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Habitat preference of leopard cat (*Prionailurus bengalensis* Kerr. 1792) in the Cisokan Hydropower Development Area, West Java, Indonesia

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Abstract. *Shanida SS, Megantara EN, Husodo T, Mutaqin AZ, Kendarto DR, Wulandari I. 2023. Habitat preference of leopard cat (*Prionailurus bengalensis *Kerr. 1792) in the Cisokan Hydropower Development Area, West Java, Indonesia. Biodiversitas 24: 2284-2293.* Leopard cat (*Prionailurus bengalensis* Kerr. 1792) can occupy various habitats, including degraded and human-modified landscapes such as agricultural lands, plantations, and settlements. Nonetheless, there is little information about their responses to infrastructure development impacts the habitat preference of leopard cats. This study aims to reveal the habitat preferences of leopard cats in the Upper Cisokan Pumped Storage (UCPS) hydropower development area, Cianjur Regency and West Bandung Regency, West Java. Direct observation was conducted to collect habitat preference in terms of biotic, abiotic and anthropogenic parameters and analyzed using Vanderploeg and Scavia's Resource Selection Index (VSI). The results showed that in term of biotic factors, leopard cats preferred natural forests, shrubs, and rice fields; tree canopy area of 51%-75%, tree DBH >20 cm, tree height 0-5 m and 11-15 m, and tree density of 0-20 trees. Leopard cats preferred 76%-100% shrubs canopy; ground-plant cover of 26%-75% with withered grass cover of 76%-100%. According to their abiotic factors, leopard cats preferred habitats with north and south, gentle, and lower slopes. The leopard cats also preferred habitat with wet soil. In term of anthropogenic factors, leopard cats preferred habitat close to water sources (<500 m). Leopard cats chose habitats with moderate distances (500 m-1000 m) from anthropogenic disturbances with weak intensity. Agricultural activities could affect its habitat preference directly. Leopard cats were found at various levels of disturbance in human-modified lands, such as rice fields and shrublands. Since the main prey is cosmopolitan animals, as long as there is human-modified land, prey availability will remain guaranteed. Although the leopard cat can tolerate anthropogenic disturbances, there is little information on the direct impact of construction activities on this population, so further research is needed to observe their population and habitat in the construction area.

Keywords: Anthropogenic disturbance, grid, human-modified land

INTRODUCTION

Anthropogenic activities, including human expansion, are the major threats to biodiversity and affect ecosystems worldwide (Hooper et al. 2012). Such activities cause habitat destruction, fragmentation and over-exploitation (Seto et al. 2012; Coudrat et al. 2014), resulting in unprecendented loss of biodiversity. Java Island is among the regions with the highest density of human population in Indonesia and the world. This island has been experiencing high deforestation rates, significantly threatening its wildlife (Meijaard and Ferguson 2014). The increasing human population and rapid development in Java Island have put pressure on the natural habitat of wildlife including the forest ecosystem remained on the island. This is a serious threat since most of the wildlife in Java is associated with or dependent on the forest.

While agriculture and logging are among the major drivers of habitat loss that affect biodiversity in Indonesia (Chua et al. 2016; Partasasmita et al. 2016), other types of threats also occur in West Java due to the development of hydropower. The Upper Cisokan Pumped Storage (UCPS) Hydropower Plant is being developed by a state-owned hydropower company (i.e. PT. PLN (Persero) UIP JBT) with a capacity of 4x260 MW and being the first pumped storage type hydropower plant in Indonesia. This development was carried out to meet the increasing demand for electricity at peak loads and improve the reliability of the Java-Bali interconnection system. Currently, the development is at the construction stage, with funding assistance from the World Bank. The water source for the UCPS comes from the Cisokan and Cirumamis Rivers. The UCPS development activities include the construction of two dams and reservoirs, transmission lines, power stations, access roads, quarries, and other facilities, which are estimated to require ±723.15 ha of land (consisting of ±337.89 ha of community land and state forest area of ±385.25 ha) located in West

Bandung and Cianjur Regencies (PPSDAL 2014). The construction of the hydropower likely impacted the habitat of wildlife, including leopard cat *Prionailurus bengalensis* Kerr. 1792. The presence of the UCPS also might alter the habitat preferences of leopard cat due to its adaptation to environmental changes.

Leopard cat is a carnivore species generally found in Asia, such as Afghanistan, Pakistan, India, Laos, Myanmar, Thailand, Malaysia, Vietnam, Taiwan, Indonesia, Borneo, Nepal, Korea, and Cambodia (Srivathsa et al. 2015). Leopard cat is habitat generalist species that can adapt to multiple land cover types and is known to use partially human-modified areas. Leopard cats are more tolerant to habitat disturbances and can be found in primary and secondary forests, plantations, and orchards (Mohamed et al. 2016). The density of leopard cats increases in disturbed forests (Mohamed et al. 2013). With the wide distribution of the leopard cat in multiple conditions, its abundant population (Wilting et al. 2016), and its ability to persist in altered habitats, the leopard cat is classified as Least Concern (LC) by the IUCN Red List of Threatened Species (Mohamed et al. 2013). Leopard cat is also listed as Appendix II by the CITES (UNEP-WCMC 2022), and is protected by Regulation of Ministry of Environment and Forestry of Republic of Indonesia No. P. 20 of 2018 regarding Protected Plant and Animal Species. Their populations are believed to be relatively stable in other parts of their range (Mohamed et al. 2013).

