javan deer (*Rusa timorensis*) in Wanagama I Forest, Yogyakarta

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Abstract. *Purnomo DW. 2010. A Habitat selection model for Javan deer (Rusa timorensis) in Wanagama I Forest, Yogyakarta. Nusantara Bioscience 2: 84-89.* Wanagama I Forest is the natural breeding habitat of Javan deer (*Rusa timorensis* de Blainville, 1822). Habitat changes had affected Timor's resource selection and caused the deer to move from undisturbed areas to developed areas with agriculture and human settlements. We suspected that the degradation of natural habitat caused this shift. The research aimed to identify factors that might influence future habitat selection. Habitat selection was analyzed by comparing proportions of sites actually used to sites that we considered available to use. The results of a logistic regression of site categories showed there are three habitat variables that influence resource selection: sum of tree species (expß=1.305), slope (expß=1.061), and distance to a water source (expß=1.002). The three variables influence the deer existing in a certain site of Wanagama Forest and arrange resource selection probability function (RSPF).

Keywords: habitat selection, *Rusa timorensis*, Wanagama I Forest.

Abstrak. *Purnomo DW. 2010. Model seleksi habitat rusa (*Rusa timorensis*) di Hutan Wanagama I, Yogyakarta. Nusantara Bioscience 2: 84-89.* Hutan Wanagama I merupakan habitat rusa (*Rusa timorensis* de Blainville, 1822) yang populasinya berkembang biak secara alami. Perubahan habitat telah mempengaruhi populasi rusa dalam memilih sumber daya di habitatnya dan telah menyebabkan rusa bergerak keluar dari hutan menuju daerah yang lebih strategis, yaitu di lahan pertanian dan pemukiman. Kami menduga bahwa kasus ini terjadi karena degradasi kualitas habitat di dalam hutan. Penelitian bertujuan untuk mengidentifikasi berbagai faktor yang mempengaruhi pemilihan habitat rusa. Seleksi habitat dianalisis dengan membandingkan proporsi antara used dan availability dengan menggunakan site-categorizing. Hasil analisis site-categorizing menggunakan regresi logistik menunjukkan bahwa terdapat tiga variabel habitat yang mempengaruhi pemilihan sumber daya, yaitu jumlah spesies pohon (expß = 1,305), kemiringan (expß = 1,061), dan jarak sumber daya air (expß = 1,002). Tiga variabel tersebut mempengaruhi kehadiran rusa di site tertentu di Hutan Wanagama I dan menyusun fungsi probabilitas seleksi sumber daya (RSPF).

Kata kunci: seleksi habitat, *Rusa timorensis*, Hutan Wanagama I.

INTRODUCTION

Javan deer or also called as Javan rusa, Rusa, Rusa deer, and Timor deer (*Rusa timorensis*) is a Red List Category & Criteria species (Hedges et al. 2008) listed as vulnerable C1 ver 3.1. Population size estimated less than 10,000 mature individuals and an estimated continuing decline at least 10% within 10 years or three generations, whichever is longer, (up to a maximum of 100 years in the future). The declining natural deer population due to the high level of utilization encouraged the Minister of Forestry to issued decree No.301/Kpts-II/1991. This issue is sequel of the Wild Animals Protection Ordinance 1931, No.134 and 226, which stated that Javan deer was one type of animal protected by law in Indonesia. Environmental change affected habitat conditions and it forced the deers to move out from the forest to more strategic areas, i.e., agricultural and settlement. According to Dewi (2006), some deer populations in the Wanagama Forest I had become pests for agricultural crops around the area.

Selection is the process of selecting wildlife habitat components that are used (Johnson 1980). Animals choose habitats through a process of spatial hierarchy that can occur on a scale roaming area (*home range*) (Johnson 1980; Hutto 1985). Selection of a habitat type is closely related to the resources availability. Manly et al. (2002) explained that resource selection functions (Resources Selection Function/RSF) is a unified concept to explain the selection of several types of habitat. RSF can be analyzed through two approaches, namely habitat-categorizing and site-categorizing (Alldredge et al. 1998).

