Status and Distribution of Elephants in India - 2017

Project Elephant Division,

Ministry of Environment, Forest and Climate Change, Government of India

Ministry of Environment, Forest and Climate Change

ANCF

October 2020

Status and Distribution of Elephants in India - 2017

Prepared by Asian Nature Conservation Foundation

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CONTENTS

1. **Message from IGF, Project Elephant**
2. **Acknowledgements**
3. **Preface**
4. **Section 1: Introduction**
5. **Section 2: Methods**
6. **Section 3: Results**
    - **3.1 Elephant Distribution**
    - **3.2 Direct Count Estimates**
    - **3.3 Indirect Count Estimates**
    - **3.4 Population Structure - Age and Sex Classification**
7. **Section 4: Discussion**
8. **Section 5: The Way Forward**

MESSAGE INSPECTOR GENERAL OF FORESTS, PROJECT ELEPHANT, GOVERNMENT OF INDIA, MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

नोयल थॉमस
NOYAL THOMAS

सत्यमेव जयते

वन महानिरीक्षक
भारत सरकार
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
INSPECTOR GENERAL OF FORESTS
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PREFACE

India, the land of elephants, is estimated to host approximately 60% of Asian Elephant population and plays a vital role in the long-term survival of this species. The population of Indian elephants continue to grow despite habitat loss and degradation in some of the range states in the country. Elephants occupy a variety of habitats from dry deciduous to evergreen and shola forests. This varied nature of its habitat makes the population estimation, a difficult task. In India, the elephant population estimation is being conducted every five years by the State Forest Departments using traditional methods. In order to bring uniformity in population estimation, Government of India had decided to carry out an All India synchronized elephant population estimation in 2017 across the various elephant landscape to reduce the bias in estimation. The exercise was completed successfully and it is estimated that India holds 29964 elephants in the various elephant range states. This document, the "Status and Distribution of Elephants in India 2017" gives an overview of how the elephant population is distributed across the landscapes, relative abundance, population size, and population structure etc. This exercise has provided, for the first time, relative density estimates of elephants across the elephant range states in the country. The present population structure estimation indicates a healthy population growth across the elephants landscapes in the country.

Regular monitoring of elephant populations is a critical requirement for the long-term conservation of elephants and I am sure that this document will be immensely useful for planning conservation strategies and framing an ecologically sound policy for the protection and conservation of our National Heritage Animal.

(Noyal Thomas)

New Delhi
October, 2020

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Shri Noyal Thomas, Inspector-General of Forests, Project Elephant Division, Dr. K. Muthamizh Selvan, Scientist D Project Elephant Division, Ministry of Environment, Forests and Climate Change (MoEFCC) along with his team offered valuable support during the preparation of this report. Shri R K Srivastava, Ex-IG Project Elephant Division (and a co-author of this report) provided consistent support throughout the period of preparations for and the execution of the all-India synchronized elephant population exercise.

Raman Sukumar and co-authors

PREFACE

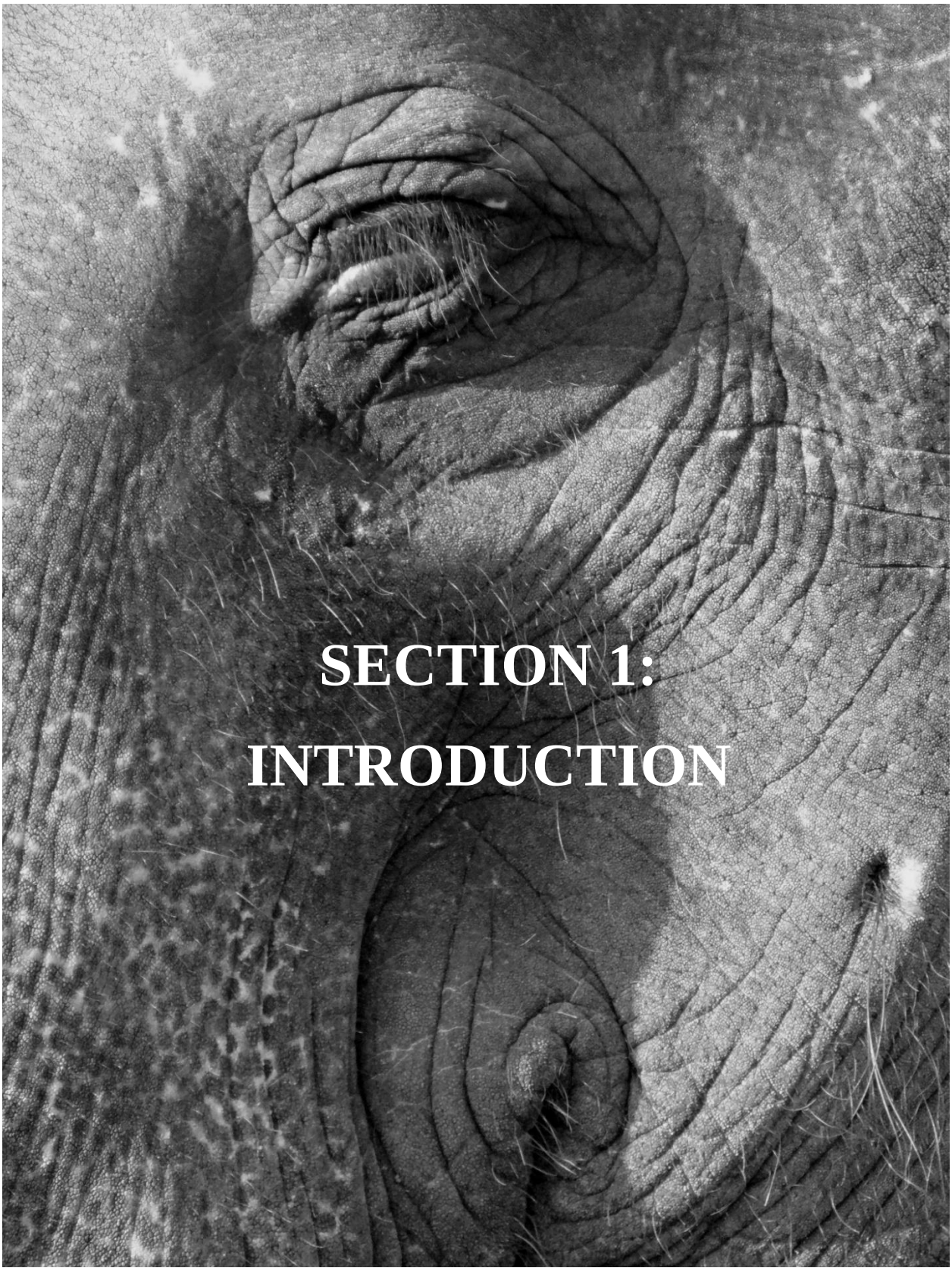
Despite being the largest land mammal, a robust population and demographic assessment of free-ranging elephants continues to pose several challenges both in Asia and Africa.

The elephant population of India has been estimated since the late 1970s by elephant range states using various methods. The southern states employed the “total count” method in which enumeration parties traversed each forest beat in an attempt to record all animals within that area. In the northeast, states such as Assam used elephant-back transects (e.g. Kaziranga), while “sample-based counts” were followed by some other states during certain years. In the 1990s the use of the indirect, dung-count method, came into vogue, as researchers across Asia and Africa began employing this method for estimating elephant population sizes, especially in densely forested areas.

During the early 2000s, Project Elephant Steering Committee recommended the use of at least one “direct count method” and one “indirect count method” for comparison of population estimates. Since the 2002 synchronized elephant census, the three southern states of Karnataka, Tamil Nadu and Kerala have generally adopted this approach of using the direct “sample block count” and the indirect “dung count”.

During the preparations for the five-yearly nation-wide elephant population estimation of 2017, both in Project Elephant Reserves and areas outside, the Project Elephant Division of Ministry of Environment, Forest and Climate Change decided at a national-level meeting held on 15th July 2016 to adopt and follow a standard approach to estimate elephant population sizes by bringing all the elephant range states on to a common platform. The goals of this exercise were, firstly, to prepare a state- and region-wise map of elephant distribution for the entire country, secondly to estimate the elephant population size using one direct and one indirect count method, and finally to document the elephant population demographic structure.

This "Status and Distribution of Elephants in India 2017" document gives an overview of how elephant populations in dense forest areas can be monitored for their geographical spread, relative abundance or population size, and population structure. This exercise has yielded, probably for the first time, detailed maps of elephant presence and their relative abundance across all elephant-bearing forest divisions in the country. Their distribution outside these areas in human-use production landscapes, however, is yet to be ascertained. It also highlights the specific challenges faced during the field implementation of the indirect dung-count method which has been recommended by CITES/MIKE (Monitoring the Illegal Killing of Elephants) for use in Asian habitats. In our endeavor to move towards a more scientifically rigorous system of monitoring elephants in the future, it is essential to learn, not only from the experiences of the latest 2017 assessment, but also from all earlier population assessment exercises. Collectively, there is a need to now begin preparations for developing a population estimation framework and bringing together of the state forest departments and scientific institutions for this purpose. This document, therefore, also provides recommendations for a more robust elephant population estimation exercise in the future.



SECTION 1:
INTRODUCTION

SECTION 1: INTRODUCTION

ALL-INDIA SYNCHRONIZED ELEPHANT POPULATION ESTIMATION 2017

- Population estimation is the foundation on which conservation decisions for endangered species should be based.
- Without this knowledge, efforts at species management can only be fragmented and not comprehensive. The Asian elephant is listed as an *"Endangered"* species in the IUCN Red List. Keeping in mind the ability of the elephant to move across landscapes, including human-dominated habitats with serious elephant-human conflicts, it is important to have robust estimates of the elephant population. There is also a need of reliable maps of elephant distribution both in natural and human-production habitats.
- India has listed the Asian elephant in Schedule I of the Wildlife Protection Act (1972) as well as designated the species as the National Heritage Icon. The country supports an estimated 60% of the global Asian elephant population. a majority of them spread across 29 Elephant Reserves, covering 11 elephant landscapes in four distinct regions across 23 states, connected regionally by at least 101 corridors as of 2017 (Menon et al., 2017). Wild elephants in India have been recorded in the following geographical regions and states of the country:

Table 1.1: Geographical regions and states in India with wild elephants

Sl. No.	Region	States within Region
1	North eastern region	Assam, Arunachal Pradesh, West Bengal (north), Meghalaya, Nagaland, Tripura, Mizoram and Manipur
2	East central region	Odisha, Jharkhand, Bihar, West Bengal (south), Chhattisgarh, and Madhya Pradesh
3	Northern region	Uttarakhand, Uttar Pradesh, Haryana, Himachal Pradesh
4	Southern region	Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Maharashtra, and Andaman & Nicobars

- Elephants are typically long-ranging animals and distributed across landscapes covering different states in India. It is thus important to carry out synchronized elephant population estimation within each of the four geographical regions in order to minimize bias in estimation that may arise from significant movement of elephants across state boundaries over time or across seasons. Recently, wild elephants have also been dispersing from forests into agricultural landscapes, and into states where they have not been present earlier.
- Nation-wide elephant population estimation exercise has been conducted every five years by the forest departments of elephant range states. With the exception of the southern states, the "census" conducted by other states has generally used the total direct count method. There has been a pressing need to improve and harmonize the population estimation methods along more scientific lines in various states across India.
- The choice of population estimation methods should be broadly uniform across the country or at least within the elephant distribution region. It should give scope for adequately training a large number of frontline forest staff within a short period. It is also desirable to maintain some level of continuity with the previous population estimations in order to make meaningful comparisons with the past figures to infer broad trends.

Newer statistical methods will require field testing, considerable training of forest ground staff, and should be introduced in stages with the help of research institutions.

- Most states have used the direct so-called "total count" method to "census" elephants over the past several decades. This can have serious limitations when applied across large forested tracts without any measure of "detection probability"; hence, this method will not be recognized as scientific (except in the case of small groups of elephants or solitary individuals known to be present in an isolated range). Direct count using "sample block count" has been adopted in southern India since 2002 in order to maximize detection within relatively small blocks of about 5 km^2.
- Planning for the 2017 all-India synchronized population estimation exercise began a year in advance, in 2016 itself, with a national-level meeting held at New Delhi on 15th July 2016. Officials from the Ministry of Environment, Forest and Climate Change, Chief Wildlife Wardens from various states, and scientists working on elephant biology agreed that a uniform set of four activities would be undertaken for the 2017 estimation, which are as follows:

Figure 1.1: The four activities under the all-India synchronized elephant population estimation exercise

1. **Developing an elephant distribution map at forest division, forest range, forest beat/compartment and village level**.	• For this purpose, state forest departments agreed to provide geospatial maps that could be analyzed using GIS (Geographical Information System) software.
2. **Estimating the elephant population density (and size through extrapolation to the elephant distribution area) and statistical confidence limits using a direct count method**	• This exercise was to be carried out during the dry season, using sample block counts for the larger populations, and total count for small scattered elephant groups and solitary individuals.
3. **Estimating elephant population density using an indirect count method**	• For this purpose, the indirect dung count method follows the standards prescribed in Hedges & Lawson (2006) of the CITES secretariat under the MIKE (Monitoring the Illegal Killing of Elephants) programme. It requires, in addition to estimates of dung density through line transects, an estimate of dung decay rate specific to a given area or region, as well as the defecation rate of elephants.
4. **Characterizing elephant population structure and assessing its demography**	• This is done through classifying elephants in broad age groups (Adult, Sub-adult, Juvenile & Calf) and determining the ratio of males to females for the older (Adult and Sub-adult) age categories only. This is best achieved through observing elephants in open areas, water holes, and salt licks where better visibility makes it possible for more accurate sex and age class determination of elephants.

