Media Konservasi, 30 (2) 362-373

RESEARCH ARTICLE

MEDIA KONSERVASI
SCIENTIFIC JOURNAL IN CONSERVATION, ENVIRONMENT & ECOTOURISM

Does the Tricolor Langur Truly Have a Specific Habitat in Danau Sentarum Landscape? An Analysis of The Preferences Habitat Using Maximum Entropy

Sutopo[a], Nyoto Santoso[b], Ani Mardiastuti and Yeni A Mulyani[b]

[a]Doctoral Student at Tropical Biodiversity Conservation, Department of Forest Resource Conservation and Ecotourism, IPB University
[b]Department of Forest Resource Conservation and Ecotourism, IPB University

Article Info:
Received 06 May 2025
Revised 14 June 2025
Accepted 14 June 2025

Corresponding Author:
Sutopo
Department of Forest Resource Conservation and Ecotourism
IPB University
E-mail: kvt_sutopo@apps.ipb.ac.id

Abstract

The tricolored langur (*Presbytis cruciger*) is not only geographically restricted but is also believed to strongly depend on specific habitat types, particularly wetland ecosystems in northern Borneo. Despite its limited range and potential vulnerability, no comprehensive habitat assessment has been conducted within its distribution area. This study aims to model the habitat suitability of *P. cruciger* in the Danau Sentarum landscape using environmental variables derived from direct encounter data collected between 2021 and 2023, and analyzed using MaxEnt. Habitat suitability modeling revealed that 95.94% (228,658 ha) of the total study area (238,329 ha) was classified as unsuitable habitat. The remaining areas were categorized as marginally suitable (7,080 ha), suitable (1,977 ha), and highly suitable (614 ha). Highly suitable areas are concentrated in peat swamp forests, riparian forests, and lowland secondary forests located within 1 km of lake edges, extending into the hilly zones of the Danau Sentarum landscape. Among the environmental predictors, land cover contributed the most to the model, though it showed low permutation importance. In contrast, proximity to fire hotspots demonstrated high permutation importance, indicating an avoidance behavior towards fire-prone areas. The species preferred elevations ranging from 100 to 200 meters above sea level, with 8–25% slopes, and proximity to swamp forest and lake ecosystems. These results highlight the species' strong association with wetland ecosystems and underscore the importance of conserving these habitats to ensure its survival.

Keywords: *Presbytis cruciger, habitat suitability modeling, wetland ecosystem, Danau Sentarum*

1. Introduction

Conservation concerns surrounding endemic species extend beyond their limited geographic distribution or range size. A key issue lies in the species' reliance on particular habitat types that are rare and spatially restricted. Over the long term, this dependency raises the risk of accelerated local extinction, as species survival in the wild is determined not only by internal factors such as reproduction, but also—critically—by the quality and availability of the specific habitat types they require [1]. In the case of the tricolored langur (*Presbytis cruciger*), it is known that the species is confined to northern Kalimantan [2]; however, little is known about the specific habitat types it utilizes or the degree to which it depends on particular habitat conditions.

This species exhibits a markedly different habitat preference compared to other members of the Presbytis genus. Even its closest relative, *P. rubicunda*, is known to inhabit a broader range of habitats and displays a more extensive distribution, indicating a lower dependence on a single ecosystem type [3,4]. Several studies have confirmed that *P. cruciger* is found primarily in specific habitats, particularly peat swamp forests and mixed lowland forests near sub-hill areas [5,6].

In contrast, the Javan langur (*P. comata*) occurs in highland forest ecosystems [7,8], as well as in more heterogeneous landscapes, including mixed habitats [9], lowland areas, hills, natural forests, and plantation forests with diverse vegetation—some even near human settlements [10]. P. chrysomelas chrysomelas shows a relatively similar habitat preference in

Similajau National Park, which inhabits peat swamp and heath forests [11]. Likewise, *P. frontata* has been reported in rubber plantations, secondary forests, mixed agroforestry gardens, dryland agricultural areas, and mining zones [12]. Despite the ecological importance of understanding habitat use in langurs, studies on habitat preferences of the genus remain scarce, largely due to the challenges of obtaining reliable presence data in natural habitats [13,14]. Despite the ecological importance of understanding habitat use in langurs, studies on habitat preferences of the genus remain scarce, mainly due to the challenges of obtaining reliable presence data in natural habitats. This underscores the value of habitat suitability models, which can provide high-accuracy predictions and play a crucial role in informing long-term conservation strategies.

This study aims to identify and analyze the habitat preference classes and the spatial extent of habitats utilized by *P. cruciger* within the Danau Sentarum landscape, which represents its natural range. The findings of this research contribute to the broader scientific understanding of habitat selection by *P. cruciger*, while also supporting ongoing conservation efforts by relevant stakeholders—including the Danau Sentarum National Park Authority (TNBKDS), NGOs, researchers, and conservation advocates—and inform long-term mitigation strategies to prevent local extinction driven by habitat specificity and limitation.

2. Materials and Methods

2.1. Study site

The study site located in Danau Sentarum with buffer as research area is 6 kilometer from National Park. Geographic coordinate at 111° 53' 43,573" E – 112° 28' 31,576" E and 0° 36' 51,685" N – 1° 3' 38,484" N. Its buffer based on the results of a preliminary study that found the furthest point of *P.c.cruciger* encounter from the boundary of the national park area. Government administratively, study location is included in the Kapuas Hulu Regency, West Kalimantan Province (Figure 1).

