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# Habitat Preference and Habitat Suitability of Cuscus in the Work Area of PT Wijaya Sentosa, Teluk Wondama Regency

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***Abstract***

*Previous studies are most focusing on the species identification and habitat used by cuscus, while habitat changes are the most threats on cuscus. Habitat changes caused by the operation of logging concession such as PT Wijaya Sentosa creates an impact to the habitat selection of cuscus, which is highly dependent on forest cover. Efforts to protect cuscus species in production forests need to be carried out to ensure their sustainability habitat. This study aims to determine habitat preference of cuscus and model the suitability habitat of cuscus. The Neu index calculation is used to measure the level of habitat preference, while the habitat sustainability map is modelled by biotic, abiotic, and human disturbance components into MaxEnt application. Vegetation data is analyzed to describe tree density, tree richness, and strata using of cuscus by SexFI application. The study showed that the most preferred habitat by cuscus is LoA 2018 because LoA 2018 had the most species richness so cuscus might be able to choose their vegetation food. The habitat suitability of cuscus in PT Wijaya Sentosa covers 21,116.59 ha and didn't follow the pattern of increasing Et+ logging but was strongly influenced by logged blocks as much as 55.2% contribution.*

*Keywords*: *cuscus, habitat preference, habitat modelling, maximum entropy*

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## Introduction

The diversity of wildlife species in Papua is very high, as stated by Krey et al. (2019) that Papua Island in Indonesia consists of 20,000–25,000 species of woody plants, 164 species of mammals, 329 species of reptiles and amphibians, 650 species of birds, 250 species of freshwater fish, and 150,000 species of insects that are endemic and protected. The level of endemicity of each species is an important factor in population management. One of the endemic species of Papua Island in Indonesia is derived from the phalanger genus or marsupial mammals as a type of eastern Indonesia. IUCN (2021) stated that The geographical scope of cuscus is spread in Australia, Papua New Guinea, and Indonesia which consists of 26 species. There are 9 species of cuscus found on the mainland of the Papua Island in both of Indonesia and Papua New Guinea . The protection of the cuscus species in Indonesia is based on the Regulation of the Minister of Environment and Forestry Number 106/2018 only covers three species, namely *Phalanger gymnotis*, *Spilocusucs rufoniger*, and *S. maculatus*, while global protection according to IUCN is grouped into Least Concern (*S. maculatus*, *P. gymnotis*, and *P. orientalis*) and Critically Endangered (*S. rufoniger* and *S. wilsoni*). Restrictions on trade in cuscus species only cover *P. orientalis* and *S. maculatus* in Appendix II of CITES. It reveals that the protection of cuscus species is only limited to several species, while the latest research on cuscus populations has not been studied extensively in Papua Island.

Cuscus is very dependent on canopy cover in forest ecosystems. Still, land cover changes continue to occur in Papua Island, such as the decline in primary forest by -3.87%, mangroves cover by -0.06%, dryland farming by -0.02%, savannas by -0.35%, rice field by -0.20% in South Manokwari Regency from 2009 to 2018 and commonly changes to secondary dryland forest by 3.30% (Kesaulija et al., 2020). The remaining primary forests in Papua are scattered in every forest area, but species protection can only be guaranteed in conservation and protected forest areas. Status of land forests is the most important predictor variable for herbivor mammals such as native and introduced of Javan deers (Rahman et al. 2020). The Decree of the Minister of Environment and Forestry Number 782/Menhut-II/2012 states that forest areas in Papua Island in 2021 are still dominated by production forests (53.10%) over other forest areas. One of the production forests that have the potential to find cuscus species is PT Wijaya Sentosa in Teluk Wondama Regency, with four species of cuscus found (*S. maculatus, S. rufoniger, P. orientalis*, and *P. gymnotis*) and one suspected species, namely *S. wilsonii* (Wibisono et al., 2018).

In the scope of timber forest products, the activities of PT

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Wijaya Sentosa will certainly affect the cuscus habitat, so though the manager has determined ten types of HCV without logging. The Indonesian selective cutting and planting (TPTI) system that used by PT Wijaya Sentosa will remains standing stands of forest. The remaining forest which is include of feed species for the cuscus will affect the choice of habitat by the cuscus. So, we modelled cuscus habitat suitability based on biotic, abiotic components, and human disturbances. Philips et al. (2016) explained that habitat suitability can estimate suitable habitat by encounter points and environmental variable but not certainly used by animals, while habitat preference is the level of selection of animals in each habitat that is certainly used.

Recent studies are more focusing on identification of cuscus species and their habitat used (Kasi et al. 2019). A study of cuscus habitat in the relative similar locations were described by Sinery et al. (2020) who found that cuscus species are scattered in secondary forests, nursery areas, mountain forests, and swamp forests in Teluk Wondama and Teluk Bintuni. The last study of cuscus at PT Wijaya Sentosa by Wibisono et al. (2018) only focused on identifying the type of cuscus and the type of feed, but did not analyze how the cuscus chooses each habitat type. The protection of the cuscus species in the production forest of PT Wijaya Sentosa needs to examine how the cuscus uses the habitat preferences and how the habitat is suitable for the cuscus. This study aims to analyze the level of habitat preference by cuscus and provide a model of the suitability habitat of cuscus in both logged and non-logged forest at PT Wijaya Sentosa.

## Methods

**Research time and location** Data collection was carried out from November 2020 to January 2021 at at PT Wijaya Sentosa, Teluk Wondama. Study plots are determined in the form of logged-over forest cover or logged-over area (LoA 2013, LoA 2016, LoA 2018, and LoA 2020) and non-logged forests such as high conservation value (HCV) (buffer zone, springs, and coastal borders) and virgin forest (no logging activity in 2021+ blocks).