Habitat selection and utilization by wildlife species are influenced by several factors, including food and water availability, the presence of shelter to protect from disturbances, and interspecific competition (Panthi et al. 2012). Wildlife habitat selection is a behavioral strategy that allows species to adjust to environmental changes (Aryal et al. 2014). The habitat selection of leopard cat is influenced by their natural ecological requirements and human disturbance and activities. Interestingly, the population density of leopard cat increases in disturbed forests and it prefers habitats with low canopy density (Mohamed et al. 2013). In northern Taihang Mountain, China, leopard cats avoided habitats with trees and preferred habitats with shrublands, which may be related to the prey availability, suggesting that this species choose habitats with high prey density (Davidson et al. 2012). The presence of leopard cat which prefer degraded environments is associated with the higher rodent populations in such areas compared to the intact ecosystem (Pimsai et al. 2014). The species tend to choose habitats with fewer stumps, gentle slopes, and fallen woods to avoid obstacles, which might hinder them from hunting or getting away from dangers quickly (Wu et al. 2020).

The previous studies mentioned above examined the ecological characteristics of leopard cats affected by anthropogenic disturbances. These characteristics are used to identify habitat suitability so that wildlife management can reduce unnecessary development activities and increase the effectiveness of *in-situ* conservation. Furthermore, when the habitat is protected, it indirectly reduces human-wildlife interactions, positively impacting the management and protection of wildlife populations (Chen et al. 2019).

Studies on the ecology of leopard cat have been carried out in Java. The leopard cat has been studied in the UCPS hydropower development area by the Indonesian Institute of Sciences (2012), Meijaard and Ferguson (2014), PPSDAL (2017), Shanida et al. (2018), Husodo et al. (2019a), Husodo et al. (2019b), Husodo et al. (2019c), and Megantara et al. (2019). Leopard cats were also found in the Ciletuh Geopark, Kamojang, Mount Salak, and Darajat, West Java (Megantara et al. 2019; Husodo et al. 2019b). Nonetheless, there is little information regarding the habitat preferences of the leopard cat in Indonesia. Based on such rationale, this study aims to reveal the habitat preferences of leopard cats in the UCPS hydropower development area, West Java. This study is essential to understand the behavioral ecology of leopard especially in disturbed habitats, such as in the UCPS hydropower development area. The results of the study can enrich the existing knowledge on the autecology of leopard cat and might also serve as reference for the environmental management in the UCPS area.

MATERIALS AND METHODS

Study area

The study was conducted in August-September 2022 in the UCPS hydropower development area. The UCPS hydropower plant development area and its infrastructure cover an area of 775.64 ha and administratively is located in West Bandung Regency and Cianjur Regency, Indonesia. The construction area is located in the upper catchment area of the Cisokan River as a tributary of the Citarum River (PPSDAL 2017). This area has elevation ranging from 400-800 masl with flat to steep slopes ranging from 0-35°. The land cover types in this area consist of natural forests, mixed gardens/agroforestry lands/*talun*, dry and wet paddy fields, plantations (pines and teaks), riparian, and settlements.

The study area in the UCPS hydropower plant development area was divided into a 1x1 km grid (Figure 1). We created 47 grids across the study area to cover a total extent of 47 km^2. The determination of this grid was based on the Biodiversity Management Plan 2020 (PT PLN 2021) and accounted for average home range of the leopard cat which is 3-14 km^2 (Rajaratnam et al. 2007).

Data collection procedures

We conducted a quantitative method through direct observation referring to Wu et al. (2020) with modifications. This study used a grid sampling approach of 1 km x 1 km (Figure 1). Data regarding the presence of leopard cats were based on the previous studies conducted by the Indonesian Institute of Sciences (2012), PPSDAL (2017), and Shanida et al. (2018). Such presence data were used to establish observation plots as illustrated in Figure 2 and explained below.

First, a sampling plot of 20x20 m was made where there was evidence of leopard cats and this was called as used plot and treated as a central point. Then, on the grid without evidence of leopard cats, a sampling plot of 20x20

m was made at start, middle, and end of the line transect and called as non-used plot. Therefore the used plot was determined if evidence of leopard cats was found within the respective grid, grid line boundaries or grid angles. After the sampling plot was established, the parameters as presented in Table 1 are measured.

Data collection related to habitat preferences consisted of three ecological variables: biotic, abiotic, and disturbance (Table 1) (Wu et al. 2020). The biotic factors included vegetation type, tree canopy, tree density, tree diameter at breast height (DBH), tree height, shrub height, shrub canopy, ground-plant cover, stump quantity, fallen wood quantity, and withered grass cover. The abiotic factors included elevation, slope aspect, slope gradient, slope position, and soil moisture. The disturbance factors consisted of distance from the nearest water source, distance from the nearest residential area, anthropogenic disturbance types, distance from anthropogenic disturbance, and disturbance intensity (Table 1).

