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Population of Long-tailed Macaque (*Macaca fascicularis*) at several habitat conditions in Jambi Province, Indonesia

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Abstract. *Putri FM, Prasaja AS, Kurniawan PT, Fitriana YS, Wiantoro S. 2024. Population of Long-tailed Macaque* (Macaca fascicularis) *at several habitat conditions in Jambi Province, Indonesia. Biodiversitas 25: 3254-3262.* The Long-Tailed Macaque (LTM; *Macaca fascicularis* (Raffles, 1821)) plays a crucial role in forest regeneration through seed dispersal. However, recent ecological shifts have impacted their survival, pushing them to expand into human settlements. This study aims to investigate the current LTM population across various habitats in Jambi Province. Data on the number, gender, age, sex ratio, population density, and habitat conditions were collected. Sampling was conducted at sites previously reported for LTM-human conflicts and potential harvesting areas. The study employed point counts at 12 locations and line transects at 2 locations across five administrative regions. The results indicated a higher female-to-male ratio, with the largest population of LTMs (n = 923) found at PT Perkebunan Nusantara (PTPN) VI Bunut, followed by the Berbak River (n = 740). The smallest populations were observed at Mendalo Darat (n = 74) and Talang Bakung (n = 76). The line transect method was employed to estimate the population density at PTPN VI Bunut, resulting in approximately 0.742 individuals per hectare, translating to an estimated population of 3,436 individuals. At Muaro Jambi Temple, the density was approximately 0.826 individuals per hectare, with an estimated population of 1,884. Habitat-type Watersheds had the highest average number of individuals (713.5), followed by agricultural land (407.33), indicating that these habitats have a high carrying capacity for Long-tailed Macaques due to the availability of water and food. One limitation of this study is the single-instance sampling in 2023, which underscores the need for further research to capture population dynamics fully. The urgency and importance of this topic cannot be overstated.

Keywords: *Macaca fascicularis*, population, sex ratio, wild animal

Abbreviations: LTM: Long-Tailed Macaque; PTPN: PT Perkebunan Nusantara

INTRODUCTION

The Long-tailed Macaque (*Macaca fascicularis* (Raffles, 1821), Cercopithecidae), also known as the crab-eating macaque or cynomolgus monkey, boasts a widespread distribution across Southeast Asia (Liedigk et al. 2015). Historical records indicate their once-uniform presence throughout the region, with Indonesia harboring populations on Sumatra, Kalimantan, Sulawesi, Java, Papua, and Nusa Tenggara (Kaho et al. 2018). Liedigk et al. (2015) identified four distinct subspecies within Indonesia's isolated islands: *M. fascicularis fusca* (Simeulue Island), *M. fascicularis lasiae* (Lasia Island), *M. fascicularis karimondjawae* (Karimunjawa and Kemujan Islands), and *M. fascicularis tua* (Maratua Islands). This study focuses on *M. fascicularis* within Jambi province, the most abundant and geographically widespread subspecies.

The Long-tailed Macaque plays a crucial role in forest regeneration through seed dispersal. However, their existence is significantly influenced by varying habitat conditions. Diverse habitats, such as secondary forests, agricultural lands, and human settlements, present different challenges and opportunities for the population of these monkeys. Previous studies have shown that habitats rich in food resources and with complex vegetation structures tend to support larger populations of *M. fascicularis*. Conversely, fragmented habitats or those affected by human activities, such as oil palm plantations, can reduce the availability of food and shelter, negatively impacting population numbers (Rustiadi et al. 2023). Additionally, differences in habitat types also affect the social interactions and behaviors of the monkeys. In more natural habitats, monkeys can behave more freely and exhibit more complex social dynamics. However, in habitats with which humans are more influenced, they may be forced to adapt to a more aggressive or stressed way of life, which can affect their health and reproduction (Shano et al. 2021).

Historical population estimates for the Long-tailed Macaque in Jambi placed the population at approximately one million individuals in 1996 (Supriatna et al. 1996). However, the absence of recent surveys necessitates reevaluating the current population size. Furthermore,

extensive deforestation documented across Jambi in recent decades (Drescher et al. 2016; Rustiadi et al. 2023) warrants investigation into potential population changes and associated behavioral modifications within this primate species. Long-tailed Macaques exhibit a social lifestyle, residing in groups predominantly comprised of adult females. Adult males demonstrate sexual dimorphism, possessing a heavier body weight (5,000-7,000 grams) and longer tails (38-65 centimeters) compared to females (Meishvili and Chalyan 2021). Their pelage coloration varies from grey to chocolate tones, with a characteristic white abdomen (Fitriyah et al. 2021).