**Tools and materials** This study used several tools: A laptop containing Ms Excel to process data graphically and analyze simple linear regression; Arc Map 10.5 software for GIS-based data processing such as Landsat 8 image processing. In addition, other tools used are the Cuddeback Hunting Camera Trap 1279 20Mp-X as many as ten units, binoculars, headlamps and flashlights, DLSR cameras, tally sheets, and Garmin 76 CSX GPS for primary data collection in the field. The materials used in this study were Landsat 8 satellite images from https://eartheexplorer.usgs.gov/, PT Wijaya Sentosa administrative maps, climate maps from https://www.worldclim.org/ (air temperature and rainfall), and Indonesian map from https://tanahair.indonesia.go.id/.

**Data collection** The presence of cuscus in their habitat is

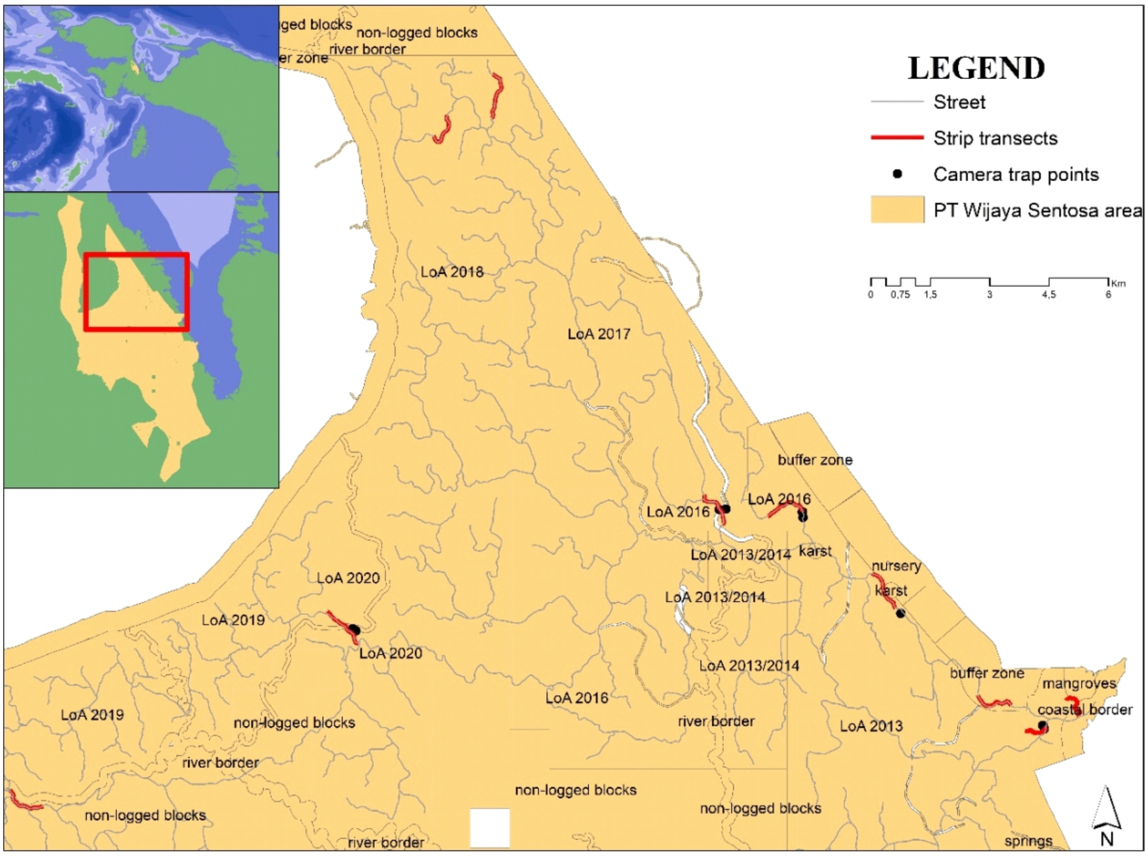


Figure 1 Distribution of camera trap points and strip transects.

shown by the point distribution data. That data requires information about their habitat such as number, coordinates, location of findings (blocks and plots), time of encounters, behaviour, temperature, strata, tree species, and behaviour observed. This data was obtained either directly in the field (camera traps, strip transects) or through the record kept by PT Wijaya Sentosa– reports, employees explorations, and previous study from the Forestry Research and Development Agency of Manokwari (Wibisono et al., 2018). Strip transect method and camera traps are used to record the cuscus encounter points. Secondary data of 22 points where cuscus were encountered from a study of PT Wijaya Sentosa and research and development agency of Manokwari are used to located the sites by purposive sampling. Cuscus observations along the transect strips (1 km long and 100 m wide) were carried out in 10 lines in each observation period, 19.00–21.00 (GMT+9), 23.00–01.00 (GMT+9), and 03.00–05.00 (GMT+9) (total 30 replicates). Ten camera traps were distributed and installed at line transect locations where cuscus were absent and they were the LoA 2016, LoA 2013, LoA 2020, and springs, as shown in Figure 1. The camera was installed on a tree trunk with a height of 35 m, 23 m from the animal path, and tilt 0–15º. Each camera was set in hybrid mode and harvested twice after seven days of recording.

Environmental parameters including physical components (height, slope, air temperature, rainfall, river distance), human disturbance (road distance and building distance), and biotic (NDVI, logging block distance, non-logged block distance) were observed. All environmental variables that have been downloaded from each source are processed in the ArcMap 10.5 application through the euclidean distance feature except for slope maps and NDVI maps. The slope map is derived from the elevation map with the slope feature, while the NDVI map is derived from the calculation of the bands as shown in Equation *[1]* (Braun & Herold 2003).

$$\text{NDVI} = \text{NIR RED/NIR} + \text{RED} \qquad [1]$$

note: NDVI = normalized difference vegetation index; NIR = near infrared reflectance (0.845–0.885 μm); RED = visible red (0.630–0.680 μm).

