

**PAN-INDIA ASSESSMENT AND MONITORING  
OF ENDANGERED SPECIES COVERED UNDER THE  
INTEGRATED DEVELOPMENT OF WILDLIFE  
HABITATS PROGRAM (IDWH) - NILGIRI TAHR**



**भारतीय वन्यजीव संस्थान  
Wildlife Institute of India**



Ministry of Environment, Forest and Climate change  
Government of India

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- NILGIRI TAHR



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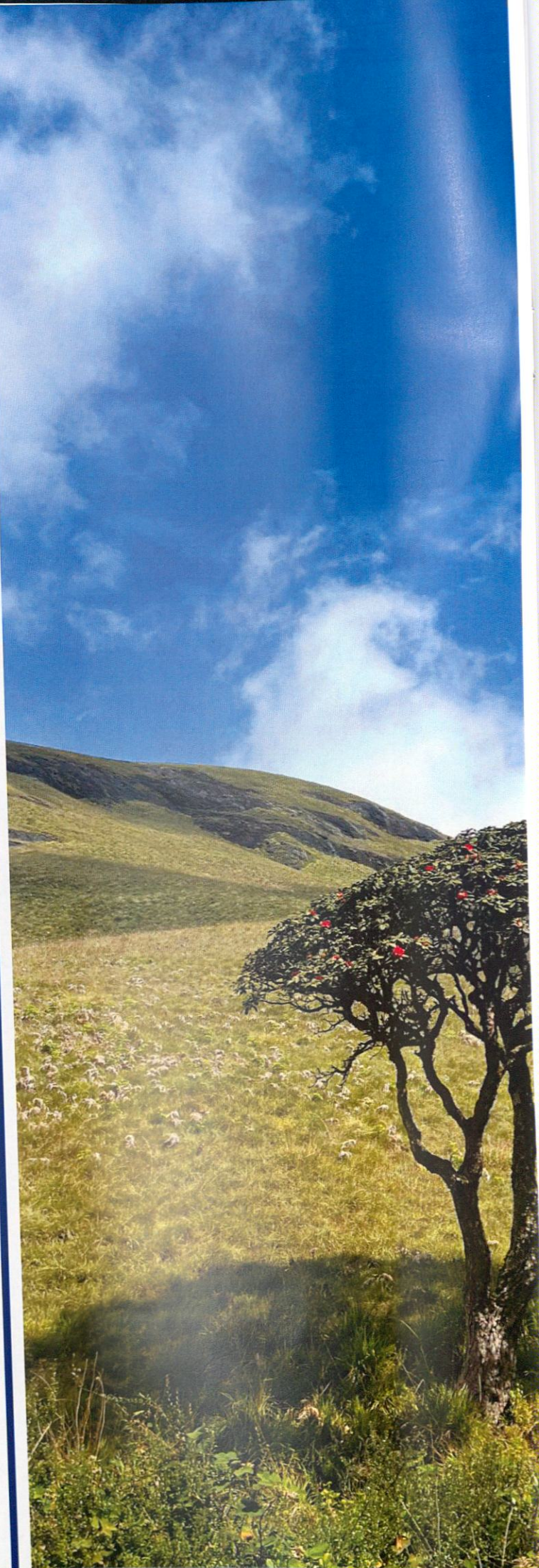
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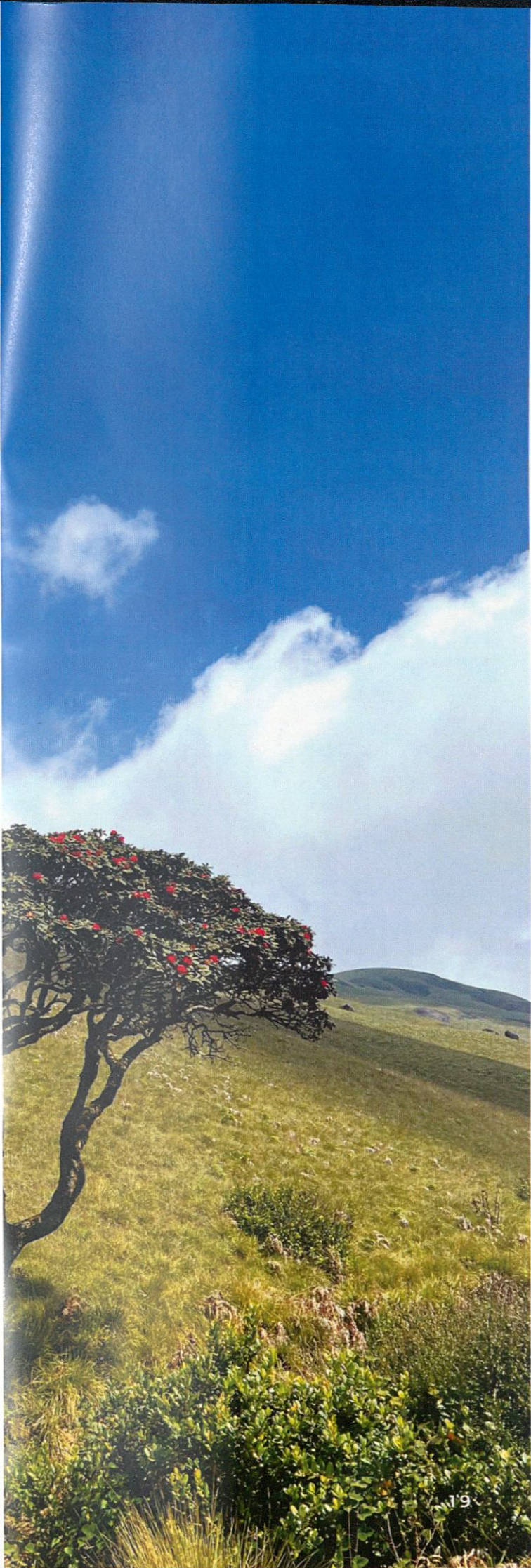
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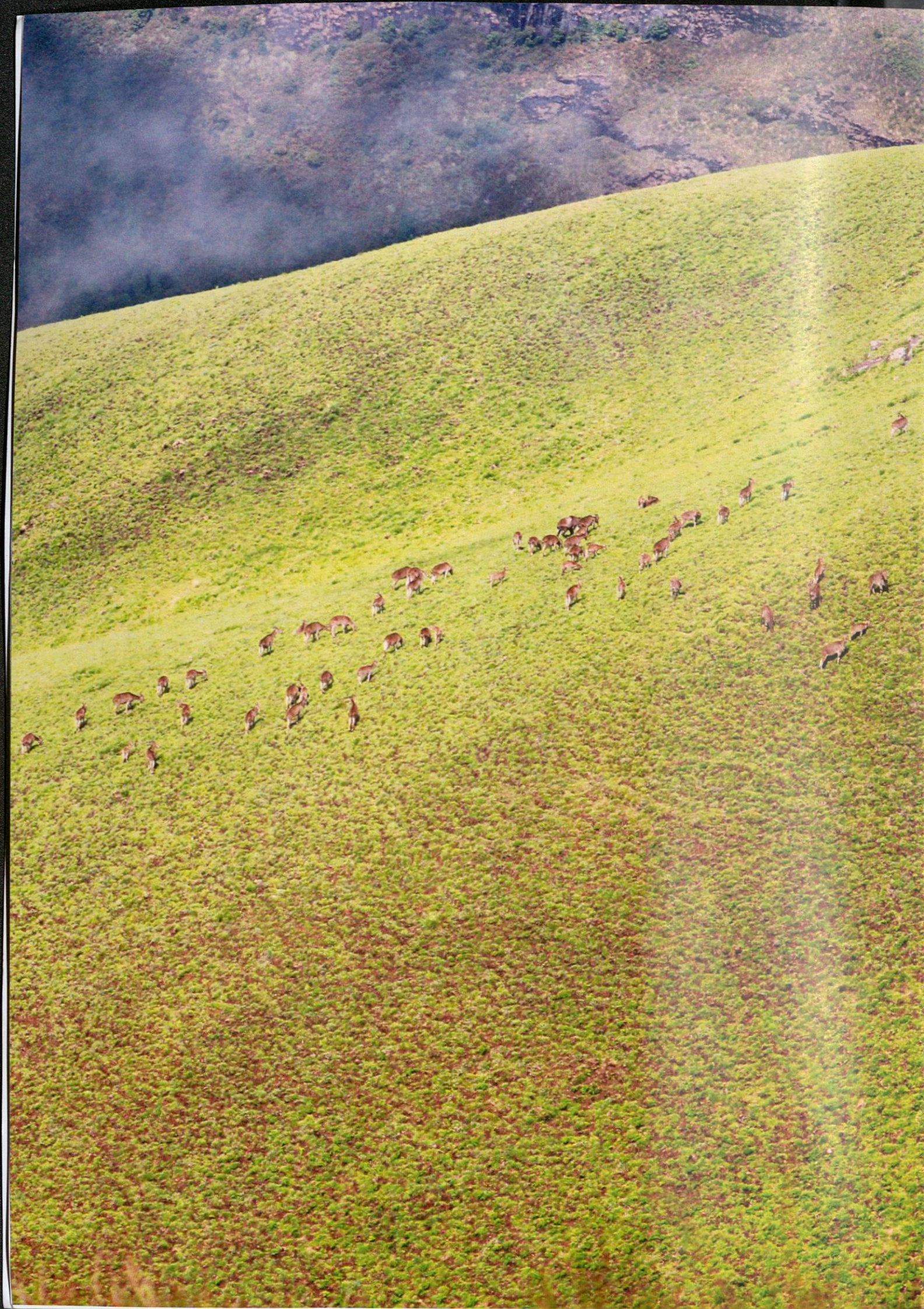
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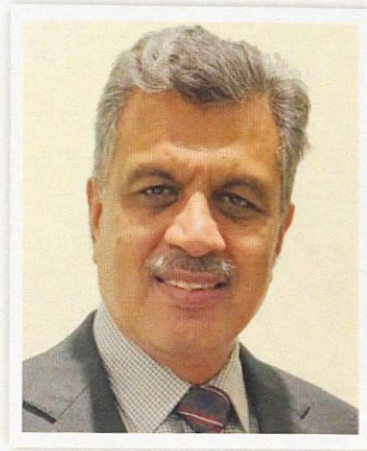




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# PREFACE

PAN-India Assessment and Monitoring of Endangered Species Covered Under the Integrated Development of Wildlife Habitats Program (IDWH) - Nilgiri tahr is a milestone document in our ongoing efforts to conserve the Nilgiri tahr. This iconic species is endemic to the southern Western Ghats and is both ecologically and culturally important. It plays a vital role in maintaining the integrity of high-altitude montane grassland ecosystems and serves as a key indicator of ecosystem health. Furthermore, it holds deep cultural and heritage value for the states of Tamil Nadu and Kerala.

In recent decades, the species has come under increasing threat from a confluence of factors, including climate variability, habitat fragmentation, and the spread of invasive species. These stressors have collectively heightened the vulnerability of tahr populations, underscoring the urgent need for a comprehensive and data-driven assessment. This report provides updated and reliable information about the tahr and outlines what must be done to protect it.

This endeavour has been made possible through the synergistic collaboration of the MoEF&CC, the Tamil Nadu Forest Department, Project Nilgiri tahr, the Kerala Forest Department, the Wildlife Institute of India, and WWF-India. As part of this collaborative effort, a synchronized population survey of the Nilgiri tahr was conducted across key landscapes in Tamil Nadu and adjoining regions of Kerala. The implementation of this program has not only contributed important information on population trends and structure, but has also identified critical areas where conservation action must be prioritized.

Integrating empirical research with ecological insight, this report presents critical findings that will guide future conservation strategies, adaptive management frameworks, and policy directives. I hope this document serves not only as a valuable scientific resource but also as a source of inspiration for ongoing research and long-term protection of the Nilgiri tahr and its fragile montane habitat.

(Virendra R. Tiwari)



# Executive Summary

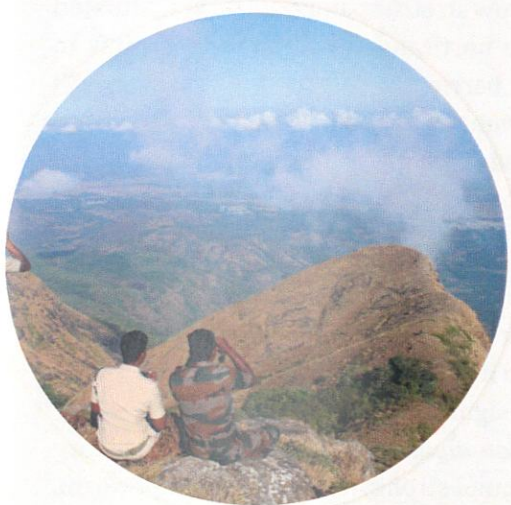
The Nilgiri tahr (*Nilgiritragus hylocrius*) is an endangered mountain ungulate endemic to the southern Western Ghats of India, predominantly inhabiting montane grasslands. Historically, the species occupied a wide range along the Western Ghats. However, its current distribution has contracted to less than one-tenth of its former extent, primarily due to habitat loss, anthropogenic pressures, and poaching. Consequently, the Nilgiri tahr is classified as Endangered by the IUCN Red List and listed under Schedule I of the Indian Wildlife (Protection) Act, 1972.

Despite its threatened status, comprehensive data on population size, population dynamics, and distribution remain patchy and limited. To address this knowledge gap, we standardized Double Observer method alongside the Bounded Count method, and also piloted Camera Trapped based Distance Sampling in selected sites. Based on the learnings, we conducted a synchronized population survey across Tamil Nadu and adjoining parts of Kerala (Eravikulam and Silent Valley National Parks) from April 29 to May 1, 2024. A total of 141 blocks were delineated for the survey, with the blocks subdivided to the beat level in isolated patches to ensure comprehensive coverage for the population estimation. To accurately assess the abundance and distribution of the species across this diverse landscape, we employed two methodologies: the Double Observer Method for continuous landscapes and the Bounded Count Method for fragmented habitats.

A total of 404 individuals were observed during the survey, including 32 juveniles, 37 yearlings, 92 adult females, 25 light brown males, 14 dark brown males, 29 saddleback males, and 175 unclassified individuals. Based on these data, the overall estimate for the surveyed landscape was 1,115 individuals.

Among the 141 surveyed blocks, 92 showed evidence of Nilgiri tahr presence, including both direct sightings and indirect signs such as hoof marks and pellets. Tanakamalai emerged as a significant area, with the highest count of Nilgiri tahr across all divisions, indicating its potential as a prime habitat within the Grass Hills National Park. One notable finding of the survey was the documentation of two previously unknown populations at Pasumalai in the Megamalai Division. Conversely, 49 blocks showed no signs of tahr presence, signaling range contractions and the loss of potentially viable habitats. Several of these areas, though historically significant, may still offer ecological potential for future recolonization, provided appropriate habitat restoration measures are implemented.

The findings of this study reinforce the imperative to secure and restore large, connected habitats to facilitate natural dispersal and recolonization. Furthermore, the adoption of consistent and scientifically rigorous monitoring protocols is essential. This assessment recommends the standardized use of the Double Observer method for extensive habitats and the Bounded Count method for smaller, fragmented landscapes. The Double Observer approach, in particular, offers greater precision and statistical robustness, making it more effective for detecting changes in population size.



# INTRODUCTION

**W**ild ungulates are mammalian species that belong to the Bovidae family, which also includes even-toed and horned ungulates and falls under the Caprinae subfamily. All the caprinae animals are social ungulates exhibiting external dimorphism and herbivorous ruminants. They are ancient relatives of true goats, as they exhibit certain traits of primal goat-antelopes. Characteristics such as uniformity in horn size, striking coat color, and the existence of odoriferous glands for both sexes (Madhusudhan, 1998). There are three types of tahr present globally that are native to Asia; Himalayan tahr (*Hemitragus jemlahicus*, Smith 1826), the Nilgiri tahr (*Nilgiritragus hylocrius*, Ogilby 1838), and the Arabian tahr (*Arabitragus jayakari*, Thomas 1894).