This species exhibits remarkable adaptability, enabling its presence in diverse habitats ranging from jungles and watersheds to coasts, mangroves, and hill forests (Ruppert et al. 2018; Syah 2020; Fitriyah et al. 2021). This adaptability is particularly significant in the context of human-modified environments, with LTMs frequently found in settlements, parks, and recreational forests. However, habitat variation and population density can influence LTM behavior, potentially leading to increased aggression and conflict with humans. For instance, disruptions to their natural habitat or exceeding their carrying capacity can trigger LTMs to venture outside their natural range, causing damage to agricultural fields, settlements, and plantations (Kusumadewi et al. 2014). Group size and composition further influence daily behaviors, which encompass a variety of innate and learned actions (Sajuthi et al. 2016). Notably, their behavior closely aligns with their environment, with both natural and artificial habitats supporting the expression of six key behaviors: innate (feeding, locomotion, sleeping) and learned (grooming, playing, agonistic) (Sajuthi et al. 2016).

Long-tailed Macaques play a vital role in the ecosystem and human life. As omnivores, they control insects, crabs, and other small animal populations, while their fruit diet and high mobility aid seed dispersal (Reinegger et al. 2023). From a human perspective, they offer benefits in ecology, bioremediation, medicine, recreation, and aesthetics (Fitria et al. 2020). The Indonesian government previously did not list the Long-tailed Macaque as a protected species (Permen LHK No.P.106/2018). However, their status was elevated to endangered in 2022 by the International Union for Conservation of Nature (IUCN) (Eudey et al. 2015; Hansen et al. 2022). This revision reflects the high threat from habitat disruption across multiple locations, overutilization, inadequate regulation, and human culling (Gamalo et al. 2023). The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) currently lists the Long-tailed Macaque in Appendix II, allowing trade under strict regulations (Fitria et al. 2020).

Due to their close genetic, anatomical, and physiological similarities to humans, Long-tailed Macaques are valuable research subjects, particularly in pre-clinical drug testing (Albanese et al. 2021). Once a major exporter, Indonesia implemented a zero quota in 2022, with future quotas dependent on updated population data from various regions. Primate population studies are crucial for gathering data on population density, group structure, and population dynamics, which inform conservation status assessments and guide the development of evidence-based management strategies. These data are essential for understanding population size, distribution, and social dynamics, enabling conservationists to design targeted interventions that address threats and promote the long-term viability of primate populations (Boonkusol et al. 2018).

Despite the historical estimates suggesting a substantial population of Long-tailed Macaques in Jambi, there are significant gaps in our current understanding of their population status and dynamics within the province. Reliance on historical estimates since 1996 presents major limitations. In addition, rapid habitat change in Jambi, characterized by deforestation and agricultural expansion, necessitates a contemporary assessment of the Long-tailed Macaque population. Understanding how these changes have impacted their population size, distribution, and behavior is crucial for developing effective conservation strategies. Recent studies on Long-tailed Macaques in Southeast Asia have primarily focused on specific aspects, such as their behavioral ecology, social dynamics, or disease transmission. Although these studies provide valuable insights, a comprehensive assessment of their population status and the impact of habitat modification on their ecology remains largely unexplored in Jambi. The necessity for this research is evident in the fact that the Long-tailed Macaque population data will serve as the basis for determining the catch quota of LTM as an export commodity and for informing and guiding the development of strategies for species conservation status management.

This research focuses on the observation and data collection related to Long-tailed Macaque ecology in several habitat types within Jambi province. Specifically, the research aims to gather data on the following aspects: Individual numbers, age and sex percentages, Habitat preferences, Sex ratio, Population density, and Estimated population size.

