Article

Analysis of the Carrying Capacity of Proboscis Monkey Habitat on Bakut Island, South Kalimantan, Based on Leaf Area Index

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Abstract. Bakut Island is one of the conservation forest areas in South Kalimantan. This island is the habitat of proboscis monkeys, and the proboscis monkey population is increasing from year to year. Therefore, it is estimated that one day the proboscis monkey habitat on Bakut Island will be over capacity. This study aims to estimate how long the population of proboscis monkeys on Bakut Island Nature Tourism Park can survive there by examining the amount of food the island's vegetation can produce. Proboscis monkey feed itself is estimated using the Leaf Area Index (LAI). LAI was extracted using UAV imaging and NICFI multitemporal imagery. Meanwhile, the carrying capacity of the proboscis monkey habitat is assessed using the quantity of consumption of the proboscis monkey population relative to food availability. Simulations of the carrying capacity of proboscis monkey habitat into the future were carried out using projections of the future proboscis monkey population and LAI growth. The entire computational process of simulating habitat carrying capacity is carried out using the Python language. The results of the analysis show that Bakut Island is only able to support proboscis monkey habitat until 2038. In that year, the proboscis monkey population on Bakut Island is projected to number 1,290 individuals. After 2038, the predicted amount of feed needed by the proboscis monkey population will exceed the feed available on Bakut Island. The limitation of this research is that it only uses one parameter to assess the carrying capacity of proboscis monkey habitat, namely food availability. There are still other parameters that have not been accommodated, including the home range and trees for nests.

Keywords: wildlife habitat, proboscis monkey, carrying capacity, remote sensing, geospatial

INTRODUCTION

South Kalimantan is home to a wide variety of plants and animals. There are a lot of unique plants and animals there, and some of them will be gone soon. People cut down trees and change how the land is used, which means there are always fires. This has made things worse. Indonesia's woods have a lot fewer trees now than they did 30 or 40 years ago. Most of the dead trees are in lowlands, swamps, and protected area networks. El Niño causes a lot of wetland fires, which makes ecosystems even worse. In the United States, strong fires got more than 12% stronger from 2015 to 2021 (Schmidt et al., 2024). The weather changes have harmed many species that can only live on Borneo. This is a picture of a proboscis monkey, also known as *Nasalis larvatus*. It lives in the woods.

The proboscis monkey is one of a kind because of where it lives and how it has changed over time. The main reason for this is its unusual shape, especially the male's bigger nose, which helps with both sight

and sound. Studies have shown that males can make loud, low-pitched sounds because their noses are very different from females' (Balolia & Fitzgerald, 2024). This supports the idea that sexual selection has had an effect on how this species has changed over time. This species is a key part of habitats along rivers and in mangroves. It eats plants, which is a sign that a marsh is healthy. Thiry et al. (2025) monitored the consumption of 89 plant groups from 45 families, indicating a diverse array of diets. Matsuda (2022) demonstrated that their digestive system resembles that of ruminants. This shows that they have adjusted well to a diet of leaves and the need for very productive habitats.

Nasalis larvatus is protected by CITES Appendix I, Government Regulation No. 7 of 1999, and the IUCN Red List as Endangered (Rezeki et al., 2020; Boonratana et al., 2021; Jayasukma et al., 2022). These animals are losing popularity because people are bothering them and breaking their homes. Wardatutthoyyibah et al. (2018) say that in 2008, more than 25,000 people lived in protected areas, but now only about 5,000 do. The proboscis monkey cares about both its environment and the people and things that live there. Governor Decree No. 29 of 1990 made it the state animal of South Kalimantan (Saidah et al., 2002). Culture being recognized makes it easier to protect people in a way that is based on culture and cares about the community.

To stay alive, *Nasalis larvatus* groups need food, a place to sleep, and a way to get around. Even though Bakut Island in South Kalimantan is small and has more problems caused by people (Rezeki et al., 2020), it is a safe place for this species. Sakti A et al. (2024) did a study on habitats, and found just 11.54 percent of the potential locations meet the biological needs of the species. So, there aren't many good places to live. Some plants get sick when they lose their homes and food. This shows that we need a security system that is based on facts.

In this case, the Leaf Area Index (LAI) is a good way to find out how productive an ecosystem is and how many *Nasalis larvatus* populations it can support without hurting the ecosystem. LAI is a full measurement that links the structure of plants to the amount of food they can get. It gives a number that can be used to make flexible and long-lasting plans for conservation. Combining satellite-based remote sensing with unmanned aerial vehicle (UAV) technologies allows for high-resolution ecological tracking, which is important for learning how habitat productivity changes over time and space.