Wanagama I Forest consists of various types of vegetation that need to be analyzed in relation to the provision of resource requirements for deer. Shift in the utilization of resource is likely related to changes in resource availability in the forest. Therefore its necessary to identify the factors affecting the habitat selection in the cruising area. This study aims to determine the factors influencing habitat selection by Javan deer in the Wanagama I Forest. The factors then analyzed to establish

the formulation of habitat selection models based Resources Selection Probability Function (RSPF) in Forest Wanagama I, Yogyakarta.

MATERIALS AND METHODS

This research was conducted in the area of Wanagama I Forest Gunungkidul Regency. The data was taken during the dry season in July until the early November 2008. Utilization of habitat by the deer was estimated by the indirect approach in the form of footprints and droppings the deer (Lavieren 1983; Strien 1983). Plots were placed systematically (distance between transect 200 m and distance between plots 100 m). Plots which had population indicators, was called used plot, while plots which had not found population indicators was called unused plots, and both used and unused was called availability plots (Figure 1). In each plot the habitat variables measured with the sampling protocol technique (Noon 1981). Habitat variables include all components that affect the welfare of animals (welfare factors), including biotic and abiotic components (Bailey 1984; Higgins et al. 1994).

Habitat selection determination was approached by site-categorization that explained the selection stated of certain resources by the animals in a site (Alldredge et al. 1998). Habitat variables in used plot were compared with the habitat variables in availability plot using logistic regression to find out what factors influence the resources selection (Alldredge et al. 1998; Manly et al. 2002).