We also counted the number of trees and the number of tree species with criteria D > 20 cm in 3 vegetation plot 20 × 20 m in 19 cuscus encounter points.

**Data analysis** Habitat preference were identified using the Neu index calculation; before the calculation, data on habitat type (land cover) needs to be processed into a square measuring 1×1 km. The use of selected habitat components that are not proportional to habitat availability could be represented by the analysis of the Neu index as shown in Equation *[2]*.

$$wi = [(ni/N)/(ai/A)] \qquad [2]$$

note: *wi* = the Neu index; *ni* = the number of cuscus encounter in *i*-habitat; *N* = the total of cuscus encounter in all habitats; *ai* = the wide of *i*-habitat; *A* = the wide of all habitats.

A habitat preference index value of more than 1 (wi ≥ 1) indicates that the habitat is favoured; on the other hand, if it is less than 1 (wi < 1), the habitat is less favourable. We calculated the tree density by the formula i.e. number of trees/plot area, while species richness was calculated by the formula as shown in Equation *[3]*.

$$\text{Dmg} = (\text{S-1}) / \ln(\text{N}) \qquad [3]$$

note: S = the number of species; N = the total number of individuals.

In addition, the data was analyzed using SexFI to describe the using tree canopy by cuscus. According to Soerianegara and Indrawan (1982), tree stratum consists of A strata (height > 30 m), B strata (20 m > height > 30 m), C strata (4 m > height > 20 m), D strata (0 m > height > 4 m), and E strata (forest floor).

Habitat suitability were analyzed using MaxEnt software input data point coordinates for the presence of cuscus (comma-separated value) and environmental data (ASCII). Environmental variables in the form of land cover, slope, altitude, distance from the road, distance from the river, distance from settlements, surface temperature, and NDVI. All environmental variables data types were classified as continuous data except for NDVI, grouped into categorical data. Multicollinearity analysis was carried out on all variables in the SPSS application with a limit of ± 0.75. The settings on the menu in the MaxEnt application had to be carried out on three menus, namely basic, advanced, and experimental settings which refers to Putri et al. (2019). Ten replications are used in the modeling.

## Results and Discussion

We found 30 individuals of cuscus in the sampled PT Wijaya Sentosa working areas and represent nine individuals of *P. gymnotis*, 11 individuals of *P. orientalis*, seven individuals of *S. maculatus*, and three individuals of *S. rufoniger*. No cuscus was found for all blocks in PT Wijaya Sentosa, except for the LoA 2014, LoA 2015, LoA 2017, and LoA 2019 blocks. The distribution map of cuscus in the PT Wijaya Sentosa area can be seen in Figure 2.

**Habitat preference** Habitat preference by wildlife occurs when each habitat type with equal availability is not used in equal proportions, so an animal uses a habitat more than expected by thehabitat's availability (Jessica et al., 2016). The Chi-square test shows that H0 is rejected, because cuscus do not use all blocks (land cover) proportionally based on their availability. The calculations in Table 1 shows that the value of the $X^2_{count}$ is greater than the $X^2_{(0.05;7)}$ table of 14.1. Kusumanegara et al. (2017) stated that habitat preference in javan *surili* (arboreal mammals) can be seen from the rejected H0 of the Chi-square test analysis.

The pattern of habitat use in each block by cuscus is unequal, because the vegetation composition in each habitat is different, which is caused by logging activities or not. Furthermore, based on the Neu index analysis as shown in Table 1, the LoA 2018 (*b* = 0.32) and the HCV block (coastal border, buffer zone, and springs) are the preferred habitat types for cuscus with a value of w > 1. Both LoA 2016 and LoA 2021 blocks with habitat types are less favourable for cuscus, as seen in Table 1. In each of these two blocks we only observe the presence of 1 individual of *P. orientalis*. Although from the analysis, the individual number of cuscus and the areas have been examined, another factor such as

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forest stands are also affecting our findings. Beest et al. (2014) stated that the choice of habitat for large mammals was due to the main factor, namely the depletion of forage grass in Sable Island National Park, Canada, so that management efforts to revegetate grass in winter. Frugivorous arboreal mammals such as cuscus are highly dependent on the presence of forage trees in each habitat. Forage trees in the selection of animal habitats can then be explained by dense canopy cover with high species richness to determine food sources, sleeping trees, and means of movement of animals (Bismark, 2012). In addition, the density of stands in the form of trees affects arboreal mammals such as Javan Surili (Kusumanegara et al., 2017). Based on the researcher's preparation, the density and species richness index value in the LoA 2018, coastal boundaries, and springs are shown in Table 2.