- The above methods were selected for the 2017 population estimation on the basis of their relative simplicity in being implemented by frontline field staff of the forest department, and the fact that the entire exercise would be carried out within a few days rather than over weeks or months (with the exception of dung decay rate experiments).
- Following this, two rounds of regional workshops were conducted during 2016-17, the first round of workshops to initiate the dung decay rate experiments, and the second round of workshops to provide training on all the population estimation methods prior to the actual "census" exercise.

Table 1.2: Schedule of regional workshops to train forest staff in setting up the elephant dung decay rate experiments

Sl. No.	Region	Time-Period
1	North-eastern region (Guwahati)	24th September 2016
2	East-central region (Bhubaneshwar)	26th October 2016
3	Northern region (Chila, Rajaji NP)	19th November 2016
4	Southern region (Bannerghatta)	2nd November 2016

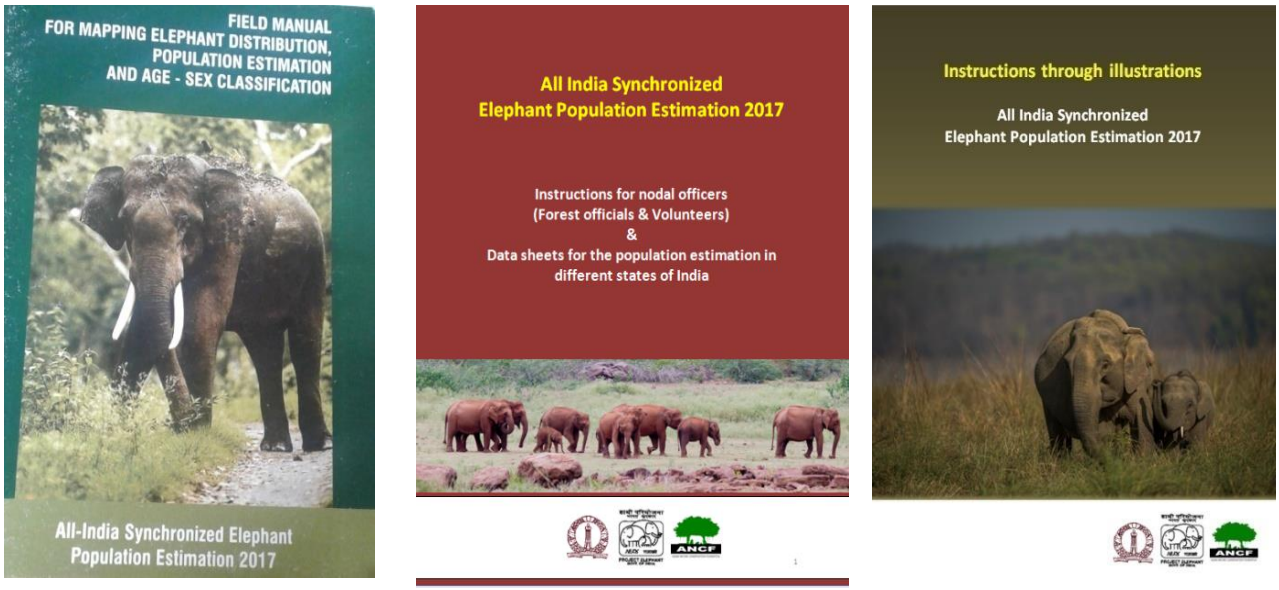
Table 1.3: Schedule of regional workshops to train forest staff in the various elephant population estimation methods

Sl. No.	Region	Time-Period
1	North eastern region (Guwahati)	10th February 2017
2	East-central region (Bhubaneshwar)	10-11th March 2017
3	Northern region (Dehradun)	25-26th April 2017
4	Southern region (Periyar TR)	18-19th April 2017

- Apart from total eight regional workshops conducted from September 2016 to April 2017, state level and division level workshops were also conducted to impart training on the methods of survey design and data collection.
- More than 25 such workshops were conducted. Large number of forest department ground staff was thus trained. Some states also included volunteers from the general public to help in the enumeration exercise. These people were also trained three months prior to the field enumeration.

Figure 1.2: Training programmes conducted for the forest team at different regions, states, and divisions across India

Figure 1.3: Resource materials used for conducting training and executing the population estimation exercise for 2017



- Following this, the field operations of population estimation took place in 2017 as detailed below:

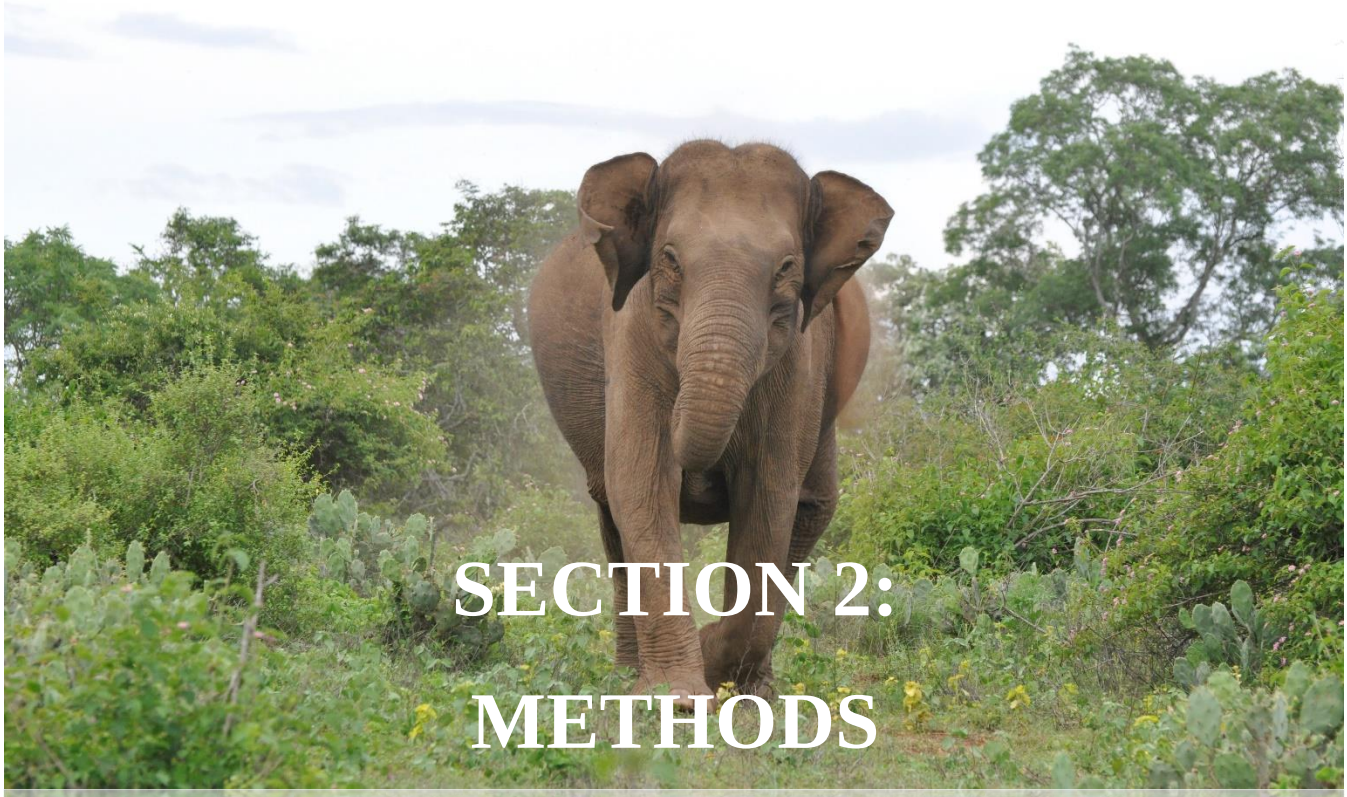
Table 1.4: Schedule of field operations for elephant population estimation conducted in each region

Sl. No.	Region	Time-Period
1	North-eastern region	26th to 29th March 2017
2	East-central region	8th to 12th May 2017
3	Northern region	23rd to 26th May 2017
4	Southern region	16th to 19th May 2017

- The "first report" of the elephant population estimation 2017, released in August 2017 (EPE 2017) presented initial results only from the direct count method. The figures provided in this report under the section of direct count method have been arrived at in many cases by the state forest departments or have been computed by researchers at the Asian Nature Conservation Foundation (based at Indian Institute of Science, Bengaluru) on the basis of the data made available to them by the state forest departments.
- In particular, mapping elephant distributions in a Geographical Information System (GIS) domain, collating data from the indirect dung count method from several state forest departments, processing and analyzing them, and compiling more accurate population structure data took several months of work as large volumes of data had to be gathered from the various states, collated, corrected and processed.
- Reliable information on elephant distribution area is lacking in the case of some states or forest divisions within a state for extrapolation of elephant density. For instance, mapping elephant distribution in areas under the Protected Area network and reserved forests was relatively easier when compared to computing their distribution across agricultural regions, for which there is a dearth of information. Similarly, robust data on elephant age/sex was not available in many cases, as photographs of elephants taken during population estimation exercise were not available for analysis.
- This is still work in-progress with inputs required/pending from several stakeholders such as state forest department officials, administrative staff who handle data, and GIS department from IT cell of state forest departments. Also, this being the first synchronized population estimation exercise that uses at least two different methods (indirect and direct count methods) across India, an improvement from a mixture of direct and indirect methods used by different states in 2012, we emphasize that the results presented in this report should be interpreted with caution and simplistic comparisons should not be made with the earlier 2012 census. In particular, no trend assessment should be made for individual forest divisions or states from these results in 2017, which also saw major shifts in dry season habitat use by elephants in the south due to a drought in the previous year. A regional comparison would be more meaningful.
- We suggest that this report should, in fact, be evaluated in terms of understanding the implementation process, challenges faced and how the same was addressed to obtain desired outcomes during the first all-India synchronized elephant population estimation exercise held in 2017. These include evaluation of challenges faced while collecting and collating data, and processing and analyzing the same. If these challenges are documented, it could help improve future population estimation exercises to provide them a more rigorous scientific basis.
- Other newer population estimation methods (line transect direct count, camera trapping using a mark-recapture framework, DNA-based profiles, occupancy models and so on) have been used by research groups at some sites, but require substantial research and development before they are implemented within

a short period across the entire country. However, it is important to initiate the use of one or more of these research methods, with the help of scientific institutions, for regular monitoring of elephant populations within selected areas in each of the four regions.

Elephants at a salt lick in Similipal from Odisha (East Central Region)



SECTION 2:
METHODS

SECTION: 2.1 ELEPHANT DISTRIBUTION MAPPING

The exercise to map the distribution of elephants across forest beats, range and divisions was carried out using the administrative maps provided by the Forest Departments. The presence or absence of elephants within each of these administrative regions was mapped with the help of field personnel, either during the training programmes or during the time of the actual elephant population estimation exercise.

In addition, data on the presence or absence of dung piles as assessed during the line transect surveys was also used, post-hoc, to arrive at the elephant distribution across forest divisions.

As mentioned previously, it was, however, not possible to accurately estimate the distribution of elephants across the agricultural landscapes and human settlements, which is still work in-progress.

Figure 2.1: Forest staff undergoing training for preparation of elephant distribution maps

- For understanding the elephant distribution pattern in India, we used GIS as a mapping and data analysis platform (ArcView). The GIS data on division boundary and land use (landscape elements) patterns were extracted where possible from the Forest Department records.
- From May 2018 onwards, several elephant states were visited, individual forest officials met through a number of workshops, and available data on elephant distribution collected. For other states, the distribution data were provided by the state (e.g. Tamilnadu, Kerala) or were based on expert institutional inputs (Chhattisgarh). It should be noted that the elephant distribution area pertained entirely to areas under the administrative control of the state forest departments, with the exception of some of the states in the northeast.