The Nilgiri tahr (*Nilgiritragus hylocrius*) is endemic to the western ghats of Kerala and Tamil Nadu (Madhusudhan, 1998). Adult males weigh about 80-100 kg with horns comparably larger than females, with a length of 40 cm and a base girth of 22 cm (Schaller, 1970). The weight of the female is around 60 kg (Hawkins, 1986), and having two teats (Walker, 1964). Nilgiri tahr are typically found in mixed groups of up to 150 individuals, with males often forming smaller herds of up to 20 animals outside the rutting season. The rutting season for tahrs occurs during the monsoon, with births primarily from January to March (Rice, 1984). Davidar (1978) observed peak calving in winter and a secondary peak in August-September, with a gestation period of around 179 days. For females, to increase their lifetime reproduction, they give birth twice a year (Rice, 1988b). After one or two weeks of birth, the mortality rate of the young one is high during the monsoon season (Rice 1988a). Rice (1987) observed the tahrs as grazers in specific areas depending on the season while in lower drier areas as browsers on trees and shrubs (Davidar, 1978). During the winter season in grasslands, its foraging preference is low due to a reduction in the density of preferred food species. After the pre-monsoon fire, feeding on the new shoots of *Chrysopogon zeylanicus*, shows strong seasonal preferences among plant parts (Rice 1987). According to Rice (1988a), the stability of the larger population may be due to a density-dependent regulatory mechanism affecting natality or mortality, which is also influenced by nutrition. Nilgiri tahr plays a major role in protecting ecosystems by regulating the vegetation growth, plant species communities, and exchange of nutrients. (Augustine and McNaughton, 1998; Bagchi and Ritchie, 2010).

Nilgiri tahr was once distributed almost throughout the Western Ghats (Davidar, 1978). In historic times, Nilgiri tahr occupied the entire southern half of the peninsula, which extends up to Karnataka. Tahr presence was confirmed in the Agumbe Ghat in Karnataka as late as 1954, as confirmed by Mr. G. J. Raja Singh, Conservator of Forests (Davidar

1978). The present geographic range of the Nilgiri tahr is confined to a narrow stretch spanning 400 km, situated between 11°30' N and 8°20' N. This region is bordered by the Nilgiris to the north and the Kanyakumari Hills to the south (Predit et al., 2015). The Palghat Gap, a significant biogeographic barrier for several species, is a 30-40 km wide gap observed along the Western Ghats at around 11°N. (Subramanyam and Nayar 1974; Ali and Ripley 1987). The Nilgiri tahrs are highly adapted to mountainous terrains and are found in the montane grassland ecosystem with rocky cliffs at elevations of around 300-2600 m above mean sea level (Abraham et al., 2006; Predit et al., 2015).

The reduction of the species habitat to one-tenth of its original range, along with poaching and other human activities, has contributed to the population decline and has been classified as "Endangered" on the International Union for Conservation of Nature (IUCN) Red List and it is also listed under Schedule I of the Indian Wildlife Protection Act of 1972 (Alempath and Rice, 2008). Nilgiri tahr significantly contribute to predator population density, with leopards (*Panthera pardus*), Asiatic wild dogs (*Cuon alpinus*), and humans as primary predators (Carbone and Gittleman, 2002; Rice, 1988). Rice (1988b) found strongyle nematode, tapeworm, and whipworm ova in tahr pellets, though these did not lead to mortality. Diseases like Rinderpest and observable growths have adversely affected their populations (Davidar, 1978; Schaller, 1970; Easa et al., 2010). Environmental conditions and health issues further impact their survival.

Recent studies on the Nilgiri tahr population have been limited to small areas where bounded count method was used and extended over long periods, resulting in less accurate data. The only exception was the pilot study of the double observer method by Suryawanshi et al. (2021), conducted by the Nature Conservation Foundation (NCF) in the Anamalai Tiger Reserve. To address these issues, we initially tested the most suitable methods through a pilot study. We conducted a synchronized survey across all known tahr habitats in Tamil Nadu and selected blocks in Eravikulam and Silent Valley National Parks in Kerala. This comprehensive approach aims to provide baseline information and identify the most effective methodologies, such as the double observer and bounded count methods. By ensuring statistical robustness and reliability of the estimates, we aim to improve our understanding of Nilgiri tahr distribution and establish a solid foundation for future conservation efforts of the species.





# LITERATURE REVIEW

## TAXONOMY

The Nilgiri tahr was initially described by Gray, who named it using the Tamil word for rock or precipice goat. In Madras, sportsmen referred it as Ibex (Jerdon, 1874). Rice (1984) provided a detailed account of the tahr's taxonomic history. The first genus member to be scientifically identified was the Himalayan tahr, named *Capra jemlahica* in 1827 by H. Smith (Lydekker, 1913). In 1833, Hodgson introduced a synonym, *Capra jharal*, making no reference to Smith's earlier description. After discovering the presence of four mammary glands, Hodgson renamed it as *Hemitragus quadrimammis*. In 1847, Gray altered the original name of the Himalayan tahr to *Hemitragus jemlahicus*. Gervais was the first to note the similarities between the Himalayan and Nilgiri tahr, adopting the contemporary name for Nilgiri tahr. However, Sclater still used the genus *Capra* for both species in 1891. In 1913, Lydekker reestablished the name as *Hemitragus jemlahicus* for the Himalayan tahr. Ogilby first named the Nilgiri tahr as *Kemas hylocrius* in 1838. Gray named it *Capra warryato* in 1842 and later changed it to *Kemas warryato* in 1852 (Lydekker, 1913). In 1859, Blyth classified the Nilgiri tahr under the genus *Hemitragus*, calling it *Hemitragus hylocrius*. There was a strong belief that the three tahr species were subspecies (Haltenorth, 1963). However, Ropiquet and Hassanin (2005) proposed the name *Nilgiritragus hylocrius* for the Nilgiri tahr based on molecular phylogenetic analysis, claiming that the Himalayan, Arabian, and Nilgiri tahrs have different lineages.

## MORPHOLOGY

Standing tall among Indian Caprinae species, the Nilgiri tahr reaches a shoulder height of up to 110 cm, comparable to the Takin and Serow (Prater, 1965). Adult males typically weigh between 80-100 kg and boast horns measuring 40 cm in length with a base girth of 22 cm (Schaller, 1970), while female Nilgiri tahr weigh around 60 kg and have two teats (Hawkins, 1986; Walker, 1964). Prater (1965), Schaller (1970), and Davidar (1978) classified male Nilgiri tahr into three distinct categories based on colour patterns. The oldest males exhibit a dark, nearly black coat with a noticeable pale "saddle patch" on their loins, resembling white from a distance. The third category comprises grey adult males, often challenging to differentiate from adult females due to similar overall coloration. Nevertheless, Rice (1984) proposed distinguishing males from females by observing a more conspicuous white line anterior to the eye in males and assessing the relative prominence of the knee-patch.



## BEHAVIOUR & BIOLOGY

The Nilgiri tahr, known for its social behaviour, typically forms herds of two or more individuals, can vary significantly due to factors such as season and habitat, ranging from as few as 6 to over 100 individuals as documented. (Madhusudan, 1995; Schaller, 1970). Historical records provide further insights into herd compositions, with Sterndale (1884) documenting varying sizes of herds, including 60, 65, and 120 individuals, while Kinloch (1926) and Fischer (1915) reported herds with 60, 90, and 86 members, respectively. Schaller (1970) determined that the average herd size was 23, based on observations of mixed herds. Healthy herds of Nilgiri tahr display a consistent structure, with saddle backs, dark brown males, light brown males, adult females, yearlings, and young each occupying specific proportions, as reported by Schaller (1970), Davidar (1971), and Rice (1984). Like various other Caprinae species, the Nilgiri tahr forms two fundamental kinds of social groups that are a mix of both sexes, and groups that consist solely of males (Rice, 1984). Tahrs are grazers in grasslands and browsers in lower drier areas (Rice, 1987) and it shows strong seasonal preferences for plant parts (Davidar, 1978). During the dry season, it has been observed that the tahr ventures at least 10 meters into the sholas and feeds on trees and shrubs (Rice, 1987). The rutting season for the Nilgiri tahr typically takes place during the monsoon, with the calving season spanning from January to mid February. Despite this, there have been observations of calving occurring year-round (Stockley, 1928; Willet, 1968). The onset of warmer weather has been noted as the calving season by Kinloch (1926) and Prater (1965). Leydekker (1898) identified June and July are the calving months. Schaller (1970) strongly suggested that most young ones are born between December and February. Davidar (1978) noted a peak in calving during the winter, with a secondary peak in August-September. As per Sterndale's observations in 1884, it's common for a tahr to give birth twins. Furthermore, if a newborn tahr dies within the first two weeks, it's been reported that the mother tahr can enter a new gestational period (Rice, 1988b). The short lifespan and reproductive challenges of the tahr can have significant impacts, especially for smaller populations. Population stability may be influenced by density-dependent mechanisms, which are affected by nutrition and environmental factors. The health and survival of young tahrs are particularly influenced by the nutritional status of females. (Easa et al., 2010). Parasitic ova were found in a significant percentage of the faecal samples, with no direct correlation to mortality (Rice, 1988b; Olsen, 1967; Soulsby, 1982). Diseases like Rinderpest have severely impacted their populations (Schaller, 1970), and health issues such as growth and poor condition have been observed (Davidar, 1978).

## GENETICS

The lineage of the Nilgiri tahr can be traced back to a now-extinct species of bovid mammal, *Myotragus balearicus*, which once populated the Balearic Islands during prehistoric times (Lalueza-Fox et al., 2000). In terms of chromosomal count and similarity, both the Nilgiri tahr and the Arabian tahr possess 29 pairs of chromosomes, resulting in a diploid number of 58 (Bernischke and Kumamoto, 1980).

## HABITATS & ECOLOGY

The knowledge of habitats and biology of the Nilgiri tahr primarily comes from hunting accounts and anecdotal descriptions of encounters with the animals. Systematic studies have been scarce, with Schaller's 1971 study being a notable exception. Rice (1984) was the first to conduct an extensive study on the ecology and behavior of the Nilgiri tahr. Additionally, several papers have been published on the biology and management of the Nilgiri tahr in captivity (Pillai, 1963; Potti, 1966; Chandran, 1980; Wilson, 1980; Swengel & Pichner, 1987). Rice (1988) and Murugan (1997) explored the population dynamics and habitat requirements of the Nilgiri tahr in Eravikulam and the Nilgiris in Tamil Nadu, respectively. Rice (1986) and Easa (1995) focused on the prey-predator relationships in Eravikulam landscape. Sumitran (1993) studied the ecology of the tahr in the Nilgiris, while Mishra and Johnsingh (1994) compared the habitat and populations in the Anamalai and Parambikulam wildlife sanctuaries. Further, Madhusudan (1995) and Madhusudan and Johnsingh (1998) reported on sexual segregation and habitat preferences, respectively. Davidar (1978) previously reported on the fragmented populations of the Nilgiri tahr within its range. Observations and reports of such populations have also come from

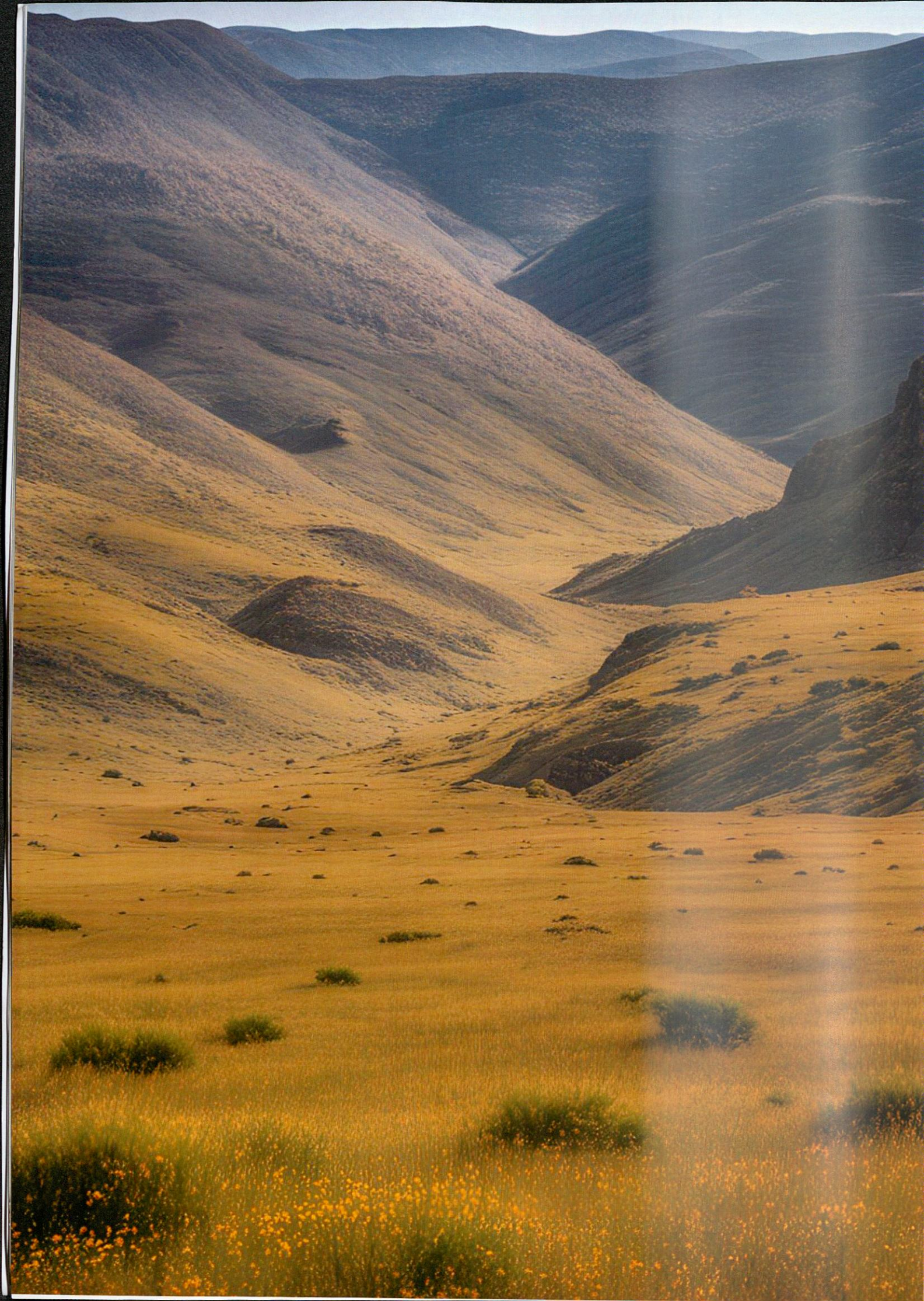
other sources (Fletcher, 1911; Davidar, 1976, 1978; Daniel, 1987). Schaller (1971), Daniel (1971), Davidar (1963, 1971, 1975, 1976, 1978) and Green (2000) provided information on the locations and sizes of tahr populations. Additionally, Easa and Sivaram (2002) assessed the status of the tahr as part of developing a habitat suitability index for the species. Sukumar (2000) emphasized the significance of habitat loss for the tahr, which is driven by climate changes and leads to a decrease in the natural grasslands of the Western Ghats.

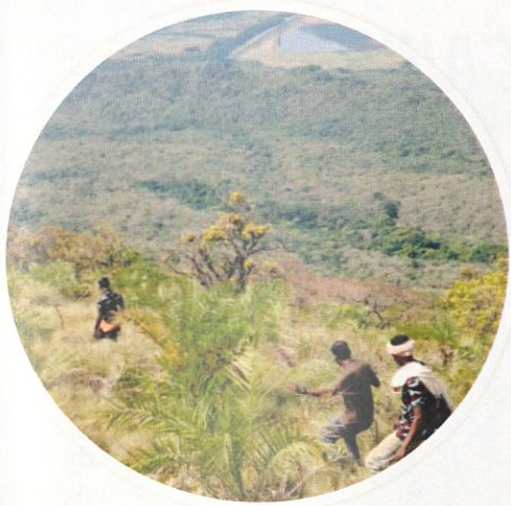
## DISTRIBUTION

Historical records, primarily sourced from reports on hunting activities across different regions, provide insights into the past distribution of the Nilgiri tahr, with much of the information stemming from Davidar's works in the 1960s and 1970s. According to Davidar (1978), the Nilgiri tahr once inhabited a vast expanse across the Western Ghats, stretching from the southern half of the Peninsula up to most of Karnataka. As late as 1954, tahr presence was confirmed in the Agumbe Ghat region of Karnataka by Mr. G. J. Rajasingh, Conservator of Forests. Davidar observed that the species was primarily found in scattered pockets along the crest of the ranges, spanning latitudes between 11°30' and 820'N, at elevations ranging from 1300 m to 2600 m.