This project used remote photography and unmanned aerial vehicle (UAV) technology to learn a lot about the island's plants and food sources. The information will help keep this very rare Bornean monkey safe for a long time. This study is crucial for formulating an effective scientific strategy for the management and conservation of *Nasalis larvatus* populations. Ecosystems are getting worse, and problems with the environment are getting worse too. This study uses remote images and unmanned aerial vehicle (UAV) technology to learn a lot about the plants and food sources on the island. People should be able to change their plans to protect this Very Endangered Bornean monkey so that it can live a long time.

MATERIAL AND METHODS

Research Location

This research was conducted in Bakut Island, Barito Kuala Regency, South Kalimantan Province, Indonesia. The Bakut Island is a small island located in the middle of the Barito River. Spatially, the island is located between 3°13'11.8" S and 3°12'44.24" S and between 114°33'17.44" E and 114°33'36.81" E. The research location can be seen in Fig. 1. Bakut Island is a delta island formed from sediment of the Barito River. In the field, this island is dominated by trees and mangrove bushes. Bakut Island is the habitat of proboscis monkeys, so it was designated by the Government of the Republic of Indonesia as a conservation forest area, specifically a nature tourism park (TWA).

Administratively, the Bakut Island Nature Tourism Park is under the management of the South Kalimantan Natural Resources Conservation Agency (BKSDA). BKSDA is a technical implementation unit institution from the Ministry of Environment and Forestry of the Republic of Indonesia. According to the Decree of the Director General of Natural Resources and Ecosystem Conservation Number: SK.112/KSDAE/SET/KSA.0/3/2017, concerning the Bakut Island Nature Tourism Park Management Block, Barito Kuala Regency, South Kalimantan Province, Bakut Island has an area of 15.58 hectares. As seen in Fig. 1, above Bakut Island, the Barito Bridge passes, which is one of the longest bridges in Indonesia. This bridge

is part of the trans-Kalimantan road, which connects the provinces of South Kalimantan and Central Kalimantan. To some extent, the existence of this bridge has the potential to interfere with the proboscis monkey's habitat. Considering that proboscis monkeys are shy animals that will stay away when they meet humans.
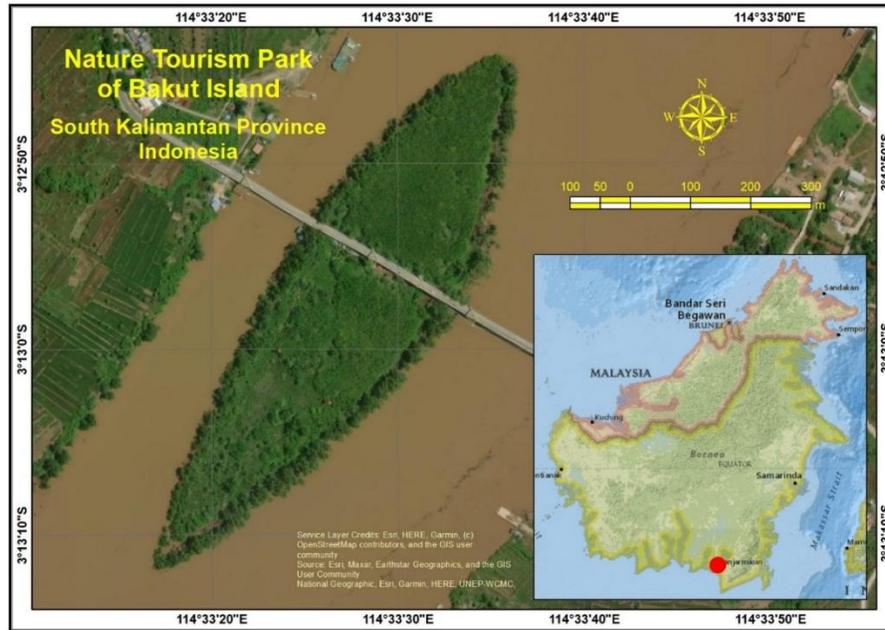

Figure 1. Research location

Leaf Area Index (LAI)

Leaf Area Index (LAI) is defined as the area of one side of a leaf per area of the soil surface beneath it. As illustrated in the image below. The thicker the canopy and the denser the foliage, the higher the LAI will be. There are many methods for measuring LAI, both directly in the field and using remote sensing technology. LAI illustration is shown in Fig. 2.
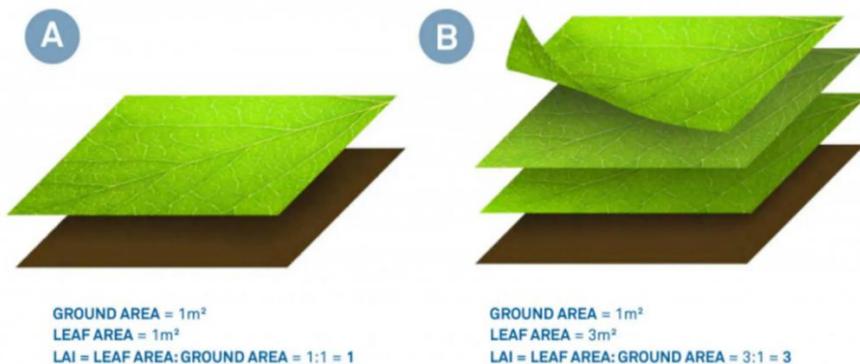