Table 2.1: States visited between May 2018 and March 2019

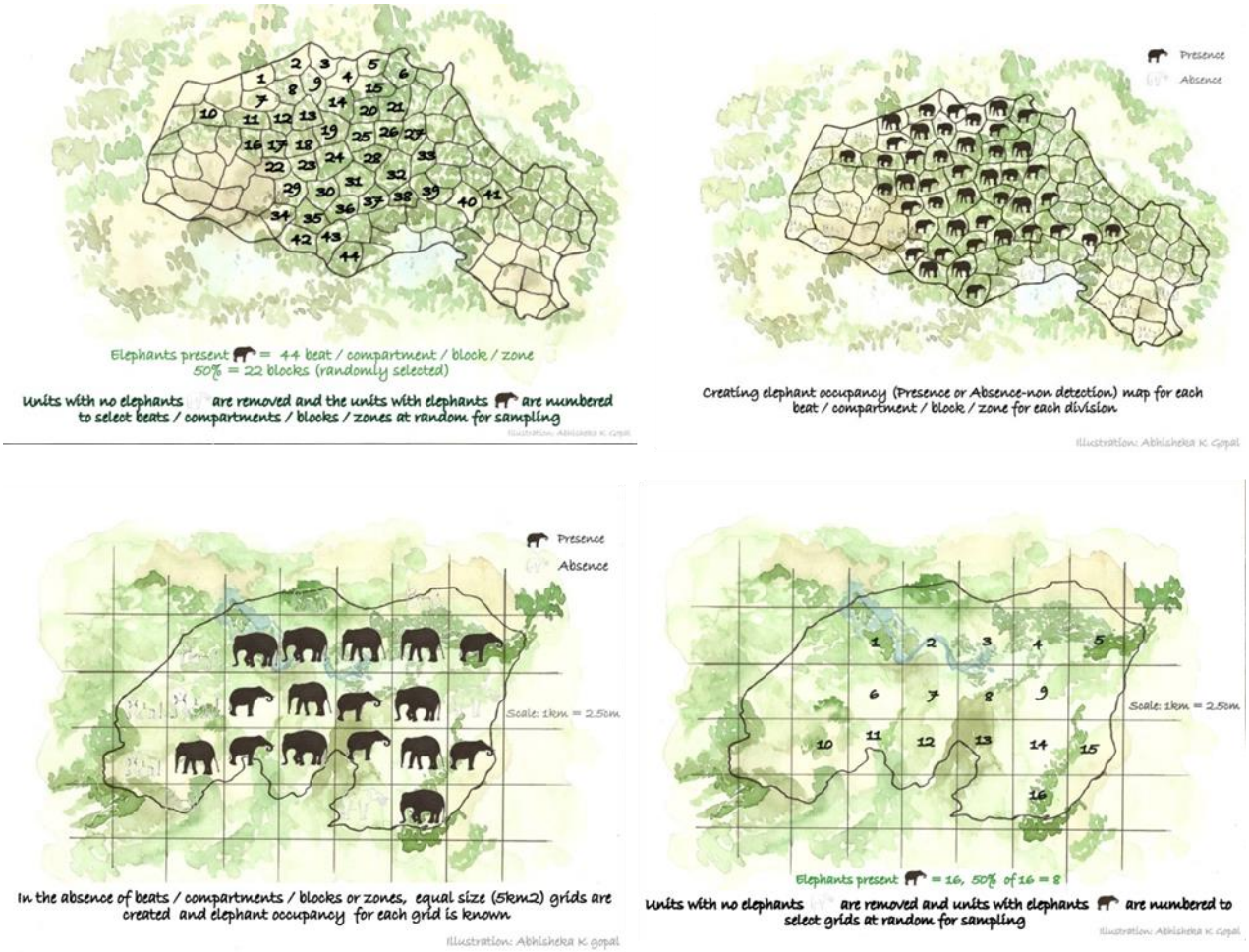
Sl. No.	State	Number of Elephant Divisions/Districts
1	Karnataka	33
2	Arunachal Pradesh	25
3	Assam	31
4	Nagaland	7
5	West Bengal	22
6	Uttarakhand	15
7	Uttar Pradesh	8
8	Himachal Pradesh	1
9	Haryana	1
10	Kerala	37
11	Manipur	3
12	Mizoram	2
13	Meghalaya	4
14	Tripura	8
15	Andhra Pradesh	4
16	Maharashtra	4
17	Goa	1
18	Andaman & Nicobars	2

Note: The remaining states could not be visited during the above time period for various reasons

SECTION: 2.2 ELEPHANT POPULATION ESTIMATION USING DIRECT COUNTS IN SAMPLE BLOCKS

- Sample block count involves direct sighting of elephants by the survey team in each selected block and is conducted simultaneously across all forest divisions and states within a region on a given day.
- During the training workshop conducted in various regions and states, it was emphasized that block sizes should ideally be about 4-6 km^2. This was based on data from the Karnataka elephant census 2012 that indicated maximum detection probability for the above block area sizes. Each block could be the smallest administrative unit (beat/compartment) or a more restricted area defined within this unit.
- The number of blocks sampled would depend on the size of the forest division; the goal was to sample 30-50% of the area of a forest division and at least 20-30 blocks within a division. The blocks were to be selected randomly within a division.

Figure 2.2: Block or beat and uniform grid-based sampling designs for block counts in a given forest division



- The boundary of each block was marked on maps using natural features such as streams, ridges and roads, and the area determined. In each block, two to three staff perambulated the area carefully trying to locate the presence of elephants from sounds of animals feeding, moving through the forest, or vocalizing. Care

was taken to avoid double counts within a block and in making sure all elephants detected were counted and, if possible, age-sex classified.

- As some animals would certainly escape detection, the results from this exercise would provide a "minimum" estimate of the population.

Data Processing:

- Data collected from the field exercise includes details of number of elephants counted (y_j), the area sampled (x_j) and total area of the division (X_j). Estimates of variance for sample blocks of unequal sizes are provided in Caughley (1977) and by Indian Statistical Institute (Kolkata) in Lahiri-Choudhury (1991).
- The formula used for estimating elephant density and elephant number along with variance, standard error and 95% confidence intervals is as follows-

i. Estimating elephant number (Y)

$$Y = (y/x) \times X$$

ii. Estimating variance (v)

$$v = \frac{X^2}{(n(n-1)} \times \sum_{j=1}^{n} \frac{(y_j - y)^2}{(x_j - x)^2}$$

iii. Estimating standard error

$$\sqrt{v} = \text{standarderroroftheestimateoftotalelephantpopulation}$$

iv. Estimate of 95% Confidence Interval (CI)

$$CI = ((Estimate\ (Y) - 1.96 \times \sqrt{v}), (Estimate(Y) + 1.96 \times \sqrt{v}))$$

CI= Estimate of the upper and lower confidence interval of total elephant population for a given forest division or stratum

Where,
X=Total area of the region (Forest Division)
n= Total Number of blocks in that region (Forest Division)
y_j= No. of elephants in the j^{th} block j=1,2,…,n
x_j= Area in km^2 of the j^{th} block
y = The total number of elephants counted in all sample blocks
x = Total area (in km^2) of all sample blocks
(y/x)= Estimate of elephant density/km^2

SECTION: 2.3 ELEPHANT POPULATION ESTIMATION USING THE INDIRECT DUNG COUNT METHOD

Indirect method of estimating elephant density involves obtaining information of dung density, elephant defecation rate, and dung decay rate (Barnes and Jensen 1987). The most challenging aspect in indirect count method is obtaining robust dung decay rate estimates for a period of time prior to the dung density survey. The CITES MIKE programme, in which India is a participant, recommends the use of indirect dung-count using the "Faecal Standing Crop" (FSC) method to estimate elephant densities in forested habitats (Hedges and Lawson 2006; Hedges 2012). The Dung Count method was carried out for the first time across India to provide a picture of relative elephant abundance as well as an estimate of the elephant population where possible.

Dung decay rate and dung density estimation exercises were executed independently, while defaecation rate was derived from the literature. Variables such as skill-sets required to plan and execute these exercises, time period needed, order of execution, local conditions of rainfall, and ambient temperature were taken into consideration while planning and executing all exercises. At the end of execution, data was collated, compiled and cleaned. These datasets were processed and analyzed and the results obtained shared in subsequent sections. These observations would be taken forward eventually to strengthen the approach of the indirect count method to estimate elephant population size.

2.3.1 Defaecation Rate

- One of the key variables required to estimate elephant density using the indirect dung-count method is the dung defecation rate of elephants. The defecation rates estimated for Asian elephants have ranged from about 9.3 to as high as 18.1 times per day (See Hedges 2012 for a review). In southern India, the defecation rate of elephants per day or 24 hours has been estimated to be around 14 to 16 times on average (Dawson 1990, Watve 1992) and, hence, a rate of 15 times per day can be used as the defecation rate of elephants. In addition, elephant defecation rate does not seem to vary much, even across seasons, as seen in several studies (Tyson et al. In review).

2.3.2 Dung Decay Rate

- Dung decay may vary widely across the regions and seasons depending on local conditions of rainfall, temperature and other factors. Therefore, using results of dung decay rate from one location in a state cannot necessarily be expected to give a reliable estimate of elephant density at other locations. States were thus asked to set up experiments in different environmental regimes.
- The dung experiments across different states were initiated in October 2016 and a map given below provides the locations of the dung decay rate experiments carried out for different regions and states across India.
- In a selected forest division, 15 fresh dung piles each were marked at intervals of 20 days and their status (presence or absence) eventually noted during the week of the dung density estimate exercise. In most cases, these sets of dung piles were marked seven to eight times prior to the line transect exercise.
- The dung decay rate is derived from fitting a logistic regression to the data as suggested by Laing et al. (2003).

Figure 2.3: Map showing the locations of dung decay rate experiments carried out in different regions and states across India

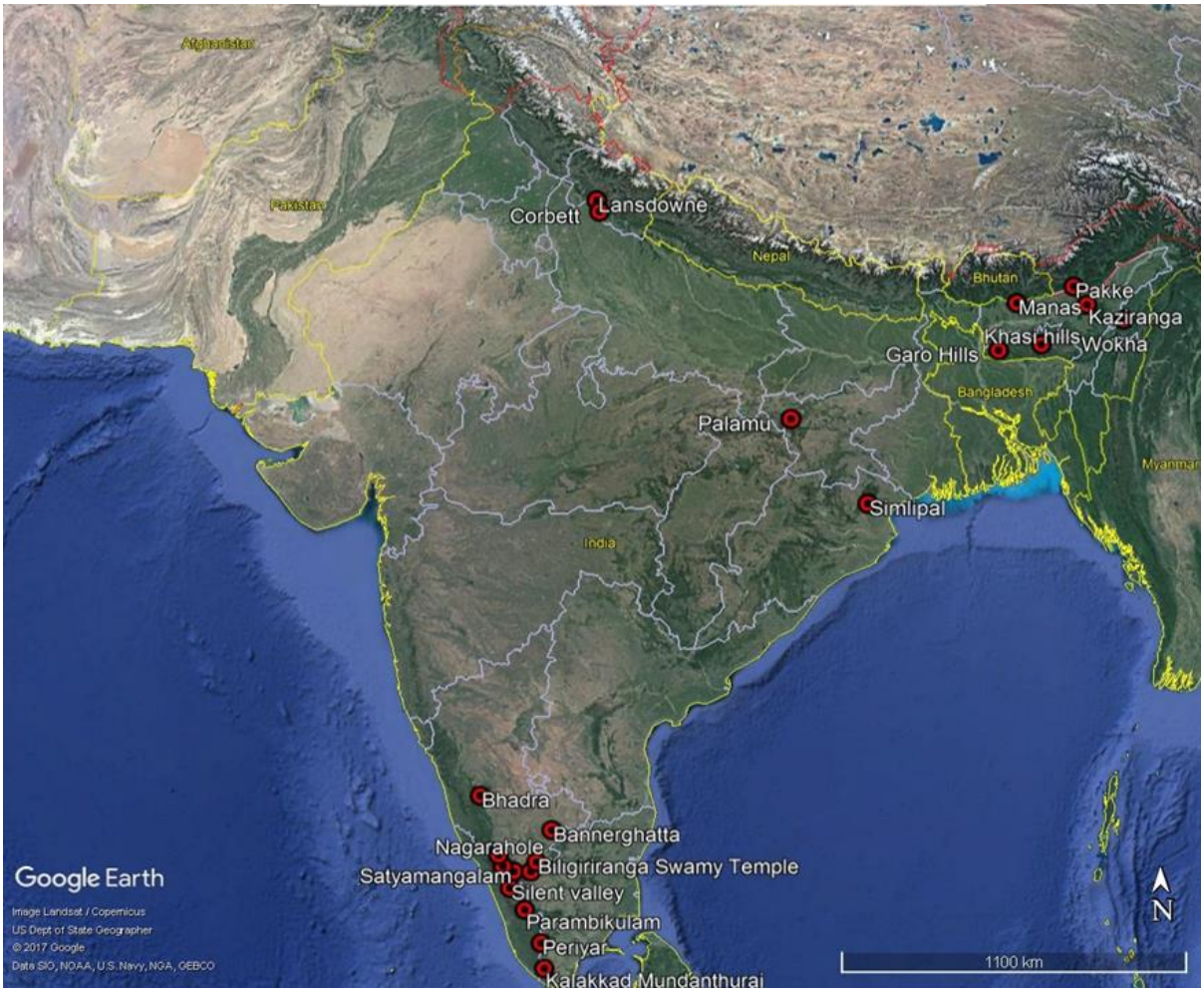
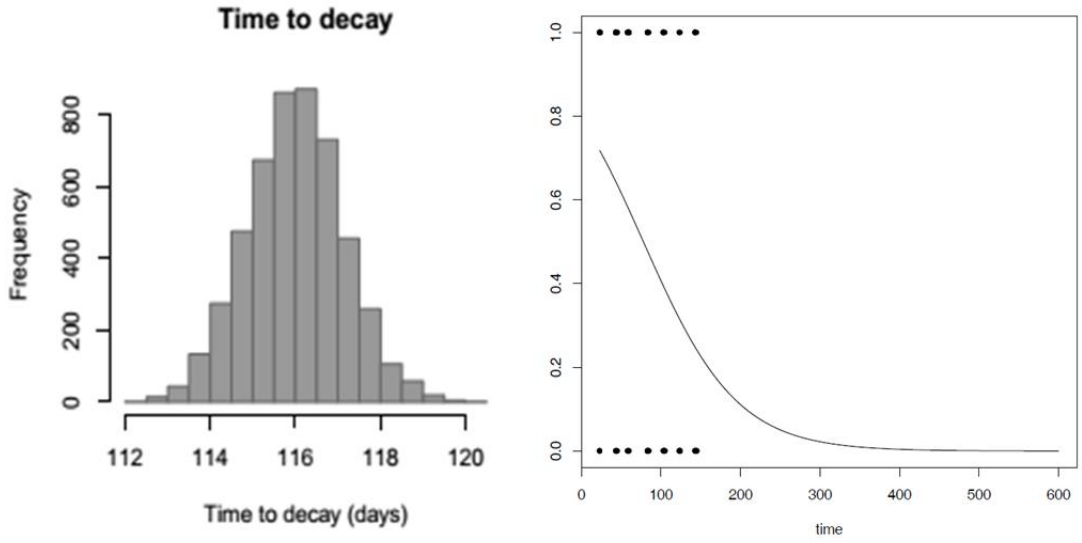


Figure 2.4: Training and marking of fresh dung pile for decay rate experiment

Figure 2.5: Examples of the status of dung piles marked and monitored over time

Fresh Sample No. 5 (as on 27/01/2017) Sample No. 5 (as on 08/03/2017)

Figure 2.6: Illustrative pattern of distribution of elephant dung decay and a logistic regression fitted to estimate dung decay rate at a site.