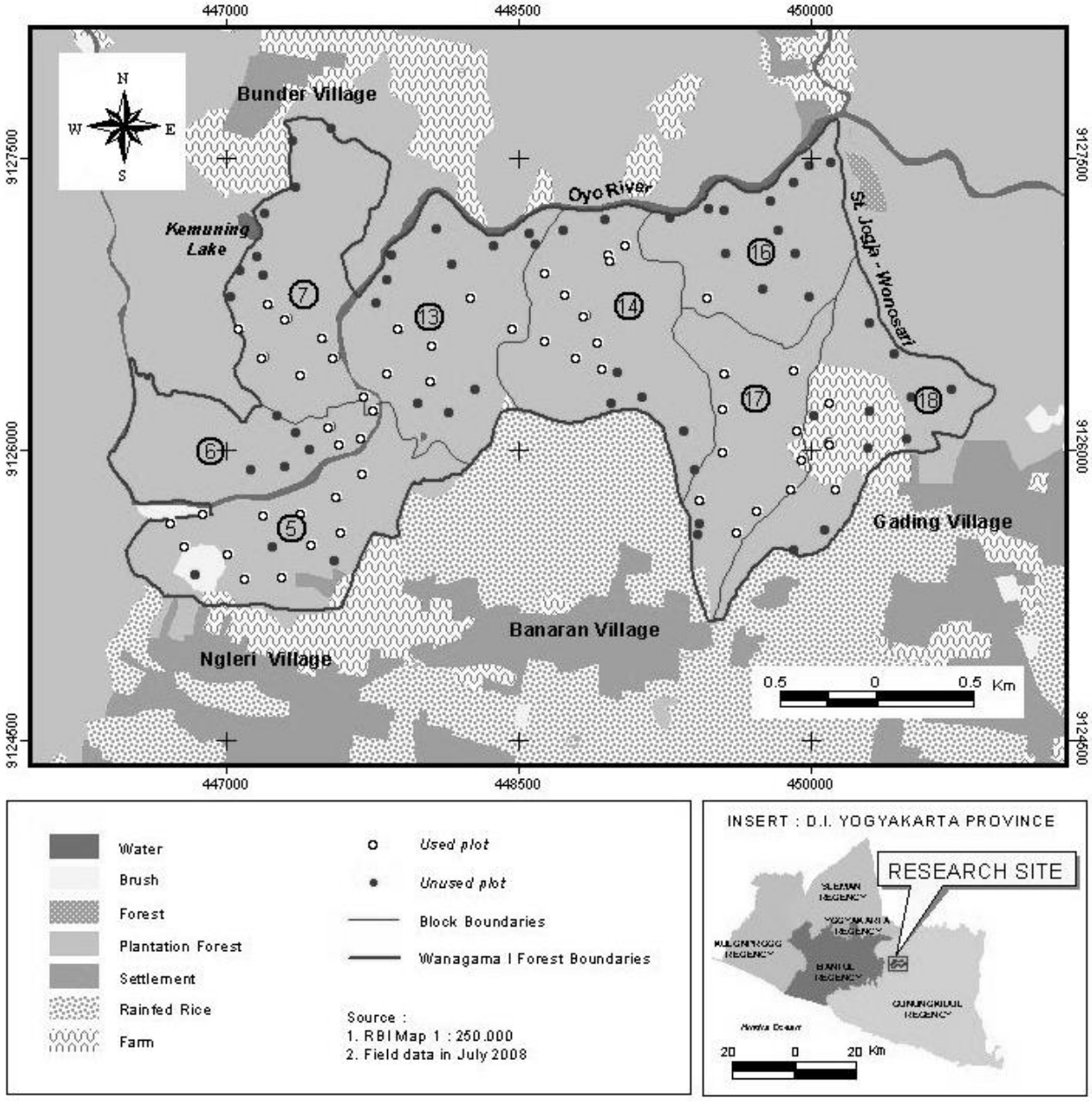

Figure 1. Distribution of used-unused plots of Javan deer habitat research in Wanagama I Forest

Each used plot was marked "1" while availability plots "0". All of habitat variables plots were selected randomly to get the data sample. In addition, each variable analyzed with Multicollinearity Test to avoid correlation between variables. The data analyzed using SPSS 16.0 for Windows Evaluation Version to determine the resource selection probability functions (RSPF). This function subjected as selection model and simulated using some site in the field.

Wanagama I Forest located in Gunungkidul District, Yogyakarta Province with average annual rainfall 1500-2000 mm. The rainy season usually falls in November-April and the dry season comes in June to September. Based on the distribution of climate types by Schmidt and Ferguson, Wanagama I Forest is included in the D climate types (Anonymous 1988). Based on measurements of rainfall measuring station near in Wanagama I, i.e., Wonolegi (Playen), in the last 10 years showed that the wettest month is January with the average amount of rainfall on 425.18 mm while the driest month on is August with the average amount of rain 16.55 mm (Anonymous 2005).

Wanagama I Forest has diverse vegetation composition and structure. This area is divided into blocks of plants in blocks of vegetation. The species number of forest vegetation in Wanagama I today reaches 190 species (Anonymous 2005). Various types of trees planted with homogeneous or heterogeneous pattern (mixed). Mixed stands of *Acacia auriculiformis, Samanea saman, Swietenia macrophylla, Adenanthera* sp., *Tectona grandis, Pinus merkusii, Delonix regia, Dalbergia latifolia, Melaleuca leucadendron*, and *Vitex pubescens*.

Based on observational data, population movement patterns have 3 major groups, namely: group 1 in the vicinity of Block 5, group 2 in the vicinity of Kemuning and Wonolagi, and Group 3 in the vicinity of Block 14 and 17. Each group moving on a periodic basis to several places in the vicinity. Deer population ages varied, consisting of adults, young, and chicks (Anonymous 2005). Meanwhile, according to Supraptomo (2006), the structure of the deer population, especially in Block 5 was one male versus three females.