MATERIALS AND METHODS

Study area

The observation occurs at 14 different points in five administrative regions (Table 1.) The sampling point selection according to the conflict report from The Natural Resources Conservation Center (BKSDA) Jambi and habitat type in Jambi, Indonesia. The topological area of Jambi consists of lowland and medium highlands. The land covered and utilization levels consist of secondary forest, swamp, peatland, agriculture, coast, industry, and urban area. Habitat types and characteristics for each sampling point include:

Secondary forest

Hutan Kota Muhammad Sabki 1 and 2. These two locations are secondary forests that include an urban forest area as part of the green open space in Jambi City. Other use areas, including rubber and oil palm plantations, human settlements, shrubs, and retention basins, surround the forest.

PT. Indofood. The research area is located in a factory and warehouse owned by PT Indofood, directly adjacent to a secondary forest connected to rubber and oil palm plantations and human settlements.

Muaro Jambi Temple. The research site is located in Muaro Jambi National Cultural Heritage Area, characterized by the historical buildings of Muaro Jambi Temple and surrounded by community plantations. The land use areas consist of secondary forests, plantations, horticultural agriculture, rice fields, settlements, rivers, and tributaries, ancient canals, swamps, and shrubs. Muaro Jambi Temple research area is 2,280 ha, divided into 6 transect lines (A-E) with a total transect length of 21.09 kilometers.

Human settlements

Talang Bakung. This location is a human settlement intermingled with community plantations.

Mendalo Darat. The research area is a human settlement with a high population density that retains secondary forest cover. Other use areas, such as public facilities, rubber and oil palm plantations, and shrubs surround it.

Jambi University and UIN Sulthan Thaha Saifuddin Jambi. This location is an educational facility and human settlement that still has secondary forest cover or plantation vegetation.

Agricultural land

Ness. The study site comprises rubber and oil palm plantations and human settlements.

Betara. The research location is primarily a concession of Sinarmas Group Industrial Plantation Forest (PT. WKS), which borders on the cultivation rights of oil palm plantations. The land cover in this area consists of industrial plantation forests (*Acacia microcarpa* F.Muell.), oil palm and areca nut plantations, as well as shrubs.

PTPN VI Bunut. The study site is located in the PTPN VI Bunut plantation concession area, which is dominated by oil palm plantations and other land uses such as secondary forests, rubber plantations, settlements, shrubs, swamps, rivers, and tributaries. The PTPN VI Bunut research area covers 4,631 ha and is divided into 6 transect lines (A-E) with a total transect length of 41.67 kilometers.

Peat swamp forest

Hutan Lindung Gambut (HLG) Sungai Buluh. This location comprises mostly peat swamp forests with dense vegetation cover and some areas of oil palm plantations. It is a former production forest situated near settlements and concession areas of oil palm plantations and oil mining companies.

Watershed/Riparian area

Berbak River. The research site is located within the Batanghari watershed. The Berbak River flows through the East Tanjung Jabung District for approximately 69 kilometers, with an average width of 100-300 meters. Secondary forests, mangroves, settlements and public facilities, oil palm plantations, areca nut plantations, coconut plantations, and shrubs characterize the riparian area.

Tembikar River. The research area is situated in the Tembikar River, which forms a part of the Tembikar River Sub Watershed. The river has an approximate length of 92 kilometers and an average width of 8-38 meters. Secondary forests and mangroves, settlements and public facilities, oil palm plantations, areca nut plantations, coconut plantations, and shrubs characterize the riparian area.

Data collection

The research was conducted from September to November 2023. From the end of the dry season to the beginning of the rainy season. The lowest temperature was 24°C, while the highest was 31°C at all sampling sites. The individual number was estimated using "Point count" and "Line transect (Perpendicular distance)". Point count was used for concentrated observation at several locations with a high possibility of encounters. On the other hand, the line transect has used a distance to estimate the macaque population at the observation point.

Point count

Point count or Concentration count is an observational method conducted on most concentrated animals (Ziyus et al. 2019). This method was conducted at 12 sampling points (Table 2). The number of individuals was estimated by counting one by one encountered at the predetermined concentration point. The observers conducted observations over a single day, starting from 06:00 AM to 12:00 AM and continuing by re-counting individuals from 01.00 to 06.00 PM. Time, coordinates, gender, age, habitat condition, and weather were collected during observation.

Line transect (Perpendicular distance)

Line transect sampling with Perpendicular distance was a common method to estimate primate species' density and population size (Figure 1). The width of the line in this approach is calculated by the distance between the observed primate and the perpendicular line (Marshall et al. 2008).