Numerous authors have contributed to the knowledge regarding the status and distribution of the Nilgiri tahr within its range, including Russell (1900), Phythian-Adams (1927, 1939, 1950), Schaller (1970), and Davidar (1978). Davidar (1976, 1978) specifically reported on the status and evaluated the conservation threats in various areas. The most recent estimates of the Nilgiri tahr populations come from several sources: the Kerala Forest Department (KFD 1989) for Eravikulam National Park, the Tamil Nadu Forest Department for Anamalai Tiger Reserve, Arumugam (unpublished 2004) for Mukurthi National Park, Bala (2001) for the Palani Hills, Abraham et al. (2006) for parts of Kerala, Daniels et al. (2006) for the entire range, Sharon (2010) for the Agasthyamala region in Kerala, and Predit (2009) for most other areas.







# STUDY AREA

The study areas for the synchronized survey to estimate the population of Nilgiri tahr in Tamil Nadu and Kerala were selected based on the current distribution of the tahr, as obtained through secondary data from communication with Forest Department staff from the respective divisions, preliminary surveys, and previous studies. The current occurrence of Nilgiri tahr was confirmed across 13 Forest Divisions of Tamil Nadu, ranging from the Nilgiris in the north to Kanyakumari in the south. A total of 130 blocks were delineated for the synchronized survey, with the blocks subdivided to the beat level in isolated patches to ensure comprehensive coverage for the population estimation. Detailed descriptions of the number of blocks per division are provided in Table 1.1

S.No.	Divisions	No. of Blocks
1	Nilgiris	6
2	Gudalur	2
3	MTR core	5
4	Coimbatore	5
5	Pollachi	27
6	Tiruppur	13
7	Megamalai	21
8	Theni	8
9	Srivilliputhur	28
10	Tirunelveli	8
11	Ambasamudram	8
12	Kalakkad	9
13	Kanyakumari	1
<b>Total</b>		<b>141</b>

# Age - Sex Classification of Nilgiri Tahr

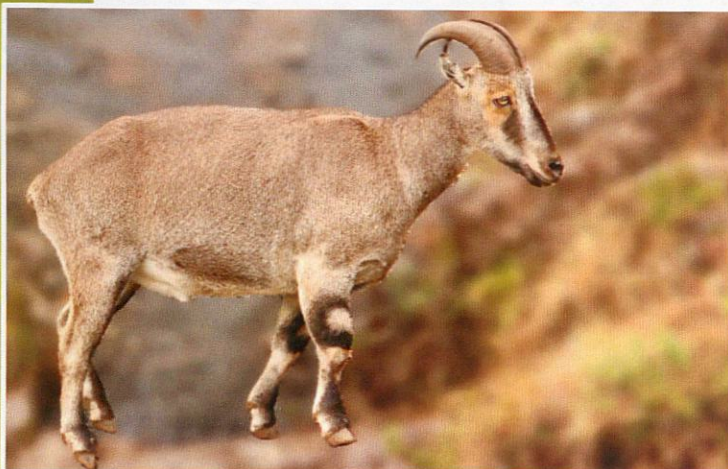


## **Young:**

Age 0-1 years; grey-brown or light brown coat; horns up to 7 cm in length; maximum 45cm height at the shoulder.

## **Yearling:**

Age 1-2 years; grey-brown coat; intermediate in size between young and adult females; horns up to a maximum of 12 cm.



## **Light Brown Male:**

Age category 2-4 years, grey-brown coat; larger and more robust than adult females; larger horns and more distinct facial markings; easily identified when the genitals are visible.

Schaller (1971); Davidar (1978); Rice (1984)





***Dark Brown Male:***

Age category 5 years, grey-brown to dark brown coat; larger and more robust than adult females; larger horns and more distinct facial markings; carpal patches white.

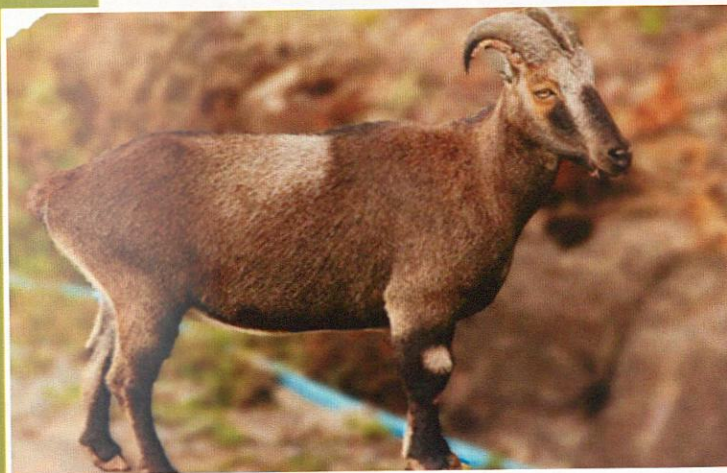
***Adult Female:***

Age 2+ years; grey-brown coat; carpal patch black; height at shoulder 70-80cm; horns slender and maximum of 30 cm



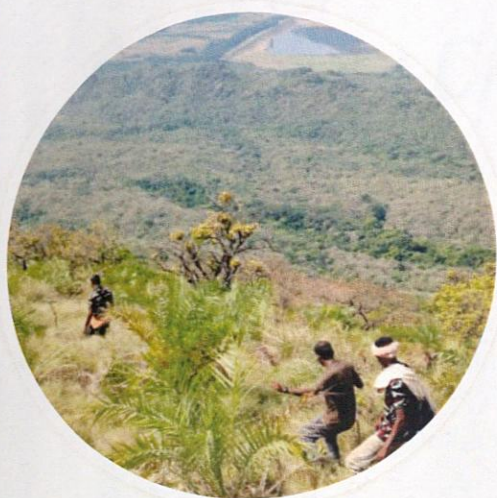
***Saddleback Male:***

Age category 6+ years; dark brown coat with an area of light brown/ white/ silvery hair covering the lower back; rump and/or flanks; carpal patches white.



Schaller (1971); Davidar (1978); Rice (1984)





# METHODOLOGY

The Nilgiri tahr (*Nilgiritragus hylocrius*) inhabit rugged, rocky terrains and steep cliffs, making their population difficult to assess using conventional survey methods. Given the complexity of their habitat and their elusive nature, it is crucial to identify methodologies that align with their ecology. Initially, we evaluated a range of potential survey techniques that could be used to estimate the Nilgiri tahr population accurately. We then conducted a pilot survey to test these methods, ultimately selecting the most suitable approaches for a synchronized census. The importance of a synchronized census cannot be overstated, as it ensures consistent and comprehensive data collection across different regions and time periods, thereby providing a more accurate and reliable estimate of the population (Schaller, 1970; Davidar, 1978).

In January 2024, to address the challenges of accurately assessing Nilgiri tahr populations, we conducted a pilot survey using four different methods: total count, bounded count, double observer, and drone count, at Grasshills National Park in Tamil Nadu. A training workshop was conducted for participants involved in the pilot survey. The best method was selected based on cost, feasibility, and reliability of the estimates. The double observer method and the bounded count method were finalized for estimating the Nilgiri tahr population in large contiguous landscapes and isolated patches, respectively.

Secondary data on the current occurrence of Nilgiri tahr were obtained from the respective divisions of the Forest Department in Tamil Nadu. The survey area was mapped, and survey blocks at the beat level were delineated. A total of 133 survey blocks encompassing 13 forest divisions were listed throughout Tamil Nadu, from the Nilgiris to Kanyakumari.

Training workshops were conducted by researchers from Project Nilgiri tahr with assistance from associates at the Wildlife Institute of India. The training covered Nilgiri tahr identification and classification, survey methods, and data collection techniques.

Additionally, we piloted a non-invasive camera trap-based distance sampling method, previously used for estimating mountain ungulate populations in the Himalayan region, for the first time in Eravikulam National Park during April-May 2023. This approach aimed to estimate the Nilgiri tahr population within the reserve by capturing photographic and video data through strategically placed camera traps. This method, chosen for its minimal disturbance to the animals, provides detailed insights into tahr density and distribution, enhancing our ability to assess their population.



### Bounded Count Method:

The bounded count technique, proposed by Regier and Robson (1966), was used to estimate the population in 120 blocks in Tamil Nadu. Trained observers equipped with binoculars and data sheets surveyed the delineated blocks, recording Nilgiri tahr sightings, age-sex classification, and GPS coordinates. Surveys were conducted from early morning until dusk, overlapping with the Nilgiri tahr activity period, and repeated for three consecutive days in each block.



#### Data Analysis:

The population size (N) in Bounded count method is estimated as

$$N = X_m + (X_m - X_{m-1})$$

Where  $X_1 < X_2 < \dots < X_m$  represent the numbers observed in consecutive days, arranged in increasing order and  $X(m)$  and  $X(m-1)$  are the largest and second largest counts obtained, respectively.

The Lower Confidence Interval (NL =  $X_m$ )

The Upper Confidence Interval NU =  $X_m + (X_m - X_{m-1}) (1-a)/a$

Where a is the type 1 error, fixed at 20 percent.

### Double Observer Method

This method, based on mark-recapture principles, involved two observers conducting surveys simultaneously and independently. A herd was treated as an individual rather than each tahr. Surveyors started from opposite ends with temporal and spatial separation, ensuring the same visual coverage. They collected data on group size, demography, GPS locations, and other relevant details. Independently recorded sightings were discussed post-survey and entered into a master data sheet, confirming if both observers spotted the same groups.

#### Data Analysis:

The data obtained by both observers is carefully discussed and compiled into a master data sheet to ensure that each sighting of the herds is accurately compared. This process helps determine whether the same herds were observed by both individuals or if there were differences in their sightings. Once the data has been consolidated, it is analyzed using the BBRecapture package in R statistical software.

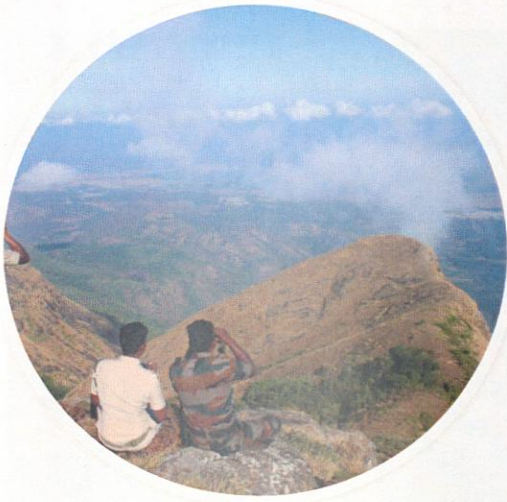


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Muvattupuzha, Kerala

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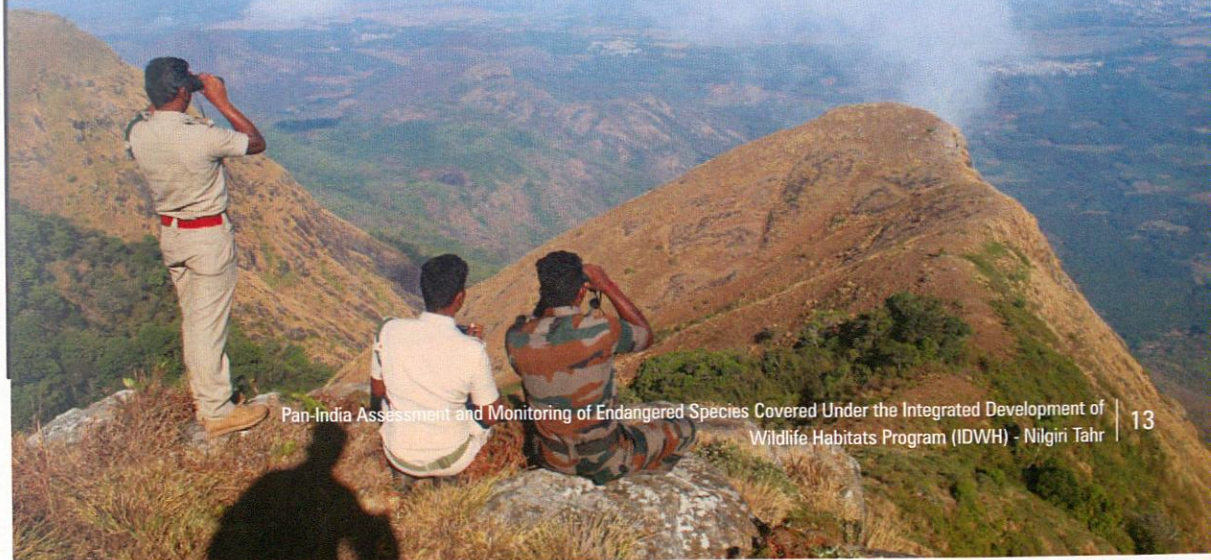
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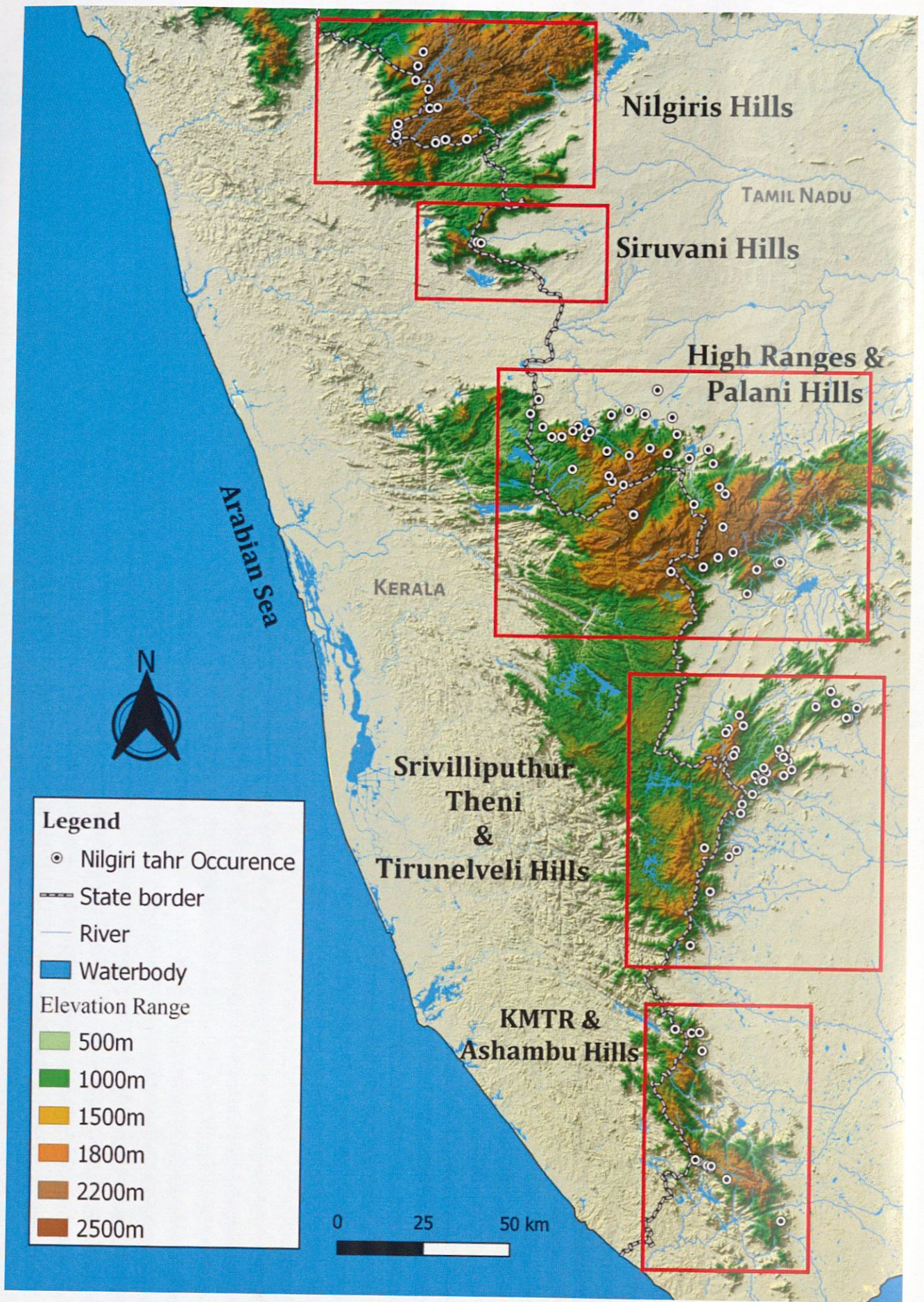


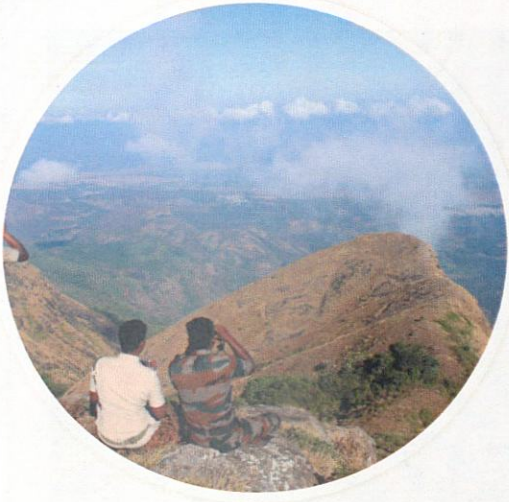


# FIELD SURVEY

A field coordinator was nominated for each division to ensure the survey's efficiency and accuracy. Representatives from the Wildlife Institute of India (WII), Project Nilgiri tahr-Tamil Nadu, Tamil Nadu Forest Department staff, WWF (World Wildlife Fund for Nature), and the Advanced Institute of Wildlife Conservation (AIWC) participated in the survey. The survey began on foot at 07:00 each day. The observers followed designated transect routes, consistently covering these routes for three consecutive days. They recorded GPS locations using a GPS Etrex 20 handheld device and the GPS Logger app on their mobile phones. Teams used 10x50 magnification binoculars to observe and classify individuals. They also relied on indirect evidence to ensure comprehensive coverage, with particular emphasis on scanning rocky and cliff areas where Nilgiri tahr are likely to be found. To minimize double counting, observers identified and excluded individuals likely to have been seen more than once based on their location and time of observation. This methodology adhered to the protocols established by Mishra and Johnsingh (1998), ensuring accurate and reliable data collection.



