Population Estimate of Long-Tailed Macaques (*Macaca fascicularis*) on Tinjil Island

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ABSTRACT

Tinjil Island was established as a Natural Habitat Breeding Facility for long-tailed macaques (*Macaca fascicularis*) in 1997. Between February 1998 and January 2007, 603 (61 males and 542 females) simian retrovirus (SRV) free long-tailed macaques were introduced to the island on the south coast of West Java and function as a primate resource and conservation program. To date, 3256 progenies have been harvested and used as the animal model. Therefore, it is necessary to survey the current population of the long-tailed macaques to evaluate whether the population is still under the island's carrying capacity. This research aims to identify the population estimate of long-tailed macaques currently occupying the island. The observation was conducted in July 2021 using line transect sampling starting from 07.00 AM and 01.00 PM. Twelve observations were conducted during the study using CD and ES transects. CD (Chuck Darsono) and ES (Emil Salim) are the two longest trails on the island and represent the names of the people who initiated the captive breeding of Tinjil Island. The estimated group density of the long-tailed macaques on Tinjil Island is 13.46 groups/km², while the estimated population density is 111.04 individuals/km². The population estimated on the island is 627.38±23.53 individuals. The number indicates that the population is still under carrying capacity.

1. Introduction

Long-tailed macaques (*Macaca fascicularis*) are geographically widespread and range across Southeast Asia. The species is found throughout Indonesia (except on Sulawesi and Papua) and lives in primary, secondary, coastal, mangrove, and riverine forests. Currently, the species is categorized as Vulnerable (ver 3.1) in the IUCN Red List 2021 (Eudey *et al.* 2021).

The long-tailed macaque serves two important roles, one that contributes to environmental conservation and the second in terms of its importance to studying human disease. From an environmental standpoint, the long-tailed macaques play a vital role in forest maintenance via their support as seed dispersers and pollinators. Suppose the population size of long-tailed macaques is decreasing, particularly in forest habitats. In that case, this may present a significant, long-term impact on the natural restorative processes of the forests and the fruiting species that support considerable biodiversity. The long-tailed macaque also serves a critical role as an animal model in studying human disease and treatments/cures. This macaque species has become one of the most important species in support of biomedical research in Indonesia and worldwide. It is frequently used in the study of some of the most serious infectious diseases (e.g., HIV-AIDS, malaria, dengue fever, Zika virus, infection, covid-19) and health issues (cardiovascular disease, osteoporosis, dementia, erectile dysfunction) facing our global community (Colman 2018; Harding 2017; Koide *et al.* 2016; Morton *et al.* 2005, Williams *et al.* 2012; Salguero *et al.* 2021). As such, the long-tailed

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macaque plays a central role in future research on human health. Most long-tailed macaques used in research in Indonesia are captive bred; any macaques sent abroad must be captive bred. Suppose we are to ensure the supply of macaques for important human-health research. In that case, it will be necessary to supplement existing captive breeding colonies in Indonesia with occasional animals from the wild to maintain sufficient genetic diversity and sustainable breeding programs. As such, the conservation of the species in the wild is also critical to supporting Indonesia's captive breeding programs and future discoveries and cures for human disease.

PSSP LPPM IPB carried out the captive breeding of long-tailed monkeys on Tinjil Island in 1987. Between 1998 and 2007, 603 (61 males and 542 females) retrovirus (SRV) free long-tailed macaques were introduced onto Tinjil Island. This species lives freely and breeds in a natural habitat of 565 ha. Since the beginning of captivity, 3256 progenies have been harvested and used as the animal model. Although the harvesting program is still being carried out, it is very important to evaluate the population of long-tailed macaques on the island to determine whether the population is still below its carrying capacity.

2. Materials and Methods

2.1. Study Site

Tinjil Island is a semi-natural breeding facility for long-tailed macaques, managed by the Primate Research Center of IPB University and located on the south coast of West Java, surrounded by the Indian Ocean and geographically located at 6°57′44″S and 105°47′0″E. The island's area is 5.65 km², covered by secondary lowland rainforest and beach forest. Tracks are available from East to West and North to South (Figure 1).