Data collection was conducted using line transects at two locations: PTPN VI Bunut and Muaro Jambi Temple. The selection of these two sites was based on their suitability for the line transect method, taking into account the area and topographic conditions. Line design at the observation location consisted of six transect lines with each length from 2 to 7 km long at each observation location. Each transect apart approximately ±1 to 2 km wide (Figure 2).

Several teams of observers walked along the transect lines. The number of individuals was estimated by counting one by one the encountered Long-tailed Macaques through a transect line in a single day, starting from 06:00 AM to 12:00 AM and continuing by re-counting individuals from 01.00 to 06.00 PM. Observations using the line transect method were repeated on the following day. The angle of encounters, time, coordinate, gender, age, habitat condition, and weather were collected during observation.

Gender and age determination

Gender and age determination of Long-tailed Macaques is conducted through visual observation based on physical characteristics. Male long-tailed monkeys have a larger

body size, and adult females have a large and visible scrotum (Afifah et al. 2022). The age structure observed among long-tailed monkeys in this study consisted of adult, juvenile, and infant. However, due to the constraints of the observation period, only the adult population was identified and enumerated.

Data analysis

The data retrieved from the field underwent a cleaning data step to avoid double counting. The cleaning data step was based on several factors, including the distance of each encounter, the macaque's daily mobility, and the similarity between each encountered long-tailed individual and group. The researcher also considers the habitat and area coverage and food availability. The clean data was then tabulated at Ms. Excel for further analysis. Quantitative analysis was done to investigate the sex ratio with several formulas:

Sex ratio analysis using:

$$SR = \frac{J}{B}$$

Where:
SR : Sex Ratio
J : Number of adult males
B : Number of adult females (Krebs 1989)

Density using:

$$D = \frac{N}{(AB \times 2DE)}$$

Where:
D : Density (ind/ha)
N : Individual number
AB : Line length (m)
DE : Perpendicular distance to observer point (average) (m)

The perpendicular distance was estimated using:

$$DE = CD \sin \alpha$$

Where:
DE : Perpendicular distance of animal to observation line (average) (m)
CD : Observer distance to animal (m)
α : The angle of the animal from the observer (Buckland et al. 2016)

The estimation of the animal population at two locations from line transect methods using:

$$P = D \times A$$

Where:
P : Population
A : Area
D : Density (Krebs 1989)

Spatial data management and analysis were done using ArcGIS's Geographic Information System (GIS) software, while maps and animal spreading at the research site were generated using QGis software.

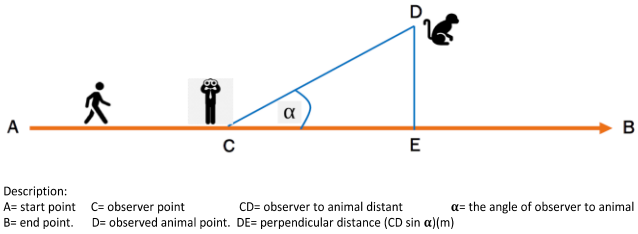

Figure 1. The illustration of the Line transect method using Perpendicular distance (Source: Bimtek Pusris Biology-BRIN 2022)