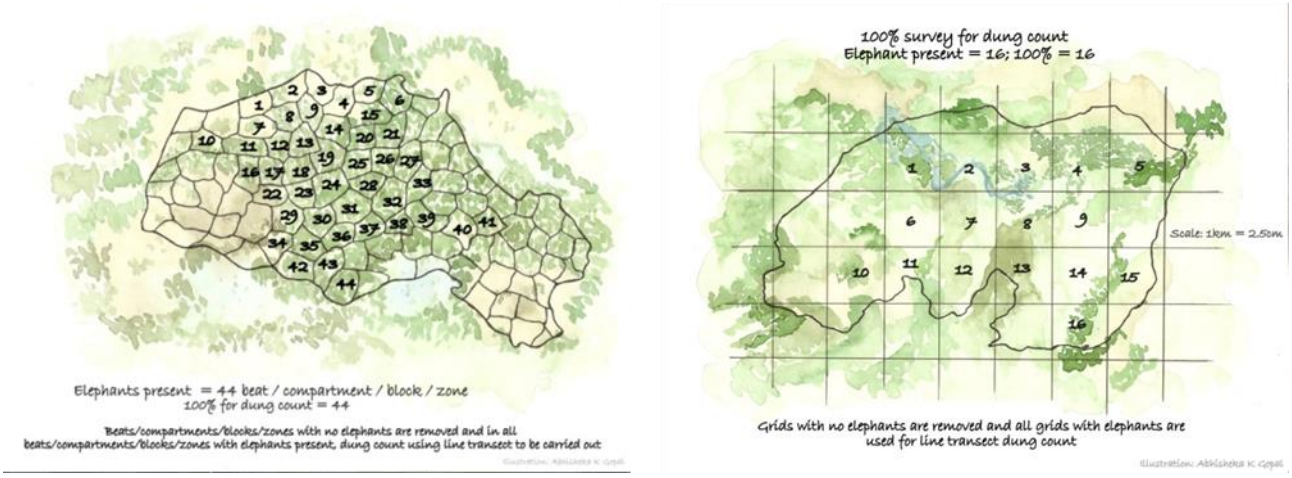
- Daily dung decay rates at the 16 sampled sites in the country varied from a low of 0.0043 (at Mudumalai Tiger Reserve, Tamilnadu) to a high of 0.0095 (at Hosur Forest Division, Tamilnadu), excluding the exceptionally high decay rate computed for Kaziranga National Park (Assam) based on limited data. The pattern of dung decay at Hosur came closest to fulfilling the condition required to obtain a robust estimate of dung decay by fitting a logistic regression (Laing et al. 2003). **However, several problems arose with the dung decay rate results from many sites, making it difficult to use these for estimating elephant density, as explained in subsequent sections**.

2.3.3 Estimating Dung Density from Line Transects

The Line Transect method (Burnham et al. 1980) used to estimate dung density and eventually elephant density can potentially be a robust method of elephant population size estimation (Barnes 2001) with a precision even better than the aerial surveys conducted to estimate elephant numbers in African savannas (Jachmann 1991, Barnes 2002). The statistically rigorous "distance sampling approach" (Buckland et al. 2001) uses "probability detection function" to estimate of dung density in each transect or a pool of these transects.

- Transects of length varying between 1 and 2 kilometers are laid in sampled beats and the perpendicular distance to each observed dung pile recorded. The perpendicular distance to each dung pile measured and the total length of the transects walked is used in the estimation of dung density at the scale of a forest division.
- The assumption central to this method is that the probability of detecting dung piles decreases as distance of the dung pile from the transect line increases, and that no pile which is directly on the transect line is missed.
- Given observed data on dung piles and perpendicular distances, a cut-off distance is arrived at using the probability detection function in order to minimize noise and maximize precision.

Figure 2.7: Block or beat and uniform grid-based sampling design for dung counts for a given forest division



- Dung density was estimated using DISTANCE software program (version 6.2) (Buckland et al., 1993). This program generates simulations based on observed occurrence of dung piles and estimates dung density for that area. DISTANCE generates dung density using perpendicular distances observed within the cut-off distance.
- Dung density is calculated using several detection functions and a combination of semi-parametric models (for details refer to the report of the Karnataka 2012 elephant census by Varma and Sukumar, 2012).
- The selected model with an estimate of dung density is arrived at using multiple qualifiers such as Akaike Information Criteria (AIC), standard error values and goodness of fit of the models to the underlying assumption of Line Transect Method.

- Elephant density can be estimated by using the following relationship (Barnes and Jensen 1987):

  E = (Y x r) / D

  Where;

  E = Density of elephants per unit area

  Y = Density of dung per unit area

  r = Dung decay rate per day

  D = Number of defecations per day by an elephant

- Information on Dung Decay Rate is integral to the estimation of elephant density in this method. Without this information, preferably specific to a given region, elephant density cannot be estimated.
- Based on the field knowledge of forest officials, the divisions, ranges and beats with known elephant presence were selected for the indirect count exercise in each state. This information along with forest cover maps (using 2011 vegetation data) was used to determine the elephant occurrence area within each division, state and region.
- Elephant dung density maps were created at regional level to showcase the state- and region-wise relative dung density using Geographical Information System (GIS) software.
- The above procedure was followed to estimate dung density for each forest division (or a cluster of adjoining divisions in case of very low sample size and elephant abundance). These maps, in addition, would enable us to compare the elephant abundance estimates from the indirect dung count method with the direct block-count method.

SECTION: 2.4 ELEPHANT POPULATION STRUCTURE – AGE AND SEX CLASSIFICATION

Data on population structure were collected during the sample block count and by monitoring locations where the visibility was good and elephants were expected to spend sufficient time for observers to classify them into age and sex categories.

- Following this principle, waterholes, open areas, salt licks, locations where elephants commonly crossed roads or rivers were identified as potential monitoring locations based on the ground knowledge of the field staff.
- Here, details such as number of elephants, the age and sex of the elephants seen were recorded. Sex was differentiated based on presence or absence of tusks for animals above 2 years. Individuals less than 2 years were not sexed, while enumerators were also trained to try and differentiate tuskless males (makhna) based on characteristic features such as the presence of penis sheath, slanting back, broad musculature at trunk base and the social context of the individual (solitary sub-adult or adult without tusks).
- The observers were encouraged to take photographs of elephants when possible during this exercise and the age of elephant was classified into four major classes based on their shoulder heights following Sukumar et al. (1988). The categories are:

Table 2.2: Age classification of elephants based on shoulder height measurements

Sl. No.	Region	Time-Period
1	Calf	<1 yr old; up to 120 cm height
2	Juvenile	1–5 yrs old; 121–180 cm
3	Subadults	5–15 yrs old; 181–210 cm for female and 181–240 cm for male
4	Adults	15 yrs; >210 cm for female and >240 cm for male

**Individuals were recorded as 'unidentified' if they could not be categorized for age class and sex.*

Figure 2.8: Examples of elephant groups that can be classified into their age and sex categories

SECTION: 2.5 ON-GROUND SAMPLING EFFORT

Figure 2.9: Key highlights of on-ground sampling efforts at consolidated all India level and across different states of India

Area of Forest Divisions Surveyed

- **Area of 212,095 km^2**
- **Across 23 states**

Forests Surveyed using Direct Count Method

- **No. of Blocks Surveyed : 4,021**
- **Area of Blocks Surveyed : 24,558 km^2**
- **Across 10 states**

Forests Surveyed using Indirect Count

- **Number of Line Transects : 4,134**
- **Total Length of Transects : 6,420 km**
- **Dung Piles Recorded : 46,645 piles**
- **Across 14 states**

Elephants Classified

- **No. of Elephants Sighted : 14,939**
- **Across 12 states**

Notes:

1. Not all divisions are updated with the latest forest area.

2. Only 10 states reported data on number and area of blocks sampled using direct count method.

3. Data on elephant population structure is based on reports received from only 12 states.

Table 2.3: On-ground Sampling Effort for Direct-Count Method

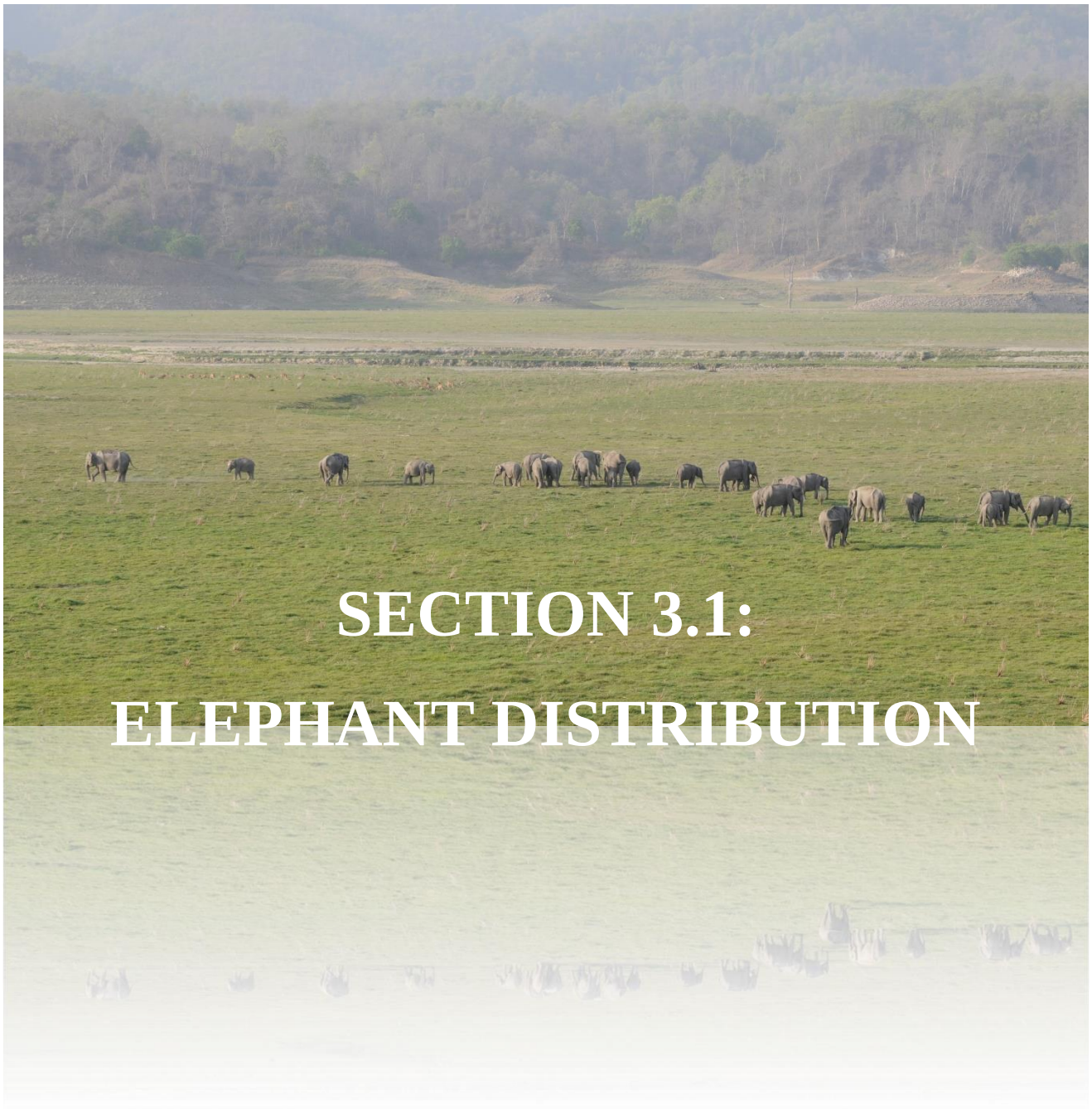
Sr. No.	State	Number of Blocks	Area of Blocks Sampled (km^2)
1	Arunachal Pradesh	138	744
2	Assam	865	5205
3	Meghalaya	232	1185
4	West Bengal (North region)	58	550
5	Jharkhand	311	2667
6	Odisha	NA	NA
7	Chhattisgarh	NA	NA
8	West Bengal (South region)	57	985
9	Uttarakhand	555	3038
10	Karnataka	654	3284
11	Kerala	615	3895
12	Tamilnadu	535	3005
Grand Total		**4021**	**24558**

Notes: Among the major elephant states, Odisha did not report the number and area of blocks sampled, while Chhattisgarh made a total count of all elephants recorded by field teams. The other states with small (<100) elephant populations likewise reported total counts.