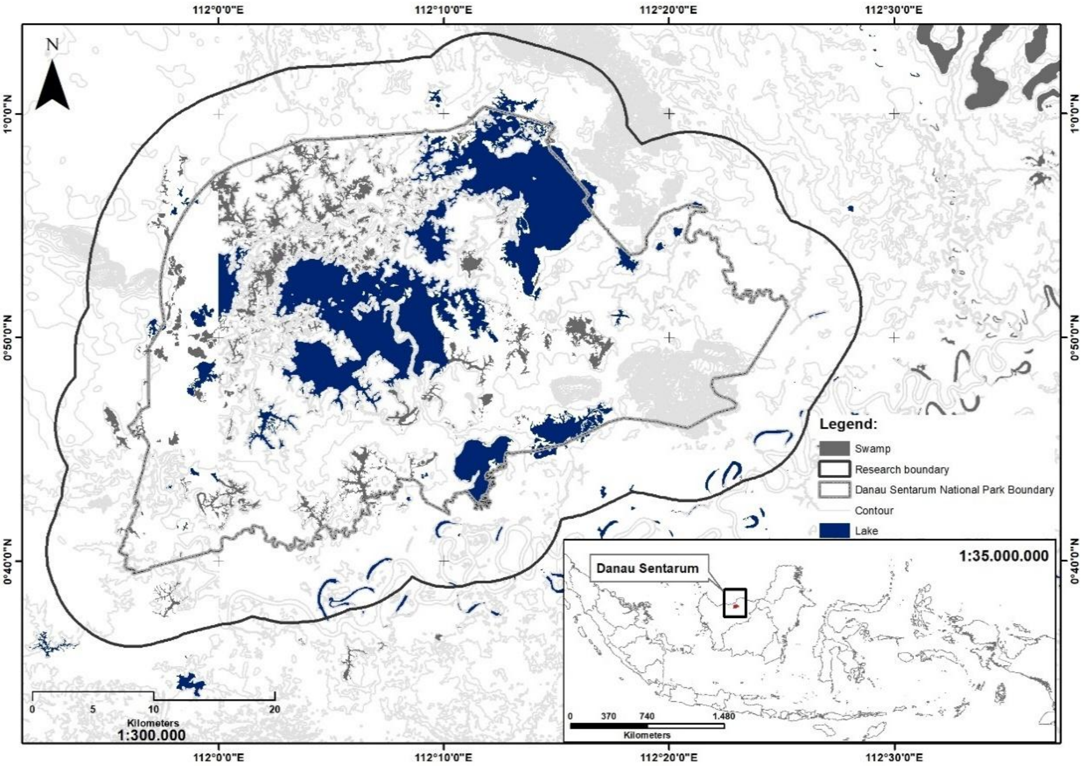

Figure 1. Topographic map of the study area in Danau Sentarum Data collection.

Presence data of langur as primary data are collected on direct encounter observations by field survey, were collected from July 2021 to June 2023, resulting in a total of 219 presence points for the tricolored langur. These presence records were subsequently converted into a

.csv file format for spatial analysis. The environmental variables used to build the habitat suitability model were categorized into two types: continuous and categorical data. Secondary data for several environment variable i.e. distance from swamp, settlement, agricultural areas, hotspot, forest areas, shrubland, river and road are collected from DEMNAS, temperature collected from landsat 8 OLI, elevation and slope are collected from SRTM of Kapuas Hulu Regency. Among these, only one variable—land cover—was categorical, while the remaining variables were continuous. These included distance to swamps, distance to settlements, distance to agricultural areas, distance to fire hotspots, distance to forested areas, distance to shrubland, distance to rivers, distance to roads, temperature, elevation, and slope. All environmental variables were prepared in raster format and projected using the WGS_1984_UTM_Zone 49N coordinate system. Swamp as wetland in Danau Sentarum, forest and river are important as a source of food, shelter and breeding grounds for many species [15,16]. Some anthropogenic i.e. settlement, land burning as hotspot presence, road, agricultural could affecting to the existence species and habitat change [17,18].

2.2. Data analysis

All preference data processing was performed using maximum entropy modelling, and raster data was prepared using ArcGIS 10.8. There are 14 (fourteen) environmental variables to be prepared i.e. land coverage type (var.11), distance from swamp (var.7), lake (var.4), forest area (var.14), shrub (var.6), elevation (var.9), slope (var.10), rivers (var.2), plantation (var.1), temperature (var.12), rainfall (var.13), and anthropogenic variable i.e. hot spot (var.8), that presence as land burning activities, settlements (var.5) and roads (var.3). Its variable was categorized into two types of data, i.e. categorical and continuous, and all data were included as continuous data except for land coverage data, which was categorized as continuous. Land cover classified into 14th type i.e. fresh freshwater swamp forest, lowland primary forest, lowland secondary forest, hills primary forest, hills secondary forest, dryland shrub, grassland, tall kerangas forest at sandstone, riparian forest, swamp grassland, food-crop field, agroforestry, palm-oil plantation, bare land (dry season), and water. Before running MaxEnt, all raster environmental variable (continous variable) was tested by a multicollinearity test.

The model was run with 15 replicates, using a maximum of 3,000 iterations and a convergence threshold of 0.00001. Model performance was evaluated using the Receiver Operating Characteristic (ROC) curve, a standard tool for assessing the predictive accuracy of species distribution models. The ROC curve illustrates the trade-off between the True Positive Rate (TPR) and the False Positive Rate (FPR) across different threshold values. The closer the curve approaches the top-left corner of the graph, the better the model's performance. The Area Under the Curve (AUC) value, derived from the ROC curve, represents the model's overall predictive accuracy. An AUC value approaching 1.0 indicates a high ability of the model to classify between suitable (preference) and unsuitable (non-preference) habitats. In contrast, an AUC of 0.5 suggests the model performs no better than random prediction. AUC values above 0.5 are typically classified into four categories of model quality: $0.5 < AUC \leq 0.7$ (low performance), $0.7 < AUC \leq 0.8$ (moderate performance), $AUC > 0.8$ (high performance), and $AUC = 1.0$ (perfect model) [19].

The class of habitat suitability index ranges from 0 to 1, where values closer to 0 indicate unsuitable habitat and values closer to 1 indicate highly suitable habitat. According to Elith et al. (2011), the index values can be classified into four suitability classes: $0.00 \leq class < 0.25$ (unsuitable), $0.25 \leq class < 0.50$ (marginally suitable), $0.50 \leq class < 0.75$ (suitable), and $0.75 \leq class < 1.00$ (highly suitable). The habitat suitability model for Presbytis cruciger demonstrated excellent classification performance, high accuracy, and strong stability. As evaluated using the Receiver Operating Characteristic (ROC) curve, the model's predictive ability effectively distinguished between suitable and unsuitable areas for the species' presence.

3. Results and Discussion

3.1. Results

3.1.1. Multicollinearity test

Multicollinearity test was found that rain has a significant correlation with hotspot (>0,7), The correlation test used is Pearson Correlation with a value range of -1 to +1 and high correlation threshold at >0,7 or <-0,7 [16,19], and one of the variables must be eliminated, and rainfall (var.as a deleted variable because it has a greater influence on the daily activity time budget, and does not have a specific correlation to the habitat selection.

Table 1. Multicollinearity test to ensure and eliminate variables that have a significant correlation.