Figure 2. LAI illustration (Source: https://www.metergroup.com/)

One method of estimating LAI based on remote sensing technology that is easiest to implement is using the fraction of vegetation (FVC) approach. FVC is the ratio or percentage of vegetation cover in each pixel of a remote sensing image. If in a remote sensing image pixel, there is vegetation cover of 70%, then the FVC is 0.7, while the remaining 0.3 is for features other than vegetation. FVC itself can be extracted using various techniques; the easiest technique is using a vegetation index, such as the Normalized Difference Vegetation Index (NDVI). NDVI is formulated as in equation 1 (Rouse et al., 1973).

$$NDVI = \frac{NIR-Red}{NIR+Red} \tag{1}$$

where Red = Red band or band 4 in Sentinel-2 imagery, and NIR = Near infrared band or band 8 in Sentinel-2 imagery.

Choudhury et al. (1994) estimated FVC and LAI with formulas as in Equation 2 and Equation 3.

$$FVC = 1 - \left(\frac{NDVI_{max}-NDVI}{NDVI_{max}-NDVI_{min}}\right)^{\frac{1}{\zeta}} \tag{2}$$

where NDVImax and NDVImin are the maximum NDVI value and minimum NDVI value respectively. Next, LAI is extracted with equation 3 (Choudhury et al., 1994).

$$LAI = \frac{ln(1-FVC)}{-\beta} \tag{3}$$

The Zeta parameter (ζ) is close to 0.8 for planophile canopies and close to 1.4 for erectophile canopies. Meanwhile, the Beta parameter (β) is in the range of 0.41 to 0.91 (Choudhury et al., 1994). In this research, the parameters were extracted using the regression method between FVC estimated using NDVI and FVC measured using Unmanned Aerial Vehicle (UAV) imagery in parts of Bakut Island. In this research, NDVI itself was extracted from Norway's International Climate and Forests Initiative (NICFI) imagery, which has a spatial resolution of around 4.7 meters. UAV imagery, vegetation leaves classification, and NDVI from NICFI imagery can be seen in Figure 3.
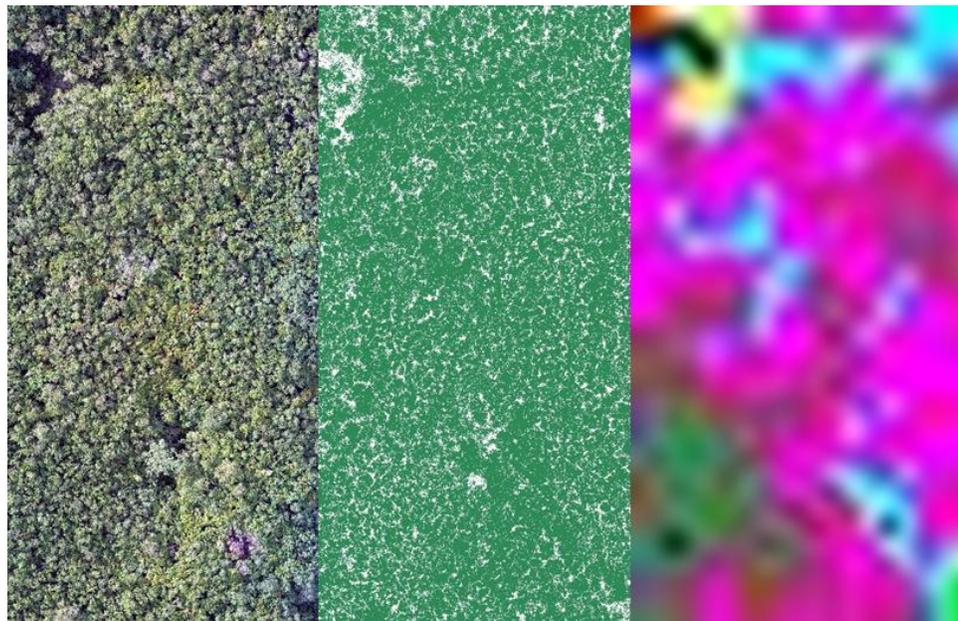

Figure 3. UAV imagery, vegetation leaves classification, and NDVI from NICFI imagery

Vegetation foliage was extracted from UAV images using K-Means automatic clustering (MacQueen, 1967). Next, the vegetation foliage data from the UAV is overlaid with NDVI from the NICFI image to obtain empirical data on the vegetation fraction for each NDVI pixel. By correlating empirical FVC data from UAV and NDVI from NICFI, the values of ζ and β are estimated using an iterative method until the highest Pearson correlation (R) value is found for each parameter. A similar method was also implemented by Thorp et al. (2012).