Table 2.4: On-ground Sampling Effort for Indirect-Count Method

Sr. No.	State	Number of transects	Distance covered (km)
1	Arunachal Pradesh	141	222
2	Assam	597	776
3	Meghalaya	153	129
4	Tripura	61	80
5	Nagaland	39	48
6	West Bengal (North region)	186	251
7	Odisha	512	885
8	Jharkhand	191	295
9	Uttarakhand	334	343
10	Karnataka	864	1641
11	Kerala	615	1162
12	Andhra Pradesh	83	148
13	Andaman & Nicobars	11	11
14	Tamilnadu	347	429
	Grand Total	**4134**	**6420**

SECTION 3:
RESULTS

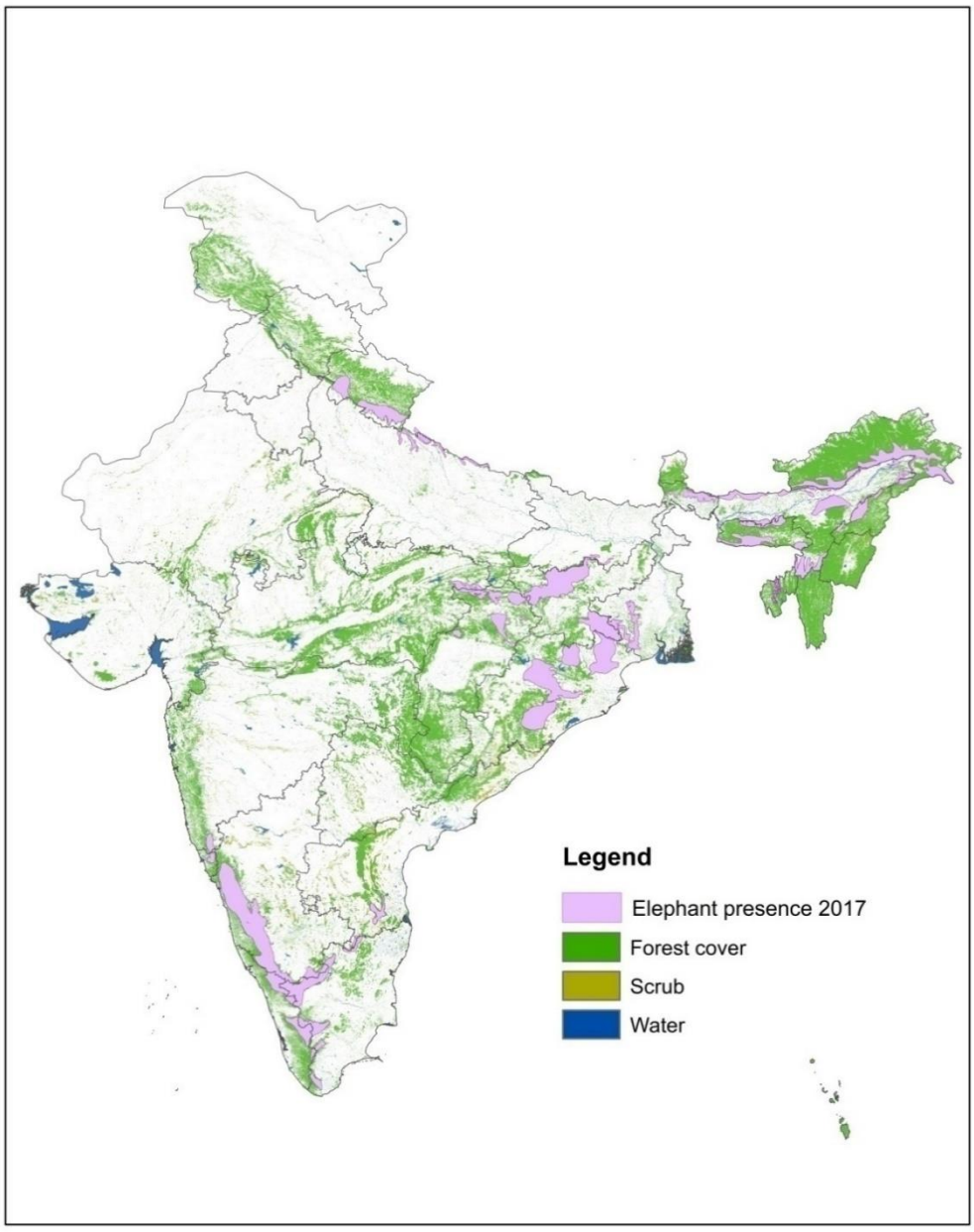


SECTION 3.1:

ELEPHANT DISTRIBUTION

SECTION: 3.1 DISTRIBUTION OF ELEPHANTS

Figure 3.1: Map of India showing the forest cover (as per Forest Survey of India) and the broad distribution of wild elephants (EPE 2017)



3.1.1 Elephant Distribution Area across Regions and States

The elephant distribution area is a minimum of 1,29,268 km^2, across 4 regions, 23 states and 301 forest divisions. This figure represents the land area administered by the state forest departments, with the exception of some of the northeastern states where most of the forests are under community ownership and management. In a few states with small elephant numbers (<100) or occasional incursions of elephants from neighbouring states, the distribution areas could not be determined. Elephants also widely range in predominantly agricultural or settled areas; these areas have not yet been computed for lack of adequate data. The total area of elephant distribution and presence in the country would certainly exceed 200,000 km^2 if one were to take both forests and agricultural land into consideration.

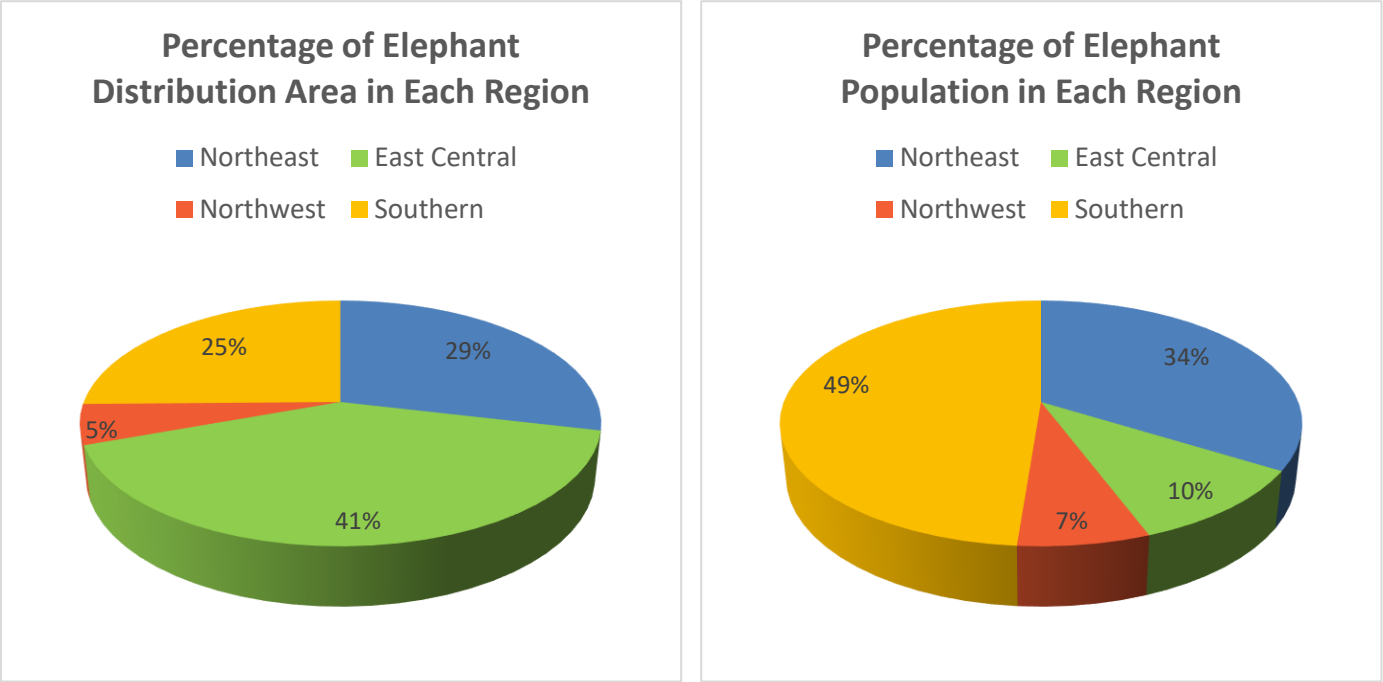
Table 3.1: Region and state-wise elephant distribution areas (based on EPE 2017)

Sl. No.	Region/ State	Elephant distribution area in km^2	Number of divisions with elephant presence
	Northeast Region		
1	Arunachal Pradesh	7000	25
2	Assam	15050	31
3	Meghalaya	11119	4
4	Tripura	987	8
5	Nagaland	1000	7
6	West Bengal (north)	1933	9
7	Manipur	UD	3
8	Mizoram	UD	2
	Sub-total:	**37,089**	**89**
	East Central Region		
9	Odisha	16825	37
10	Jharkhand	4156	8
11	Chhattisgarh	27635	29
12	Bihar	UD	NA
13	Madhya Pradesh	UD	NA
	West Bengal (south)	4067	13
	Sub-total:	**52,683**	**87**
	Northern Region		
14	Uttarakhand	4087	15
15	Uttar Pradesh	2745	8
16	Haryana	UD	1
17	Himachal Pradesh	UD	1
	Sub-total:	**6,832**	**25**
	Southern Region		
18	Karnataka	8976	33
19	Kerala	9606	37
20	Maharashtra	UD	4
21	Andhra Pradesh	6318	4
22	Andaman & Nicobars	133	2
23	Tamilnadu	7562	20
	Sub-total:	**32,595**	**100**
	Total:	**129,199**	**301**

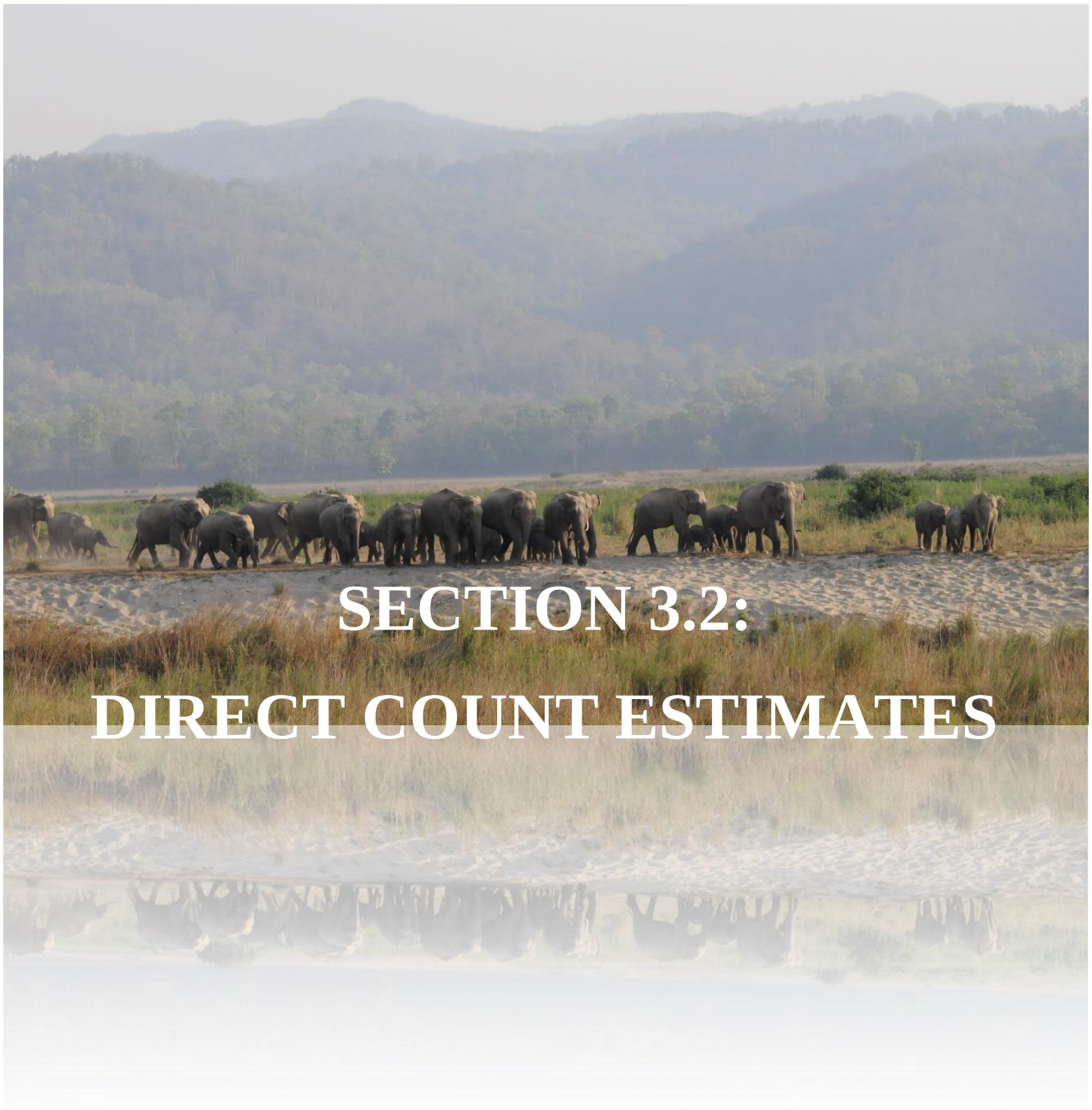
*Note: * Data of elephant distribution is not available for 7 states with very low elephant population*

3.1.2 Proportion of Elephant Distribution Area and Population across Regions

Figure 3.2: Elephant distribution and direct count population estimates across regions



- The large elephant distribution area (41% of the total in the country) in the East-Central Region but only 10% of the total elephant population is a consequence of the dispersal and widespread movement of elephants in recent times. The Southern region which covers 25% of the total elephant distribution holds the largest population (49% of the total) of elephants in the country at some of the highest densities recorded. The Northeastern Region is the second most important in terms of elephant population found roughly in proportion to the area of geographical distribution in the country. The Northern Region has the smallest population and distribution area of elephants.