Var.	1	2	3	4	5	6	7	8	9	10	12	13	14
1	1	-0.304	0.644	-0.358	-0.064	-0.111	-0.381	0.598	-0.115	-0.195	0.166	0.473	0.018
2	-0.304	1	-0.187	0.361	0.286	0.298	0.309	-0.326	0.340	0.128	-0.295	-0.241	0.037
3	0.644	-0.187	1	-0.361	-0.143	0.132	-0.452	0.286	-0.058	-0.289	0.216	0.123	-0.310
4	-0.358	0.361	-0.361	1	0.133	0.083	0.078	-0.070	0.174	0.278	-0.211	-0.053	0.329
5	-0.064	0.286	-0.143	0.133	1	0.313	-0.065	-0.284	0.087	0.086	0.062	-0.127	0.379
6	-0.111	0.298	0.132	0.083	0.313	1	-0.033	-0.263	0.040	-0.035	0.088	-0.274	-0.014
7	-0.381	0.309	-0.452	0.078	-0.065	-0.033	1	-0.138	0.157	0.226	-0.524	0.111	-0.057
8	0.598	-0.326	0.286	-0.070	-0.284	-0.263	-0.138	1	-0.105	0.020	-0.115	0.840*	0.162
9	-0.115	0.340	-0.058	0.174	0.087	0.040	0.157	-0.105	1	0.084	-0.294	-0.019	-0.041
10	-0.195	0.128	-0.289	0.278	0.086	-0.035	0.226	0.020	0.084	1	-0.356	0.168	0.167
12	0.166	-0.295	0.216	-0.211	0.062	0.088	-0.524	-0.115	-0.294	-0.356	1	-0.451	0.030
13	0.473	-0.241	0.123	-0.053	-0.127	-0.274	0.111	0.840*	-0.019	0.168	-0.451	1	0.249
14	0.018	0.037	-0.310	0.329	0.379	-0.014	-0.057	0.162	-0.041	0.167	0.030	0.249	1

Note: distance from plantation (var.1); distance from rivers (var.2); distance from roads (var.3); distance from lake (var.4); distance from settlements (var.5); distance from shrub (var.6); distance from swamp (var.7); distance from hot spot (var.8); elevation (var.9); slope (var.10); land coverage type (var.11); temperature (var.12); rainfall (var.13); and distance from forest area (var.14).

3.1.2. Performance of model

The Area Under the Curve (AUC) value reached 0.951, with a standard deviation of 0.012, indicating a very high level of model performance. This high AUC value was consistently observed in the test data, showing only a slight decrease from the training data, thereby reflecting the strong generalizability of the model. The low standard deviation across replications (0.012) confirms the model's stability. An AUC value approaching 1.0 suggests excellent discriminatory power in identifying suitable versus unsuitable habitat for the tricolored langur.

The shape of the ROC curve, which rises steeply at the beginning and then levels off, indicates that the model has high sensitivity across most of the prediction space—that is, it effectively identifies areas that are genuinely suitable for *P. cruciger*. Additionally, the false positive rate (1 – specificity) remains low even as sensitivity increases, reflecting the model's efficient classification capability. The ROC plot also includes a shaded blue area representing the mean ± one standard deviation across model replications, which illustrates the variability in prediction performance. The narrowness of this shaded area indicates that the model is consistent and stable across replications and is not significantly influenced by variations in training data or randomization processes. For comparison, a black diagonal line is displayed, representing random prediction. The substantial distance between the ROC curve and this diagonal line shows that the model performs significantly better than random chance (Figure 2).

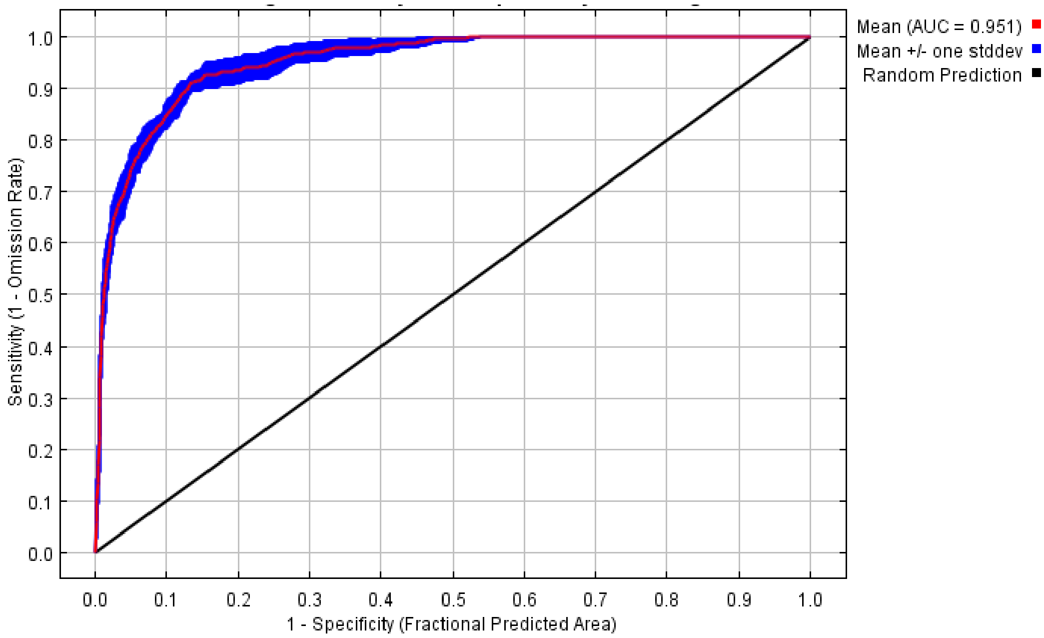

Figure 2. ROC (Receiver Operating Characteristic) and AUC (Area Under Curve).

The environmental variables used in predicting the model contributed differently to the model's overall predictive output and exhibited varying levels of importance. Land cover contributed the highest percentage (33.5%) among all variables; however, its permutation importance was relatively low at 2.4. In contrast, the variable with the highest permutation importance was distance to fire hotspots, with a value of 20.9. Another variable with a relatively high permutation importance was distance to swamps, contributing 16.5% to the model and showing a permutation importance of 18.6 (see Table 2 and Figure 3).

Table 2. Percent contribution and permutation importance for each variable used on preferences habitat modelling.