Simulation of Habitat Carrying Capacity

In this research, the carrying capacity of the proboscis monkey habitat is determined based on the availability of food for the entire proboscis monkey population at the location. Food availability is determined based on the estimated average quantity of food consumed by each proboscis monkey in one day. There are 23 species of plants in Bakut Island TWA (Azizah et al., 2024) with 5 plant species as food sources for proboscis monkeys (*Nasalis larvatus*). Lisnaini et al. (2020) stated that the *Sonneratia caseolaris* plant species is the main food source for proboscis monkeys in TWA Bakut Island. Other species that are food sources for proboscis monkeys are *Hibiscus tiliaceus*, *Anubias* sp., *Crinum asiaticum* L, and *Acrostichium aureum*. Based on information from the Bakut Island TWA, an average proboscis monkey consumes 50 leaves per day. The average area of a leaf consumed by proboscis monkeys is 34.75 cm². The carrying capacity of their habitat, as estimated using Leaf Area Index (LAI), assumes that all plant species are equally utilized by proboscis monkeys. However, this assumption may not accurately reflect their selective feeding behavior. The reliance on specific plant species for nutrition indicates that the carrying capacity should be adjusted to account for the actual dietary preferences of proboscis monkeys, rather than assuming uniform consumption across all available plant species (Matsuda et al., 2009; Feilen & Marshall, 2020). This nuanced understanding of their feeding ecology is essential for effective conservation strategies, particularly in light of habitat degradation and loss due to human activities (Mazlan et al., 2024).

Therefore, in simple terms, it can be stated that the carrying capacity of proboscis monkey habitat on Bakut Island is determined based on the availability of foliage area (LAI) on Bakut Island per year, which is reduced by the area of foliage consumed by proboscis monkeys per year. If at a time (year) it is predicted that the consumption of proboscis monkey foliage area will exceed the available foliage area for that year, then it can be concluded that in that year Bakut Island will no longer support proboscis monkey habitat. In other words, that year, the proboscis monkeys were running out of food.

Of course, to model or simulate the carrying capacity of proboscis monkey habitat, information is needed, such as the current population of proboscis monkeys, the percent increase in the proboscis monkey population per year, the quantity of foliage consumed by one proboscis monkey per day, and estimates of the leaf area usually consumed by proboscis monkeys. Based on data from the Bakut Island Nature Tourism Park (TWA), information was obtained that in December 2021, the population of Bakut Island proboscis monkeys was 116 individuals. Meanwhile, the percent growth rate of the proboscis monkey population is 15.22% per year, which is extracted based on the data in Fig. 4.
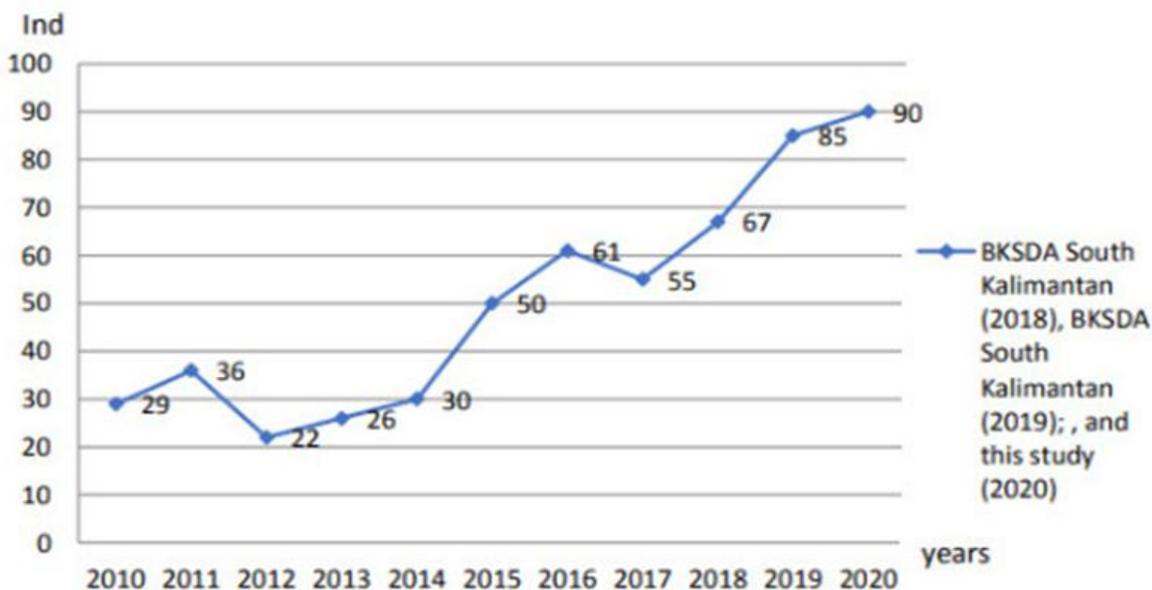

Figure 4. Proboscis monkey population dynamics in TWA Bakut Island

Based on the data in Fig. 4, the average growth of the proboscis monkey population on Bakut Island can be calculated, as in equation 4.