2.2. Data Collection

This study has been approved by the Animal Care and Use Committee Protocol Assessment with IPB PRC-21-E006 as the protocol assessment number. The observation was conducted on the CD and ES transects during July 2021. These two transects are the longest transects on the island that run from east to west, while others are only 870-1,000 m in length that crosses from north to south. Selecting CD and ES transects makes it possible to identify groups from the east to the west of the island. The observation was conducted using line transect sampling starting
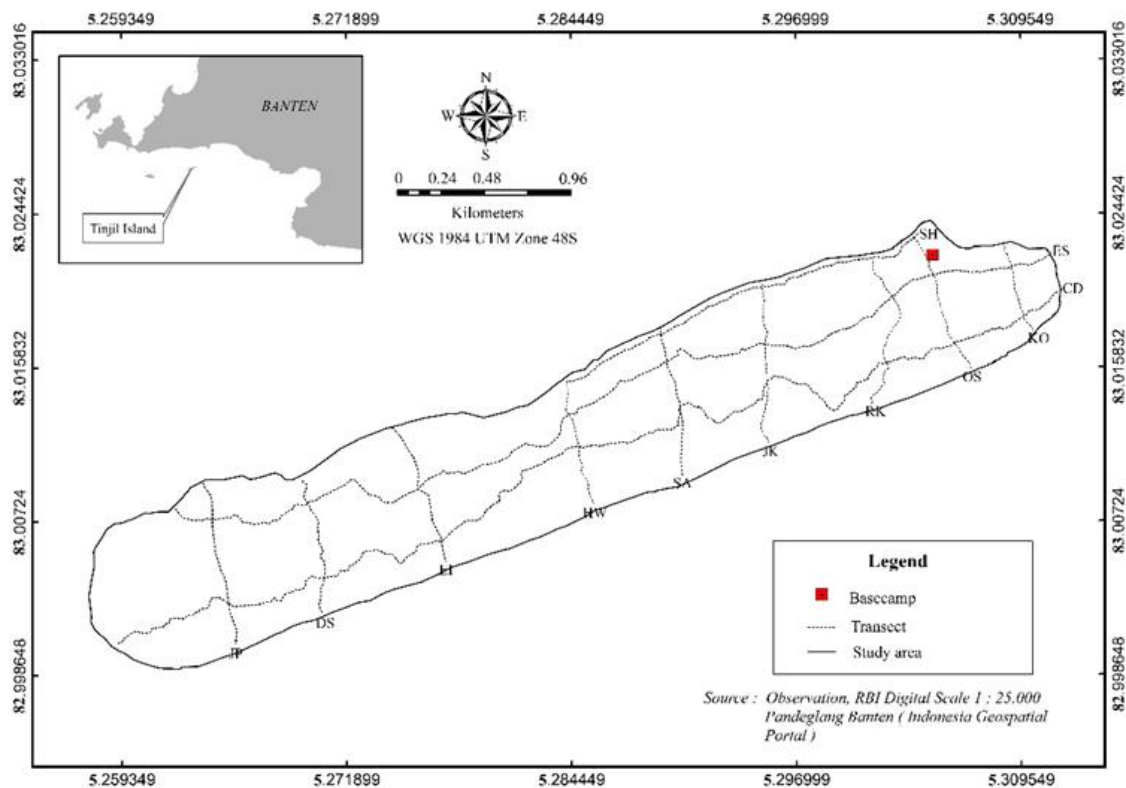

Figure 1. Tracks on Tinjil Island

from 07.00 AM and 01.00 PM local time. The team were divided into two groups, consisting of 2-3 people. Each transect was observed 6 times from the total possible 8 observation times due to weather issues. The length of CD and ES are 7.45 km and 6.37 km, respectively. The width of the sampling area was 50 m for each side of the transects, resulting in 100 m (0.1 km) of sampling width. Observers walked slowly and quietly along the transect making frequent stops to listen and scan the area. When an individual/group was detected, the following standard information was recorded: time of the sighting, location (via GPS and transect number), transect to animal distance (perpendicular distance from the transect to the first animal observed used in calculating strip width), group size (and age/sex composition if possible). Although visual contact data was preferred, we also recorded vocal contacts with a subjective assessment of transect-animal distance.

3. Results

There are 16 groups of long-tailed macaques on the island, mostly identified in the eastern part of the island's centre. We considered the two groups to be different if the distance between these two groups is more the 300 m due to the consideration that Tinjil Island is a small island. The group encounters' coordinates are plotted into the Tinjil Island map to avoid overlap between groups. If the distance between the two groups is less than 300 m, they are grouped into the same group (Figure 2).

Twelve observations were conducted during the study on CD and ES transects, resulting in data as shown in Table 1.