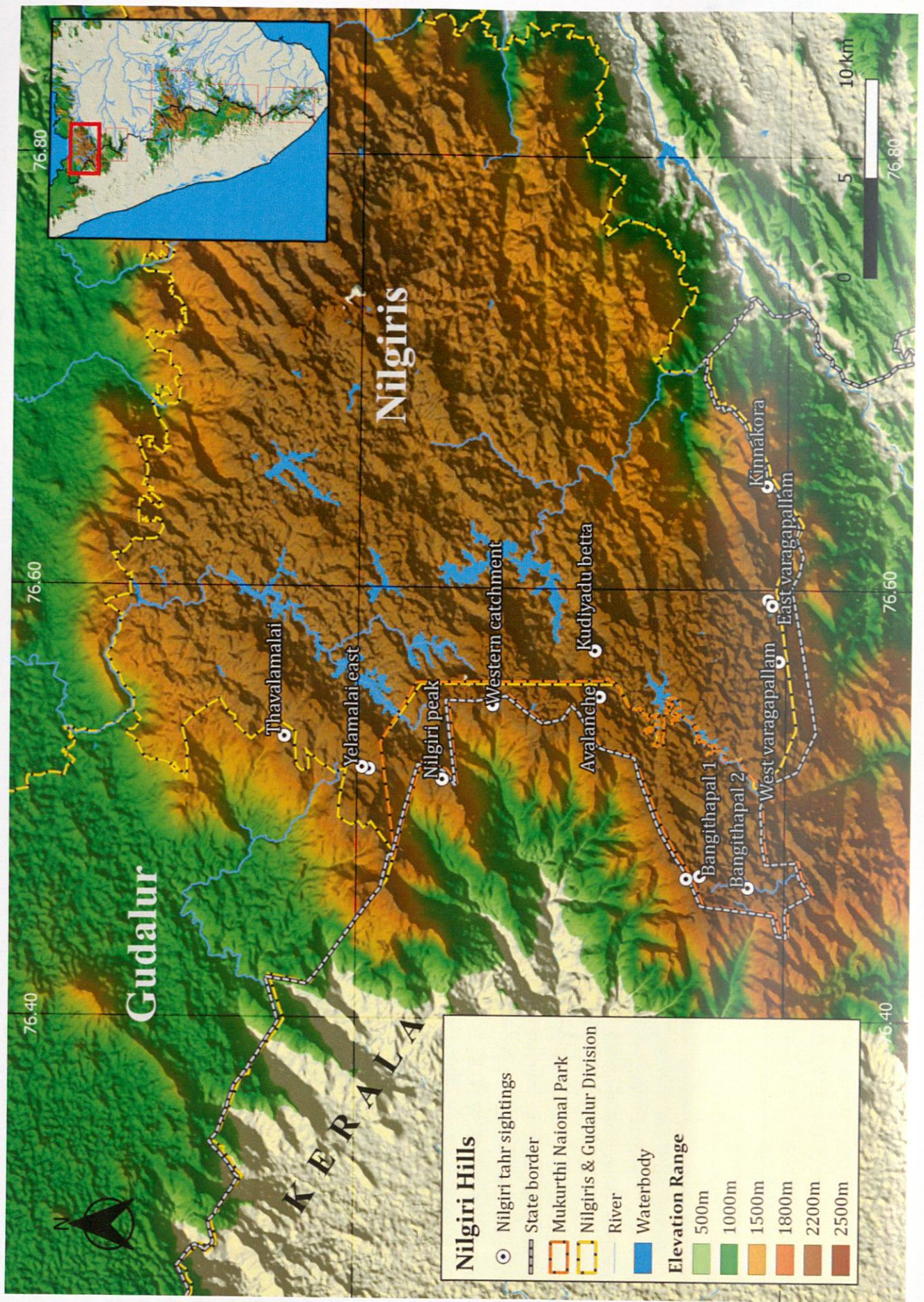


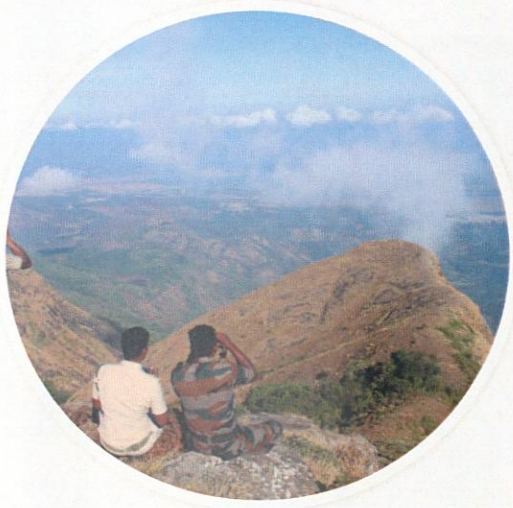


# STATUS & DISTRIBUTION

The Nilgiri tahr is distributed in the Western Ghats of Tamil Nadu, and Kerala encompasses a diverse array of habitats, from dense evergreen forests to open montane grasslands with steep slopes of rocky cliffs. The population estimation was done by conducting a synchronised survey for Tamil Nadu and adjoining areas of Kerala from April 29<sup>th</sup> to May 1<sup>st</sup>, 2024. To accurately estimate the abundance and distribution of species in this diverse landscape, we employed two methodologies: the Double Observer Method for continuous landscapes and the Bounded Count Method for fragmented habitats. The survey area in Tamil Nadu was delineated into 141 blocks. Of these, 129 blocks were surveyed using the bounded count method, and the remaining 12 blocks were surveyed using the double observer method. A total of 404 individuals were recorded in this survey, including 32 juveniles, 37 yearlings, 92 adult females, 25 light brown males, 14 dark brown males, 29 saddleback males, and 175 unclassified individuals. Based on this data, the overall estimate for Tamil Nadu is 1,115. These populations are likely part of a metapopulation residing in fragmented and continuous landscapes. Additionally, in some of the locations recorded, no sightings of Nilgiri tahr may be attributed to the dry season. Eravikulam National Park and Silent Valley National Park in Kerala were incorporated into the synchronized survey of their contiguous areas. The double observer methodology was employed in Eravikulam National Park, which comprised four blocks under the Munnar Wildlife Division. In Silent Valley National Park, the bounded count methodology was employed for estimation. A total of 474 individuals were estimated for Grass Hills National Park and Eravikulam National Park, where the tahr migrate freely across the landscapes. The Grass Hills National Park in the Pollachi division contains one-fourth of the total population of Tamil Nadu. It is part of the Anamalai Tiger Reserve, which maintains its connectivity across the landscape. The Mukurthi National Park in the Nilgiris division holds 18.56% of the tahr population and is a potential habitat for the tahr. Given these findings, the areas that could contribute to the maintenance of a viable population include the Nilgiris and Pollachi divisions. The synchronized survey of the Nilgiri tahr in Tamil Nadu and adjoining areas of Kerala has provided valuable data on the species' population size, structure, and distribution. The findings highlight the importance of maintaining habitat connectivity and a viable population. By focusing conservation efforts on key areas and employing these statistically robust techniques, we can support the long-term survival of the Nilgiri tahr in the Western Ghats.







# RESULTS

## NILGIRIS

The Nilgiris Division, adjacent to Mukurthi National Park and extending into the Ootacamund Plateau, features diverse habitats due to varying land uses. Many grasslands have been replaced by exotic plantations, though failed plantations may now offer potential habitats. Gundukkal Parai has rocky cliffs with sparse vegetation, Kinnakorai is threatened by fires and encroachment from agriculture and tea estates, and Kudiyakadu Betta is dominated by restrictive monoculture plantations. In contrast, Devabetta provides suitable grasslands, and East and West Varahapallam offer favorable conditions with their undulating terrain and rocky cliffs. Recent fires in these areas have led to new vegetation growth, which may attract tahr.

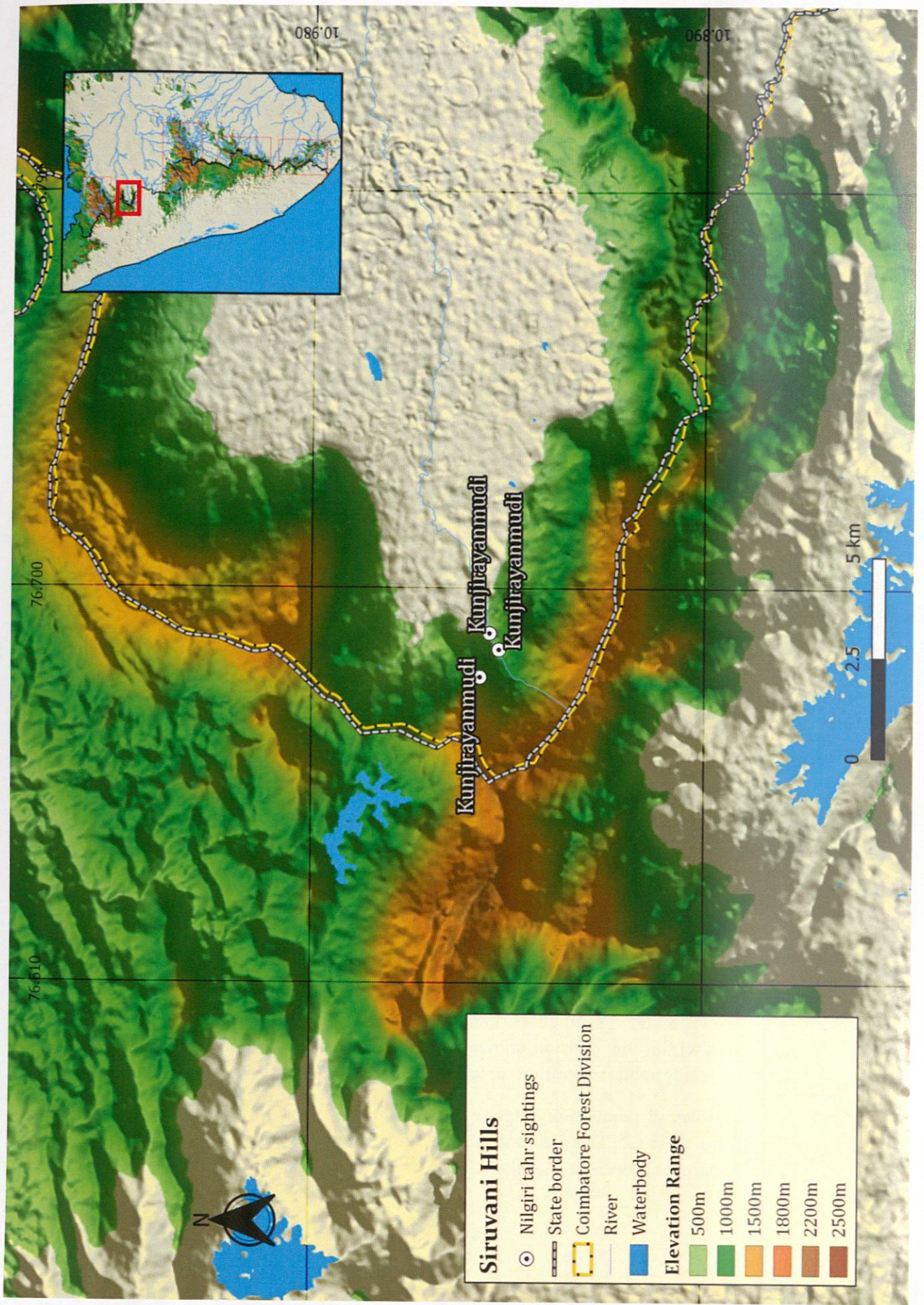
The survey results for the Nilgiris Division was 14 tahrs, including 2 young ones, 1 yearling, 3 adult females, 1 light brown male, 2 saddleback males, and 5 unclassified individuals. The overall population estimate for the division is 27 tahr (with a 95% confidence interval of 14 to 66).

## GUDALUR

The Gudalur Division, particularly the Yellamalai area, serves as a crucial habitat for the Nilgiri tahr. This region, connected to Mukurthi National Park, provides essential montane grasslands and rugged terrain that are ideal for the species. In Yellamalai East, 14 individuals were directly observed, including 2 yearlings, 5 adult females, 1 dark brown male, 1 saddleback male, and 5 unclassified individuals. Thavalamalai, another area within the division, showed only indirect signs of tahr presence, suggesting less favorable habitat conditions or lower population densities.

The overall population estimate for the Gudalur Division is 26 individuals, with a range from 14 to 62. This estimate highlights a significant presence in Yellamalai East and an apparent absence in Thavalamalai.