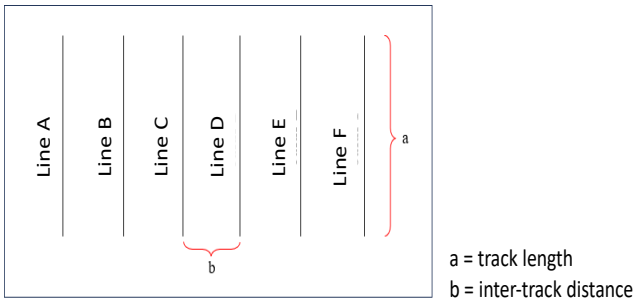

Figure 2. The transect line design at the observational location

Table 1. The selected sampling site location in this research

Administrative region	Coordinate	Sampling point	Method
Kota Jambi	103.560°E; -1.675°S	• Hutan Kota Muhammad Sabki 1	PC
		• Hutan Kota Muhammad Sabki 2 (Hutan Kota Bagan Pete)	PC
		• PT. Indofood	PC
		• Talang Bakung	PC
Muaro Jambi	103.413°E; -1.927°S	• Mendalo Darat	PC
		• UNJA	PC
	103.413°E; -1.927°S	• UIN	PC
		• PTPN VI Bunut	LT
	103.670°S; -1.469°E	• Muaro Jambi Temple	LT
Batanghari	103.339°E; -1.728°S	• Ness	PC
Tanjung Jabung Barat	103.434°E; -1.023°S	• Betara	PC
Tanjung Jabung Timur	103.900°E; -1.149°S	• Hutan Lindung Gambut (HLG) Sungai Buluh	PC
	103.560°E; -1.073°S	• Berbak River	PC
		• Tembikar River	PC

Note: PC: Point Count; LT: Line Transect

RESULTS AND DISCUSSION

After conducting two sampling methods at 14 locations in five different administrative regions (Figure 3), the acquired data was tabulated (Table 2). The number of LTM encountered is influenced by various factors related to the habitat types and conditions of each sampling location.

The highest number of Long-tailed Macaques (n = 923) was found at PTPN VI Bunut, followed by Sungai Berbak (n = 740). On the other hand, the lowest number was at Mendalo Darat (n = 74), then Talang Bakung (n = 76). The sampling point at PTPN Bunut is located in an area primarily used for oil palm plantations. Long-tailed Macaques in this area are likely due to the availability of food resources, specifically the consistent and abundant supply of palm fruits. Macaques spend approximately two-thirds of their time foraging and feeding within palm oil plantations (Holzner et al. 2021). Due to water and food availability, Long-tailed Macaques are also commonly found in the rivers (Berbak and Tembikar Rivers). Water availability is crucial for primates as it is necessary for drinking, food digestion, metabolism, and cooling through evaporation. Rivers often support diverse plant and animal life that can serve as a food source. Additionally, riparian areas can provide a better microclimate and act as migration corridors for macaques (Rifqi et al. 2023). Meanwhile, there were fewer macaques found in human settlement areas. Human settlements can be less favorable for macaques than natural habitats due to habitat loss, reduced food availability, conflicts with humans, and other dangers associated with human activities.

Based on the sampling methods, the "Point count" retrieved 111 groups and 2,834 individuals from 12 sampling points, whereas line transects found 38 groups and 1,378 individuals from 2 sampling points. The majority of Long-tailed Macaques encountered were adults. In this study, the number of individuals was 20 to 30 in each group, which was similar to previous reports (Hansen et al. 2019; Fauzi et al. 2020).

The analysis of the data revealed a significant correlation between habitat type and the number of Macaca observed at the study site (Figure 4).

Table 2. The number and characteristics of Long-tailed Macaque (*Macaca fascicularis*) at 14 different locations

Location	Habitat type	No. of groups	Male				Female				Unidentified gender	Total
			D	R	A	SR	D	R	A	SR		
Jambi City												
• Hutan Kota Muhammad Sabki 1	SF	4	17	-	-	1	25	-	-	1.47	52	94
• Hutan Kota Muhammad Sabki 2 (Bagan Pete)	SF	10	38	-	-	1	63	-	-	1.63	191	292
• PT. Indofood	SF	3	14	-	-	1	25	-	-	1.78	86	125
• Talang Bakung	HS	2	14	-	-	1	30	-	-	2.14	32	76
Total												587
Muaro Jambi District												
• Mendalo Darat	HS	3	3	-	-	1	39	-	-	13	32	74
• Jambi University	HS	5	23	-	-	1	48	-	-	2.08	80	151
• UIN Sulthan Thaha Saifuddin Jambi	HS	3	18	-	-	1	30	-	-	1.66	66	114
• PTPN VI Bunut	AL	22	165	-	-	1	264	-	-	1.6	494	923
• Muaro Jambi Temple	SF	16	52	-	-	1	129	-	-	2.48	274	455
Total												1717
Batanghari District												
• Ness	AL	5	18	-	-	1	30	-	-	0.94	77	125
Total												125
Tanjung Jabung Barat District												
• Betara	AL	4	19	-	-	1	32	-	-	1.68	135	186
Total												186
Tanjung Jabung Timur District												
• Hutan Lindung Gambut (HLG) Sungai Buluh	PSF	7	22	-	-	1	38	-	-	1.72	110	170
Berbak River	WS	33	151	-	-	1	216	-	-	1.43	373	740
• Tembikar River	WS	32	168	-	-	1	239	-	-	1.42	280	687
Total												1597