Although the tree density in LoA 2021 is higher (tree density = 300 ind $ha^{-1}$), the lower species richness causes the cuscus to dislike this habitat type. The study results also showed the highest species richness of the LoA 2018 (2 years

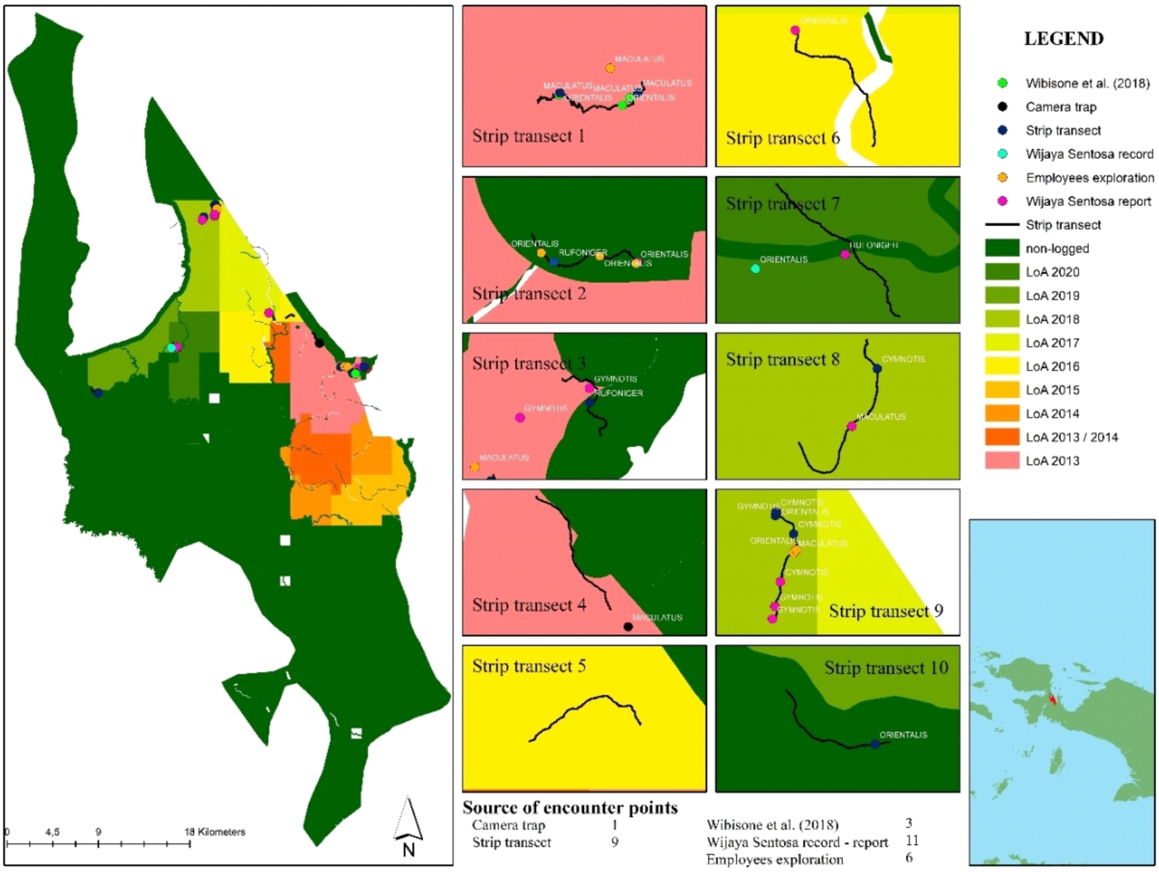


Figure 2 Map of the distribution of cuscus in each transect.

Table 1 Calculation of Chi-square value and Neu index

| Block | | LoA 2013 | LoA 2016 | LoA 2018 | LoA 2020 | LoA 2021 | Springs | Buffer zone | Coastal border | N |
|---|---|---|---|---|---|---|---|---|---|---|
| Area (ha) | *a* (ha) | 5204 | 3726 | 3696 | 3138 | 2442 | 4529 | 4935 | 500 | 28170 |
| | *p* (%) | 18.47 | 13.23 | 13.12 | 11.14 | 8.67 | 16.08 | 17.52 | 1.77 | 100.00 |
| Cuscus encounter | *o* (ind) | 4 | 1 | 11 | 2 | 1 | 6 | 5 | 1 | 31 |
| | *u* (%) | 12.90 | 3.23 | 35.48 | 6.45 | 3.23 | 19.35 | 16.13 | 3.23 | 100.00 |
| Chi-square test | *e* | 5.73 | 4.10 | 4.07 | 3.45 | 2.69 | 4.98 | 5.43 | 0.55 | 31.00 |
| | $(o\text{-}e)^2$ | 2.98 | 9.61 | 48.06 | 2.11 | 2.85 | 1.03 | 0.19 | 0.20 | 67.04 |
| | $X^2$counted | 0.52 | 2.34 | 11.82 | 0.61 | 1.06 | 0.21 | 0.03 | 0.37 | 16.96 |
| | $X^2_{(5\%;7)}$ | | | | | | | | 14.07 | |
| Neu index | *w* | 0.70 | 0.24 | 2.70 | 0.58 | 0.37 | 1.20 | 0.92 | 1.82 | 8.54 |
| Rank | | 5 | 8 | 1 | 6 | 7 | 3 | 4 | 2 | - |

Note: a = areas; p = area proportion; N = total; o = observed; u = obsered proportion; e = expected; w = Neu index; b = standardized Neu index logged), enabling the cuscus to be more selective in choosing the availability of feed species. Like cuscus, an arboreal mammal, slow lorises also prefer habitat in the form of community forests with human intervention in the form of bamboo vegetation dominance (Wirdateti et al., 2011). Slow lorises used the density of bamboo leaves to hide from natural predators in primary forests (Wirdateti 2012). Tree stand density is also a factor in habitat preference. Kusumanegara et al. (2017) mentioned that the javan surili preferred the habitat type with a stand density of > 50%. The same thing is also seen in the study results, namely the LoA 2018 stand density, coastal borders, and springs can affect habitat preferences by cuscus. The low density of trees in the springs is due to many fallen trees naturally due to pests.