Variable	Percent contribution	Permutation importance
Land coverage	33.5	2.4
Distance from the swamp	16.5	18.6
Distance from the hotspot	12	20.9
Distance from the shrub	9.6	3.8
Distance from the road	5.9	19.8
Slope	4.9	1.3
Distance from the river	4.7	6.4
Distance from the forest area	3	11.9
Distance from the lake	2.8	4.7
Distance from the settlement	2.8	4.2
Temperature	2.5	2.8
Distance from the plantation	1.6	2.7
Elevation	0.2	0.3

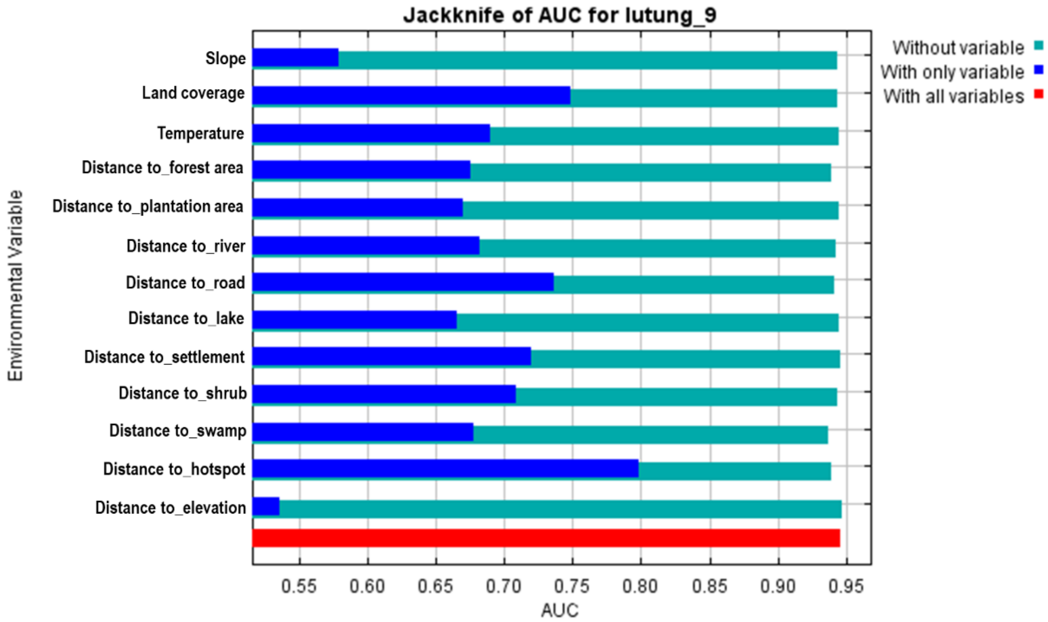

Figure 3. Jackknife test to AUC the environmental variable.

3.1.3. Response of langur to environmental variables

Langurs have various responses to the environmental variables. Model analysis showed that, regarding land cover, the langur preferred lowland secondary forest and lowland shrubland (excluding swamp forest), with habitat suitability values ranging from 0.7 to 0.82. Riparian forest was also used, although with lower suitability (0.52) (Figure 4a). The species was more commonly associated with areas at elevations between 100–200 meters above sea level (Figure 4b), and with gentle to moderately steep slopes typical of lowland to sub-hill terrain (Figure 4c). In several encounter points, individuals were also found within agroforestry areas—particularly mixed rubber plantations—up to a distance of 10 kilometers (Figure 4d). While langurs were occasionally observed near riverbanks, such occurrences were rare and limited to specific areas within populations 2, 3, and 4, with distances up to 3,000 meters from the river edge (Figure 4e). Response to road proximity varied by population: in population 3 (Sepandan area), langurs were sometimes found near roads, whereas in other populations, encounter probability increased at distances around 7 kilometers from roads (Figure 4f).

For the variable representing distance to lakes, the response curve indicated that *P. cruciger* was not presence at or near the immediate lake edges. The highest encounter probability occurred at distances of 1,000–1,500 meters from the lake, particularly in areas covered by lowland secondary forest, swamp shrubland, and riparian forest (Figure 4g). The species was occasionally recorded near settlements, especially those located within the Danau Sentarum landscape. The response pattern was fluctuating at distances between 1,000 and 1,300 meters from settlements, particularly in areas transitioning into sub-hill forest zones within and around the lake (Figure 4h). Regarding the distance to swamp areas, langurs were frequently found in close proximity to swamp forests (Figure 4i). In contrast, the response to fire hotspots—used as a proxy for fire risk—showed that langurs were most likely to be encountered at distances of 14,000–15,000 meters from the nearest hotspot. At close distances (0–1,000 meters), the probability of occurrence was low (0.3–0.6) (Figure 4j). Overall, most langur observations were recorded near forested areas, encompassing a variety of classified forest cover types (Figure 4k). For the temperature variable, langurs clearly preferred areas with moderate temperatures (18–25°C). Suitability declined significantly in areas where temperatures exceeded 25°C (Figure 4l).