Average percent growth of the proboscis monkey population on Bakut Island =

$$\frac{\left(\frac{36-29}{29}\right)x100\%+\left(\frac{22-36}{36}\right)x100\%+\left(\frac{26-22}{22}\right)x100\%+\left(\frac{30-26}{26}\right)x100\%+\left(\frac{50-30}{30}\right)x100\%+\left(\frac{61-50}{50}\right)x100\%+\left(\frac{55-61}{61}\right)x100\%+\left(\frac{67-55}{55}\right)x100\%+\left(\frac{85-67}{67}\right)x100\%+\left(\frac{90-85}{85}\right)x100\%}{10} = 15.22\% \qquad (4)$$

Therefore, the average percent growth of the proboscis monkey population on Bakut Island is 15.22%. Of course, in the simulation, the number of proboscis monkeys per year is calculated using the number of proboscis monkeys recorded in 2021, namely 116, and the growth rate of the proboscis monkey population, which is 15.22%. Foliage consumption by proboscis monkeys during fishing is the product of the number of proboscis monkeys in that year and the area of foliage consumed by one proboscis monkey per day, namely 50 pieces multiplied by 0.3475 square meters. Meanwhile, the availability of foliage on Bakut Island from year to year is predicted using empirical data on the average change in LAI from 2017 to 2022, based on the results of previous calculations.

RESULTS

LAI Growth: Determinants of Feed Availability

LAI in this study using the dynamics of LAI approach that occurred on Bakut Island. Fig. 5 shows the dynamics of LAI on Bakut Island over the last six years.
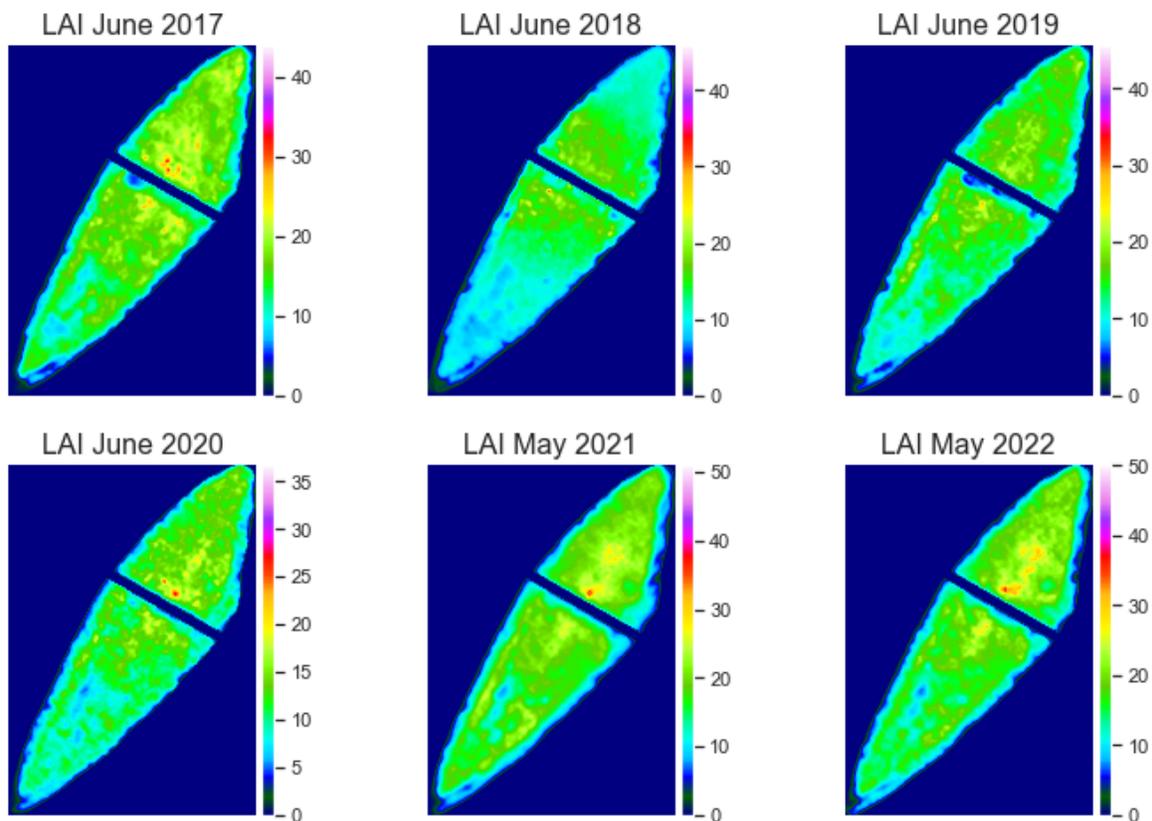