Stand density and species richness will affect the shape of the strata used by the cuscus, thus impacting the habitat preferences used by the cuscus. Based on our interpretation, the canopy strata on transect 9 (LoA 2018) and transect 10 (LoA 2021) in Figure 3 and Figure 4 show visual differences. Transect 9 identified 16 types of tree vegetation so that the most cuscuses were found on this route. The strata used by *P. orientalis* were B and C, while the D strata were used by *S. rufoniger*. Only *P. orientalis* was identified in LoA 2021 on *Syzygium kuiense* trees in B strata. Sinery et al. (2020) stated that *P. orientalis* is indeed a cuscus species that is more adaptive than other species. It agrees to our found in the LoA 2021 with fewer tree species richness. The part of the feed used by the cuscus is young leaf (25%) and fruit (75%) located on the main stem, while the *Macaca nigra* consumes more young leaf and fruit on the edge of the canopy (Lengkong, 2011). It is due to the slower movement of the cuscus, and the sharp claws make the cuscus more secure on the main stem, which is relatively sturdy against extreme weather.

Both the LoA 2018 and LoA 2021 have similar tree heights of 35.7 m and 33.4 m; however, the LoA 2018, with two years logged, leaves only the remaining tree standing, so the stand density is lower (155.6 ind ha$^{-1}$). This land openness is more often found by mammals due to the availability of more feed (Mattioli, 2011) as in the LoA 2018, as many as 15 species of feed species. The remaining tree stands in LoA 2018 are more open, allowing other feed species to grow well due to the intensity of light received. Another feed species of that was used *P. gymnotis* is *Dracontomelon dao*. *P. gymnotis* used that tree only for consuming matoa fruit (*Pometia* sp.) around that tree. Febriadi (2015) mentions that the *D. endule* species is used by *S. maculatus* because it has a wide canopy so that other species can grow well.

**Modelling accuracy** Multicollinearity analysis showed that four values were correlated with the limit of the multicollinearity value referring to Putri et al. (2019) of ± 0.75. The four values are presented in detail in Table 3; thus, the modelling is carried out based on six models to eliminate correlated variables such as rainfall (ch), altitude (kt), building distance (bg), air temperature (su), and land cover (tp). Meanwhile, other variables such as river distance (sg), slope (kl), non-logged block distance (nt), NDVI (nd), and cutting block distance (tbg) are still used in the model.

Based on the results of the six modelling trials, it can be seen that the modelling by eliminating altitude, air temperature, and land cover at the number of replicates 10 is more (Model 1) is better than other models. Hence, the researchers chose Model 1 as the result of this study, as shown in Figure 4, which shows that the blue line is closer to the black line (predicted omission) with a narrower

Table 2 Tree stand density and species richness

| Block | Tree density (ind ha$^{-1}$) | Species richness (Dmg) | Neu index ($w_i$) |
|---|---|---|---|
| LoA 2018 | 155.6 | 7.21 | 2.70 |
| Coastal border | 150.0 | 2.65 | 1.82 |
| Springs | 141.1 | 5.96 | 1.20 |
| LoA 2021 | 300.0 | 4.66 | 0.37 |

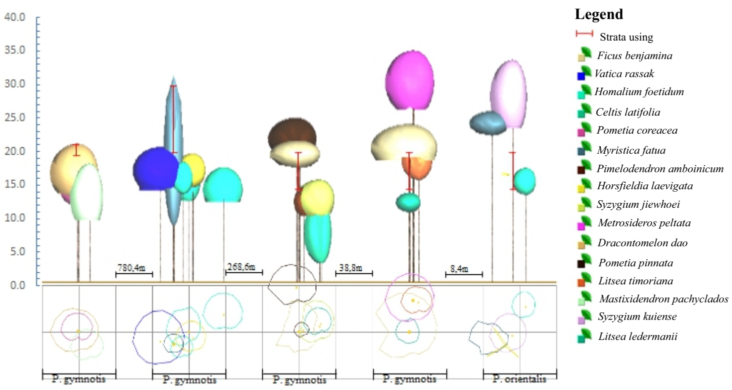


Figure 3 Use of tree canopy strata in LoA 2018.

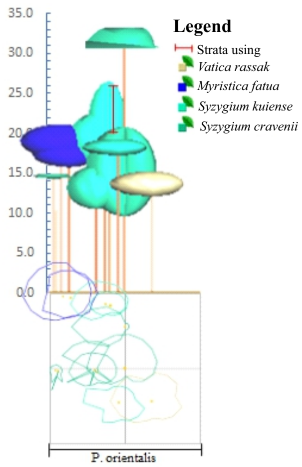


Figure 4 Use of tree canopy strata LoA 2021.

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Table 3 Multicollinearity analysis and modeling scheme

| No | Variable | ch | bg | sg | kl | kt | nt | nd | su | tp | tbg |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ch | 1 | | | | | | | | | |
| 2 | bg | 0.483 | 1 | | | | | | | | |
| 3 | sg | 0.085 | 0.056 | 1 | | | | | | | |
| 4 | kl | -0.331 | -0.484 | -0.182 | 1 | | | | | | |
| 5 | kt | **0.776** | 0.689 | 0.157 | -0.467 | 1 | | | | | |
| 6 | nt | 0.561 | 0.506 | -0.095 | -0.198 | 0.635 | 1 | | | | |
| 7 | nd | -0.509 | -0.278 | 0.049 | 0.198 | -0.394 | -0.002 | 1 | | | |
| 8 | su | 0.571 | **0.933** | -0.026 | -0.54 | 0.726 | 0.662 | -0.217 | 1 | | |
| 9 | tp | 0.311 | **0.780** | -0.047 | -0.335 | 0.608 | 0.612 | -0.041 | **0.831** | 1 | |
| 10 | tbg | -0.375 | -0.35 | 0.094 | -0.045 | -0.368 | -0.465 | -0.186 | -0.446 | -0.672 | 1 |

| Variable | Mode 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|---|---|---|---|---|---|---|
| ch | √ | √ | √ | × | × | × |
| kt | × | × | × | √ | √ | √ |
| bg | √ | × | × | √ | × | × |
| su | × | √ | × | × | √ | × |
| tp | × | × | √ | × | × | √ |