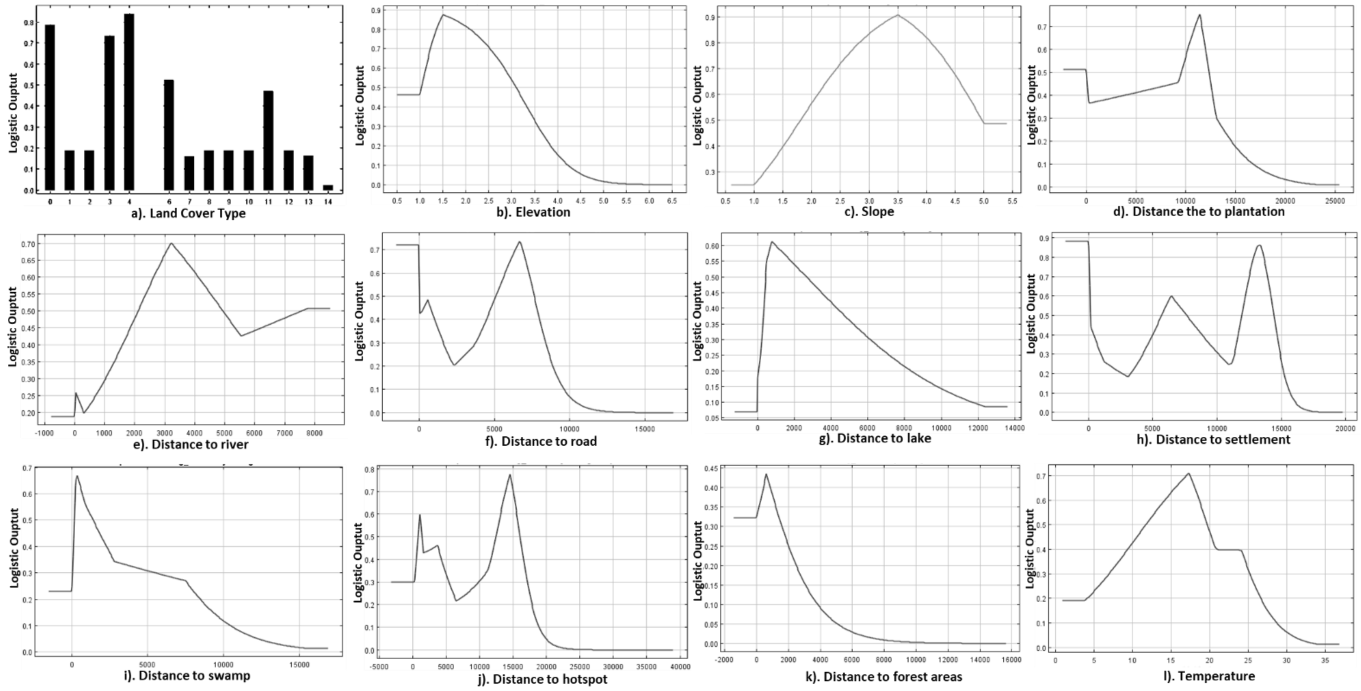

Figure 4. Response curve for each environmental variable: a. Land coverage (e.g. secondary low-land forest; swamp forest; riparian forest); b. elevation; c. slope; d. plantation area; e. rivers; f. roads; g. lake; h. settlement; i.e. swamp; j. hot spot; k. forest areas; l. temperature.

3.1.4. Preferences class and areas

Further analysis of the spatial extent of each habitat suitability class revealed that, out of the total 238,329 hectares of the study area (within a 6-kilometer buffer from the Danau Sentarum National Park boundary), only 2,591 hectares were classified as suitable and highly suitable habitat. When combined with marginally suitable areas, which are still utilized by langurs based on field observations, the total potential habitat area increases to 9,671 hectares. This represents only 4.06% of the entire study area, a proportion that is critically low in relation to the long-term spatial requirements of the species.

Table 3. Areas and percentage classes of habitat preferences.

No.	Habitat preferences	Areas (Ha)	Percentage (%)
1	Non-preferred habitat (unsuitable)	228,658	95.94
2	Fewer preferences (marginally suitable)	7,080	2.97
3	Preferences (medium suitable)	1,977	0.83
4	High preferences (highly suitable)	614	0.26
	Total	238,329	100

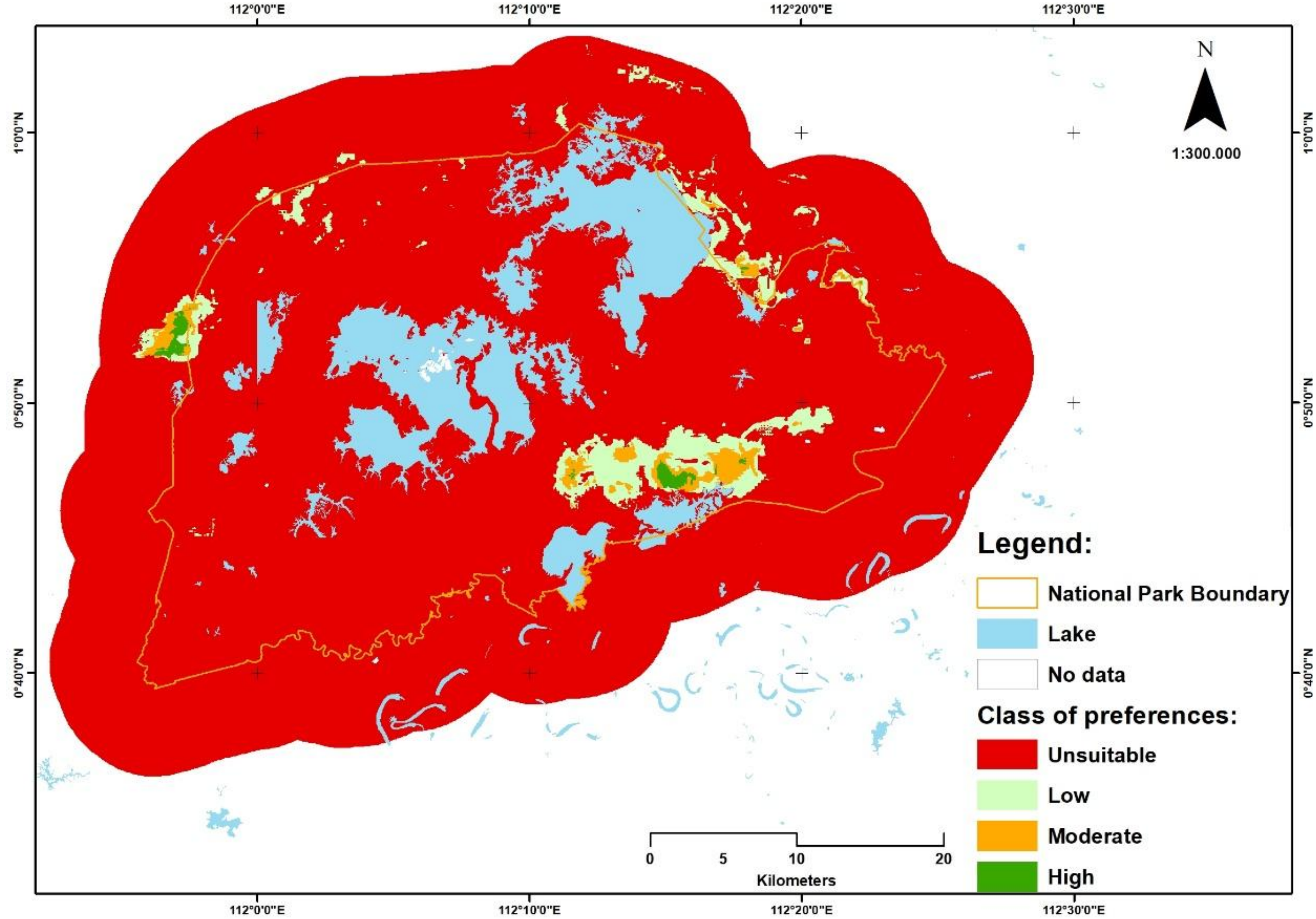

Figure 5. Map the preferences of the habitat class in the Danau Sentarum Landscape.