SECTION 3.2:

DIRECT COUNT ESTIMATES

SECTION 3.2 DIRECT BLOCK-COUNT ESTIMATE

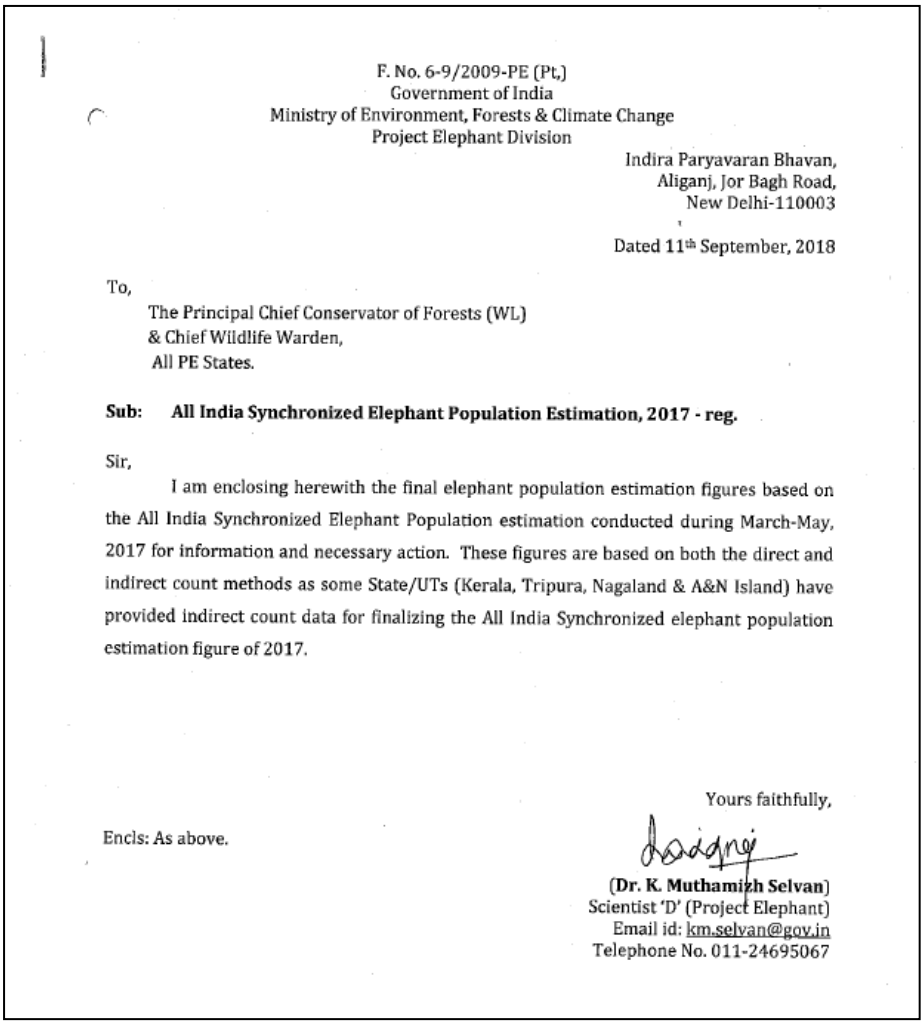
- A population of 27,580 elephants has been estimated from 23 states in India by the direct count method using random block sampling.
- Northeast Region estimated 10,139 elephants (34%), East-Central Region 3,128 elephants (10%), Northern Region 2085 (7%) elephants and Southern Region estimated 14,612 elephants (49%).
- Eight states in India have more than 1500 elephants each, while another 8 states report less than 25 elephants each. The number of elephants in a state ranges from 6049 (Karnataka) to 6 (Maharashtra) individuals.

Table 3.2: Region and state-wise estimate of elephant numbers by the direct block count method (EPE 2017)

Sl. No.	Region/ State	Elephant Density/ km^2	Elephant distribution area in km^2	Elephant Population (Estd)
	Northeast Region			
1	Arunachal Pradesh	0.23	7000	1614
2	Assam	0.38	15050	5719
3	Meghalaya	0.16	11119	1754
4	Tripura**	0.10	987	102
5	Nagaland**	0.45	1000	446
6	West Bengal (north)	0.25	1933	488
7	Manipur	UD	UD	9
8	Mizoram	UD	UD	7
				Sub-total: **10139**
	East Central Region			
9	Odisha	0.12	16825	1976
10	Jharkhand	0.16	4156	679
11	Chhattisgarh	0.009	27635	247
12	Bihar	UD	UD	25
13	Madhya Pradesh	UD	UD	7
	West Bengal (south)	UD	4067	194
				Sub-total: **3128**
	Northern Region			
14	Uttarakhand	0.45	4087	1839
15	Uttar Pradesh	0.08	2745	232
16	Haryana	UD	UD	7
17	Himachal Pradesh	UD	UD	7
				Sub-total: **2085**
	Southern Region			
18	Karnataka	0.67	8976	6049
19	Kerala	0.35	9606	3322
20	Maharashtra	UD	UD	6
21	Andhra Pradesh	0.01	6318	65
22	Andaman & Nicobars**	0.14	133	25
23	Tamilnadu	0.37	7562	2761
				Sub-total: 12228
	Total		**129199**	**27580**

*Notes: 1. **Results are based on indirect (dung) count method (for the states of Tripura, Nagaland, and Andaman & Nicobars) to obtain the pan-India figures of elephant population. 2. UD- undetermined*

Letter of the MoEFCC, Project Elephant Division stating the change in numbers presented by Kerala state



F. No. 6-9/2009-PE (Pt.)
Government of India
Ministry of Environment, Forests & Climate Change
Project Elephant Division

Indira Paryavaran Bhavan,
Aliganj, Jor Bagh Road,
New Delhi-110003

Dated 11th September, 2018

To,

The Principal Chief Conservator of Forests (WL)
& Chief Wildlife Warden,
All PE States.

Sub: All India Synchronized Elephant Population Estimation, 2017 - reg.

Sir,

I am enclosing herewith the final elephant population estimation figures based on the All India Synchronized Elephant Population estimation conducted during March-May, 2017 for information and necessary action. These figures are based on both the direct and indirect count methods as some State/UTs (Kerala, Tripura, Nagaland & A&N Island) have provided indirect count data for finalizing the All India Synchronized elephant population estimation figure of 2017.

Yours faithfully,

Encls: As above.

(**Dr. K. Muthamizh Selvan**)
Scientist 'D' (Project Elephant)
Email id: km.selvan@gov.in
Telephone No. 011-24695067

(Source: File No. 6-9/2009-PE(Pt), Government of India, Ministry of Environment, Forests & Climate Change, Project Elephant Division, 11th September, 2018)

Notes: Elephant population estimation from Kerala has been updated as per the letter received from Project Elephant Division (File No. 6-9/2009-PE(Pt), Government of India, Ministry of Environment, Forests & Climate Change, Project Elephant Division, 11th September, 2018) to 5706 and are based on indirect (dung) count method analyzed by Kerala Forest Department. This figure replaces the elephant population of 3054 estimated by direct (block) count method reported previously in EPE (2017).

Table showing the official estimates of the MoEFCC, Project Elephant Division after incorporating the changes in numbers reported by Kerala

Population Estimation of Elephants in India, 2017

REGION	STATE	ELEPHANT POPULATION
North-East	Arunachal Pradesh	1614
	Assam	5719
	Meghalaya	1754
	Tripura **	102
	Nagaland **	446
	West Bengal (North Region) #	488
	Manipur	9
	Mizoram	7
		10,139
East Central Region	Odisha	1976
	Jharkhand	679
	Chhattisgarh	247
	Bihar	25
	Madhya Pradesh	7
	West Bengal (South Region) #	194
		3128
North West Region	Uttarakhand	1839
	Uttar Pradesh	232
	Haryana	7
	Himachal	7
		2085
South Region	Karnataka	6049
	Kerala **	5706
	Maharashtra	6
	Andhra Pradesh	65
	Andaman & Nicobar Islands **	25
	Tamil Nadu	2761
		14612
GRAND TOTAL		**29964**

The total elephant population estimation figures for West Bengal is 682 (North Bengal (488) + South Bengal(194)).

** Population estimation figures are based on indirect (dung) count method as informed by State & UTs like Kerala, Nagaland, Tripura and A&N Islands.

(Source: File No. 6-9/2009-PE(Pt), Government of India, Ministry of Environment, Forests & Climate Change, Project Elephant Division, 11th September, 2018)

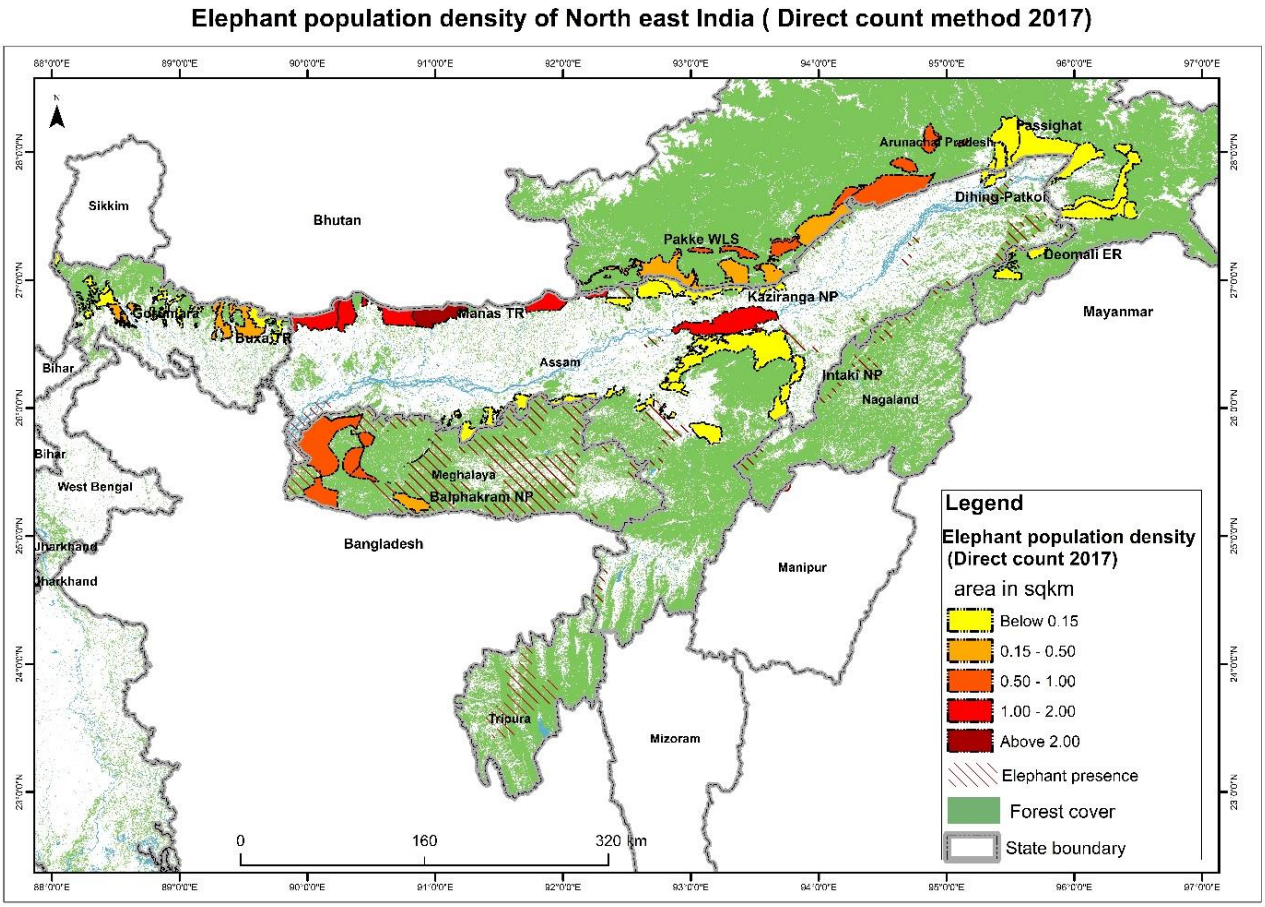
3.2.1 Region and State wise Estimates of Elephant Population using Direct Block-Count Method

In this section an extended version (compared to that reported in the All-India Synchronized Elephant Population Estimation 2017) of the direct block count estimation of the elephant population at the region, state and division-wise is provided. In addition, maps of the relative density of elephants across each region has also been provided. For each state, the figures are first pooled across all sampled blocks and later the estimates are provided for each division or cluster of divisions constituting a contiguous landscape or an Elephant Reserve. **It should be noted that the total of the estimated population in each division of a state need not add up to the number estimated for the entire state through pooled analysis**. In some cases, only partial data were available for the elephant areas of a state. **Please see Appendix 1 for map index of all elephant divisions.**

3.2.2 Direct Count Elephant Population Estimation – North East Region

A total of 10,139 elephants was estimated in Arunachal Pradesh, Assam, Meghalaya, Mizoram, Manipur, Nagaland, Tripura and northern West Bengal of the northeast region.