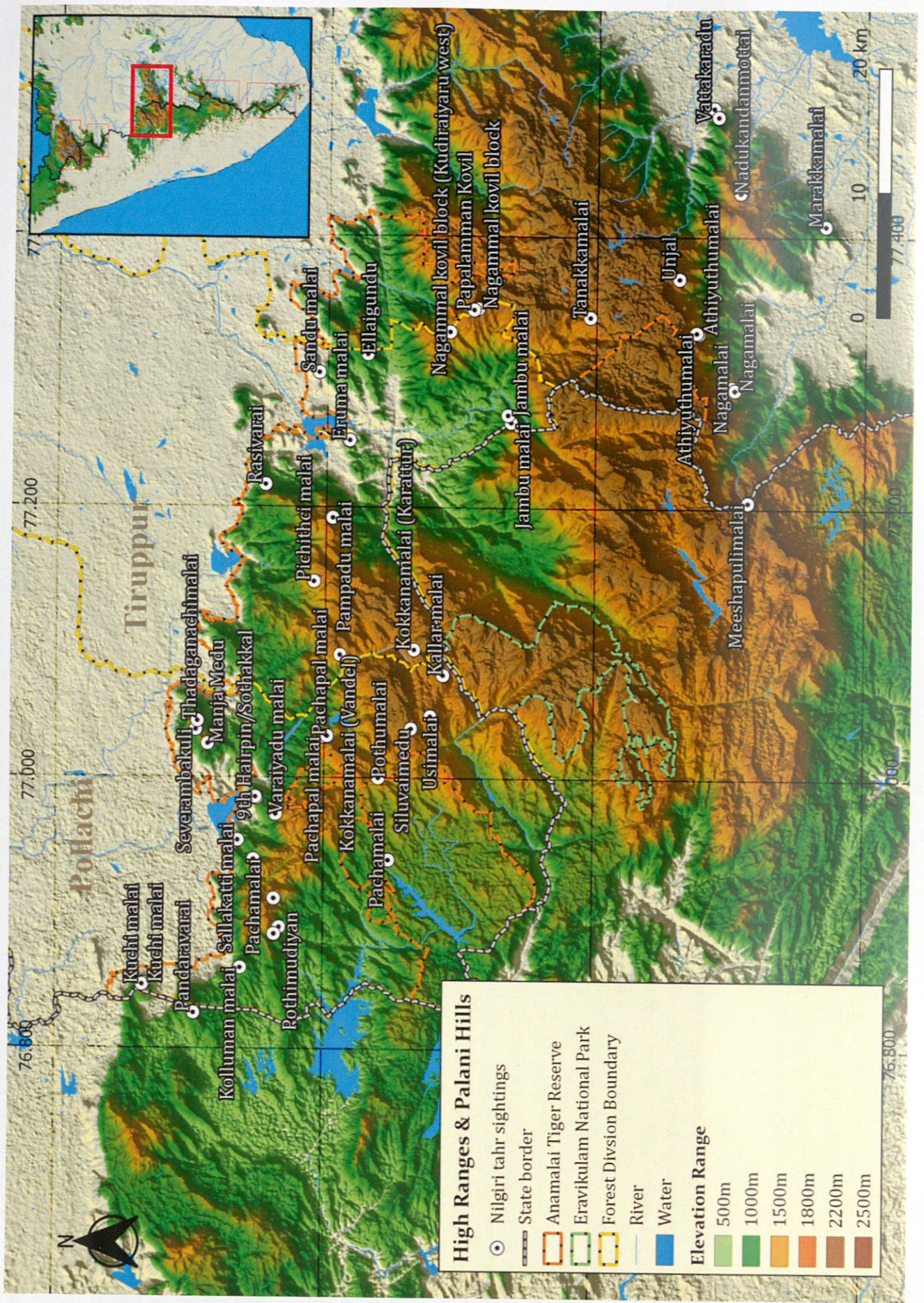




## COIMBATORE

The Coimbatore Forest Division, encompassing areas such as Chinna Aatumalai, Periya Aatumalai, Kunjirayanmudi, Velliyangiri Malai, and Kurudi Malai, has historically provided suitable habitat for the Nilgiri tahr. Previous observations recorded the presence of tahr in Chinna Aatumalai and Kunjirayanmudi (Predit et al., 2015). However, the recent survey yielded no sightings of Nilgiri tahr in any of these locations, rather than pellets in Kunjirayanmudi. Historical records noted 20 individuals in Kunjirayanmudi and 2 in Chinna Aatumalai (Davidar, 1976; Predit et al., 2015).





## POLLACHI

The Pollachi Division, part of the Anamalai Tiger Reserve, encompasses several areas historically considered significant habitats for the Nilgiri tahr. The present survey evaluated 27 blocks using two methods: the double observer method for the 6 blocks within Grass Hills National Park and the bounded count method for the remaining 21 blocks. No evidence of tahr was found in blocks like Vengoli/Pamban Malai, Chinna/Periya Thalanar, Nedunkundru, Thenvarai, Ramarmalai, Moodupalimalai, Manjamedu, and Bhuthagundru/Navamalai. Historical records noted 27 individuals in Navamalai (Davidar, 1978), one individual in Vengoli (Mishra et al., 1997), and four in Chinna/Periya Thalanar Malai (Suryawanshi et al., 2020). Indirect evidence, such as hoof marks and pellets, was observed in Kozhuman Malai and Varaiyadumalai, indicating potential tahr presence, with Suryawanshi et al. (2020) recording nine individuals in Varaiyadumalai.

Several blocks recorded fewer than 10 individuals, including Pandaravarai, Pothumudiyan, Kovilmattam, Kovilpillai Malai, Pachaipal Malai, Kuchi Malai, Sallakatti Malai, Pachamalai, Sevverumbukuli, and Thadaganachimalai. Notably, eleven individuals were observed in the Nineth Hairpin Bend/Sothakkal area. A total of 45 individuals were observed in the division, comprising 9 young ones, 6 yearlings, 14 adult females, 6 light brown males, 3 dark brown males, 2 saddleback males, and 5 unclassified individuals. The overall estimate for the tahr population in this division is 65 individuals, with a lower limit of 45 and an upper limit of 125.

The Pollachi Division, historically rich in Nilgiri tahr populations, is experiencing changes in tahr presence across its various habitats. The division includes prominent ridges like Pandaravarai, Vengoli/Pamban Malai, and areas such as Grass Hills National Park, which provide extensive and varied habitats for the tahr. However, factors such as habitat fragmentation, erosion, and decreased food species abundance are influencing tahr distribution. Despite extensive surveys, many traditional habitats showed no current evidence of tahr, underscoring the need for ongoing monitoring and targeted conservation efforts to address these challenges and ensure the species' persistence in the Pollachi Division.

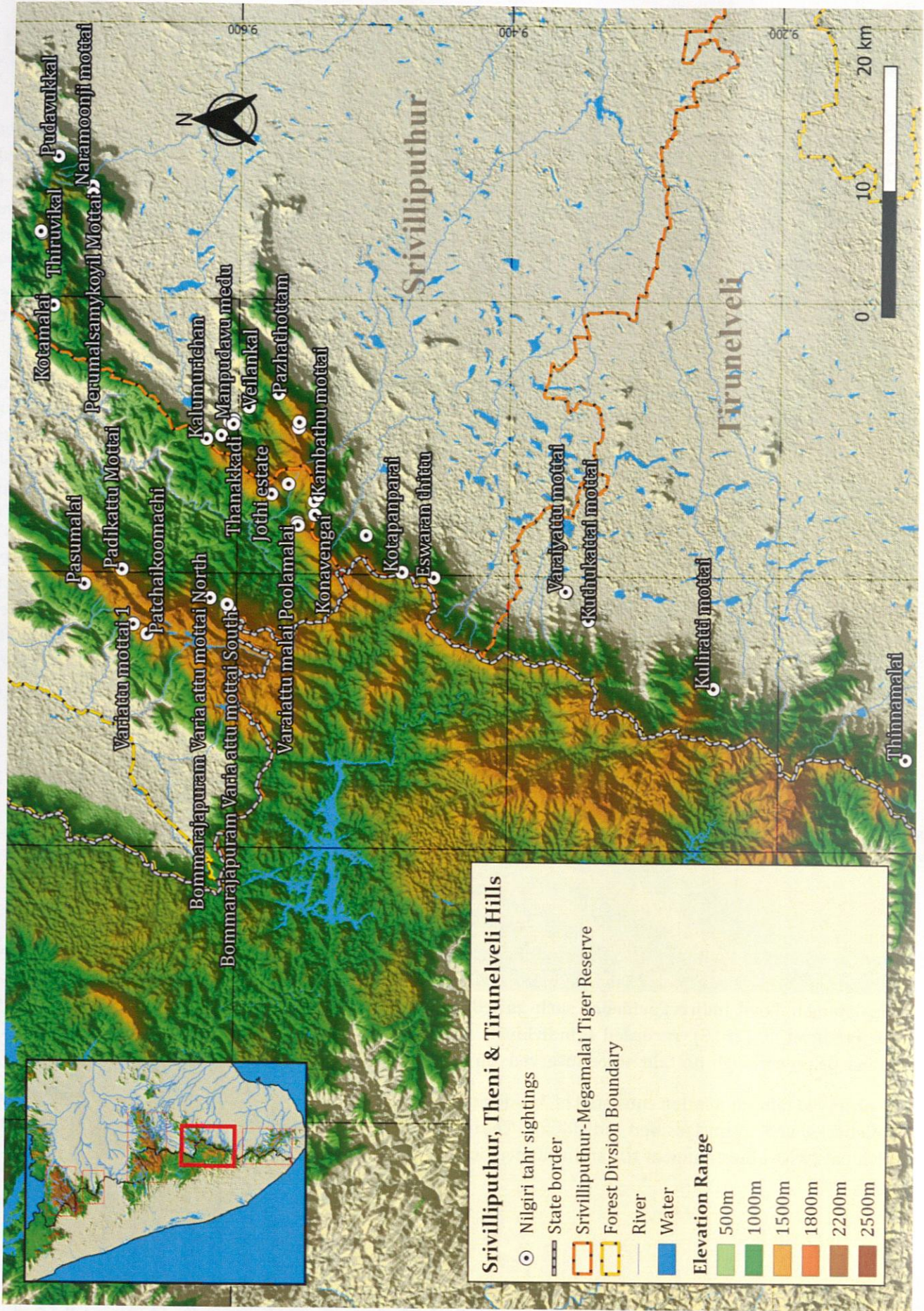
## TIRUPPUR

The survey of the Tiruppur Division, encompassing 13 blocks, revealed a total of 100 Nilgiri tahr individuals. This includes 42 tahr in Podhumalai, 34 in Pampadumalai, and fewer than ten individuals each in blocks such as Pitchutchi Malai, Kokkana Malai, Sadaiyandi Malai, Jambumalai, Erumamalai, Sandumalai, Kudhiraiyaru West, and Pappalamman Kovil. Indirect evidence, such as pellets, was found in Rasivarai and Ellaigundu. Historical data from Predit et al. (2015) recorded 6 individuals in Rasivarai, 13 in Ellaigundu, and 32 individuals in Ibeex cliff and peak, although no tahr were observed directly in the Ibeex block during the current survey.

The observed tahr population consisted of 7 young ones, 6 yearlings, 14 adult females, 2 light brown males, 14 saddlebacks, and 57 unclassified individuals. The overall estimated population for the Tiruppur Division is 167 individuals, with a lower limit of 100 and an upper limit of 368.

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## MEGAMALAI

The Megamalai Division, situated within the Megamalai Wildlife Sanctuary, encompasses 21 blocks distributed across five ranges: Megamalai, Varushanaadu, Gudalore, Cumbum East, and Chinnamanur. This division, which borders the Giant Grizzled Squirrel Wildlife Sanctuary, features diverse habitats that are well-suited for the Nilgiri tahr. Significant habitats include Bommarajapuram Varaiyattumottai South and Varaiyattumottai-1, both of which support more than fifteen tahr individuals, with Bommarajapuram Varaiyattumottai South reporting the highest number at 26 individuals. In contrast, other blocks such as Padikattumottai, Bommarajapuram Varaiyattumottai North, Varaiyattumalai Poolamalai, and Patchakoomatchi each showed fewer than ten individuals. Additionally, blocks like Thillukudimottai, Mangaladevi Varaiyattumottai, Vittathallimedu, and others had no direct tahr sightings, though indirect evidence of their presence was noted in Salimuthan Estate, Jothi Estate, and Pasumalai. The identification of Pasumalai as a potential new habitat highlights opportunities for further research and conservation efforts.

Current survey recorded a total of 71 tahr individuals across the division. This population includes 5 young ones, 10 yearlings, 26 adult females, 6 light brown males, 4 dark brown males, 2 saddlebacks, and 18 unclassified individuals. The overall estimated tahr population for the Megamalai Division stands at 118 individuals, with a lower limit of 71 and an upper limit of 259.

Historically, the Megamalai Division has been recognized as a key tahr habitat. In 1978, Davidar recorded 20 tahr individuals in Padikattumottai, 27 in Metla Malai, and approximately 16 in Venniyar Varaiyattumottai. Rice (1988) estimated around 100 tahrs in the Highway Mountains, which border the Periyar Tiger Reserve and feature extensive grasslands on cliffs. Hutton (1947) also documented tahr sightings in Metia Malai within the Highway Mountains. The combination of historical data and recent findings, including the new identification of Pasumalai as a tahr habitat, underscores the need for ongoing monitoring and conservation to support and enhance the Nilgiri tahr population in the Megamalai Division.

## THENI DIVISION

Located in the southwestern Ghats, this division spans from 9.62° to 10.10° North and 77.14° to 77.48° East, bordering the Grizzled Giant Squirrel Wildlife Sanctuary. The division comprises 8 blocks with varied terrain and habitat types. Nadukandanmottai features grasslands interspersed with rocky areas, situated at altitudes ranging from 1985 to 2000 meters, where only pellets have been recorded. Marakkamalai presents undulating terrain but similarly shows only pellet evidence of tahr presence. Athiyuthumalai, Agamalai, Meeshapulimalai, and Nagamalai offer favorable tahr habitats, characterized by grasslands with rocky cliffs. In the current survey across these 8 blocks, tahr sightings were recorded in Athiyuthumalai, Meeshapulimalai, Vattakaradu, and Nagamalai, each with fewer than five individuals observed. Nadukandanmottai, Marakkamalai, and Unjal yielded only pellet evidence, while Kunderi showed neither sightings nor pellets. Predit et al. (2015) documented 18 tahr individuals in Marakkamalai and six in Kunderi.





The survey identified a total of eight individuals, including 1 light brown male, 1 saddleback male, and 6 unclassified individuals. The estimated population for this division is 15 individuals, with a lower limit of 8 and an upper limit of 36, indicating a small and potentially vulnerable population.

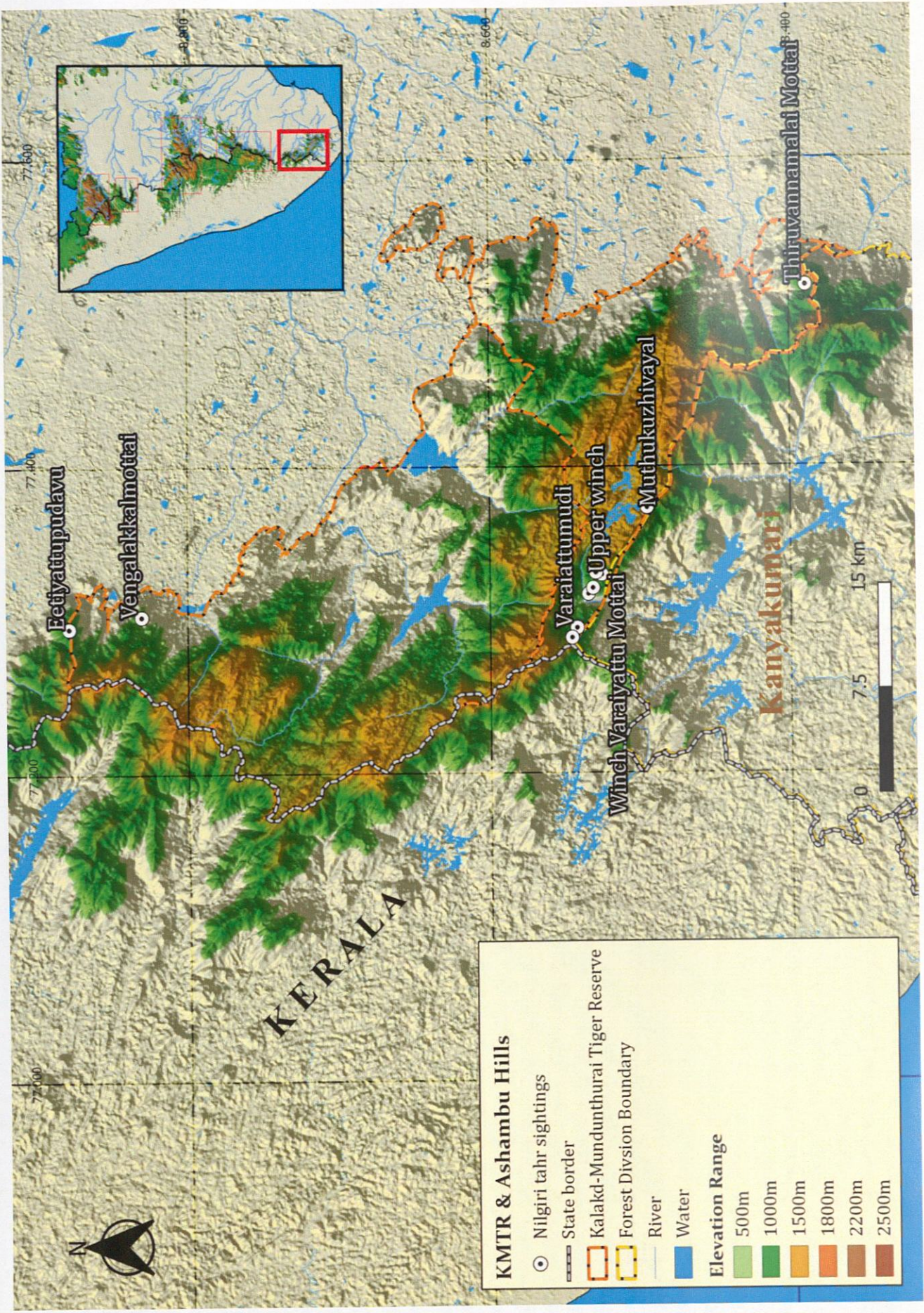
## Srivilliputhur

The Srivilliputhur Division, situated in the southwestern Ghats, spans between 9°21' to 948' North and 77°21' to 7746' East. It includes the Grizzled Giant Squirrel Wildlife Sanctuary, which shares boundaries with the Megamalai Wildlife Sanctuary to the northeast and the Periyar Tiger Reserve to the southeast, creating a contiguous forest patch. This region features diverse topography, including deep valleys, large rocky sections, and steep cliffs that offer suitable habitats for the Nilgiri tahr. Perumalsamy Kovil Mottai, characterized by rocky slopes and seasonal streams, and Naaramoonji Mottai, with its available water sources, represent key areas for the tahr. Vengai Silambu Mottai, with its dry, cattle-grazed areas, may function as a migration route. Additionally, fragmented grasslands and rocky patches in Suli Varai and Moongam Pannai, as well as seasonal water scarcity in habitats such as Thiruvikkal Mottai and Thanakkadi Mottai, impact tahr distribution.