The types of Javan deer feed that available especially in Block 5 is very abundant compared to other plots. Vegetation types of Javan deer feed in Wanagama I include *Arachis hypogaea, Manihot utilisima, Euphorbia prostata, Ipomoea batatas, Leucaena glauca, Swietenia macrophylla, Polytrias amaura, Imperata cylindrica*, and *Ageratum conyzoides* (Purnomo 2003). Furthermore, Purnomo (2003) noted that three kinds of vegetation most preferred feed was peanuts (*Arachis hypogaea*) (Level of Feeding Preferences/LFP=0.88 on a scale of 1 of 9 kinds of feed), weeds (*Imperata cylindrica*) (LFP=0.67) and cassava (*Manihot utilisima*) (LFP=0.33).

There are several water sources in the Wanagama I Forest. However, the main water source for deer in the Wanagama I Forest was Oyo River that not dry all year round. At the time of observation (dry season), the water still available for the deer. Therefore, areas along the River Oyo are the main location of the activity of deer population (Purnomo 2003; Supraptomo 2006).

RESULTS AND DISCUSSION

Analysis of resource selection probability function

The field research resulted in 114 plots (total length of transect ± 11.4 km) with 55 categories of used plots and 59 categories of unused plots (Figure 1). Numbers of sample plots are about 100 plots (40 used plots and 60 availability plots). The results of Multicollinearity Test of habitat variables show that the highest correlation between temperature and humidity is 0.494 (49.4%). This value is far below 95%, it means there is no significant multicollinearity. All variables could be subjected to further logistic regression analysis. The logistic regression was used because it did not require the normal distribution (Ghozali 2006).

Comparison of used-availability plots is more reasonable than used-unused considering detection of animals present at one time will be different at other times (Keating and Cherry 2004). Logistic regression was performed with backward stepwise method to filter out any variables that come in and produce the best-fit model. Statistics value -2LogL in the table used to screen the independent variables, which included in the model and assessed the data overall fit model (Ghozali 2006).

Table 1. Iteration history of logistic regression analysis

Iteration		-2 Log likelihood	Coefficients			
			Constant	Tree	Slope	Water
Step 8	1	120.178	-2.572	0.225	0.05	0.002
	2	119.858	-3.003	0.264	0.059	0.002
	3	119.858	-3.026	0.266	0.06	0.002
	4	119.858	-3.026	0.266	0.06	0.002

Note: a. Method: Backward Stepwise (Likelihood Ratio). b. Constant is included in the model. c. Initial -2 Log Likelihood: 134.602. d. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001. e. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

The value -2LogL in step 8 (Table 1) was 119.858 and X^2 distribution with df97 (100-3). This value was not significant at α=0.05, which means the model has been fit with the data. In these circumstances, the addition of three independent variables, which is the number of trees, slope, and distance of water would improve the model.

Fit Model could be tested with the Hosmer and Lemeshow Test by testing Ho that the empirical data state with the model. The result showed the value of Hosmer and Lemeshow is 3.297 and the P value for 0.914 (Table 2). Because the P value is higher than 0.05, it could be concluded that the model is fit and acceptable. Classification Table could be used to test the practicability of the model, i.e. the model ability to estimate true (correct) and false (incorrect) (Table 3). The simulation with availability status (code 0), if there are 60 points in the field, then 49 points will be availability status, so the classification accuracy reaches 81.7%. Meanwhile, in the area with used status from 40 points in the field, then 22

points will be used, and contributed to 55% of classification accuracy. Overall, this model could predict the classification accuracy of 71%.

Table 2. Hosmer and Lemeshow test of logistic regression analysis

Step	Chi-square	df	Sig.
1	9.377	8	.311
2	9.069	8	.336
3	4.531	8	.806
4	4.556	8	.804
5	4.290	8	.830
6	2.877	8	.942
7	2.257	8	.972
8	3.297	8	.914

Table 3. Classification table of logistic regression analysis

Observed			Predicted		
			Presence		Percentage correct
			0	1	
Step 8	Presence	0	49	11	81.7
		1	18	22	55.0
	Overall percentage				71.0

Note: 1 used, 0 availability

Independent variables included in the model could be seen in Table 4. There are 3 significant variables, namely the number of tree species, slope, and distance of water sources. The influence value of independent variables affecting the dependent variables of the deer presence could be explained in the column Exp (ß). Number of tree species variable with a value of Exp (ß) for 1.305 was the highest value, it means if the slope and distance of water sources variables are considered constant then the odds ratio of deer presence will change for 1.305 in every one-unit change in the number of trees variable. In slope variable, if the number of trees and distance of water sources variables considered constant, then the odds ratio of deer presence will change for 1.061 at every change of one unit of the slope variable. Similarly, the distance of water sources variable, if the number of species of trees and the slope variables considered constant, then the odds ratio of deer presence will change for 1.002 at every change of one unit of the distance water sources variable.