*Note: D: Dewasa (Adults); R: Remaja (Juvenile); A: Anak (Children); SR: Sex Ratio; SF: Secondary Forest; HS: Human Settlement; PSF: Peat Swamp Forest; AL: Agricultural Land; WS: Watershed

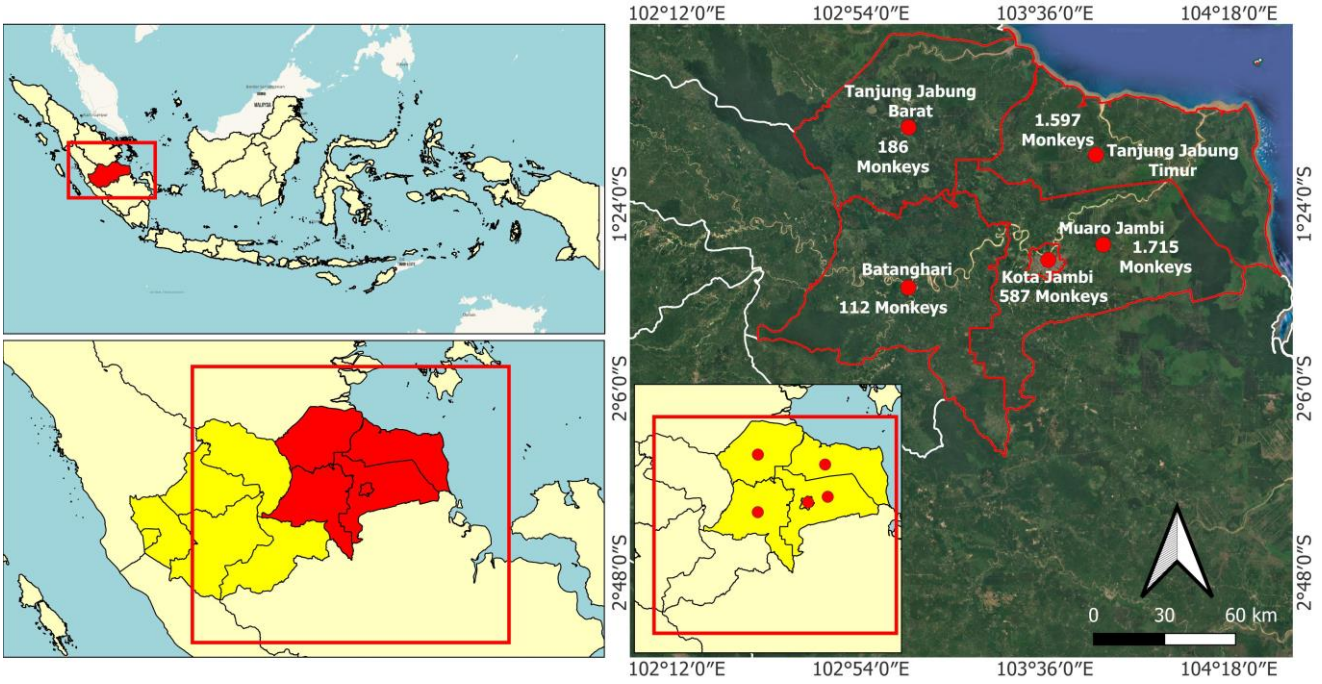

Figure 3. Aerial visualization of sampling locations in Jambi Province and the total number of Long-tailed Macaques (*Macaca fascicularis*) obtained in each administrative region. Note: The red dots are the locations of Long-tailed Macaque