Current surveys in 28 blocks within this division revealed significant tahr populations in specific areas. Thanakkadi, Thiruvikkal, and Kambathumottai were identified as prime habitats, with observed populations of 27, 18, and 13 individuals, respectively, while Veilankal supported 6 individuals. Several other blocks, including Kotamalai, Naramoonjimottai, and Chembaralimottai, recorded fewer than five individuals. Indirect evidence of tahr presence, such as hoof marks and pellets, was found in Pudavukkal, Perumalsamy Kovil Mottai, and Varaiyattumottai. No sightings or indirect signs were detected in Pechimottai, Peimalamottai South and North, Anaimutti, Periyaputhu, Vellakaltheri, Mayandikidai, Kulirattimottai (PTR Boundary), and Saralaimottai. Predit et al. (2015) reported 26 individuals in Pudavukkal, 18 in Perumalsamy Kovil Mottai, and additional sightings in various locations. The current survey observed a total of 77 individuals, including 2 young, 2 yearlings, 1 light brown male, 2 dark brown males, 3 saddlebacks, and 65 unclassified individuals. The overall estimated tahr population for this division is 117 individuals, with a lower limit of 77 and an upper limit of 237.

Srivilliputhur Division has been recognized as a significant tahr habitat. Davidar (1978) noted a population of 15 tahrs in Vellakaltheri in May 1976, highlighting the division's long-standing importance for the species. Although recent surveys suggest fluctuations in tahr densities, likely due to environmental changes and human activities, the division's diverse and interconnected habitats continue to support the Nilgiri tahr.





## Tirunelveli Division

Historically, the Tirunelveli Division has had varied records of the Nilgiri tahr. The region, known for its grasslands, shrubs, and rocky cliffs, has seen significant tahr populations in the past, though recent surveys suggest fluctuating numbers. The presence of tahr has been documented through both direct sightings and indirect evidence, such as pellets and hoofmarks, across its diverse topography.

Present survey in the division was conducted across eight blocks, Thinnamalai emerged as a key habitat, with the highest recorded population of 14 individuals. This area stands out as a significant site for the Nilgiri tahr. Conversely, Varaiyattumottai, Kuthukattimottai, and Kulirattimottai were found to support fewer than ten individuals each, reflecting smaller populations. Locations such as Kuranguparai/Vengaipudai, Periya Sudangimottai, Suyambunathar Temple, and Theerthaparai Mottai showed no tahr presence. The survey documented a total of 23 tahr, including one young, four yearlings, six adult females, seven light brown males, three dark brown males, one saddleback, and one unclassified individual. The estimated tahr population for the division is 41 individuals, with a lower limit of 23 and an upper limit of 95.

## Ambasamudram Division

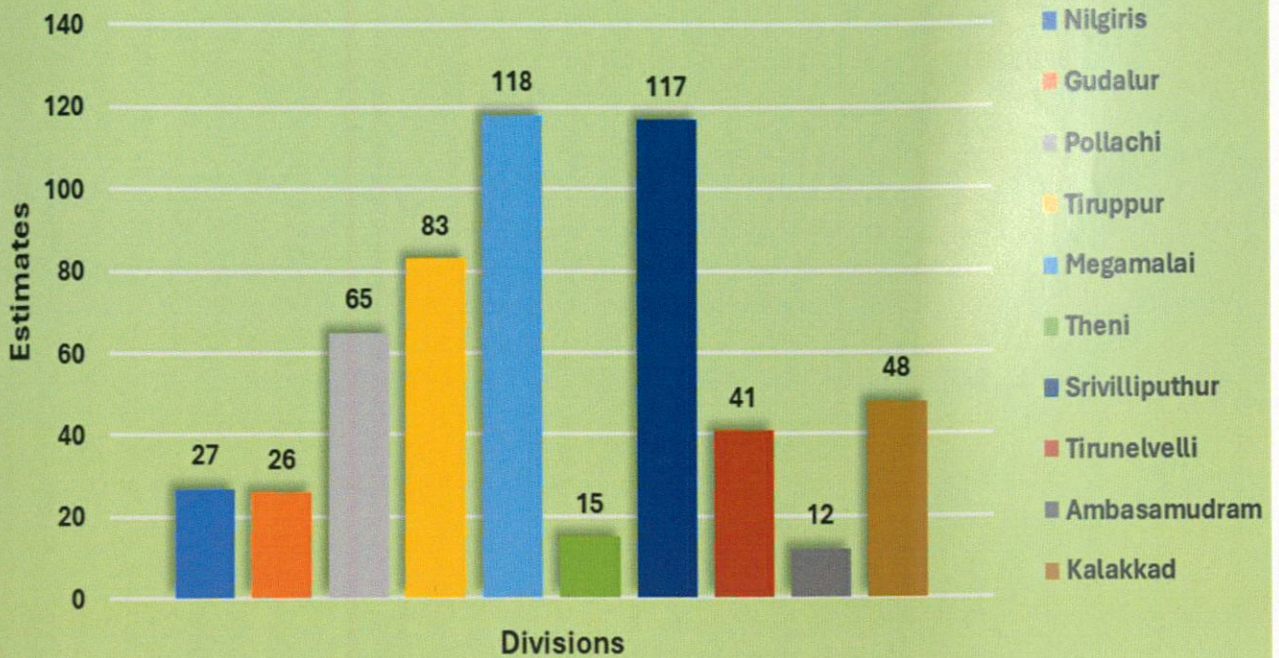
In this division, which encompasses eight blocks within the Kalakad Mundanthurai Tiger Reserve (KMTR), Varaiyattumottai stands out as the most significant habitat for the Nilgiri tahr. This block, characterized by its grasslands interspersed with rocky areas, recorded the highest number of tahr sightings, with twelve individuals observed, including four young ones, three adult females, one light brown male, and four unclassified individuals. This block's habitat features are conducive to tahr habitation, with available water sources that, although limited, support the tahr population.

The historical record reveals varied tahr presence across the division. While Vengalakkalmottai, Kudiraitheri, and Eetiayathupudavu have shown indirect evidence of tahr presence through hoof marks and pellets, no direct sightings were recorded. Conversely, Aduppukkalmottai, Chemmunjimottai, Ainthalainagapodhigai, and Agasthiyamalai have shown no signs of tahr, indicating their absence in these areas.

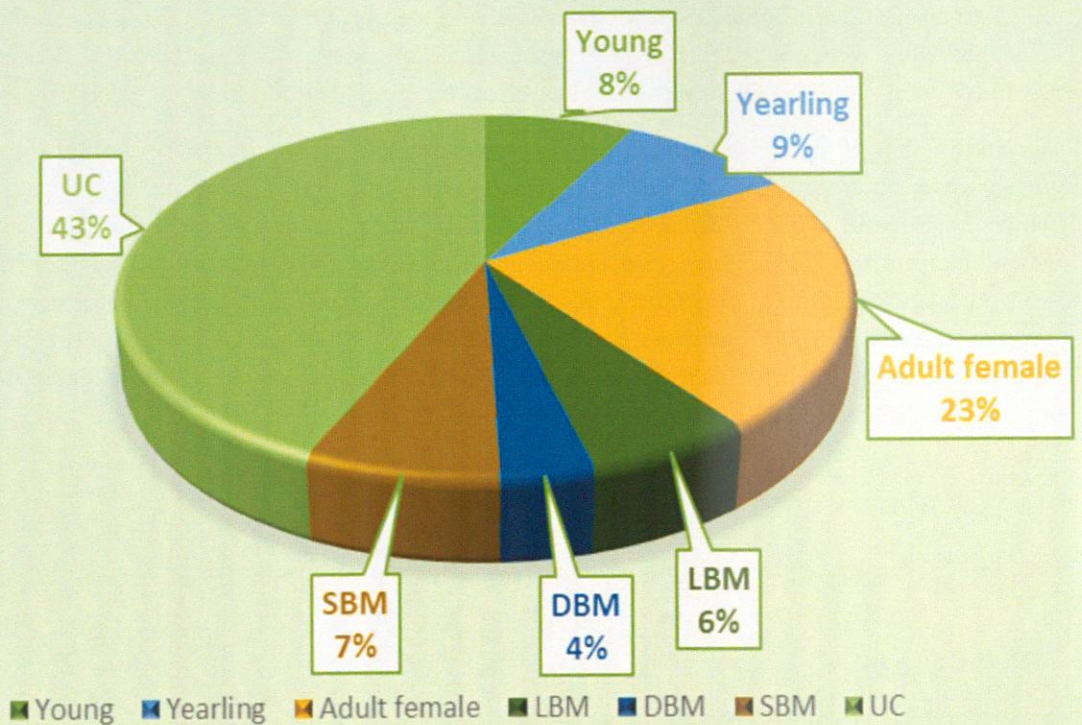
The survey results for this division indicate that Varaiyattumottai supports the highest population of Nilgiri tahr, with twelve individuals recorded. This figure includes four young ones, three adult females, one light brown male and four unclassified individuals. Despite some indirect evidence of tahr presence in Vengalakkalmottai, Kudiraitheri, and Eetiayathupudavu, the absence of sightings and the lack of evidence in Aduppukkalmottai, Chemmunjimottai, Ainthalainagapodhigai, and Agasthiyamalai suggest that the population is concentrated in Varaiyattumottai. Therefore, the overall population estimate for the division stands at twelve individuals, with both the lower and upper confidence limits being the same, reflecting a concentrated population with limited distribution.



## Division wise population estimation for Tamil Nadu – Bounded Count Method



## POPULATION STRUCTURE - TAMIL NADU



## Kalakkad Division

In the current survey of nine blocks within the Kalakkad-Mundanthurai Tiger Reserve (KMTR), the Nilgiri tahr was sighted in Varaiyattumudi, Muthukuzhivayal, and Winch Varaiyattumottai, with populations of 10, 7, and 24 individuals, respectively. Indirect evidence, including hoof marks and pellets, was recorded at Lower Winch Point, Upper Winch Point, and Thiruvannamalai Mottai. Additionally, 13 tahr were observed in Thiruvannamalai Mottai, and 20 in Lower Winch Point (Predit et al., 2015). No tahr were found in Pandadikalam Mottai, Panchanathangimottai, and Nandoothumottai. The overall population estimate for this division is 48 individuals, with a lower limit of 41 and an upper limit of 69.

The division comprises nine blocks within the Kalakkad-Mundanthurai Tiger Reserve (KMTR). Panchanthatangi Malai, also known as Muthalathi Malai, has been identified as a promising tahr habitat with a historically good population. In 1977, approximately 20 tahr were reported, despite the challenges posed by tall grass. Varaiattu Mottai, which once supported a notable tahr population, is now believed to have lost its tahr due to poaching. Klamala, spanning Kerala and Tamil Nadu, was reported to have two herds of tahr in 1976, with a total estimated population of 70 in 1977. Muthukuzhivayal in the Valukkuparai area, with its grasslands and steep rocks, remains a suitable habitat for tahr. The Thiruvannamalai Peaks, located in the Boothapandi Forest Range, represent the southernmost tahr habitat. Despite heavy poaching pressures in 1976, an estimated 40 to 50 tahrs were present. Adjacent hills such as Kattangathatty and Kannikatti had tahr until 1971 but faced issues from cattle grazing. Recent surveys found no tahr in Nandoothu Mottai and Kuvattatti Mottai over the past 20 years. These areas, previously suitable with coarse grasslands and steep cliffs, could potentially support tahr if populations in the Kodayar area remain protected. The reserve's current protection and management offer a chance to support at least 500 tahr (Predit et al., 2015).

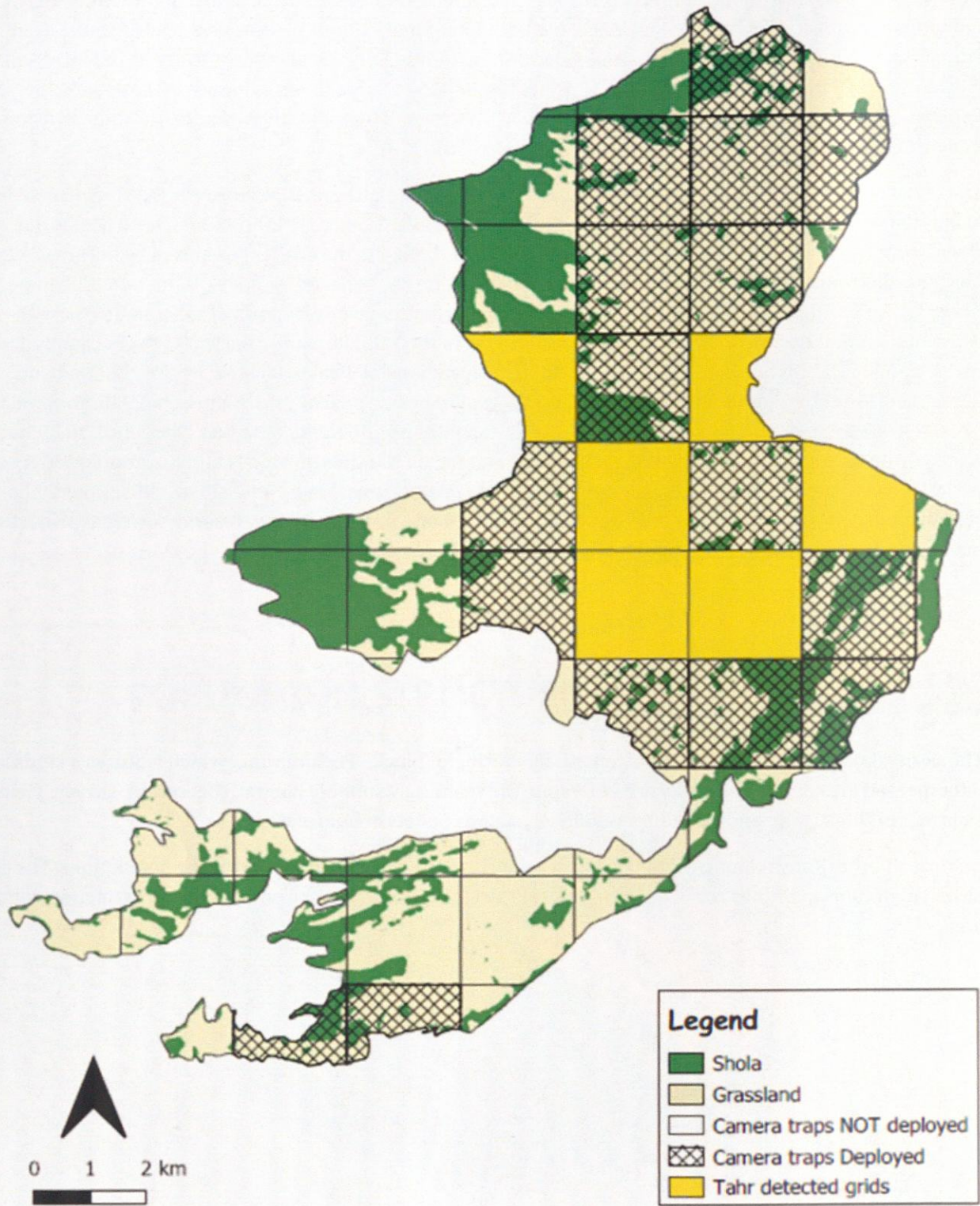
## Kanyakumari Division

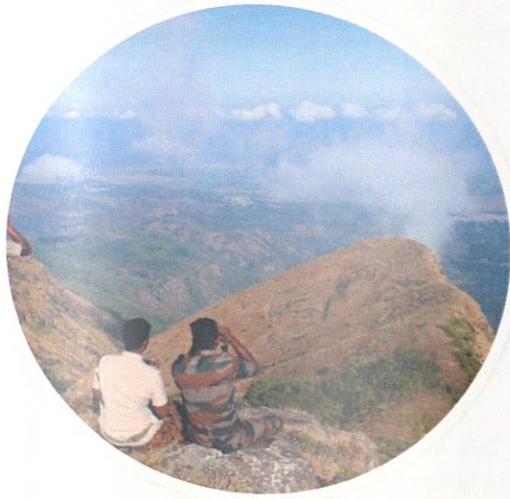
The Kanyakumari Division is represented by a single block, Pechimottai, which features a landscape of interspersed grasslands and rocky areas. Despite the seemingly suitable habitat, the recent survey yielded no sightings of Nilgiri tahr and no indirect evidence, such as pellets or hoof marks.