Table 4. Variables in the equation of logistic regression analysis

		ß	S.E.	Wald	df	Sig.	Exp(ß)	95.0% C.I. for EXP(ß)	
								Lower	Upper
Step 8(a)	Tree	0.266	0.12	4.876	1	0.027	1.305	1.03	1.652
	Slope	0.06	0.027	4.712	1	0.03	1.061	1.006	1.12
	Water	0.002	0.001	11.116	1	0.001	1.002	1.001	1.003
	Constant	-3.026	0.854	12.556	1	0	0.049		

The resulting model is as follows:

$$\pi(x) = \frac{\exp(-3.026+0.266x_j+0.06x_k+0.002x_a)}{1+\exp(-3.026+0.266x_j+0.06x_k+0.002x_a)}$$

$\pi(x)$ = probability of the deer presence
x_j = number of tree species
x_k = slope
x_a = distance of water sources

The number of tree species could be used to describe biodiversity at a site. The diversity of tree species would increase the height variation, especially the quantity of feed resources and the availability of cover required by animals (Bailey 1984; Higgins et al. 1994). The diversity of vegetation could serve the environment and create a balance of wildlife communities and ecosystems within (Bolen and Robinson 1995). Javan deer would looking for places that with a higher variety of tree species to meet the needs of their group. The composition of the tree was also associated with the provision of grass and understory plants that affect the grazing behavior of animals (Mligo and Lyaru 2008).

According to the field observation, locations of deer's activity center (Block 5 and 17) had a variety of feed vegetation such as *Arachis hypogaea*, *Manihot utilisima*, *Euphorbia prostata*, *Ipomoea batatas*, and *Ageratum conyzoides*. In fact, according to report, understory plants abundance in Block 5 were dominated by *Ageratum conyzoides* (Important Value / IV = 0.20 on a scale of 1 of the 8 species of understory plants), *Eupatorium odoratum* (IV = 0.15), and *Imperata cylindrica* (IV = 0.15) (Anonymous 2005). Meanwhile, the three dominant shrubs, that potentially as a cover for the deer in Block 5, were *Flacourita indica* (IV = 0.44 of the 3 types of shrubs dominant), *Gliricidia maculate* (IV = 0.31), and *Santalum album* (IV = 0.25) (Anonymous 2005).

Slope had a positive effect in the model which means that Javan deer tend to like the steep places. A steep slope is usually far from the human interference activity, and relatively high vegetation density. Several locations with flat or slightly sloping in the Wanagama I Forest had intercropping systems of agricultural land, and tumpang sari, for example in the Block 14, Block 16, and Block 18. Farmers will have intensive activity, especially in the mornings from 06.00 until 09.00 am and the afternoon between 15.00 and 18.00 pm. In the steep locations, usually, the vegetation was found in the form of forest or dense bush. Therefore, the steep areas were strategic place for animals to protect themselves from predators and the disturbance of human activity. In the steep slope category areas (25-45%), Javan deer would tend to used locations with greater opportunity rather than simply used it as resource availability. Phenotype deer's body had a strong leg that could move very swiftly (Dradjat 2002; Semiadi 2002). Therefore, it could be said that the slope is not a limiting factor for deer movement (Semiadi 2002).