3.2. Discussion

3.2.1. Response of langur to environmental variables

Based on the habitat suitability modeling results, the highest probability of langur presence was associated with areas characterized by lowland secondary forest, swamp forest, and riparian forest—particularly those located on slopes of 8–25% (equivalent to 5–12°) and at elevations between 100–200 meters above sea level. Areas with these habitat characteristics tend to provide a diverse composition of food plants and areas with slopes and heights above these criteria are generally rocky areas that are only overgrown with uniform species, especially from the group of shrubs [13,20–22]. These areas were also typically distant from fire-prone zones, as indicated by low proximity to fire hotspots. Such locations were classified across a suitability gradient, from marginally suitable to highly suitable. In marginal areas that retained the structural characteristics of these three habitat types, langur groups were occasionally observed, albeit at lower frequencies than areas classified as highly suitable. The habitat suitability of *Presbytis cruciger* in Danau Sentarum differs notably from that of other langur species. For instance, the Javan langur (*Trachypithecus auratus*) in Bromo Tengger Semeru National Park strongly prefers specific elevation ranges, dense vegetation cover, and optimal temperature conditions [23]. Similarly, the Javan surili (*Presbytis comata*) tends to avoid areas with high human activity and favors habitats with dense vegetation and specific elevation zones [24]. In contrast, *T. auratus* in Baluran National Park prefers habitats farther from roads and located in secondary forest areas, while avoiding high-elevation zones [25].

The response curve of langur presence indicates that the species is often observed near roads and residential areas. However, this presence does not necessarily suggest a preference for roadside habitats [26,27]. Instead, it is likely a result of landscape fragmentation and the high variability in land cover, which may compel langur to cross roads to move between habitat patches occasionally [28]. This interpretation is supported by the fact that the highest probability values are limited to a narrow range close to the road, followed by a sharp decline, suggesting that such proximity is not a strong or sustained preference [29]. In residential areas, the response curve shows relatively high probabilities of langurs' presence near human settlements. Field observations reveal that local communities have resided in stilt houses built over lake surfaces for over 80 years. This long-term habitation has likely allowed for a stable and positive coexistence between humans and lutungs. The langurs do not appear to perceive human presence as a threat, and residents likewise do not disturb the langurs [30].

3.2.2. Preferences class and areas

Preferences of tricolor langur closely similar to *P.rubicunda* which have a preference for habitat occurring at primary and secondary dipterocarp forests, peat swamp forests, freshwater swamp forests, hill and montane forests up to 2,000 meters elevation [4,31]. Moreover*, P. rubicunda* tolerates moderate habitat degradation and is occasionally recorded in human-modified landscapes such as logged forests or forests adjacent to settlements [32]. However, habitat disturbance can alter forest structure and vegetation composition, impacting their behavior and habitat use patterns, particularly vocal communication and group spacing [33,34]. Areas categorized as marginally suitable (<0.25) in Danau Sentarum landscape are still used as habitat by the langurs, although no direct sightings were recorded during field surveys. Presence information for these areas was obtained from local community reports. As such, reliance on indirect presence data weakens the robustness of the habitat suitability model and reduces the model's predictive accuracy under random conditions. On the other hand, areas classified as unsuitable were confirmed to be unoccupied, both through direct observation and community information. These areas typically consist of open land with kerangas (heath forest) sandy substrates, shrubs, and grasses. Such environments fail to provide essential habitat requirements, particularly the absence of food-providing plant species—unlike suitable areas that support fruit- and seed-bearing vegetation. Field observations indicated that natural regeneration in these unsuitable areas is highly unlikely due to severe leaching. The exposed substrate often resembles salt crystals, indicating extreme nutrient depletion [35]. The absence of a topsoil layer further hinders plant growth and makes rehabilitation efforts extremely challenging [36]. Therefore, relying solely on natural regeneration in these sandy zones is improbable for successful habitat restoration [37].

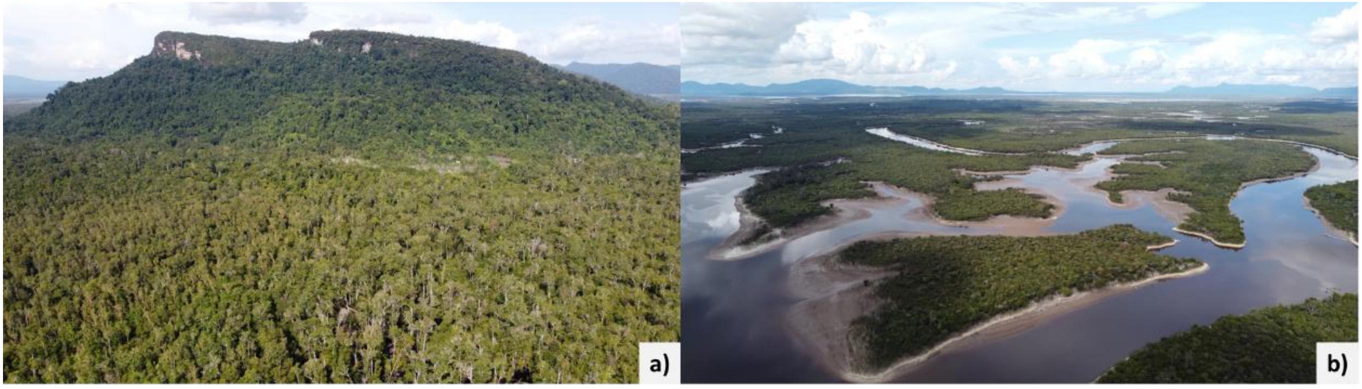

Figure 6. Habitat conditions that have high preferences (a) in Bukit Semujan with land coverage of swamp forest, secondary forest around the hills, and non-preference habitats (unsuitable) with water and shrub land coverage.

Based on canopy cover characteristics, areas with high habitat suitability tend to exhibit well-connected canopy structures and diverse food plant compositions, thereby offering a broader array of dietary resources beyond foliage [22,38]. In contrast, areas of low suitability are characterized by a high number of small vegetation patches, particularly in regions frequently affected by the lake's tidal fluctuations [39]. During the rainy season with high precipitation, the lake area becomes inundated due to increased water inflow from various tributaries and major rivers, especially the Kapuas River. Apart from being a seasonal lake, this lake can be said to be a shallow lake based on the regular influence of water entering and leaving the Kapuas River [40]. Conversely, during prolonged dry seasons (up to a month), previously inundated zones become extremely dry, exposing sandy substrates and fragmented shrub vegetation that form patches and matrices across the lake ecosystem landscape. This cyclical pattern recurs annually, with a marked contrast between the rainy and dry seasons. However, in years when rainfall occurs consistently with little to no dry season, the lake tends to remain flooded for years.

3.3. Implication of conservation

Further research is expected to be directed at areas where langurs are present, especially areas with low to high suitability, to be more efficient. Through this research, this species has become mandatory and a priority species by the management unit for management. This species is encouraged to become a protected species by legislation if there are changes to the current regulations.