Historically, the Kanyakumari Division has been less documented for its Nilgiri tahr populations. The current absence of tahr sightings or evidence suggests a significant decline or potential local extinction within this area.



## Nilgiri tahr detected in Camera traps in Eravikulam National Park

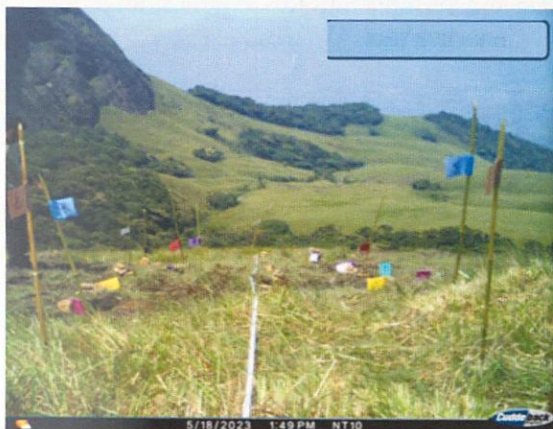




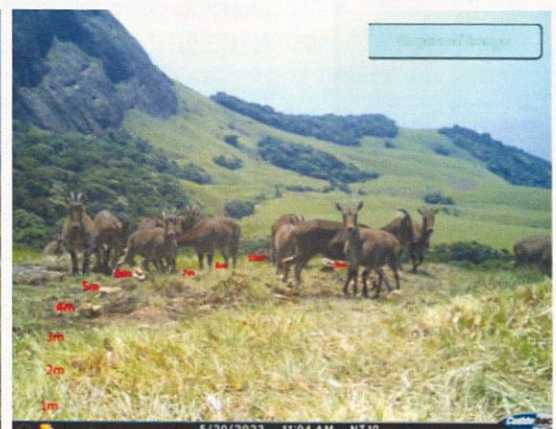
# OVERVIEW OF CAMERA TRAP BASED DISTANCE SAMPLING IN ERAVIKULAM NATIONAL PARK

Camera trap-based distance sampling (CTDS) employs the principles of distance sampling, with the camera serving as the observer (Howe et al., 2017; Pal et al., 2021). To estimate the distance of Nilgiri tahr from the camera traps, we calibrated field measurements using natural markers and color-coded poles placed at known distances around the camera's field of view. After calibration, the poles were replaced with natural markers from the surroundings.

In May 2023, CTDS was implemented in Eravikulam National Park, Kerala. The park was divided into 4 km<sup>2</sup> grid cells, and 20 Cuddeback camera traps were deployed at grid centroids, covering an effective sampling area of 60 km. The cameras were positioned 30-40 cm above the ground and programmed to capture an image followed by a 30-second video when triggered.



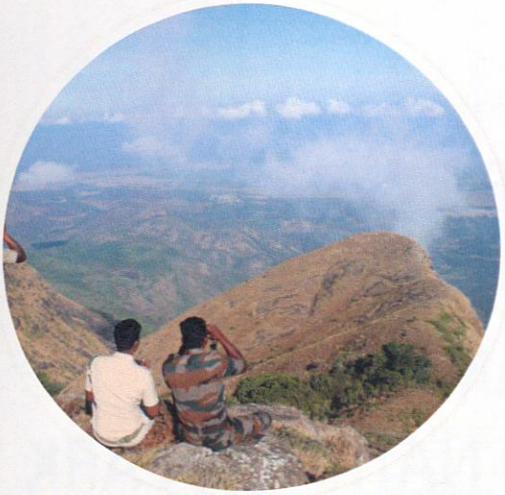
Field Calibration



Captured image

Six out of the twenty camera traps deployed successfully captured images of the Nilgiri tahr, generating a total of 3,023 snapshots from the recorded videos. The data were further analyzed using the "Distance" package in R statistical software version 4.2.3. The half-normal model with cosine adjustment produced an estimated density of 6.58 individuals/km<sup>2</sup> with a standard error of  $\pm 3.94$  (CV= 0.37) for Eravikulam National Park.





# DISCUSSION

One of the primary challenges faced in conservation biology is the mitigation of extinction risk among endangered species. This challenge is particularly pertinent in the case of the Nilgiri tahr, where effective conservation strategies must be informed by a comprehensive understanding of various factors, including habitat utilization, population dynamics, behavior, and spatial population structure. As emphasized by Gilpin and Soule (1986), the conservation of small populations hinges significantly on understanding key population parameters such as natality, mortality, immigration, and emigration rates, along with population structure. Fluctuations in these parameters can profoundly impact the vulnerability of species to extinction. Lande (1988) underscores the immediate importance of population parameters in conservation efforts, suggesting that they outweigh genetic concerns in the context of species conservation. Additionally, Shaffer and Samson (1985) assert that large contiguous reserves are paramount for maintaining existing populations. In this regard, the Anamalai Tiger Reserve, characterized by extensive and suitable habitat, and its connectivity with the Eravikulam National Park, emerge as pivotal for the long-term conservation of the Nilgiri tahr.

In the present survey, we conducted a comprehensive assessment of 141 blocks in Tamil Nadu. Among these blocks, 92 showed records of Nilgiri tahr, including both direct sightings and indirect evidence such as hoof marks and pellets. Conversely, 49 blocks exhibited no evidence of tahr presence, highlighting the necessity for further investigation into the factors contributing to their absence in these regions. Tanakamalai emerged as a significant area with the highest count of Nilgiri tahr across all divisions, indicating its potential as a prime habitat within the Grass Hills National Park. This region, which features the highest peak at 2513 meters in the Anamalai Tiger Reserve, recorded 65 individuals. However, this number is notably lower than the 126 individuals recorded during the pilot survey in January 2024 for selecting the best method for estimating the Nilgiri tahr population in the synchronized survey and the 137 individuals recorded in the same area by Suryawanshi et al. in 2020. This suggests that many of the animals might have moved to lower areas due to the low availability of food and water during the harsh dry season witnessed during the current survey.

One notable finding of our survey was the documentation of two previously unknown populations at Pasumalai in the Megamalai division. Among all divisions in Tamil Nadu, we observed a total of 404 individuals during the survey. This population included 32 young ones, 37 yearlings, 92 adult females, 25 light brown males, 14 dark brown males, 29 saddlebacks, and 175 unclassified individuals. The ratio of young to adult



females was 1:3, and the ratio of males to females was 3:1. The previous study reported higher numbers, underscoring the need for intensified conservation efforts. Compared to the findings of Predit et al. (2015), the current numbers indicate a significant decline. The lower numbers observed in this survey could be attributed to various factors, including habitat degradation, food source availability, climatic changes and differences in the methodologies used to estimate populations. Many previous studies relied on traditional techniques like total count and secondary data from the forest department, with survey periods extending over long periods without uniformity. In contrast, the present synchronized survey, covering all known tahr occurrence sites in Tamil Nadu, was conducted uniformly in terms of period and methods, thus producing much more reliable data on the current population. This data can serve as a baseline for future research on the conservation of the Nilgiri tahr. Density of Nilgiri tahr increases with altitude, and the extent of cliffs plays a crucial role in their distribution. The spatial arrangement of habitat patches is critical in isolated, fragmented areas, as the Nilgiri tahr is known to move and disperse between these patches. Observations have shown that these animals move from Vengoli and Pandaravarai to neighboring similar habitats, which are separated by woody vegetation along the same hill range. This movement pattern is typical for all isolated patches. When food sources are depleted or a fire occurs in their habitat, the tahr temporarily relocate to other areas. Once the disturbance has passed and new sprouts begin to emerge from the burnt land, the tahrs are attracted back to the original area.

This cyclical movement highlights their adaptive response to environmental changes and resource availability. The Nilgiri tahr appears to be slow to colonize new areas, as evidenced by the abandonment of Panchanhangi Mottai in the Kalakad-Mundanthurai Tiger Reserve, reportedly due to the invasion of lemon grass. This suggests that these populations could be considered non equilibrium metapopulations, where extinctions occur at a faster rate than colonization (Harrison, 1994; Hanski and Simberloff, 1997). Gilpin (1991) cautioned that such systems should be managed carefully to prevent the extirpation of smaller groups while promoting the colonization of suitable habitats. This involves reversing the processes that led to population decline and enhancing the movement between populations to increase the size of the metapopulations. Effective management strategies should focus on mitigating habitat invasions, restoring degraded areas, and creating corridors to facilitate tahr movement and colonization.

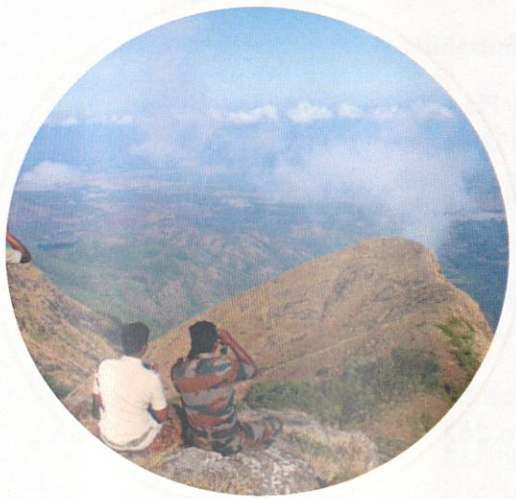




# THE WAY FORWARD

Obtaining reliable abundance and density estimates for mountain ungulates remains a significant challenge. Traditional monitoring methods, such as total counts, provide population parameters but lack statistical feasibility. The current population estimation of Nilgiri tahr stands at 1,115 individuals across all known habitats in Tamil Nadu. This estimate includes 636 Nilgiri tahrs counted using a bounded count method across various isolated patches of tahr habitats, and 479 individuals estimated using the double observer method in the larger, continuous landscapes of Grass Hills National Park and Mukurthi National Park. Specifically, 474 tahr individuals were estimated in Grass Hills National Park and the adjoining regions of Kerala. This population count shows a decline compared to the 2015 survey conducted by Predit et al. Several factors might contribute to this observed reduction. Firstly, the methodology employed in the recent survey differed from that used in 2015, potentially affecting the comparability of the results. Secondly, the WWF survey was not synchronized, which could also impact the accuracy and consistency of the population estimates, as population dynamics can fluctuate over short periods due to factors like migration, birth rates and mortality. In this survey, we observed 3 lump affected individuals in Theni, Mukurthi National Park and Pollachi. The Nilgiri tahr is integral to the mountain ecosystem and presents challenges for study and monitoring. The Nilgiri tahr population is influenced by various factors including predation, poaching, disease, breeding and survivability challenges, pollution, and climate change. Fragmented habitats and lack of corridors lead to enclosed populations and inbreeding. These factors highlight the need for efficient health monitoring and intervention. Continuous monitoring of genetic diversity in all populations is essential to understand outbreeding, inbreeding, and overall genetic diversity. During this survey, no evidence of Nilgiri tahr presence was recorded in 45 locations and moreover some of the historical areas, tahr were disappeared completely which are critical as they hold potential for future recolonization by tahr subgroups. According to May (1991), even the destruction of a fraction of available habitat can drive a metapopulation to extinction by disrupting the balance between colonization and extinction rates. Therefore, it is crucial to maintain and protect larger, suitable habitats to ensure opportunities for future colonization and the long-term survival of the Nilgiri tahr. By preserving these habitats, we can support the species natural recolonization processes and enhance the stability of its populations. The improved monitoring efforts needs to be considered for all habitats. We have standardized the double observer method and bounded count method for estimating the population of Nilgiri tahr in large connected landscapes and smaller isolated habitats, respectively. Our results demonstrate that the double observer method offers greater precision and statistical robustness, making it more effective for detecting changes in population size.





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# APPENDIX

Table No: 1 Division wise distribution

Divisions	No. of Ranges	No. of Beats	No. of Blocks
<b>Anamalai Tiger Reserve</b>			
Tiruppur	4	13	13
Pollachi	3	18	27
<b>Mudumalai Tiger Reserve</b>			
MTR Core	1	4	5
<b>Srivilliputhur Megamalai Tiger Reserve</b>			
Srivilliputhur	4	18	28
Megamalai	5	13	21
<b>Kalakad Mundanthurai Tiger Reserve</b>			
Kalakad	3	5	9
Ambasamudram	2	5	8
<b>Non-Tiger Reserve</b>			
Coimbatore	2	4	5
Nilgiris	4	5	6
Gudalur	1	2	2
Theni	3	8	8
Tirunelveli	3	8	8
Kanyakumari	1	1	1
<b>Total</b>	<b>36</b>	<b>104</b>	<b>141</b>



**Table No: 2 : Bounded Count - Population estimation in fragmented habitats of Tamil Nadu**

S.No	Divisions	No.of blocks	Estimates	Lower limit	Upper Limit
1	Nilgiris	6	27	14	66
2	Gudalur	2	26	14	62
3	Coimbatore	5	0	0	0
4	Pollachi	21	65	45	125
5	Tiruppur	14	77	58	158
6	Megamalai	21	118	71	259
7	Theni	8	15	8	38
8	Srivilliputhur	7	17	11	77
9	Tirunelveli	8	41	23	95
10	Ambasamudram	8	12	12	12
11	Kalakkad	9	48	41	69
12	Kanyakumari	10	96	66	158
<b>Total</b>		<b>129</b>	<b>552</b>	<b>363</b>	<b>1119</b>

**Table No: 3 Day-wise abundance and estimation - Bounded Count Method**

**A) Nilgiris Division | C) Coimbatore Division | D) Tiruppur Division**

<b>Nilgiris Division</b>					
S.No	Blocks	Estimates	Lower Limit	Upper Limit	
1	Terrace estate & Gundukal parai	0	0	0	
2	Pandiyar & Deva betta	0	0	0	
3	Kudiyadu betta	1	1	1	
4	Kinnakorai	4	2	10	
5	East varagapallam	14	7	35	
6	West varagapallam	8	4	20	
<b>Total</b>		<b>27</b>	<b>14</b>	<b>66</b>	



### Gudalur Division

S.No	Blocks	Estimates	Lower Limit	Upper Limit
1	Yelamalai east	26	14	62
2	Tavalamalai	0	0	0
<b>Total</b>		<b>26</b>	<b>14</b>	<b>62</b>

### Coimbatore Division

S.No	Blocks	Estimates	Lower Limit	Upper Limit
1	Chinna/Periya atatumalai	0	0	0
2	Beeman Kali urundai	0	0	0
3	Kunjirayamalai	0	0	0
4	Velliyangiri malai	0	0	0
5	Kurudi malai	0	0	0
<b>Total</b>		<b>0</b>	<b>0</b>	<b>0</b>

### Tiruppur Division

S.No	Blocks	Estimates	Lower Limit	Upper Limit
1	Rasivarai	0	0	0
2	Pichitchi malai	7	5	13
3	Sadaiyandi malai	6	3	15
4	Kokkanamalai	7	5	13
5	Pompadu malai	44	34	74
6	Ellaigundu	0	0	0
7	Jambu malai	2	1	5
8	Eruma malai	6	3	15
9	Sandu malai	2	2	2
10	Kudirayar west	7	4	16
11	Ibex	0	0	0
12	Papalamman kovil	2	1	5
<b>Total</b>		<b>83</b>	<b>58</b>	<b>158</b>