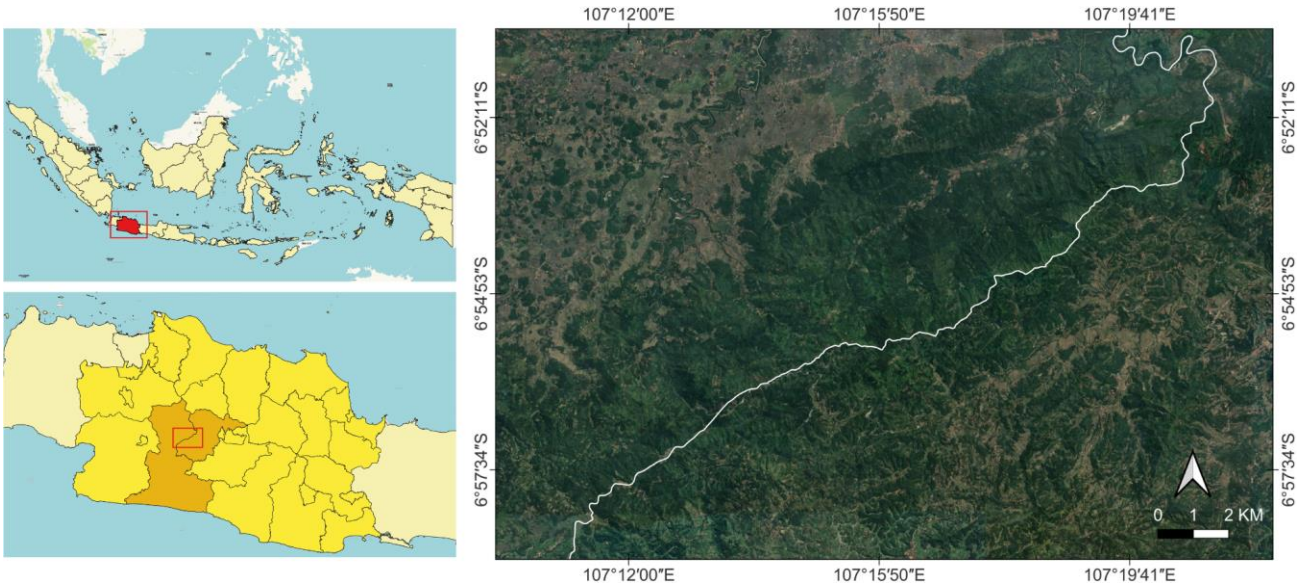

Figure 1. Map of the study area in UPCS hydropower plant development area in Cianjur Regency and West Bandung Regency, West Java (48 M 745739.21 m E 9231299.47 m S)

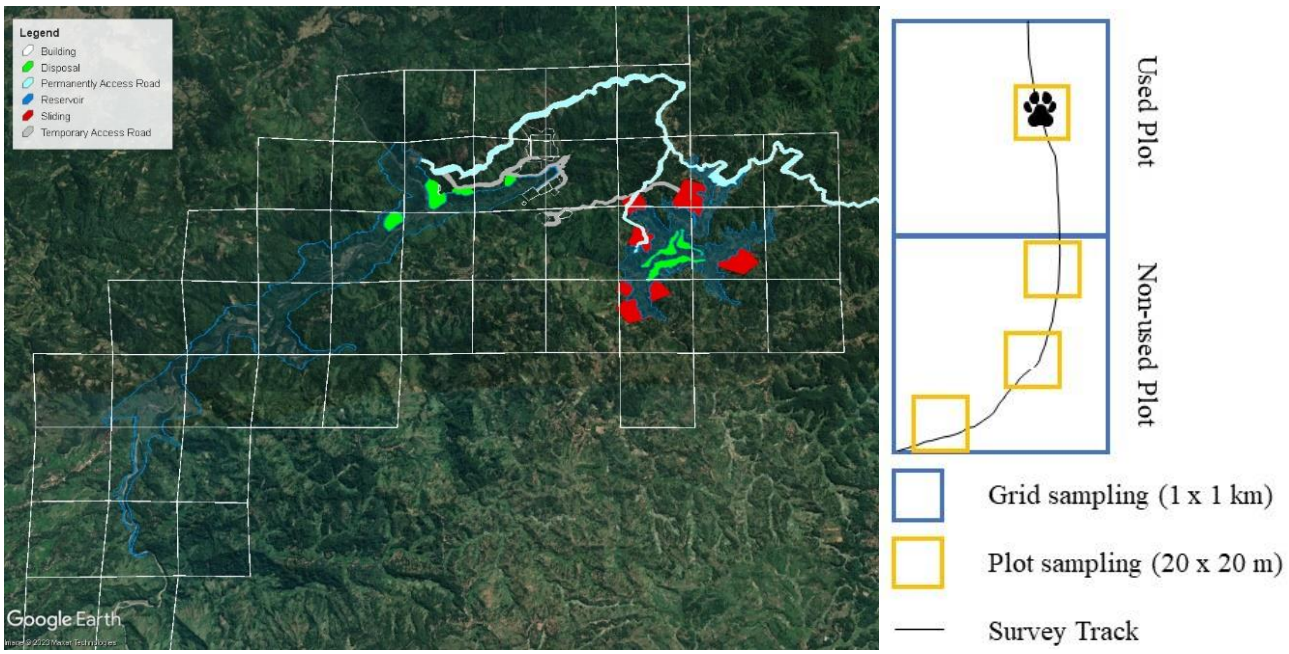

Figure 2. Illustration of used plot and non-used plot in grid sampling. Map source: Google Earth (2022)

Data analysis

Data from various ecological variables were tabulated using Microsoft Excel and analyzed using VSI (Vanderploeg and Scavia's Resource Selection Index) to assess the leopard cat habitat preferences (Zhou et al. 2013). The habitat preference is then categorized as Especially Preferred (EP), Preferred (P), Almost Randomly Selected (AR), Randomly Selected (RS), Not Preferred (NP), and Not Selected (NS). The Especially Preferred (EP) indicates a complete preference for the habitat characteristic. The Preferred (P) indicates a slight to strong preference for the habitat characteristic. The Almost Randomly Selected (AR) indicates a weak preference or avoidance of the habitat characteristic. The Randomly Selected (RS) indicates that leopard cats do not show any preference or avoidance of the habitat characteristic. The Not Preferred (NP) indicates a slight to strong avoidance of the habitat characteristic. Finally, the Not Selected (NS) indicates complete avoidance of the habitat characteristic (Wu et al. 2020). The VSI was calculated using the formula as follow (Wu et al. 2020):

$$w_i = \frac{\frac{r_i}{p_i}}{\sum \frac{r_i}{p_i}}, E_i = \frac{w_i - \frac{1}{n}}{w_i + \frac{1}{n}}$$