Figure 5. Multitemporal LAI of Bakut Island from 2017 to 2022

In this research, LAI is extracted multi-temporally to obtain empirical data on foliage growth rates on Bakut Island, which will later be used as input in the simulation of the carrying capacity of proboscis monkeys. The results of the analysis show that there is a significant change in LAI value from 2017 to 2018 while after 2018 until 2022 there is a gradual increase in LAI value and the highest LAI value is in 2022. In 2017, the LAI values were relatively even with a fairly wide distribution of green to yellow colors. In 2018,

the LAI value was at its lowest point as the distribution of green color was drastically reduced indicating a decrease in vegetation density. In 2019 there was an increase in LAI value compared to the 2018 results and slowly, the LAI value showed an increasing trend with green color in Bakut Island TWA experiencing an increase in area which means that there is a gradual recovery of vegetation. LAI was extracted from NICFI images recorded in June 2017, June 2018, June 2019, June 2020, May 2021, and May 2022. Henceforth, LAI change data per year was calculated using the change detection method or subtraction between the following year's LAI and the previous year's LAI. So we can get information on changes in LAI from year to year, as seen in Fig. 6.
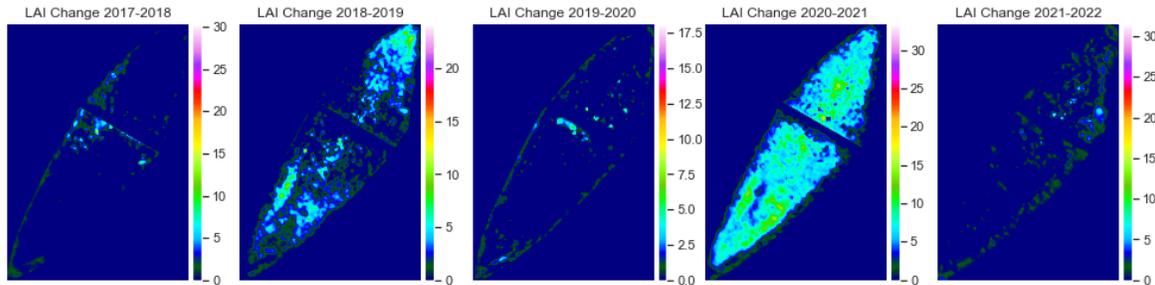

Figure 6. LAI changes in Bakut Island from year to year during the period 2017–2022

Fig. 6 shows the trend of changes in LAI values that occurred in the Bakut Island TWA from 2017 to 2022. In 2017-2018 there was a significant decrease in LAI value in several areas shown in red. This indicates that in 2017-2018 vegetation degradation occurred. In 2018-2019 there was a recovery in some areas indicated by an increase in green color in the LAI results. However, in some places in 2018-2019 there was still a decrease. In 2019-2020 there was a fairly stable increase in several areas. In 2020-2021 there was a significant increase in LAI values in most areas indicating vegetation recovery or vegetation regeneration. In 2021-2022, the increase in LAI value still occurred in several areas marked by the increasing green color in the analysis results.

Simulation of Future Habitat Carrying Capacity

The simulation of the carrying capacity of the proboscis monkey habitat was executed from 2022 to 2050. The simulation can be seen in Fig. 7.
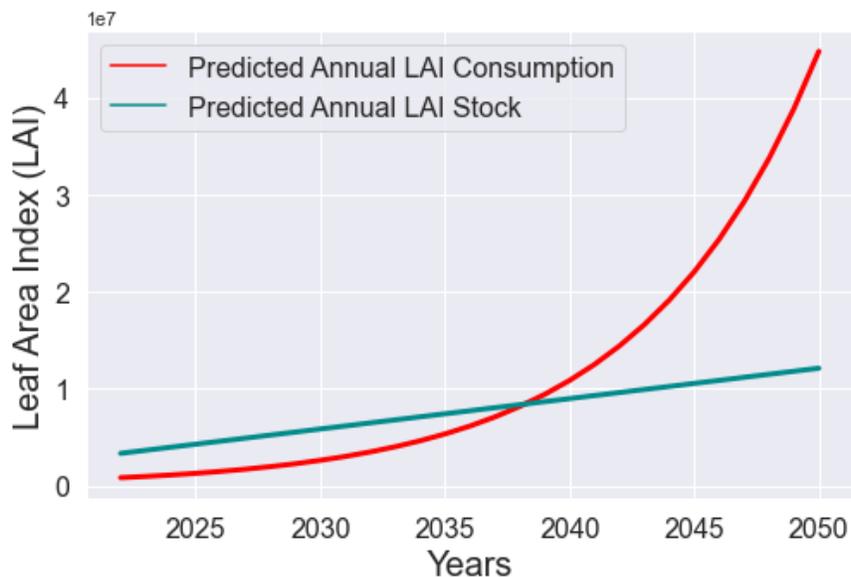