4. Conclusions

Referring to the results analysis of the preferences for habitat of the tricolor langur, it can be concluded that on a micro-landscape scale in Danau Sentarum as a wetland ecosystem, langurs choose a particular habitat, and are very dependent on habitats such as swamp forests, lowland forests around the hills in the Danau Sentarum area. This habitat is thought to support food needs that are unavailable in other habitat types outside the lake area. However, broader research on the landscape of the Kapuas Hulu and West Kalimantan regions still needs to be carried out comprehensively.

Author Contributions

STP: Conceptualization, Methodology, Software, Investigation, Writing - Review & Editing; **NS:** Review & Editing, Supervision; **AMS:** Review & Editing, Supervision, **YAM:** Review & Editing, Supervision.

Conflicts of interest

We want to state in this article that there are no conflicts to declare.

Acknowledgements

I convey my high appreciation and thanks to the Indonesian Biodiversity Trust (Yayasan KEHATI) through the Tropical Forest Conservation Act (TFCA) Kalimantan Program as a supporting fund for the research, the Bioecology and Conservation of Tricolour Langur Project. And we would like to thank the Management Unit of Danau Sentarum National Park, the Faculty of Forestry and Environmental, IPB University, and the local community for their desire to learn about langur ecology.

References

1. Buchanan, K.; de Perera, T.; Carere, C.; Carter, T.; Hailey, A.; Hubrecht, R.; Jennings, D.; Metcalfe, N.; Pitcher, T.; Peron, F.; et al. Guidelines for the Treatment of Animals in Behavioural Research and Teaching. *Anim. Behav.* **2012**, *83*, 301–309, doi:10.1016/j.anbehav.2011.10.03.
2. Nijman, V.; Cheyne, S.; Traeholt, C.; Setiawan, A. Presbytis Chrysomelas Ssp. Cruciger 2020.
3. Ehlers Smith, D.A. The Ecology and Conservation of Presbytis Rubicunda 2015.
4. Ehlers Smith, D.A. Feeding Ecology of Red Langurs in Sabangau Tropical Peat-Swamp Forest, Indonesian Borneo: Extreme Granivory in a Non-Masting Forest. *Am. J. Primatol.* **2013**, *75*, doi:10.1002/ajp.22148.

5. Santoso, N.; Sutopo; Meo, L.E.; Fauziah, N.N.; Diva, A.M. Preliminary Study: Feeding Ecology and Daily Activity of Three Colored Langur (Presbytis Chrysomelas Ssp. Cruciger) in Danau Sentarum National Park. *Biotropia (Bogor).* **2023**, *30*, 206–219, doi:10.11598/btb.2023.30.2.1850.
6. Santoso, N.; Fauziah, N.N.; Diva, A.M.; Sutopo Cohabitation Study of Tricolour Langur (Presbytis Chrysomelas Ssp. Cruciger) and Proboscis Monkey (Nasalis Larvatus) in Bukit Semujan Danau Sentarum National Park. *J. Ilmu Kehutan.* **2023**, *17*, 183–193, doi:10.22146/jik.v17i2.6442.
7. Nijman, V. Group Composition and Monandry in Grizzled Langurs, Presbytis Comata, on Java. *Folia Primatol.* **2017**, *88*, 237–254, doi:10.1159/000478695.
8. Widiana, A.; Hasby, R.M.; Uriawan, W. Distribution and Population Estimate of Surili (Presbytis Comata) in Kamojang Garut Regency West Java. *Al-Kauniyah J. Biol.* **2018**, *11*, 116–121, doi:10.15408/kauniyah.v11i2.6621.
9. Supartono, T.; Kosasih, D. Identification of the Cause of The Absence of Grizzled Leaf-Monkey (Presbytis Comata) in A Mixed Farm Ecosystem in Kuningan Regency, West Java. *J. Penelit. Hutan dan Konserv. Alam* **2022**, *19*, 69–83, doi:10.20886/jphka.2022.19.1.69-83.
10. Supartono, T.; Prasetyo, L.B.; Hikmat, A.; Kartono, A.P. Spatial Distribution and Habitat Use of Javan Langur (Presbytis Comata): Case Study in District of Kuningan. *Procedia Environ. Sci.* **2016**, *33*, 340–353, doi:10.1016/j.proenv.2016.03.085.
11. Noor-Faezah, M.; Nur-Aizatul, T.; Tawie, T.R.C.; Bukhori, M.F.; Mohd-Azlan, J.; Denel, A.; Md-Zain, B.M.; Abdul-Latiff, M.A.B.; Mohd-Ridwan, A.R. A Brief Review of Bornean Banded Langur Presbytis Chrysomelas (Müller, 1838) of Sarawak. *J. Wildl. Biodivers.* **2023**, *7*, 265–282, doi:10.5281/zenodo.8313172.
12. Fithria, A.; Husni, M.; Anisah, N.; Darmaji; Kissinger; Andi, N.; Syamsir, A.; Syam'ani; Rezekiah, A.R.; Yasinta, S. Distribution and Habitat Characteristics of the Lutung Dahi Putih (Presbytis Frontata) in the Senakin Mining Area of PT Arutmin Indonesia. *J. Hunan Univ. Nat. Sci.* **2023**, *50*, 64–74, doi:10.55463/issn.1674-2974.50.10.7.
13. Nijman, V. Geographic Distribution of Ebony Leaf Monkey (Trachypithecus Auratus) and Silvered Leaf Monkey (Trachypithecus Cristatus) in West Java, Indonesia. *Contrib. to Zool.* **2000**, *69*, 157–177, doi:10.1163/18759866-06903002.
14. Zhou, Q.; Wei, F.; Li, M.; Huang, C.; Luo, B. Diet and Food Choice of \textit{Trachypithecus Francoisi} in the Nonggang Nature Reserve, China. *Int. J. Primatol.* **2006**, *27*, 1441–1460, doi:10.1007/s10764-006-9082-8.
15. Guisan, A.; Zimmermann, N.E. Predictive Habitat Distribution Models in Ecology. *Ecol. Modell.* **2000**, *135*, 147–186, doi:10.1016/S0304-3800(00)00354-9.
16. Phillips, S.J.; Anderson, R.P.; Schapire, R.E. Maximum Entropy Modeling of Species Geographic Distributions. *Ecol. Modell.* **2006**, *190*, 231–259.
17. Syphard A. D., R.V.C.H.T.J.& S.S.I. Conservation Threats Due to Human-Caused Increases in Fire Frequency in Mediterranean-Climate Ecosystems. *Conserv. Biol.* **2009**, *23*, 758–769, doi:10.1078/1433-8319-00042.
18. Elith, J.; Leathwick, J.R. Species Distribution Models: Ecological Explanation and Prediction Across Space and Time. *Annu. Rev. Ecol. Evol. Syst.* **2009**, *40*, 677–697.
19. Merow, C.; Smith, M.J.; Silander, J.A.J. A Practical Guide to MaxEnt for Modeling Species' Distributions: What It Does, and Why Inputs and Settings Matter. *Ecography (Cop.).* **2013**, *36*, 1058–1069, doi:10.1111/j.16000587.2013.07872.x.
20. Chapman, C.A.; Chapman, L.J. Foraging Challenges of Red Colobus Monkeys: Influence of Nutrients and Secondary Compounds. *Comp. Biochem. Physiol. Part A Mol. \& Integr. Physiol.* **2002**, *133*, 861–875, doi:10.1016/S1095-6433(02)00104-0.
21. Gibbons, J.M.; Harcourt, A.H. Biogeography and Ecology of Primates. In *Primates in Perspective*; Campbell, C.J., Fuentes, A., MacKinnon, K.C., Bearder, S.K., Stumpf, R.M., Eds.; Oxford University Press, 2009; pp. 433–447.
22. Estrada, A.; Coates-Estrada, R. Tropical Rain Forest Fragmentation and Wild Populations of Primates at Los Tuxtlas, Mexico. *Int. J. Primatol.* **1996**, *17*, 759–783, doi:10.1007/BF02735263.
23. Ningtyas, A.N.; Astuti, P.; Supriatna, J. Spatial Modelling Habitat Suitability of Javan Langur (\textit{Trachypithecus Auratus}) in Bromo Tengger Semeru National Park. *J. Trop. Biodivers. Biotechnol.* **2022**, *7*, 228–238, doi:10.22146/jtbb.76841.
24. Nugroho, A. Pemodelan Spasial Untuk Tingkat Kesesuaian Habitat Surili Jawa (\textit{Presbytis Comata Fredericae}) Di Taman Nasional Gunung Merbabu. *Geomedia Maj. Ilm. dan Inf. Kegeografian* **2022**, *20*, 105–114, doi:10.21831/geomedia.v20i2.51818.