Where:

w_i : Resource selection coefficient
r_i : Number of plots with a certain ecological factor used by leopard cats
p_i : Sum of plots with a certain ecological factor
E_i : Resource selection index
n : Number of items in a variable

The resulting value of VSI was categorized as follow (Wu et al. 2020):

$E_i = 1$: Especially preferred (EP)
$0.1 < E_i < 1$: Preferred (P)
$-0.1 < E_i < 0.1$: Almost Randomly Selected (AR)
$E_i = 0$: Randomly Selected (RS)
$-1 < E_i < -0.1$: Not Preferred (NP)
$E_i = -1$: Not Selected (NS)

RESULTS AND DISCUSSION

The used plots were determined based on the presence of leopard cats surveyed in the previous studies, while the non-used plots were grids where leopard cats were absent in 2012 and 2017 (Figure 3). Of the 47 grids, 14 grids were identified for establishing the used plots, 16 grids were non-used, and 17 grids were areas not surveyed intensively according to the sign survey procedure (Figure 4). Some grids with hilly and cliff topography were difficult to access, making it impossible to conduct sign survey procedures. The total number of used plots were 18, while the non-used plots are 48 (Table 2).

Biotic factors

In term of vegetation type (Table 1), we found that leopard cats preferred natural forests, shrubs, and rice fields (Figure 5). Regarding their daily needs, rats as prey were more commonly found in shrubs. Shrubs were also used as a breeding ground for leopard cats, indicating that the shrubs were used as a shelter. In addition, rats as leopard cats' prey were also found in rice fields. In contrast, the leopard cats avoided swidden cultivations, home gardens, production forests, and mixed gardens. Swidden cultivations and home gardens were avoided because of the high intensity of human activity. The production forests in the UCPS area consisted of Sumatran pine (*Pinus merkusii* Jungh. & de Vriese) and teak (*Tectona grandis* L.f.). The production forests were planted close to agricultural land, so the intensity of human activity in production forests was relatively high. In several areas, pine forests were found nearby banana plantations and roads where human activity was high.

Previous studies reported the presence of leopard cats in various habitats. Wu et al. (2020) found that leopard cats preferred shrubs and avoided farmland and grasslands, while Lee et al. (2015) found more population in riparian and forests. Other studies have reported leopard cats in logged forests, rubber estates, and oil palm plantations (Silmi et al. 2013; Wahyudi and Stuebing 2013). Leopard cats also preferred forests, adjacent grassland, near the edges of mixed brushland and agricultural land as their habitats (Lee et al. 2015, 2017; Fernandez et al. 2018). The study by Fernandez et al. (2018) also revealed that in the dry season, leopard cats used forest areas more frequently, while in the rainy season, they preferred disturbed mixed brushlands, coconut plantations, and built-up areas. Lee et al. (2017) revealed that leopard cats used forest ridges and valleys as the main transport routes.

Leopard cats can occupy various habitats, both native ecosystems and human-modified land. The combined impacts of multiple factors influence the habitat distributions of wild animals (Lee et al. 2017). Environmental factors such as topographic characteristics, forest properties (Mohamed et al. 2016), and distances to essential resources, such as water, influence the habitat distributions of mammals (Mohamed et al. 2016). For *Prionailurus bengalensis heaneyi*, forests seem to be the most important habitat as forests provide both prey and shelter, which are known to be the essential resources for leopard cats (Bashir et al. 2014; Simcharoen et al. 2014). *P. b. heaneyi* also tolerate more disturbed habitats such as mixed brushlands, coconut plantations, and built-up areas (Fernandez et al. 2018). In addition, leopard cats are more tolerant of habitat disturbances and can be found in primary and secondary forests, coniferous forests, plantations, shrublands, grasslands, and orchards (Mohamed et al. 2016). Studies by Mohamed et al. (2013) and Srivathsa et al. (2015) found that the density of leopard cat was higher in degraded habitats. For example, the higher density of leopard cat in India was clustered around secondary, disturbed, or partially modified forests (Srivathsa et al. 2015).

The leopard cats preferred a tree canopy of 51%-75% with a tree DBH of >20 cm, a tree height of 0-5 m and 11-15 m, and a tree density of 0-20 trees/plot. Leopard cats avoided tree canopy of 0%-50% and 76%-100%, tree DBH 0-20 cm, tree height 6-10 m and >15 m, and a tree density >20 trees/plot. Wu et al. (2020) found that leopard cats preferred a tree density of 20-60 trees/plot, and avoided habitats with a tree canopy of >50% and tree height of >5 meters, and did not prefer an area with a tree density of >60 trees/plot. These preferences may be related to its function as a place to rest. Trees are used as a place to rest, while open land, shrubs, and settlements tend to be avoided (van der Meer et al. 2023). The leopard cats randomly selected a habitat with 0-3 trees of stumps and fallen trees, and preferred habitats with <5 stumps and fallen wood (Wu et al. 2020). Stumps and fallen woods may be related to the ease of hunting. van der Meer et al. (2023) reported that the open land improves visibility and, thus, prey catchability. However, stalking predators need a fine balance between having sufficient concealment for the stalk and being able to find prey.