Figure 7. Simulation curve between LAI consumed by proboscis monkeys and available LAI for the period 2022 to 2050

Fig. 7 shows the simulation curve between LAI consumed by proboscis monkeys (red line) and available LAI for the period 2022 to 2050 (blue line). The available LAI shows a linear increasing trend from 2022 to 2050. This increase in LAI value indicates that the vegetation in TWA Bakut Island is still growing and increasing, albeit slowly. The pattern shown by the red line (LAI consumed) has an exponential pattern, which means that there will be an increase in leaf consumption by proboscis monkeys because it is predicted that there will be a significant increase in the proboscis monkey population in the 2022 to 2025 timeframe. Based on the simulation curve above, a prediction of annual LAI consumption by proboscis monkeys can be seen in Table 1.

Table 1. Prediction if of Annual LAI Consumption by proboscis monkeys on Bakut Island

No.	Year	Predicted Population	Predicted LAI Consumption	Predicted LAI Stock	Remaining LAI
1	2022	134	849811	3354462	2504651
2	2023	154	976649	3667703	2691054
3	2024	177	1122512	3980943	2858431
4	2025	204	1293742	4294184	3000442
5	2026	236	1496682	4607425	3110743
6	2027	271	1718648	4920665	3202017
7	2028	313	1985007	5233906	3248899
8	2029	360	2283075	5547146	3264071
9	2030	415	2631878	5860387	3228509
10	2031	478	3031416	6173627	3142211
11	2032	551	3494373	6486868	2992495
12	2033	635	4027091	6800108	2773017
13	2034	732	4642252	7113349	2471097
14	2035	843	5346201	7426590	2080389
15	2036	971	6157961	7739830	1581869
16	2037	1119	7096558	8053071	956513
17	2038	1290	8181019	8366311	185292
18	2039	1486	9424026	8679552	-744474
19	2040	1712	10857290	8992792	-1864498
20	2041	1972	12506178	9306033	-3200145
21	2042	2273	14415082	9619274	-4795808
22	2043	2619	16609371	9932514	-6676857
23	2044	3017	19133437	10245755	-8887682
24	2045	3476	22044358	10558995	-11485363
25	2046	4005	25399209	10872236	-14526973
26	2047	4615	29267753	11185476	-18082277
27	2048	5318	33726091	11498717	-22227374
28	2049	6127	38856668	11811957	-27044711
29	2050	7059	44767296	12125198	-32642098

In 2020-2036, the consumed LAI value is still below the available LAI value, meaning that the prediction states that in that year the ecosystem is still able to support the food needs of proboscis monkeys. Around 2037-2038, the consumed and available LAI values began to have similar values. This indicates that the LAI consumed and available began to approach the available capacity. After 2039 to 2050, the consumed LAI value becomes higher than the available LAI, causing the remaining LAI value to be minus or negative. This situation indicates that the proboscis monkeys are experiencing a shortage of food sources that can interfere with the survival of the proboscis monkeys.

DISCUSSION

LAI Growth: Determinants of Feed Availability

The leaf area index is a parameter that measures the total area of leaves present in a forest area. LAI is closely related to the productivity and quality of forest habitat and can be used to measure the potential natural food available for proboscis monkeys on Bakut Island. Decreases and increases in LAI values affect the high and low density of plants, which means that the higher the LAI value, the more abundant the natural food source for proboscis monkeys. Of course, not all species of plants are a source of food for proboscis monkeys, so the use of LAI will be very effective if the dominant species of plants in the research location area is the species of plants that is a source of food for proboscis monkeys. The dominant plant species growing in TWA Bakut Island is the *Sonneratia caseolaris* species because this plant species exists from the seedling level to the tree level (Azizah, et al. 2024) and this species is a source of food as well as a sleeping tree for proboscis monkeys in TWA Bakut Island (Lisnaini, et al. 2020). By analyzing LAI, this research will try to understand the level of sustainability of the proboscis monkey habitat on Bakut Island. The presence of proboscis monkeys on Bakut Island is very dependent on the availability of natural food, most of which comes from plants. Thus, assessing life capacity based on LAI is an important step to maintaining the sustainability of this species. The dynamics of LAI on Bakut Island over the last six years are shown in Fig. 5.