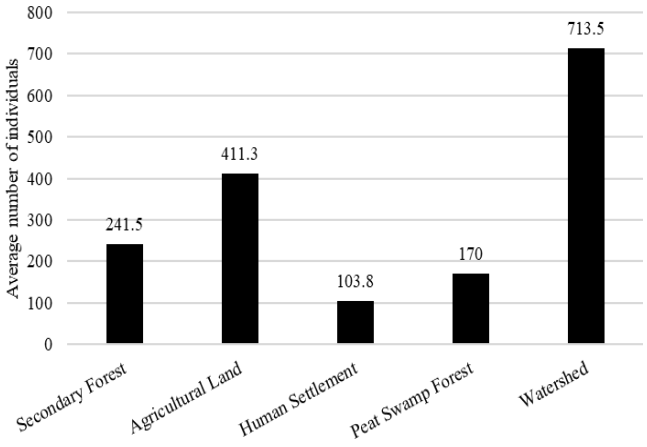

Figure 4. The average number of macaque individuals by habitat type

The highest average number of individuals was found in watersheds (n = 713.5), followed by agricultural land (n = 411.3). This shows that habitats close to water resources and food-rich agricultural land provide a high carrying capacity for Long-tailed Macaque populations. Watersheds or riparian areas provide stable water sources and abundant vegetation, which renders them highly attractive habitats for *M. fascicularis*. This indicates that riparian areas play a vital role in supporting larger populations. Meanwhile, agricultural land has shown that Long-tailed Macaques often use these agricultural areas for foraging, especially when they provide access to planted fruits, such as those found in oil palm and rubber plantations. These landscapes, which have been altered from their natural forest state, present both challenges and opportunities for the macaques. Macaques in oil palm plantations have been observed exploiting palm kernels as a primary food source by using tools such as stones to crack the kernels (Ruppert et al. 2018).

Secondary forest exhibited a moderate average number (n = 241.5), which indicated the significant yet suboptimal role of regenerated forest areas as habitats for macaques. Secondary forests typically have a more diverse and patchy vegetation structure than primary forests that have not been disturbed by human activities. Although secondary forests often have lower biodiversity, they can still serve as a habitat for species such as the Long-tailed Macaque (*M. fascicularis*); these forests provide essential resources such as food and shelter that help wildlife survive in fragmented landscapes (Pain et al. 2021). The average for the Peat Swamp Forest (n = 170) is lower than that of other natural habitats, indicating that the Peat Swamp Forest may experience less optimal conditions due to its distinctive ecological challenges. Peat swamp forests are distinguished by waterlogged conditions, acidic soils, and low nutrient availability, which may render them less hospitable for certain wildlife species in comparison to other habitats, such as watersheds (Page and Rieley 2016).

The lowest average is observed in human settlement areas (n = 103.8), which may indicate that human presence, development, and disturbances have a negative impact on macaque populations. Macaques frequently encounter obstacles in regions with elevated human activity due to habitat fragmentation, diminished food accessibility, and direct human-animal conflicts. Macaques residing in proximity to urban environments are more susceptible to conflicts with humans, which can result in decreased

population densities and even local extinctions in extreme cases. Human disturbances, such as land development, deforestation, and the presence of infrastructure, contribute to habitat loss and degradation, rendering these areas less suitable for macaque populations (Priston and McLennan 2012).

Sex percentages and ratio

Sex ratio calculations were obtained by comparing the number of male and female Long-tailed Macaques. Overall, in this study, the number of adult females was higher than males at all locations (Figure 5). This finding was similar to the previous report (Fauzi et al. 2020). The sex percentages of the LTM population in Jambi Province are 17% adult males, 29% adult females, and 54% unidentified (Figure 5), resulting in a sex ratio of 1:1.67. This result is similar to a study conducted by Boonkusol et al. (2018), who estimated that the Long-tailed Macaque population in Lopburi Province had a sex ratio of 1:1.3 (male to female), indicating that there are approximately 1.3-1.6 females for every male.

The tendency for more adult females than males in ape populations, a topic of significant importance can be attributed to several factors. Sex-biased dispersal is observed in macaques, with males leaving their natal groups to join or form new groups. This reduces the number of males in the original group and increases the number of females (Barus et al. 2018). Male mortality rates are often higher due to increased risks associated with aggression, competition for mates, and dispersal hazards (Al Hakim et al. 2022).

The number of genders that could not be identified was quite large, highlighting the challenges we faced due to several observational limitations. These limitations include the complexity of their natural habitat, such as dense foliage, and the animals' rapid movement, which makes it difficult to observe them closely. Additionally, distinguishing the sexes without close examination or if the genital area is not visible presents inherent challenges. Accurate sex determination of these primates can be tricky because they may only be observed from a distance. As a result, a significant portion of individuals in a given study may remain unidentified regarding their sex (Barus et al. 2018; Al Hakim et al. 2022).