Note: ch = rainfall; bg = building distance; sg = river distance; kl = slope; kt = altitude; nt = non-logged block distance; nd = NDVI; su = air temperature; tp = land cover; tbg = cutting block distance

distribution of standard deviation values (orange area). Philips et al. (2016) mention that a better level of accuracy in *Microryzomys minutus* modelling can be seen in the omission on the test line around the predicted omission line. The graph of sensitivity and specificity in the run 1 model illustrates the high AUC test value of 0.931 with a low standard deviation of 0.022. Habitat suitability models for arboreal marsupials in South Eastern Australia show the modelling AUC in the range of 0.75–0.91 (Isaac et al., 2014).

**Habitat suitability environmental factors** Cuscus were commonly encountered in logging blocks (56.57%) than in non-logged blocks (43.33%) either through direct observation or camera traps. We observed cuscus in 31 points with several environmental variables resulted in the level of habitat suitability (Figure 5). Less individual observed in non-logged blocks, especially in LoA 2022 and above due to the limited road access, and this causes the model describe that the non-conforming class was more dominant in non-logged blocks. Meanwhile, other results showed that the low to high class was more dominant in the logged block as secondary forest (16,737.34 ha) than in the non-logged block (4,379.25 ha), because within the primary forest we observed 11 individuals of *P. Orientalis*. The extent of each suitability class in the logged block was presented in Figure 5 because *P. orientalis* is more adaptive to habitat changes shown in the secondary forest or community plantations than primary forests that was used by *S. maculatus* and *S. rufoniger* species (Sinery et al., 2020). Previous study has also found cuscus that mostly occupied the forest areas that have been converted into plantations in Obi Island because the availability of feed sources (Tamalene et al., 2019). The factors of feed availability in habitat indicators are the abundance of species and numbers (Martin et al., 2018), as well as the flowering season in October–December (Marthinus & Tuaputty, 2015), while the time of our study carried out in November–January with the dominance of fruit of the fig species (*Ficus* spp.).

The results of the maximum likelihood classification showed that the area of each habitat suitability class in each logged block did not show a graph of decrease or increase based on the year of logging. The widest medium and high classes were seen in the LoA 2017, while the widest low and unsuitable classes were seen in the LoA 2013. Combining highly correlated variables (the distance of each block) into the distance from the logged block is proven to have a significant contribution of 55.2% (Table 4) in the modelling. The distance from non-logged blocks was only 1.3%. These results proved that the suitability of habitat for cuscus did not follow the pattern of logging duration, but the presence or absence of logging as a differentiator between primary forest and secondary forest.

Logged blocks distance illustrated the influence of vegetation in the secondary forest, which was quite large in the modelling. The openness of the area will lead to the growth of more diverse feed species as a choice of feed and then supported by the low level of hunting around the settlements in the PT Wijaya Sentosa area. Mattioli (2011) states that mammals find more open forest edges because of the availability of more food. According to Rahman et al. (2017), plantation distance contributed 56% in modelling Bawean deer because it can provide additional feed in the form of young leaves. Still, the distribution of Bawean deer does not come closer to settlements to avoid people and wild dogs. Still, one species of possible predator species in New Guinea is only the raptor species (Marshall et al., 2012), while the nocturnal cuscus can be freer to avoid the predation activity of the raptor. The threat to the cuscus population is none other than hunting activities, although it has been greatly reduced by community empowerment by the manager. It was reinforced by the results of our study, namely that the building distance factor (human