The leopard cats preferred habitats with a 76%-100% shrub canopy. They avoided habitat characteristics with a shrub canopy area of 0%-75% and height of 0-1 m, but randomly selected a habitat with a canopy of 26%-50% and a shrub height of 1.1-2 m. Leopard cats preferred habitats with ground-plant cover of 26%-75% with 76%-100% withered grass cover but avoided ground-plant cover of 0%-25% and 76%-100% with 0%-75 withered grass cover. Feral cats spend a longer time hunting in areas with structurally complex and dense cover, with vegetation height having a greater influence on site visiting time than prey cues (Moseby and McGregor 2022).

Table 1. Description of ecological variables used to analyze the habitat preference of leopard cat

Ecological variables	Parameter	Description
Biotic factors	Vegetation type	Vegetation types: ricefield, forest, shrub, etc.
	Tree canopy (%)	The average percentage of canopy cover in the four directions of the sample plot
	Tree DBH	The average DBH of trees closest to the center point (DBH>10 cm, up to 1.3 m high) in 20 m × 20 m plots
	Tree height (m)	The average height of trees closest to the center point (DBH>10 cm) in 20 m × 20 m plots
	Tree density	Number of trees (DBH >10 cm) in 20 m × 20 m plots
	Shrub height (m)	The average shrub height in 20 m × 20 m plots
	Shrub canopy (%)	The average shrub canopy in 20 m × 20 m plots
	Ground-plant cover (%)	The average ground-plant coverage in 20 m × 20 m plots
	Stump quantity	Number of stumps in 20 m × 20 m plots
	Fallen-wood quantity	Number of fallen wood in 20 m × 20 m plots
	Withered grass cover (%)	Average withered grass coverage in 20 m × 20 m plots
Abiotic factors	Elevation (masl)	Elevation at the center point of the plot
	Slope aspect	Four categories: east slope (45 ~ 135°), south slope (135 ~ 225°), west slope (225 ~ 315°), and north slope (315 ~ 45°)
	Slope gradient (°)	Three categories: gentle slope (≤30°), moderate slope (30 ~ 60°), and steep slope (≥60°)
	Slope position	Three categories: lower slope (including valley), middle slope (including mountainside), upper slope (including ridge)
	Soil moisture	Soil moisture degree is classified into three categories: wet (can form a lump), relatively wet (can form a lump but will lose after losing grip), and dry (cannot form a lump)
Disturbance factors	Distance from the nearest water source	The horizontal distance from the plot to the water source (spring, river, and other water bodies, without snow) with three categories: near (≤ 500 m), moderate (500-1000 m), and far (≥ 1000 m)
	Distance from the nearest community area	The horizontal distance from the plot center to the nearest community: near (≤500 m), moderate (500-1000 m), and far (≥ 1000 m)
	Anthropogenic disturbance	Anthropogenic disturbance types: roads, trails, farmland, etc.
	Distance from anthropogenic disturbance	The horizontal distance from the sample land to the nearest community (like roads, trails, farming or grazing), three categories: near (≤ 500 m), moderate (500-1000 m), and far (≥ 1000 m)
	Disturbance intensity	Three categories: strong (vegetation destroyed or frequently existing human activities), moderate (vegetation disturbed, less human activities) and weak (almost no disturbance and change)

Table 2. Habitat preferences of leopard cat using Vanderploeg and Scavia's resource selection index