Estimation of density and population

Density and population estimations of Long-tailed Macaques were conducted using the line transect method at PTPN VI Bunut and Muaro Jambi Temple. The total length of the transect lines in PTPN VI Bunut was 41.67 km, covering a 4,631-ha area. The population density was estimated to be 0.742 individuals/ha, resulting in an estimated population of around 3,436 individuals inhabiting the 4,631 per ha area at PTPN VI Bunut.

The lines transect in Muaro Jambi Temple were 21.09 km long and constructed over a 2,280 per ha area. The population density was 0.826 individuals/ha, estimating a population of around 1,884 individuals living in the area. The size of a habitat can affect the size of its population. Larger areas can support larger populations, although at slightly lower densities because they offer more resources and living space for individuals to thrive. On the other hand, smaller territories may be able to accommodate fewer individuals despite higher density due to competition for limited resources such as food, water, or shelter. These findings are a result of collaborative research efforts, underscoring the importance of shared knowledge in understanding and conserving primate populations. Other studies have also reported on the population of Long-tailed Macaques in certain areas. Tinjil Island had a population of 627.38±23.53 individuals, according to Perwitasari-Farajallah et al. (2022), while Deli Island had 4,860 individuals, as reported by Fitriana et al. (2024). Similarly, Tiempo et al. (2023) reported a population of 198±9 individuals (53±8 males, 81±13 females, and 64±6 juveniles) in Butuan City, Philippines.

The trend obtained in this study, which follows previous reports, underscores the importance of understanding Long-tailed Macaque populations (Figure 6). Long-tailed Macaque groups and their population numbers are intricately linked to habitat and the presence of food sources. The result on the population of Long-tailed Macaques (*M. fascicularis*) in Jambi province suggests significant ecological changes impacting their distribution and population. Our research indicates that macaque populations are higher in watershed and agricultural land compared to human settlements, underscoring the critical implications of habitat change due to deforestation and land conversion. We acknowledge that territorial behavior and habitat preferences influence the distribution of apes, but our research provides a deeper understanding of their tendency to inhabit areas with sufficient food resources and protection from predators, such as watersheds or agricultural land.

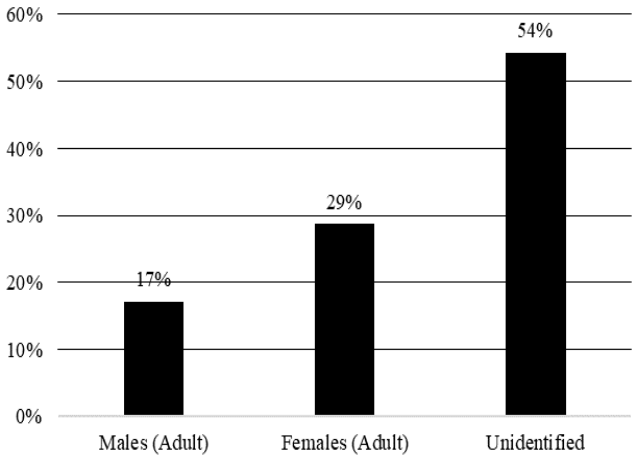

Figure 5. The sex percentage of the LTM population of Long-tailed Macaque (*Macaca fascicularis*) in Jambi Province, Indonesia

Figure 6. Long-tailed Macaque (*Macaca fascicularis*) discovered in Jambi Province, Indonesia

However, the study acknowledges the limitations of a single sampling event in 2023, which may not fully capture the population dynamics. Therefore, we recommend continued research, including annual sampling, to monitor population fluctuations accurately. Extensive deforestation poses risks like habitat loss, reduced food sources, and increased human-primate conflicts, potentially leading to decreased population sizes, behavioral changes, and migration to more fragmented areas, which can affect social structures and overall health. Further study should focus on addressing these gaps by conducting long-term monitoring to better understand population dynamics and habitat impacts.

In conclusion, the study results showed that adult women dominated the gender composition and age structure of all LTM groups encountered. Due to the availability of water and food resources, the number of LTM was higher in watershed and agricultural land than in human settlements. The Long-tailed Macaque population density ranges from 0.742-0.826 individuals per hectare, with an estimated population of 3,436 and 1,884 individuals.

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