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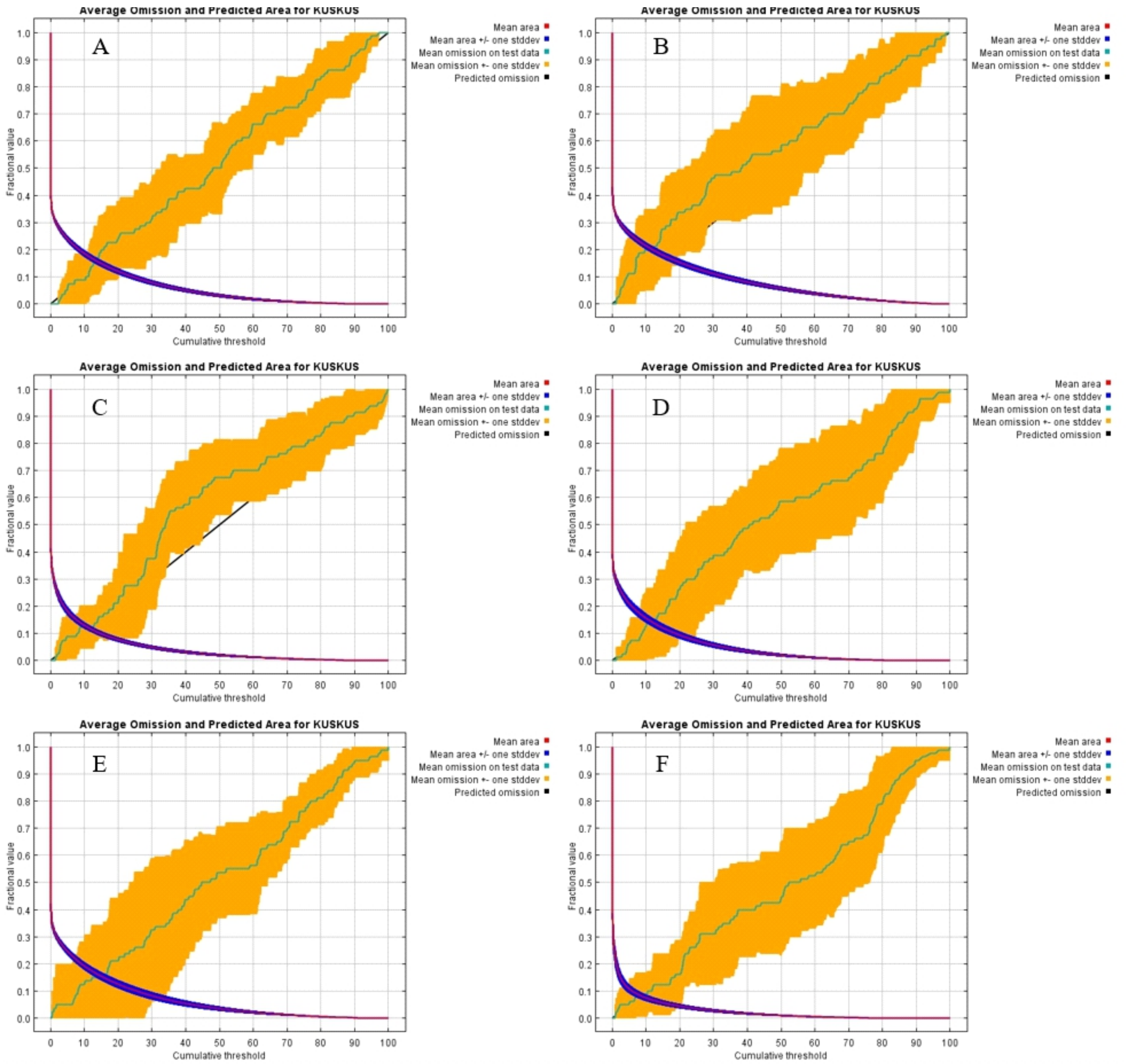


Figure 5 Area under curve in each modelling. Model 1 (A), model 2 (B), model 3 (C), model 4 (D), model 5 (E), model 6 (F).

Table 4 Present contribution of environmental variables

| Environmental variable | Percent contribution (%) | Permutation importance (%) |
|---|---|---|
| Logged blocks distance | 55.2 | 82.4 |
| Building distance | 28.4 | 7.7 |
| NDVI | 7.4 | 5.1 |
| River distance | 5.4 | 1.4 |
| Slopes | 1.9 | 1.6 |
| Non-logged blocks | 1.3 | 1.5 |
| Rainfall | 0.5 | 0.3 |

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disturbance), which was characterized by the openness of the area, has a large contribution (28.4%) in the modelling. Anthropogenic factors are the main determinants of herbivorous mammals in Thailand, such as *Elephas maximus*, *Hylobates lar*, and *Tapirus indicus* (Trisurat et al., 2012).

Another vegetation component that has a greater influence was NDVI of 7.4%. The use of NDVI in modelling showed that vegetation describes the level of chlorophyll productivity of tree stands (Cristiano et al., 2014) and stands density (Iskandar et al., 2012) as biotic factors for cuscus either as a source of food or a cover. The presence of frugivore animals such as orangutan are strongly dependent on the forests that closely related by NDVI's effects (Rahman et al., 2019). Although the manager always carried out reforestation, the TPTI system used allows the average NDVI curve in each block not to show a decrease with increasing Et+. Tree stand density is the main indicator in determining the level of production obtained by natural production forests in the next cycle with the expected wood quality (Newton, 2019; Pretzsch, 2020). The selection of felled tree species is very important in managing natural production forests to ensure the quality of animal habitats by paying attention to the vegetation species that feeds the cuscus and reforestation. Febriadi (2015) stated that if in 1 ha there is one feed species, then the availability of feed for cuscus with the ability to consume 0.3–0.5 kg $ind^{-1}$ $day^{-1}$ is abundant for the cuscus population.

**Variable interest** One of the most frequently statistical uses to describe a variable's level of importance in a model is the Jackknife operation (Esfanjani et al., 2018). The jackknife operation produces a distribution of area under curve (AUC) values to describe the performance of the model (Yackulic et al., 2013) because it can reduce the possibility of autocorrelation effects due to biased sampling (Shcheglovitova & Anderson, 2013). Based on the results of the jackknife operation on the AUC value as shown in Figure 6, the logged block distance was the variable that has the highest importance value in modelling individually (dark blue diagram) of $0.80 < AUC < 0.85$, or if the logged block distance was omitted (light blue diagram) in modelling of $0.85 < AUC < 0.90$. As with the cuscus, a potential habitat model for arboreal marsupials in South-Eastern Australia (Isaac et al., 2014) in the vulnerable to disturbance category suggests tree vegetation cover is very important in modelling when used separately. Razgour et al. (2011) also mention that the habitat suitability modelling of *Plecotus austriacus* (frugivory) shows that the variation of vegetation in each land cover has variables that affect the distribution on a wide scale.