Ecological factors	Parameters	Categories	ri	pi	ri/pi	Σ(ri/pi)	wi	n	1/n	wi-1/n	wi+1/n	Ei	HP
Biotic factors	Vegetation type	Natural forests	6	9	0.67	1.87	0.36	7	0.14	0.21	0.50	0.43	P
		Pine plantations	1	4	0.25	1.87	0.13	7	0.14	-0.01	0.28	-0.03	AR
		Mixed gardens	4	16	0.25	1.87	0.13	7	0.14	-0.01	0.28	-0.03	AR
		Shrubs	10	27	0.37	1.87	0.20	7	0.14	0.06	0.34	0.16	P
		Swidden cultivation	0	4	0.00	1.87	0.00	7	0.14	-0.14	0.14	-1.00	NS
		Ricefield	4	12	0.33	1.87	0.18	7	0.14	0.04	0.32	0.11	P
		Home garden	0	4	0.00	1.87	0.00	7	0.14	-0.14	0.14	-1.00	NS
	Tree canopy (%)	0-25	13	49	0.27	0.91	0.29	4	0.25	0.04	0.54	0.08	AR
		26-50	1	5	0.20	0.91	0.22	4	0.25	-0.03	0.47	-0.06	AR
		51-75	4	9	0.44	0.91	0.49	4	0.25	0.24	0.74	0.32	P
		76-100	0	3	0.00	0.91	0.00	4	0.25	-0.25	0.25	-1.00	NS
	Tree DBH (cm)	0-10	7	36	0.19	2.13	0.09	4	0.25	-0.16	0.34	-0.47	NP
		11-20	4	21	0.19	2.13	0.09	4	0.25	-0.16	0.34	-0.47	NP
		21-30	6	8	0.75	2.13	0.35	4	0.25	0.10	0.60	0.17	P
		> 30	1	1	1.00	2.13	0.47	4	0.25	0.22	0.72	0.30	P
	Tree height (m)	0-5	7	20	0.35	0.89	0.39	4	0.25	0.14	0.64	0.22	P
		6-10	4	27	0.15	0.89	0.17	4	0.25	-0.08	0.42	-0.20	NP
		11-15	7	18	0.39	0.89	0.44	4	0.25	0.19	0.69	0.27	P
		>15	0	0	0.00	0.89	0.00	4	0.25	-0.25	0.25	-1.00	NS
	Tree density (trees/plot)	0-10	15	57	0.26	0.60	0.44	4	0.25	0.19	0.69	0.28	P
		11-20	2	6	0.33	0.60	0.56	4	0.25	0.31	0.81	0.38	P
		21-30	1	3	0.00	0.60	0.00	4	0.25	-0.25	0.25	-1.00	NS
		>30	0	0	0.00	0.60	0.00	4	0.25	-0.25	0.25	-1.00	NS
	Shrub height (m)	0-1	7	31	0.23	0.56	0.40	2	0.50	-0.10	0.90	-0.11	NP
		1.1-2	11	33	0.33	0.56	0.60	2	0.50	0.10	1.10	0.09	AR
	Shrub canopy (%)	0-25	3	24	0.13	1.15	0.11	4	0.25	-0.14	0.36	-0.39	NP
		26-50	5	17	0.29	1.15	0.26	4	0.25	0.01	0.51	0.01	AR
		51-75	2	10	0.20	1.15	0.17	4	0.25	-0.08	0.42	-0.18	NP
		76-100	8	15	0.53	1.15	0.46	4	0.25	0.21	0.71	0.30	P
	Ground-plant cover (%)	0-25	9	49	0.18	1.81	0.10	4	0.25	-0.15	0.35	-0.42	NP
		26-50	5	9	0.56	1.81	0.31	4	0.25	0.06	0.56	0.10	P
		51-75	2	3	0.67	1.81	0.37	4	0.25	0.12	0.62	0.19	P
		76-100	2	5	0.40	1.81	0.22	4	0.25	-0.03	0.47	-0.06	AR
	Stump quantity	0-3	18	66	0.27	0.27	1.00	1	1.00	0.00	2.00	0.00	RS
	Fallen-wood quantity	0-5	18	66	0.27	0.27	1.00	1	1.00	0.00	2.00	0.00	RS
	Withered grass cover (%)	0-25	16	63	0.25	1.25	0.20	4	0.25	-0.05	0.45	-0.10	NP
		26-50	0	1	0.00	1.25	0.00	4	0.25	-0.25	0.25	-1.00	NS
		51-75	1	1	0.00	1.25	0.00	4	0.25	-0.25	0.25	-1.00	NS
		76-100	1	1	1.00	1.25	0.80	4	0.25	0.55	1.05	0.52	P
Abiotic factors	Elevation (masl)	400-800	14	50	0.28	0.53	0.53	2	0.50	0.03	1.03	0.03	AR
		>800	4	16	0.25	0.53	0.47	2	0.50	-0.03	0.97	-0.03	AR
	Slope aspect	North slope	6	19	0.32	1.03	0.31	4	0.25	0.06	0.56	0.10	P
		East slope	3	13	0.23	1.03	0.22	4	0.25	-0.03	0.47	-0.06	AR
		South slope	7	22	0.32	1.03	0.31	4	0.25	0.06	0.56	0.10	P
		West slope	2	12	0.17	1.03	0.16	4	0.25	-0.09	0.41	-0.21	NP
	Slope gradient	Gentle slope	14	34	0.41	0.59	0.70	3	0.33	0.37	1.04	0.36	P
		Moderate slope	4	23	0.17	0.59	0.30	3	0.33	-0.04	0.63	-0.06	AR
		Steep slope	0	9	0.00	0.59	0.00	3	0.33	-0.33	0.33	-1.00	NS
	Slope position	Lower slope	7	18	0.39	0.85	0.46	3	0.33	0.13	0.79	0.16	P
		Middle slope	8	35	0.23	0.85	0.27	3	0.33	-0.06	0.60	-0.11	NP
		Upper slope	3	13	0.23	0.85	0.27	3	0.33	-0.06	0.61	-0.10	NP
	Soil moisture degree	Wet	8	15	0.53	0.91	0.59	3	0.33	0.25	0.92	0.28	P
		Relatively wet	7	30	0.23	0.91	0.26	3	0.33	-0.08	0.59	-0.13	NP
		Dry	3	21	0.14	0.91	0.16	3	0.33	-0.18	0.49	-0.36	NP
Disturbance factors	Distance from the nearest water source	Near	18	56	0.32	0.32	1.00	3	0.33	0.67	1.33	0.50	P
		Moderate	0	6	0.00	0.32	0.00	3	0.33	-0.33	0.33	-1.00	NS
		Far	0	4	0.00	0.32	0.00	3	0.33	-0.33	0.33	-1.00	NS
	Distance from the nearest community area	Near	6	31	0.19	0.79	0.24	3	0.33	-0.09	0.58	-0.15	NP
		Moderate	10	24	0.42	0.79	0.53	3	0.33	0.19	0.86	0.22	P
		Far	2	11	0.18	0.79	0.23	3	0.33	-0.10	0.56	-0.18	NP
	Distance from anthropogenic disturbance	Near	15	57	0.26	1.26	0.21	3	0.33	-0.13	0.54	-0.23	NP
		Moderate	1	1	1.00	1.26	0.79	3	0.33	0.46	1.13	0.41	P
		Far	2	6	0.00	1.26	0.00	3	0.33	-0.33	0.33	-1.00	NS
	Disturbance intensity	Strong	11	30	0.37	0.92	0.40	3	0.33	0.06	0.73	0.09	AR
		Moderate	3	27	0.11	0.92	0.12	3	0.33	-0.21	0.45	-0.47	NP
		Weak	4	9	0.44	0.92	0.48	3	0.33	0.15	0.82	0.18	P