The entire computational and simulation process in this research was carried out using the Python 3 programming language (Van Rossum & Drake, 2009). Meanwhile, graphic visualization was carried out using Matplotlib (Hunter, 2007). From the processing results, the most optimal ζ value is 0.23 and the most optimal β value is 0.72. The estimation results of these two constants are then used as parameters in the LAI calculation using the Choudhury method. In this research, LAI is extracted multi-temporally to obtain empirical data on foliage growth rates on Bakut Island, which will later be used as input in the simulation of the carrying capacity of proboscis monkeys. LAI was extracted from NICFI images recorded in June 2017, June 2018, June 2019, June 2020, May 2021, and May 2022. Henceforth, LAI change data per year was calculated using the change detection method or subtraction between the following year's LAI and the previous year's LAI. So we can get information on changes in LAI from year to year, as seen in Fig. 6. In Fig. 6, the LAI trend that occurred was a decrease in vegetation from 2017 to 2018. Then, in 2019-2022 there was an increase or recovery of vegetation so that the Bakut Island TWA location became a suitable place for proboscis monkeys to live. The increase in LAI trends from 2019 to 2022 occurred due to rehabilitation and planting activities carried out at TWA Bakut Island. In addition, since 2019 TWA Bakut Island has been intensively managed by the South Kalimantan Natural Resources Conservation Center by conducting various supervision and management of the area such as protecting the area from human exploitation and conducting infrastructure development with one of the companies in South Kalimantan.

Practically, changes in LAI inform vegetation growth as well as vegetation loss (deforestation). The process of computing the LAI and changing the LAI is also completely carried out using Python. The extracted data on changes in the annual average LAI from 2017 to 2022 will be used as further input in modeling the carrying capacity of the proboscis monkey habitat. Of course, to model or simulate the carrying capacity of proboscis monkey habitat, information is needed, such as the current population of proboscis monkeys, the percent increase in the proboscis monkey population per year, the quantity of foliage consumed by one proboscis monkey per day, and estimates of the leaf area usually consumed by proboscis monkeys.

Simulation of Future Habitat Carrying Capacity

The simulation of the carrying capacity of the proboscis monkey habitat was executed from 2022 to 2050. Based on the simulation results, the critical year was found to be 2038. The intersection point of the two curves in the figure above represents the critical year. What is meant by critical year is the last year when the amount of proboscis monkey feed is still sufficient on Bakut Island. After 2038 onwards, the remaining LAI value will be negative. The remaining LAI is the result of a reduction between the availability of LAI (predicted LAI stock) in a year and the need for LAI for consumption by proboscis monkeys (predicted LAI

consumption). If the remaining LAI value is negative, it means that the proboscis monkey's need for feed has exceeded the available feed. In simple terms, this means that Bakut Island no longer supports the proboscis monkey habitat.

In 2038, the projected population of proboscis monkeys on Bakut Island will be 1,290, as seen in Table 1. Of course, Bakut Island will support up to 1,290 proboscis monkeys, assuming vegetation cover conditions in 2038, not current vegetation conditions. In this research, vegetation growth is assumed to be constant or linear, as shown in the LAI consumption curve above. Meanwhile, proboscis monkey population growth, like human population growth, generally has a geometric pattern like the curve above. As a result, up to a certain point, the LAI consumption curve will intersect the LAI stock curve; this is what is called a critical year. Of course, the simulation results above were made by ignoring the space or home range of the proboscis monkeys. If the homerange parameter is included, perhaps the tipping point will not be in 2038. It is even possible that the tipping point will be ahead of time.

Extraordinary events that are random and unpredictable are also ignored in the simulations in this research. Such as natural disasters, deforestation, infectious disease attacks on proboscis monkeys, and so on. Events like this certainly have the potential to quickly increase the critical point of carrying capacity of the proboscis monkey habitat on Bakut Island. Direct human intervention is also neglected in this research. Both interventions are disruptive, such as forest encroachment or infrastructure development. As well as remedial interventions, such as reforestation. Direct human intervention in the form of reforestation will improve the condition of the proboscis monkey habitat on Bakut Island. And of course, in the future, it will extend the carrying capacity of the proboscis monkey habitat on this island.

CONCLUSIONS

By only referring to food availability, the results of this research clearly show that Bakut Island is only able to support proboscis monkey habitat until 2038. Of course, this is assuming that the dynamics of the proboscis monkey population and also the environmental dynamics there are running normally, as has been going on so far. There are no extraordinary events that are random or unpredictable. Such as major natural disasters, and massive deforestation, including the absence of reforestation activities by humans. If several other parameters are involved, then the critical year may shift from 2038. If reforestation is carried out, for example, it may extend the carrying capacity of the proboscis monkey habitat on Bakut Island.

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AUTHOR CONTRIBUTIONS

Abdi Fithria: research coordinator, data analysis, data interpretation, manuscript writing; Rina Kanti: contributor research member, research implementer, data analysis, data interpretation, manuscript writing; Syamani D. Ali, Eva Prihatiningtyas, and Nor Aida Azizah: contributor research member, research implementer, data analysis, data interpretation, manuscript writing; Eko Budi Setiyawan, Ahdiyaka Jayakusuma Pribadi, and Naufal Noor Kamil: member contributor, research implementer, manuscript writing.

CONFLICTS OF INTEREST

The authors confirm that they have no relationship or involvement with any institution or entity that may have an interest, either financial or non-financial, relating to the topics or material presented in this manuscript.

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