25. Broekman, M.; Wulffraat, S.; Nijman, V. Habitat Suitability Analysis Reveals High Ecological Flexibility in a “Strict” Forest Primate. *Front. Zool.* **2020**, *17*, 1–10, doi:10.1186/s12983-020-00352-2.

26. Boyle, S.A.; Smith, A.T. Can Landscape and Species Characteristics Predict Primate Presence in Forest Fragments in the Brazilian Amazon? *Biol. Conserv.* **2010**, *143*, 1134–1143, doi:10.1016/j.biocon.2010.02.001.

27. Irwin, M.T. Diademed Sifaka (\textit{Propithecus Diadema}) Ranging and Habitat Use in Continuous and Fragmented Forest: Higher Density but Lower Viability in Fragments? *Biotropica* **2008**, *40*, 231–240, doi:10.1111/j.1744-7429.2007.00382.x.

28. *Primates in Fragments: Ecology and Conservation*; Marsh, L.K., Ed.; Springer, 2003;

29. Laurance, W.F.; Goosem, M.; Laurance, S.G.W. Impacts of Roads and Linear Clearings on Tropical Forests. *Trends Ecol. \& Evol.* **2009**, *24*, 659–669, doi:10.1016/j.tree.2009.06.009.

30. Santoso, N.; Aprillyasari, W.; Sutopo; Rahman, D.A. Is the Newly-Found Tricolor Langur More Tolerant of Humans than We Think? Inspecting Human-Primate Interaction in Danau Sentarum National Park. *Int. J. Conserv. Sci.* **2023**, *1492*, 671–684, doi:10.36868/IJCS.2023.02.20.

31. Cheyne, S.M.; Capilla, B.R.; Macdonald, D.W. Home-Range Use and Activity Patterns of the Red Langur (\textit{Presbytis Rubicunda}) in the Sabangau Tropical Peat-Swamp Forest, Central Kalimantan, Indonesian Borneo. *Int. J. Primatol.* **2012**, *33*, 965–985, doi:10.1007/s10764-012-9602-8.

32. Meijaard, E.; Nijman, V. Conservation of the Red Langur in East Kalimantan, Indonesia: Population Density and the Effects of Logging. *Trop. Biodivers.* **2000**, *7*, 47–54.

33. Waser, P.M.; Brown, C.H. Habitat Acoustics and Primate Communication. *Am. J. Primatol.* **1986**, *10*, 135–154, doi:10.1002/ajp.1350100205.

34. Kinnaird, M.F.; O’Brien, T.G. Comparative Movement Patterns of Two Semi-Terrestrial Cercopithecine Primates: The Tana River Mangabey and the Sulawesi Crested Black Macaque. *Ecol. Appl.* **2000**, *10*, 1479–1490, doi:10.1890/1051-0761(2000)010[1479:CMPOST]2.0.CO;2.

35. Uhl, C.; Jordan, C.F. Succession and Nutrient Dynamics Following Forest Cutting and Burning in Amazonia. *Ecology* **1984**, *65*, 1476–1490, doi:10.2307/1939127.

36. Lamb, D.; Erskine, P.D.; Parrotta, J.A. Restoration of Degraded Tropical Forest Landscapes. *Science (80-.).* **2005**, *310*, 1628–1632, doi:10.1126/science.1111773.

37. Bradshaw, A.D. Restoration of Mined Lands—Using Natural Processes. *Ecol. Eng.* **1997**, *8*, 255–269, doi:10.1016/S0925-8574(97)00022-0.

38. Chapman, C.A.; Chapman, L.J. Frugivory and the Ecology of Seed Dispersal in Tropical Forest Vertebrates. In *Ecological Studies*; 1996; Vol. 126, pp. 161–185.

39. Zhu, Z.; Wang, H.; Yang, Z.; Huai, W.; Huang, D.; Chen, X. Landscape Pattern Changes of Aquatic Vegetation Communities and Their Response to Hydrological Processes in Poyang Lake, China. *Water* **2024**, *16*, 1482, doi:10.3390/w16111482.

40. Coops, H.; Beklioglu, M.; Crisman, T.L. The Role of Water-Level Fluctuations in Shallow Lake Ecosystems – Workshop Conclusions. *Hydrobiologia* **2003**, *506*, 23–27, doi:10.1023/B:HYDR.0000008595.14393.77.