## Tiruppur Division (continued - 2)

S. No	Blocks	Estimates	Lower Limit	Upper Limit
13	Sallakatti malai	10	7	19
14	Ramar malai	0	0	0
15	Pachamalai	2	1	5
16	Severambakuli	2	1	5
17	Moodu paali malai	0	0	0
18	Manja Medu	0	0	0
19	Thadaganachimalai	6	3	15
20	9th Hairpin/Sothakkal	12	11	25
21	Bhuthagundu/Navamalai	0	0	0
<b>Total</b>		<b>65</b>	<b>45</b>	<b>125</b>

## F. Megamalai Division

S. No	Blocks	Estimates	Lower Limit	Upper Limit
1	Bommarajapuram Varaiattu mottai South	41	26	86
2	Padikattu Mottai	15	10	30
3	Bommarajapuram Varaiattu mottai North	7	5	13
4	Varaiattu malai Poolamalai	20	10	50
5	Thillukudi Mottai	0	0	0
6	Mangaladevi varayattu mottai PTR adjoining	0	0	0
7	Vittathali medu	0	0	0
8	Spring of Heaven	0	0	0
9	Salimuthan Estate	0	0	0
10	Jothi estate	0	0	0
11	Metla malai	0	0	0
12	Variattu mottai 1	31	18	70



13	Thoovanam mottai	0	0	0
14	Varaiyattu Mottai 2	0	0	0
15	Pasumalai	0	0	0
16	Iravangalar	4	2	10
17	Patchaikoomachi	4	1	10
18	Venniar varaiattumottai	0	0	0
19	Vattaparai	0	0	0
20	Thoovanam	0	0	0
21	Kurusadi Mottai	0	0	0
<b>Total</b>		<b>118</b>	<b>71</b>	<b>259</b>

### G) Theni Division

S. No	Blocks	Estimates	Lower Limit	Upper Limit
1	Nadukandanmottai	0	0	0
2	Marakkamalai	0	0	0
3	Athiyuthumalai	4	2	10
4	Meeshapulimalai	3	2	6
5	Vattakaradu	4	2	10
6	Kunderi	0	0	0
7	Nagamalai	4	2	10
8	Unjal	0	0	0
<b>Total</b>		<b>15</b>	<b>8</b>	<b>36</b>



## H) Srivilliputhur Division

S. No	Blocks	Estimates	Lower Limit	Upper Limit
1	Sulivarai	2	2	2
2	Thiruvidkal	28	18	58
3	Pudavukkal	0	0	0
4	Kotamalai	2	1	5
5	Pechimottai	0	0	0
6	Perumalsamykoyil Mottai	0	0	0
7	Naramoonji mottai	2	2	2
8	Veilankal	12	6	30
9	Chembarali mottai	1	1	5
10	Kurivikavumottai	0	0	0
11	Peimalai mottai South	2	1	5
12	Pazhathottam	2	1	5
13	Anaimutti	0	0	0
14	Peimalai mottai North	0	0	0
15	Periyaputhu	0	0	0
16	Manpudavu medu	2	1	5
17	Varaiyattumottai	0	0	0
18	Vellakathery	0	0	0
19	Konavengai	4	1	10
20	Kotapanparai	1	1	5
21	Kambathu mottai	18	13	33
22	Mayandikidai	0	0	0
23	Eswaran thittu	0	0	0
24	Kulirattimottai (PTR Boundary)	0	0	0
25	Thanakkadai	37	27	67
26	Kalumurichan	0	0	0
27	Saralai mottai	0	0	0
28	Thaliaruthan keeni	3	2	15
<b>Total</b>		<b>117</b>	<b>77</b>	<b>237</b>



## I) Tirunelveli Division

S. No	Blocks	Estimates	Lower Limit	Upper Limit
1	Varaiyattu mottai	9	6	18
2	Kuthukattai mottai	3	2	6
3	Kurangu parai/ Vengaipudai	0	0	0
4	Thinnamalai	28	14	70
5	Periya Sundangi mottai	0	0	0
6	Suyampunathar Temple	0	0	0
7	Theerthaparai mottai	0	0	0
8	Kuliratti mottai	1	1	1
<b>Total</b>		<b>41</b>	<b>23</b>	<b>95</b>

## J) Ambasamudram Division

S. No	Blocks	Estimates	Lower Limit	Upper Limit
1	Vengalakkalmottai	0	0	0
2	kudiraiatheri	0	0	0
3	Varaiyattumottai	12	12	12
4	Eetityattupudavu	0	0	0
5	Aduppukkalmottai	0	0	0
6	Chemmunji mottai	0	0	0
7	Ainthalainnagapodhigai	0	0	0
8	Agasthiyamalai	0	0	0
<b>Total</b>		<b>12</b>	<b>12</b>	<b>12</b>



### K) Kalakad Division

S. No	Blocks	Estimates	Lower Limit	Upper Limit
1	Varaiattumudi	17	10	38
2	Lower Winch Point	0	0	0
3	Upper Winch	0	0	0
4	Pandadikalam Mottai	0	0	0
5	Muthukuzhivayal	7	7	7
6	Winch Varaiyattu Mottai	24	24	24
7	Nadoothu Mottai	0	0	0
8	Panchanhangi Mottai	0	0	0
9	Thiruvanna mala Mottai	0	0	0
<b>Total</b>		<b>48</b>	<b>41</b>	<b>69</b>

### L) Kanyakumari Division

S. No	Blocks	Estimates	Lower Limit	Upper Limit
1	Pechimottai	0	0	0
<b>Total</b>		<b>0</b>	<b>0</b>	<b>0</b>



Table No: 5 Block wise age-sex classification

S.No	Block	Y	Ylng	AF	LBM	DBM	SBM	UC	Indirect Evidence
1	Nilgiri peak	0	0	0	0	0	0	0	Pellets
2	Western catchment	5	3	16	2	1	3	15	Pellets
3	Avalanche	2	3	5	0	1	1	5	Nil
4	Bangithapal 1	1	0	0	0	0	3	3	Pellets
5	Bangithapal 2	7	6	20	3	2	1	12	Nil
6	Terrace estate & Gundukal parai	0	0	0	0	0	0	0	Nil
7	Pandiyar & Deva betta	0	0	0	0	0	0	0	Nil
8	Kudiyadu betta	0	0	0	0	0	1	0	Nil
9	Kinnakora	0	0	0	0	1	1	1	Nil
10	East varagapallam	2	1	3	1	0	0	5	Pellets
11	West varagapallam	0	0	3	0	0	4	4	Pellets
12	Yelamalai east	0	2	5	0	1	1	5	Pellets
13	Tavalamalai	0	0	0	0	0	0	0	Pellets
14	Chinna atatumalai	0	0	0	0	0	0	0	Nil
15	Beeman Kali urundai	0	0	0	0	0	0	0	Nil
16	Kunjirayamalai	0	0	0	0	0	0	0	Nil
17	Velliyangirimalai	0	0	0	0	0	0	0	Nil
18	Kurudimalai	0	0	0	0	0	0	0	Nil
19	Pandaravarai	2	0	2	0	0	0	2	Nil
20	Kozhuumaan malai	0	0	0	0	0	0	0	Pellets/ Hoof marks
21	Pothimudiyar	2	0	2	0	0	0	2	Nil
22	Kovil Mattam	0	1	0	0	0	0	0	Pellets
23	Vengoli/ Pamban malai	0	0	1	0	0	0	1	Nil
24	Kovil pillai malai	0	0	1	1	0	0	2	Nil
25	Pachapal malai	0	0	0	0	0	3	3	Pellets
26	China/ Periya Thalanar	0	0	0	0	0	0	0	Nil
27	Nendukundru	0	0	0	0	0	0	0	Nil
28	Varaiyadu malai	0	0	0	0	0	0	0	Pellets
29	Thenvarai	0	0	0	0	0	0	0	Nil
30	Kuchi malai	1	2	0	2	0	0	0	Pellets
31	Sallakatti malai	0	3	1	0	1	0	0	Nil
32	Ramar malai	0	0	0	0	0	0	0	Nil
33	Pachamalai	0	0	0	0	0	1	0	Pellets
34	Severambakuli	0	0	0	0	0	0	1	Nil
35	Moodu paali malai	0	0	0	0	0	0	0	Nil
36	Manja Medu	0	0	0	0	0	0	1	Pellets



S.No	Block	Y	Ylng	AF	LBM	DBM	SBM	UC	Indirect Evidence
37	Thadaganachimalai	0	1	0	1	0	0	0	Nil
38	9th Hairpin/Sothakkal	3	3	2	1	0	2	1	Pellets
39	Bhuthagundu/Navamalai	0	0	0	0	0	0	0	Nil
40	Podhumalai	0	0	0	0	0	0	0	Nil
41	Kallar malai	4	0	1	0	0	0	0	Nil
42	Usimalai	2	2	1	0	1	1	0	Nil
43	Tanakkamalai	2	0	0	0	0	0	63	Nil
44	Nandar	0	0	0	0	0	0	0	Nil
45	Siluvaimedu	0	0	0	0	0	0	29	Nil
46	Podhumalai	2	5	6	0	0	13	16	Nil
47	Rasivarai	0	0	0	0	0	0	7	Pellets
48	Pichitch malai	3	0	1	0	1	0	0	Nil
49	Sadayandimalai	0	0	0	0	0	0	1	Nil
50	Kokkanamalai	0	0	0	0	0	0	5	Nil
51	Pampad malai	1	1	0	0	0	0	29	Pellets
52	Ellaigundu	0	0	0	0	0	0	0	Pellets
53	Jambu malai	0	0	0	0	0	0	1	Pellets
54	Eruma malai	0	0	0	0	0	0	1	Nil
55	Sandu malai	1	0	0	0	0	0	0	Nil
56	Kudirayar west	0	1	0	1	0	0	0	Hoof marks
57	Ibex	0	0	0	0	0	0	0	Nil
58	Papalamman Kovil	0	0	1	0	0	0	0	Pellets
59	Bommarajapuram Varai attu mottai South	3	3	7	3	0	0	7	Pellets
60	Padikattu Mottai	0	3	2	1	0	0	4	Pellets
61	Bommarajapuram Varai attu mottai North	0	2	1	0	1	0	2	Pellets
62	Varaiattu malai Poolamalai	0	0	0	0	0	0	0	Pellets
63	Thillukudi Mottai	0	0	0	0	0	0	0	Nil
64	Mangaladevi varayattu mottai PTR adjoining	0	0	0	0	0	0	0	Nil
65	Vittathali medu	0	0	0	0	0	0	0	Nil
66	Spring of Heaven	0	0	0	0	0	0	0	Nil
67	Salimuthan Estate	0	0	0	0	0	0	0	Pellets
68	Jothi estate	0	0	0	0	0	0	0	Pellets
69	Metla malai	0	0	0	0	0	0	0	Nil
70	Variattu mottai 1	2	2	5	0	1	0	4	Nil
71	Thoovanam mottai	0	0	0	0	0	0	0	Nil
72	Varaiyattu Mottai 2	0	0	0	0	0	0	0	Nil



S.No	Block	Y	YIng	AF	LBM	DBM	SBM	UC	Indirect Evidence
73	Pasumalai	0	0	0	0	0	0	0	Pellets
74	Iravangalar	0	0	0	0	0	0	0	Pellets
75	Patchaikoomachi	0	0	0	1	0	0	1	Nil
76	Vennirar varaiattumottai	0	0	0	0	0	0	0	Nil
77	Vattaparai	0	0	0	0	0	0	0	Nil
78	Thoovanam	0	0	0	0	0	0	0	Nil
79	Kurusadi Mottai	0	0	0	0	0	0	0	Nil
80	Nadukandanmottai	0	0	0	0	0	0	0	Pellets
81	Marakkamalai	0	0	0	0	0	0	2	Pellets
82	Athiyuthumalai	0	0	0	0	0	0	2	Pellet
83	Meeshapulimalai	0	0	1	0	0	0	2	Pellets
84	Vattakaradu	0	0	0	0	0	0	2	Pellets
85	Kunderi	0	0	0	0	0	0	0	Pellets
86	Nagamalai	0	0	0	0	0	0	2	Pellets
87	Unjal	0	0	0	0	0	0	0	Pellets
88	Sulivarai	0	0	1	0	0	0	0	Nil
89	Thiruvudkal	1	0	0	0	0	0	17	Pellets
90	Pudavukkal	0	0	0	0	1	0	0	Pellets
91	Kotamalai	0	0	0	0	0	0	0	Nil
92	Pechimottai	0	0	0	0	0	0	0	Nil
93	Perumalsamykoyil Mottai	0	0	0	0	0	0	1	Pellets
94	Naramonji mottai	0	0	0	0	0	0	1	Nil
95	Veilankal	1	0	0	0	0	1	5	Nil
96	Chembarali mottai	0	0	0	0	0	0	1	Nil
97	Kurivikavumottai	0	0	0	0	0	0	1	Pellets
98	Peimalai mottai South	0	0	0	0	0	0	0	Nil
99	Pazhathottam	0	0	0	0	0	0	0	Nil
100	Anaimutti	0	0	0	0	0	0	0	Nil
101	Peimalai mottai North	0	0	0	0	0	0	0	Nil
102	Periyaputhu	0	0	0	0	0	0	0	Nil
103	Manpudavu medu	0	0	0	0	0	0	1	Pellets/ Hoof mark
104	Varaiyattumottai	0	0	0	0	0	0	0	Pellets
105	Vellakathery	0	0	0	0	0	0	1	Nil
106	Konavengai	0	0	0	0	0	0	2	Pellets
107	Kotapanparai	0	0	0	0	0	0	1	Pellets
108	Kambathu mottai	1	0	0	0	0	0	12	Pellets
109	Mayandikidai	0	0	0	0	0	0	0	Pellets



S.No	Block	Y	Ylng	AF	LBM	DBM	SBM	UC	Indirect Evidence
110	Eswaran thittu	0	0	0	0	0	0	0	Pellets
111	Kulirattimottai (PTR Bounary)	0	0	0	0	0	0	0	Pellets
112	Thanakidacl	0	0	0	0	0	0	27	Pellets
113	Kalumurichan	0	0	0	0	0	0	0	Pellets
114	Saralai mottai	0	0	0	0	0	0	1	Nil
115	Thaliaruthan keni	0	1	0	2	0	0	0	Pellets
116	Varaiyattu mottai	0	0	1	4	1	0	0	Nil
117	Kuthukattai mottai	0	2	0	0	0	0	0	Pellets
118	Kurangu parai/ Vengaipudai	0	0	0	0	0	0	0	Nil
119	Thinnamalai	1	2	5	2	2	1	1	Pellets
120	Periya Sundangi mottai	0	1	2	0	0	0	0	Nil
121	Suyampunathar Temple	0	0	0	0	0	0	0	Nil
122	Theerthaparai mottai	0	0	0	0	0	0	0	Nil
123	Kuliratti mottai	0	0	1	0	0	0	0	Nil
124	Vengalakkalmottai	0	0	0	0	0	0	0	Pellets
125	kudiraiatheri	0	0	1	0	0	0	0	Pellets
126	Varaiyattumottai	4	0	1	0	0	0	0	Nil
127	Eetityattupudavu	0	0	0	0	0	0	0	Pellets
128	Aduppukkalmottai	0	0	0	0	0	0	0	Nil
129	Chemmunji mottai	0	0	0	0	0	0	0	Nil
130	Ainthalainnagapodhigai	0	0	0	0	0	0	0	Nil
131	Agasthiyamalai	0	0	0	0	0	0	0	Nil
132	Varaiattumudi	0	0	0	1	0	0	1	Pellets
133	Lower Winch Point	0	0	0	0	0	0	0	Pellets/ Hoof mark
134	Upper Winch	0	0	0	0	0	0	1	Pellets
135	Pandadikalam Mottai	0	0	0	0	0	0	0	Nil
136	Muthukuzhivayal	1	5	1	0	1	0	0	Pellets
137	Winch Varaiyattu Mottai	1	1	19	0	1	2	1	Pellets
138	Nandoothu Mottai	0	0	0	0	0	0	0	Nil
139	Panchanhangi Mottai	0	0	0	0	0	0	0	Nil
140	Thiruvanna mala Mottai	0	0	0	0	0	0	0	Pellets
141	Pechi mottai	0	0	0	0	0	0	0	Nil

\* Y-Young, Ylng-Yearling, AF- Adult Female, LBM-Light Brown Male, DBM-Dark Brown Male, SDB-Saddleback male, UC - Unclassified.\*