CD group density was estimated at 10.96 groups/km^2, while ES was estimated at 15.96 groups/km^2. The mean of these totals was then calculated, providing an overall density estimate of 13.46 groups/km^2. The estimated population density on CD was 66.67
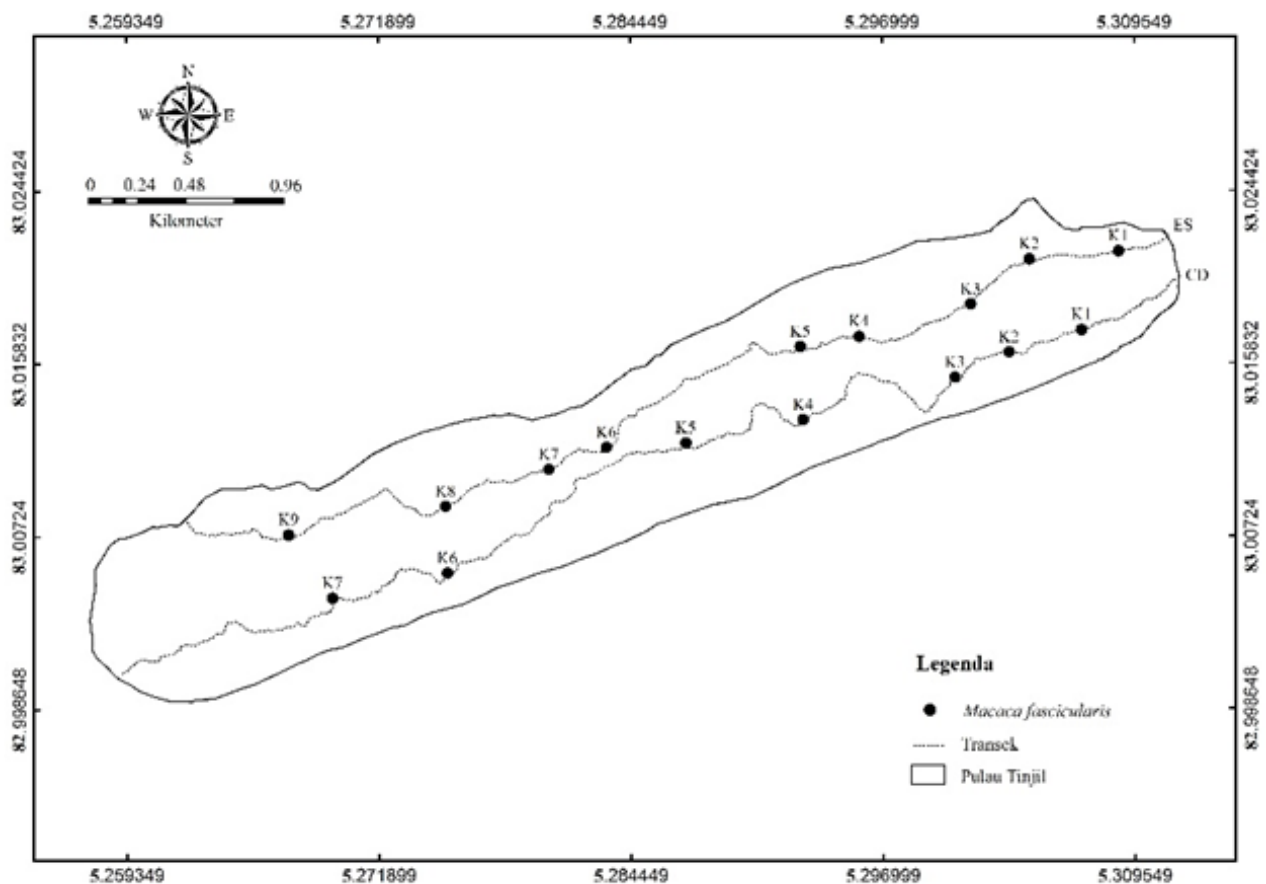

Figure 2. Groups identified on Tinjil Island

Table 1. Group density and individual density of long-tailed macaques for each track

Parameter	Track	Sampling						Total	Average	Density (per km²)
		1	2	3	4	5	6			
Number of groups	CD	8	10	7	12	9	3	49	8.17	10.96
	ES	10	10	10	10	10	11	61	10.17	15.96
Number of individuals	CD	67	65	39	55	47	25	298	49.67	66.67
	ES	91	115	93	123	128	44	594	99.00	155.42

individuals/km², while on ES was estimated at 155.42 individuals/km². The average population density was then calculated at 111.04 individuals/km². To estimate population density is to add up the number of individuals identified during the observation divided by the survey area multiplied by the number of replications. The total number of groups and individuals was calculated for the island's total area. The number of individuals occupying the island is around 627.38±23.53 individuals.

4. Discussion

The number of groups identified on the island was 16 groups. It is slightly smaller than Kyes (1997), indicating the presence of 18-20 social groups throughout the island. This slight difference in the past 24 years is due to the distance to declare the two different groups. In this study, to distinguish two different groups, the required distance is 300 m. The average population density was estimated at 111.04 individuals/km². This estimate was higher than the previous study (Leeson *et al.* 2004), which estimated the population density at 33.6 individuals/km². The group density for CD and ES were 6.4 groups/km² and 7.5 groups/km², respectively, smaller than the current group density. Besides reproductive activity, other factors, such as food availability, may influence the increasing population and groups. The population estimate obtained from this study is 627.38±23.53 individuals. The estimated population is still far below the island's carrying capacity to support long-tailed macaques, which is 1,881 individuals. The result is underestimated from the actual number, given the lack of sampling time. This population estimate is lower than the previous study (Kyes *et al.* 2012), which estimated the population size on the island at 1.350 animals. This can be assumed as the result of the time differences between the two studies, the capability to identify the number of individuals in a group and the method used. In addition, the harvest that has been carried out has reduced the number of existing populations, and there has been no addition of breeders introduced to the island for 14 years.

Acknowledgements

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