In addition, if the modelling as shown in Figure 7 was individually run, the slope of the land was the variable that has the lowest importance, namely $AUC < 0.55$, while the

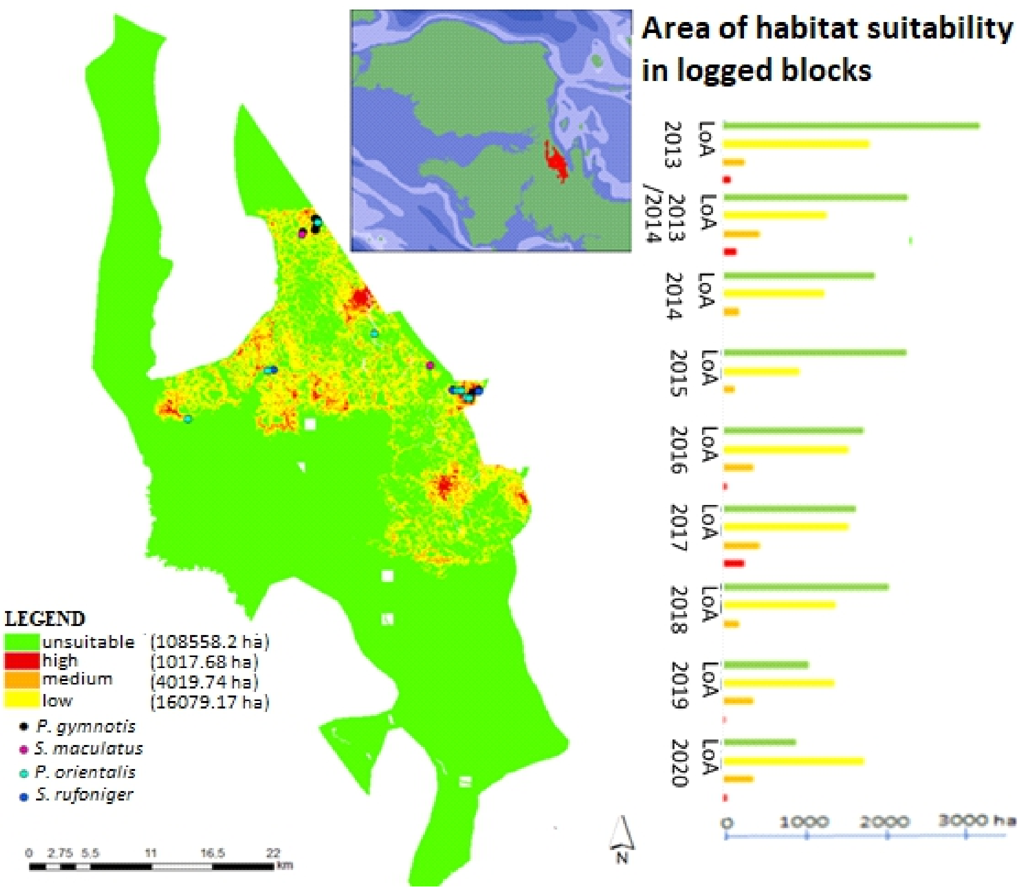


Figure 6 Habitat suitability map.

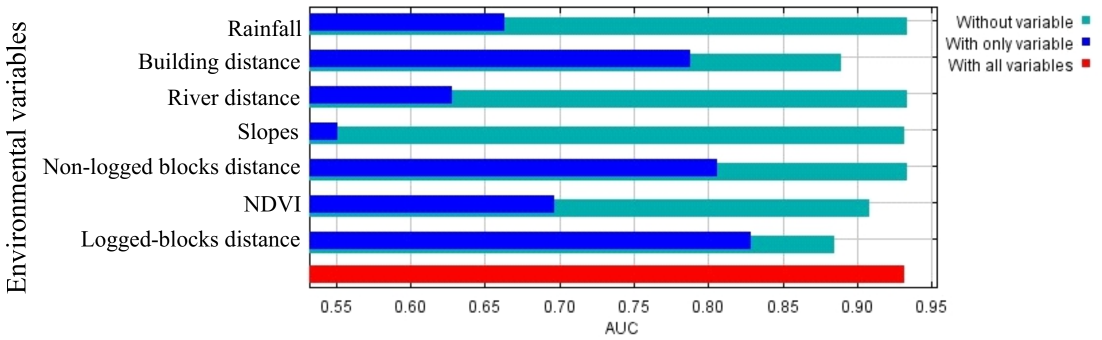


Figure 7 Jackknife diagram on the AUC value of the Model 1.

model can be said to be successful if the AUC obtained from modelling is greater than 0.7 for at least one variable (Escalante et al., 2013). Topographically, the areas of PT Wijaya Sentosa were composed of a series of mountains and hills that extend from northwest to southeast to the left of Wondama Bay.

According to Pausas et al. (1995), the probability of arboreal mammals encounter in the hills is smaller than in flat areas, followed by the low nutritional value of the soil. The decrease in soil nutrients allows fewer species of animal feed species to grow in hilly areas (Isaac et al., 2014). There were 17 species of feed species identified at our study site. Herbivor mammals such as *Bos javanicus* also has strong preferences in lowland forests because primary food source more avaiable (Rahman, 2020). Although classified as carnivor mammals, Rahman et al. (2018) stated that Javan leopard is located in the whole Ujung Kulon National Park, except at the southweast side with the high mountains because elevation was correlated negatively significant to the number of dholes' presences as their prey (Namgyal & Thinley, 2017).

## Conclusion

The most preferred habitat by cuscus is LoA 2018 and the most disliked is LoA 2021 because LoA 2018 had the most species richness so cuscus might be able to choose their vegetation food. Modelling habitat suitability for cuscus in PT Wijaya Sentosa area shows the widest medium and high classes in the LoA 2017, while the widest low and non-conforming classes in the LoA 2013. AUC values and standard deviations of 0.931 and 0.022 indicate very good modelling. In modelling, the most influencing environmental factors are biotic factors such as distance from logged blocks (55.2%).

## Recommendation

The next research needs to use a renewable data collection method, namely thermal drones. This method is expected to reach more cuscus distribution points in inaccessible areas. In addition, further research needs to examine aspects of the remaining stands in more detail, both in terms of feed and cuscus behaviour.

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