Figure 3.3: The relative density of elephants (per km^2) in the northeastern region estimated from the direct count method



Direct Count Elephant Population Estimation – Arunachal Pradesh

- Elephants are distributed over 22 forest divisions in Arunachal Pradesh and a total of 139 sample blocks were randomly selected and enumerated in Arunachal Pradesh.
- Analysis of the above indicated an overall elephant density of 0.23 elephants/km^2 for this state. The elephant distribution area for Arunachal Pradesh is estimated to be about 7000 km^2 based on the information published from the website http://www.wildlifeofindia.org/projectelephant.html. This gives a population estimate of 1614 elephants for the state.

Sl. No.	State / Division Name	Elephant density/km^2	ED-Std. Error	Elephant distribution area in km^2	Elephant Population
	Arunachal Pradesh	**0.23**	**0.02**	**7000**	**1614**
1	Shergaon-Khellong-Bomdila-Pakke-Banderdewa	0.49	0.07	1281	628
2	Sagalee-Hapoli-Likabali-Along	0.50	0.11	1992	996
3	Pasighat-Pasighat WLS-Dibang-Lohit	0.04	0.01	1589	63
4	Anjaw-Namsai-Namdapha-Nampong-Changlang-Deomali-Khonsa	0.14	0.03	814	113

Direct Count Elephant Population Estimation – Meghalaya

- Much of the elephant habitat area in Meghalaya is under community forest. A total of 232 blocks were sampled in the state and the same ranged from 2.6 km^2 to 8.8 km^2. This translated to an overall density of 0.16 elephants/km^2. The elephant distribution area for Meghalaya as estimated by the forest department is 11,185km^2 and the population estimate of 1754 elephants.

Sl. No.	State / Division Name	Elephant density/km^2	Std. Error	Elephant distribution area in km^2	Elephant Population
	Meghalaya	**0.16**	**0.01**	**11118**	**1754**
1	Balpakaram NP	0.09	0.01	220	20
2	Jaintia Hills	0.28	0.05	316	89
3	Khasi Hills	0.16	0.02	4210	695
4	Garo Hills	0.13	0.01	5260	684

Direct Count Elephant Population Estimation – Assam

- Elephants are found in 36 forest divisions in Assam. A total area of 5205 km^2 was sampled for block count direct method for the state. Elephant density of 0.38 animals/km^2 was estimated for this state. The total elephant area for the state, estimated by the Assam Forest Department is 15,050 km^2, indicating an elephant number of 5719 elephants for the state.

Sl. No.	State / Division Name	Elephant density/km^2	Std. Error	Elephant distribution area in km^2	Elephant Population
	Assam	**0.38**	**0.01**	**15050**	**5719**
1	Nameri-Sonitpur-Dhemaji	0.33	0.09	1528	504
2	Kamrup W & E- Golpara	0.22	0.03	944	208
3	Kaziranga National Park	1.52	0.54	1070	1627
4	Karbi Anglong-Nagaon	0.29	0.05	2376	691
5	Manas NP	2.21	0.17	546	1206
6	Chirang-Kachugaon-Haltugaon-Dhansiri	0.22	0.04	1685	377
7	Dibrugarh-Digboi-Doomdooma-Sivsagar	0.95	0.10	1010	960

(Note: Only major forest divisions with elephants are reported here)

Direct Count Elephant Population Estimation – Manipur

A group of 6 to 7 elephants has been reported along the eastern banks of Barak River, bordering Nagaland. This group appeared to be isolated without having any habitat connectivity. However, this group was also not enumerated during the 2017 census operations.

State / Division Name	Elephant density/km^2	Elephant distribution area in km^2	Elephant Population
Manipur	NA	NA	**9**

Direct Count Elephant Population Estimation – Mizoram

A group of 5-7 elephants has been reported to move into Mizoram on a seasonal basis. This group moves between India (Assam and Mizoram) and Bangladesh across the international border. However, this group was not enumerated during the 2017 census operations.

State / Division Name	Elephant density/km^2	Elephant distribution area in km^2	Elephant Population
Mizoram	NA	NA	**7**

Direct Count Elephant Population Estimation – West Bengal (North)

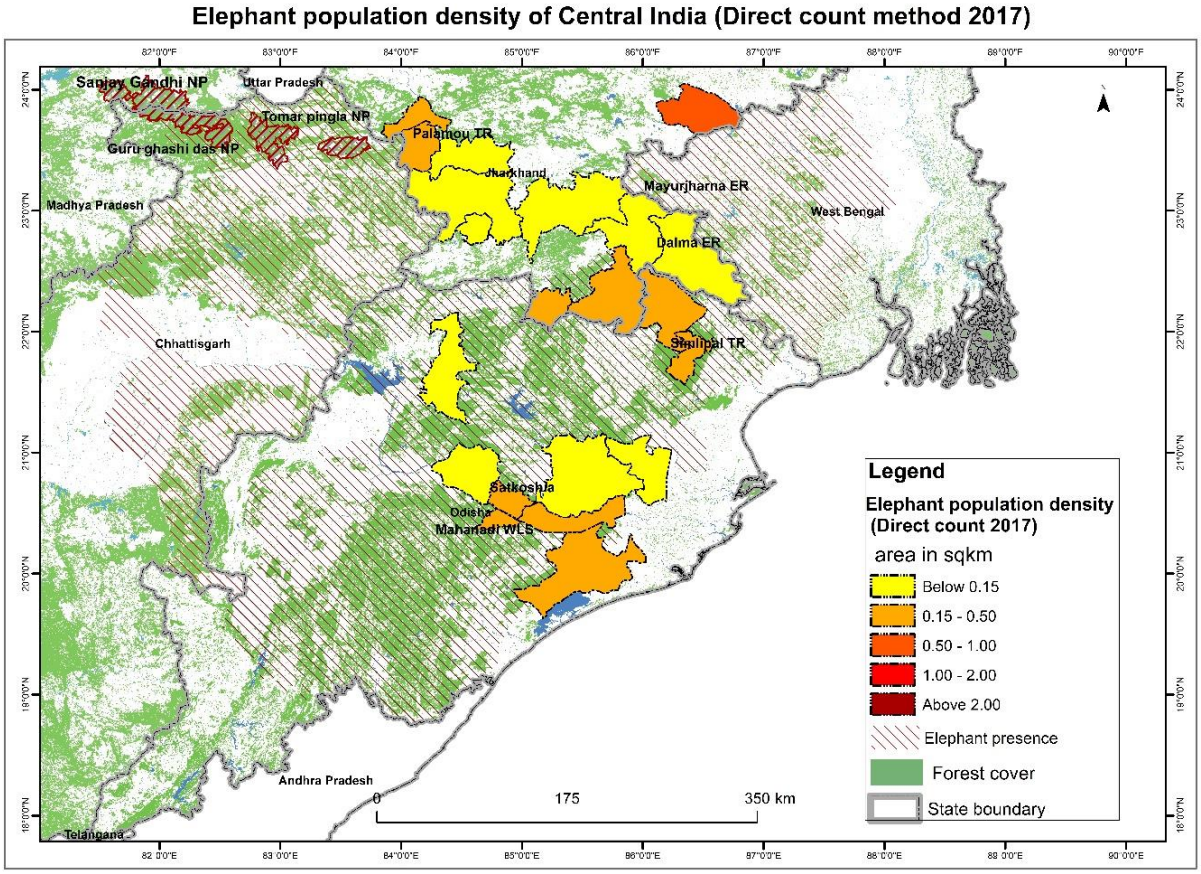
Elephants are distributed over nine forest divisions in northern West Bengal. A total of 153 blocks were sampled for the direct count method for northern Bengal. An elephant density of 0.25/km^2 was estimated for this region and a total number of 488 elephants estimated using 1933 km^2 elephant distribution area for northern Bengal.

Sl. No.	State / Division Name	Elephant Density/km^2	Std. Error	Elephant distribution area in km^2	Elephant Population
	Northern West Bengal	**0.25**	**0.02**	**1933**	**488**
1	Buxa TR East	0.10	0.02	394	40
2	Buxa TR West	0.36	0.08	367	131
3	Jaldapara NP	0.38	0.07	306	115
4	Jalpaiguri	0.15	0.04	311	46
5	Gorumara NP	1.06	0.32	104	109
6	Baikunthapur	0.27	0.08	226	61
7	Darjeeling WL	0.12	0.03	161	19
8	Kurseong	0.08	0.00	64	5

3.2.3 Direct Count Elephant Population Estimation – East Central Region

A total of 3128 elephants is estimated in Odisha, Jharkhand, Chhattisgarh, Bihar, Madhya Pradesh and southern West Bengal of east-central region of India.

Figure 3.4: The relative density of elephant population division-wise in east-central India by the direct count method



Direct Count Elephant Population Estimation – Odisha

Odisha Forest Department estimated a population of 1976 elephants in the state by the direct count method. State and Elephant Reserve (ER) wise elephant numbers estimated are given in the Table below. The elephant distribution area is assumed to be the entire area of the notified Elephant Reserve. Apart from the Elephant Reserves the remaining elephants are found in several other territorial forest divisions and revenue lands.

Sl. No.	State / Division Name	Elephant density /km^2	Elephant distribution area in km^2	Elephant Population
	Odisha	**0.12**	**16825**	**1976**
1	Mayurbhanj Elephant Reserve	0.09	7044	635
2	Mahanadi Elephant Reserve	0.23	1038	240
3	Sambalpur Elephant Reserve	0.22	427	94

Note: 1. Standard errors for elephant density was not provided in 2017 elephant population estimation report submitted by Odisha forest department.

Direct Count Elephant Population Estimation – Jharkhand

Elephants are found in 12 forest divisions in the state. A total of 311 blocks were sampled in Jharkhand. Based on an overall elephant density of 0.16 km^2 a population of 678 elephants for the state was estimated. However, a more precise estimate of the elephant distribution area in the state and its forest divisions is needed.

Sl. No	State / Division Name	Elephant density/km^2	Std. Error	Elephant distribution area in km^2	Elephant Population
	Jharkhand	**0.16**	**0.009**	**4156**	**679**
1	Palamau TR	0.21	0.02	522	113
2	Saranda	0.44	0.06	344	152
3	Chaibasa	0.17	0.04	238	40
4	Saraikela (Dhalbum & Dalma)	0.09	0.05	315	31
5	Ranchi, Lohardaga & Khunti	0.06	0.01	480	33
6	Gumla	0.03	0.01	131	4
7	Dhanbad	0.54	0.13	53	29
8	Jamshedpur	0.06	0.01	292	17

Direct Count Elephant Population Estimation – Chhattisgarh

- Chhattisgarh state has been divided into six forest circles, namely, Raipur, Bilaspur, Sarguja, Durg, Kanker and Jagdalpur. These circles are further divided into 34 territorial divisions and 13 Protected Areas. Out of these, elephant movement has been reported from 22 territorial divisions and 7 Protected Areas, during the last five years.
- Out of 22 territorial divisions and 7 Protected Areas with elephant presence, elephants were sighted in 7 territorial divisions and 2 Protected Areas during the population estimation exercise. A total of 247 elephants were recorded by the forest department. The elephant distribution area has been arrived at by totaling the areas of all forest divisions which have been visited by elephants according to study by Wildlife Institute of India. As these elephants move over a very large area, shift their range from one year to another or even disperse out of the state, estimates of elephant distribution area and elephant density are not really meaningful.

Sl. No.	State / Division Name	Elephant density/km^2	Elephant distribution area in km^2	Elephant Population
	Chhattisgarh	**0.009**	**27635**	**247**
1	Sarguja	NA	NA	108
2	Bilaspur	NA	NA	122
3	Raipur	NA	NA	17

Note: Standard error was not provided in the elephant population figures by Chhattisgarh forest department,

NA- not available

Direct Count Elephant Population Estimation – Bihar

- According to the state forest department, the forests in the state of Bihar are not inhabited by wild elephants on a regular basis. Earlier, occasional instances of wild elephants moving from the source areas of Jharkhand, West Bengal, Odisha and Chhattisgarh (in India) and from the forest regions around KosiTappu and Parsa Wildlife Sanctuary (in Nepal) were reported.
- These elephants stayed for short duration in the border districts of Bihar. However, recently elephants from Jharkhand and Nepal are more frequently moving into the districts of Bhagalpur, Banka and Jamui (bordering Jharkhand), and Supaul, Araria, Kishanganj and West Champaran (bordering Nepal). An elephant number of 25 elephants have been made by the forest department.