Notes: HP: Habitat Preference; P: Preferred; AR: Almost Randomly Preferred; RS: Randomly Selected; NP: Not Preferred; NS: Not Selected

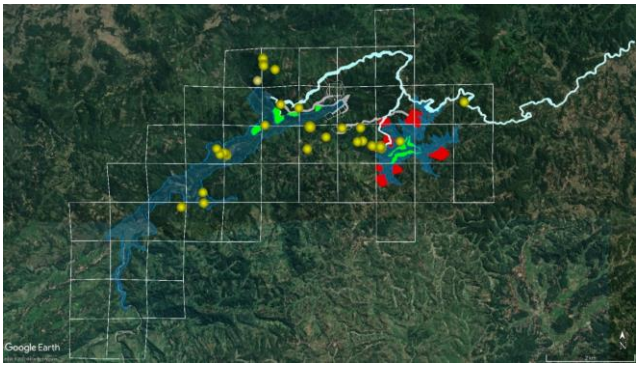

Figure 3. The presence of leopard cats in the UCPS hydropower development area based on previous studies by the Indonesian Institute of Sciences (2012), PPSDAL (2017) and Shanida et al. (2018). Map sources: Google Earth (2022)

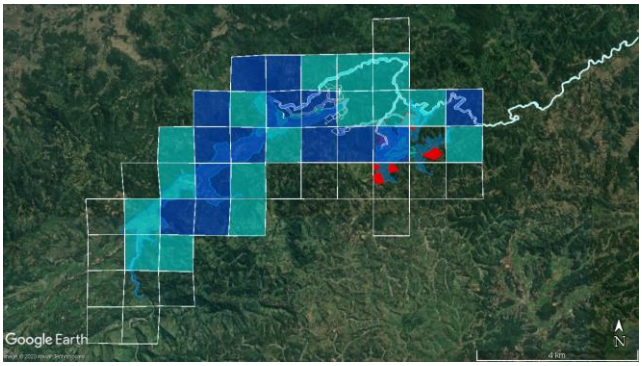

Figure 4. The used plots (■) and the non-used plots (■)in the UCPS hydropower development area

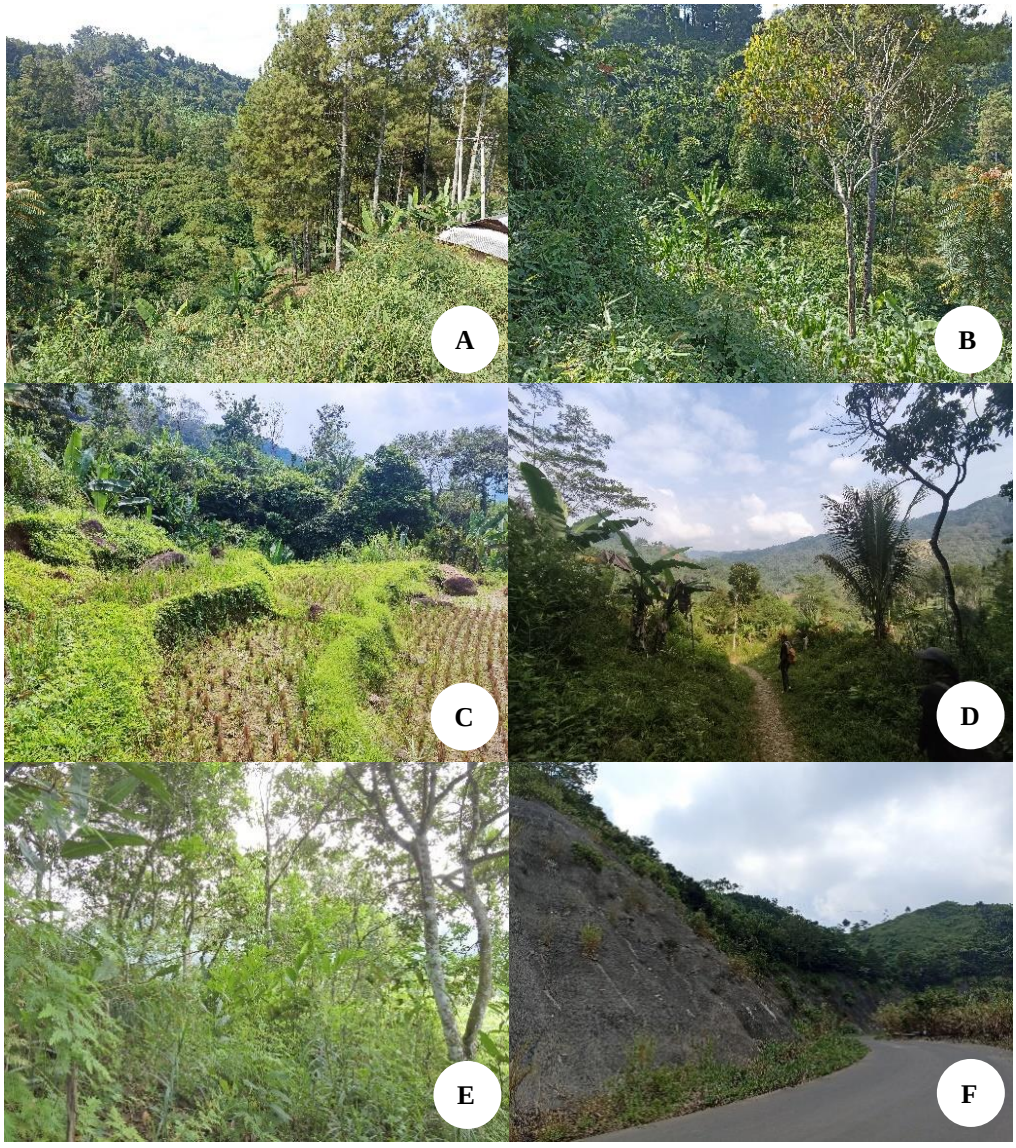

Figure 5. Various types of vegetation in the UCPS hydropower development area, West Java. A-B. Pine plantations and dry paddy fields. C. Wet paddy fields. D. Mixed gardens near settlement. E. Mixed gardens; F. Permanently access road and retaining wall