Distance of water sources has a positive correlation in the model, although coefficient value Exp (ß) lowers than the number of trees and slopes. A permanent water source in the Wanagama I Forest is the Oyo River, while the surrounding area is an agricultural area with the high intensity of human activity (Dewi 2006). Therefore, the distance of water sources positively correlated with human activity. The deer will move away from human activity because it is sensitive and had a sense of smell. In the more distant locations than 1,200 meters from the River Oyo, deer are most likely going to attend.

Deer had characteristic that could withstand drought (Dradjat 2002). To manage their water needs, the deer will drink in the river or water source during rainy season, while in the dry season the deer will take the leaf buds, which contain lots of water (Djuwantoko 2003). Therefore, deer in the Wanagama I Forest chose a place with far from human activity, although its far from water sources.

Simulation model

One benefit of the resource selection model is that this model could predict the chances of the animal's presence in one place. Resource selection model of Javan deer in the Wanagama I Forests was used to predict the deer presence in some points in the field. RSPF in Wanagama I Forest formed based on the model can be seen in Figures 2, 3 and 4.

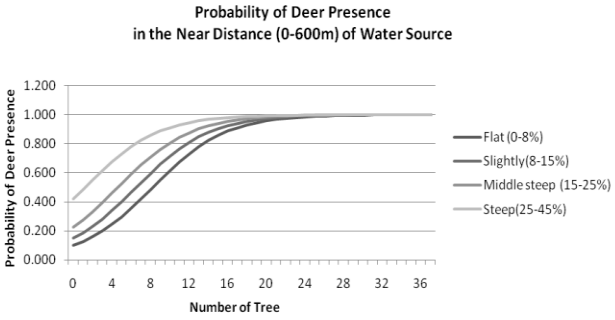

Figure 2. RSPF at locations in the near distance of water sources in the Wanagama I Forest

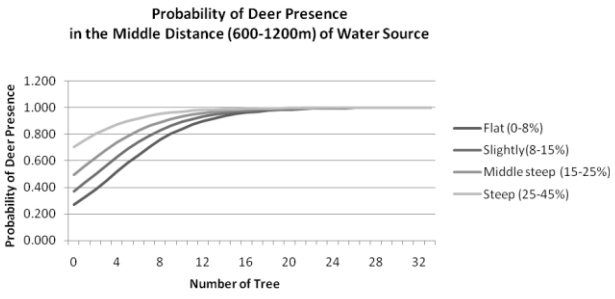

Figure 3. RSPF at locations in the middle distance of water sources in the Wanagama I Forest

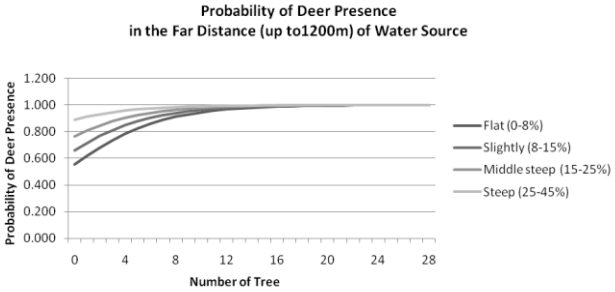

Figure 4. RSPF at locations in the far distance of water sources in the Wanagama I Forest

In general, the high probability of deer presence was indicated by the location with a steep slope and the far distance to water sources. For example in Block 6, with the average grade steep slopes (25-45%) and distance to water sources in the category of near (0-600 m), to attract the deer presence with a chance of 60% (P = 0.6) must be provided with the number of tree at least three species. Another example of other such cases in Block 17, with relatively flat slopes (0-15%) and distance water sources (up to 1,200 m), then to keep the sustainable deer population there must be five trees species composition.

CONCLUSION

Three habitat variables determine resources selection, i.e., the number of tree species, slope, and distance of water sources. These variables showed strong influences of the deer presences and formed an RSPF in the Wanagama I Forest. Furthermore, the vegetation management of Wanagama I Forest had to consider with habitat especially concerned with the minimum number of available tree species in the forest. Problem-solving of deer disturbance in agricultural could be improved through efforts to improve the quality of habitat in the forest.

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