Abiotic factors

We found that the leopard cats randomly preferred habitats with elevation of >400 masl. This result indicates no tendency for leopard cats to prefer a habitat based on elevation. In South Korea, elevation positively affected the habitat preference of leopard cat (Lee et al. 2015). Similarly, Wu et al. (2020) stated that leopard cats preferred habitats of >800 m and avoided habitats of <800 m. The leopard cats preferred habitats with north and south slopes, gentle slopes, and lower slopes. Conversely, the leopard cats avoided the western slope, moderate to steep and middle to upper. Wu et al. (2020) study found leopard cats preferred north, flat, and gentle slopes; and avoided west, gentle, and middle slopes. Besides, leopard cats preferred habitats with wet soil moisture, while relatively wet and dry humidity tends to be avoided. This differs from the study of Wu et al. (2020) which found that leopard cats preferred dry soil moisture and avoided wet soil.

Disturbance factors

This study revealed that the leopard cats preferred habitat near water sources (<500 m) and avoided moderate and far from water sources (>500 m). Similar to a previous study, leopard cats preferred habitats at a distance of 500-1,000 m from water sources and avoided habitats far from water (Wu et al. 2020). Avoiding habitats far from water may be related to their daily need for water. Furthermore, agricultural landscapes near riverbanks also influenced this preference. In agricultural areas, many pests (e.g., rats which are leopard cat's prey) trigger leopard cats to approach the rice fields near the river. Although the leopard cat's main prey is rats, they also prey on snakes and crabs with a small frequency, likely to be found in rice fields and rivers. Similar to the research by Lee et al. (2015), areas closer to water and farther from roads had higher habitat potential. Moreover, Lee et al. (2017) stated that leopard cats prefer inland wetlands, such as wild grassland along riverbanks.

The leopard cats preferred habitats with moderate distances (500-1000 m) from the nearest settlement compared to close and far distances, which may be related to the presence of rats as their main prey. Rats tend to be found in settlements and agricultural lands, so the leopard cats follow the movements/presence of their prey. However, leopard cats are elusive (avoiding humans); therefore, leopard cats prefer a moderate distance of 500 m-1,000 m to adapt to the presence of humans and prey animals simultaneously.

Moreover, leopard cats tended to prefer habitats with weak intensity of anthropogenic disturbances, thus, at moderate distances of 500 m-1000 m. Leopard cats avoided near and far anthropogenic disturbances, as well as with strong to moderate intensity. Rats tend to be found in agricultural areas as pests, so the movements of leopard cats follow the movements/presence of prey. Because of elusive, leopard cats choose a habitat with a distance of 500 m-1000 m to adapt to the presence of humans and prey. In addition, rats are also found in forests, but the distribution of plants as rat food tends to be spread out and not concentrated like in agricultural land, making it easier for rats to access food. Based on the percentage of anthropogenic disturbance in the UCPS hydropower development area, 55% was agricultural land, such as rice fields and swidden cultivations, followed by infrastructure facilities (26%), such as access roads and retaining walls; no disturbance (11%), and footpaths/settlement roads (9%).

Agricultural activity had a higher disturbance during the rainy season. However, this study was conducted in August-September 2022, when the local people were preparing agricultural land using the slash-and-burn method before the rainy season, so human activity also increased. Furthermore, agricultural patterns significantly affect habitat characteristics, so the habitat preference of leopard cats in the dry season will be different from the rainy season. In addition, the agricultural system with a slash-and-burn method will change the movement of rat populations to other agricultural lands that are still intact.

The local people used the access road to mobilize from their homes to agricultural land. Although the access road eliminated the natural habitat of the leopard cats, their presence on the access road indicates that the leopard cat used the access road as part of its habitat. But, the leopard cat was absent on the cleared land (slash-and-burn). Similar to the previous studies, leopard cats frequently used roads and artificial walking trails in Malaysian Borneo (Sollmann et al. 2013) and on Iriomote Island, Japan (Díaz-Sacco and Izawa 2013). However, there were no ongoing UCPS project activities on the study site, so the direct impact on leopard cats is unknown.

Furthermore, Xiong et al. (2016) said leopard cats were found in human-modified landscapes, such as farmlands and residences. In addition, Wu et al. (2020) reported that leopard cats chose habitats close to anthropogenic disturbance (<500 m) with medium disturbance intensity and avoided habitats with low disturbance intensity. For example, in the Visayan, the Philippines, leopard cats were found in the massive conversion of forests area into sugarcane plantations (Lorica and Heaney 2013).

In conclusion, leopard cats showed a variety of habitat preferences. Agricultural activities could affect its habitat preference directly. Leopard cats can still be found at various levels of disturbance in human-modified lands, such as rice fields and shrublands. Since the main prey is cosmopolitan animals, as long as there are human-modified lands, prey availability will remain existed. Although the leopard cat can tolerate anthropogenic disturbances, there is little information on the direct impact of construction activities on the population; therefore, further research is needed to observe their population and habitat in the construction area.

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