State / Division Name	Elephant density/km^2	Elephant distribution area in km^2	Elephant Population
Bihar	NA	NA	**25**

NA- not available

Direct Count Elephant Population Estimation – Madhya Pradesh

Seven elephants are visitors to Sanjay Tiger Reserve of Madhya Pradesh from adjoining Guru Ghasidas National Park (GGNP) of Chhattisgarh. They first appeared in 2005, later in 2008, in 2013 and recently in 2017. During these years they are reported only in the Mohan Range of Sanjay Tiger Reserve. After 2017 immigrant elephants also have moved into Bandavgarh Tiger Reserve.

State / Division Name	Elephant density/km^2	Elephant distribution area in km^2	Elephant Population
Madhya Pradesh	NA	NA	**7**

NA- not available

Direct Count Elephant Population Estimation – West Bengal (Southern Region)

- Elephant groups in southern west Bengal area were primarily "migratory" elephants from Jharkhand since about 1986-87.
- There are several elephant groups and solitary bulls that move into 13 forest divisions including the West Medinipur, Bankura, Purulia, Birbhum and Jhargram regions. Over time the numbers have increased and many elephants seem to have become resident in southern Bengal.
- Up to 200 elephants have been reported in recent years, but making an estimate is difficult because of changes in the migration patterns.
- During the elephant population estimation exercise in 2017, a total of 47 elephants were encountered in 57 beats. A density estimate of 0.05/km^2 derived from this exercise gives a figure of 194 elephants during the census period in 2017.
- The elephant distribution area reported here refers only to the area of forests as determined from satellite images; the elephants however move over a much larger geographical area encompassing agricultural and and human settlements.

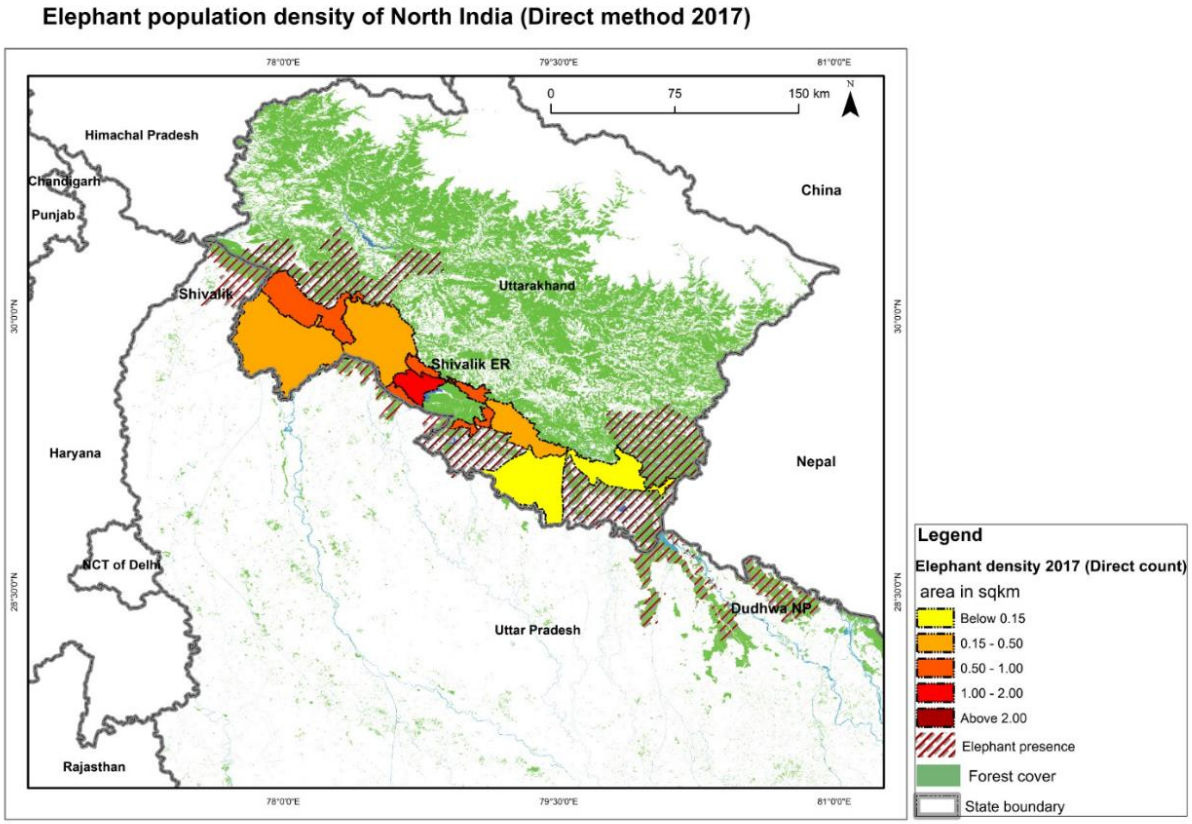
State / Division Name	Elephant density/km^2	Elephant distribution area in km^2	Elephant Population
South Bengal	0.05	4067	**194**

Note: Standard Error was not estimated because of several assumptions in the computation of density.

3.2.4 Direct Count Elephant Population Estimation – Northern Region

A total of 2085 elephants are estimated in Uttarakhand, Uttar Pradesh, Haryana and Himachal Pradesh in northern India.

Figure 3.5: The relative density of elephant population division-wise in Northern India by the direct count method



Direct Count Elephant Population Estimation – Uttarakhand

Elephants are distributed over 12 forest divisions in Uttarakhand. A total of 585 blocks were sampled for block count method in Uttarakhand. An overall elephant density of 0.45 elephants/km^2 was estimated for the state by this method. Based on the 4087 km^2 elephant distribution area estimated by Varma and Sukumar (2012), a population number of 1839 elephant can be made for the state.

Sl. No.	State / Division Name	Elephant density/km^2	Std. Error	Elephant distribution area in km^2	Elephant Population
	Uttarakhand	**0.45**	**0.02**	**4087**	**1839**
1	Corbett TR	0.83	0.07	516	430
2	Haridwar	0.17	0.04	277	47
3	Rajaji NP	0.58	0.05	815	475
4	Lansdowne	NA	NA	NA	NA
5	Kalagarh	1.32	0.31	522	692
6	Ramnagar	0.17	0.02	493	86
7	Terai Central	0.07	0.02	73	5
8	Haldwani	0.14	0.02	383	54

Note: 1. No data were available for Lansdowne Forest Division (a major elephant division) and some other (minor) divisions with elephants, 2. NA- not available

Direct Count Elephant Population Estimation – Uttar Pradesh

Number of elephants estimated for Uttar Pradesh during the 2017 population estimation period for regions of Nazibabad, Bijnur, Shivalik and Dudhwa Tiger Reserve is 232. Another 30 elephants are also reported to move seasonally from Nepal to Katarniyaghat region of U.P.

Sl. No.	State / Division Name	Elephant density/km^2	Elephant distribution area in km^2	Elephant Population
	Uttar Pradesh	**0.084**	**2744**	**232**
1	Nazibabad	1.55	66	102
2	Bijnur	2.06	31	64
3	Shivalik	0.077	310	24
4	Dudhwa TR	0.063	668	42

Note: Standard Error could not be estimated from the data provided.

Direct Count Elephant Population Estimation – Haryana

Elephants from Uttarakhand and U.P. are known to cross the Yamuna river and move to Kalsar WLS and NP regions of Haryana, according to the forest department field staff, since 1988. Initially 3 to 4 elephants used to be seen in this region, with the number going up to 12 sometimes (in 2015). In 2017, seven elephants were reported to be found in this state.

Sl. No.	State / Division Name	Elephant density/km^2	Elephant distribution area in km^2	Elephant Population
1	**Haryana**	NA	NA	**7**

Direct Count Elephant Population Estimation – Himachal Pradesh

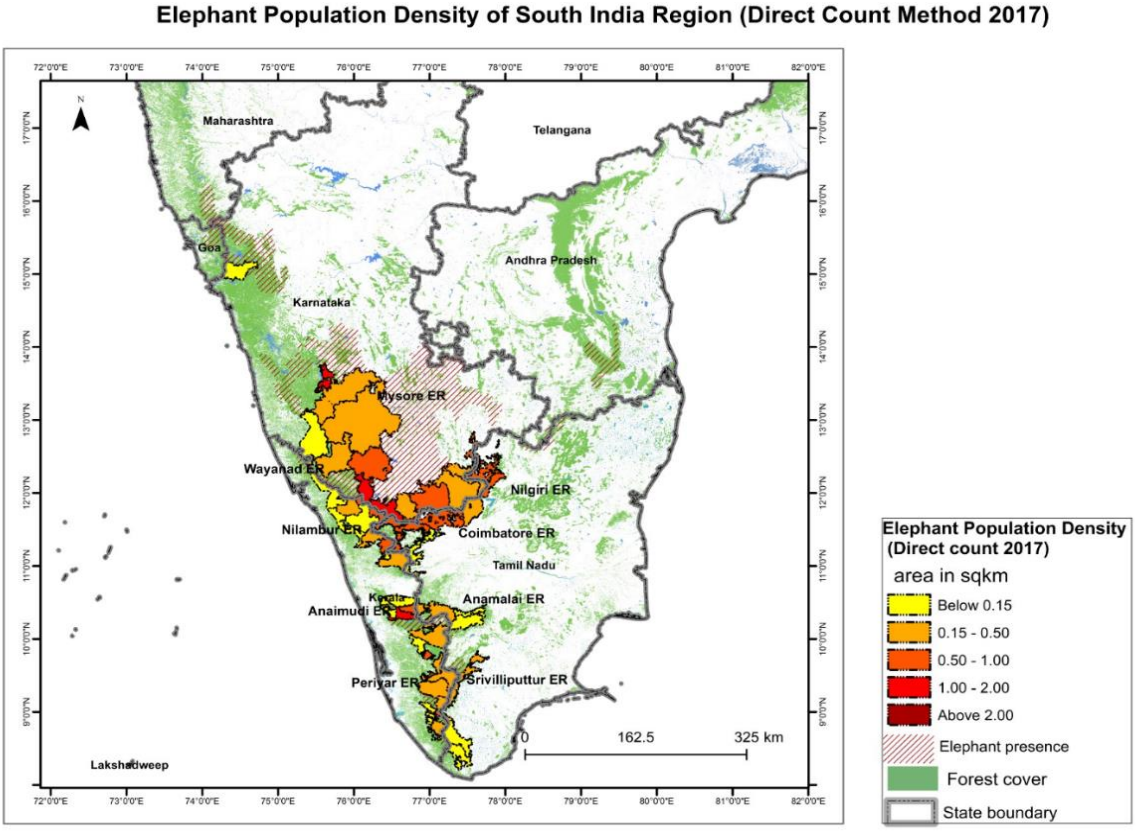
Elephants from Kalsar WLS and NP regions of Haryana enter Simbalbara WLS in Himachal Pradesh. Out of 6 forest beats this WLS, elephants are found in 5 beats and 2 beats among these are very extensively used by elephants. Their first visit to the sanctuary was in 2015. A total of 7 individuals are reported by the forest field staff (but this could also be the same elephants reported from Haryana).

Sl. No.	State / Division Name	Elephant density/km^2	Elephant distribution area in km^2	Elephant Population
1	**Himachal Pradesh**	NA	NA	**7**

3.2.5 Direct Count Elephant Population Estimation – Southern Region

A total of 14612 elephants are estimated in Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Maharashtra and Andaman & Nicobar Islands of southern region of India

Figure 3.6: The relative density of elephant population division-wise in Southern India by the direct count method



Direct Count Elephant Population Estimation – Karnataka

Elephants are found in 33 forest divisions in Karnataka. A total of 654 blocks were sampled for the block count based population estimation for Karnataka state. The results show an overall density of 0.67 elephants/km^2 which, extrapolated to an elephant distribution area of 8976 km^2, gives a total estimate of 6049 elephants for the state. In addition, wild elephants are also found outside forest areas within coffee plantations in districts such as Kodagu and Hassan; these are unlikely to have been counted in the sample blocks. During the 2017 population estimate, Karnataka clearly retains its position as the state with the highest elephant population in the country.

Sl. No.	State / Division Name	Elephant density/km^2	Std. Error	Elephant distribution area in km^2	Elephant Population
	Karnataka	**0.67**	**0.03**	**8976**	**6049**
1	Hassan	0.15	0.03	299	45
2	Hunsur	0.62	0.14	78	48
3	Nagarahole TR	1.54	0.20	643	992
4	Dandeli	0.04	0.01	824	36
5	Madikeri WL	0.24	0.04	344	82
6	Kollegal	0.24	0.03	879	207
7	Mangaluru	NA	NA	NA	NA
8	Bannerghatta NP	0.63	0.11	250	158
9	Bhadra TR	1.12	0.23	492	550
10	Chickamagalur	0.29	0.06	996	289
11	Cauvery WL	0.50	0.06	770	386
12	Biligiri Rangaswamy TempleTR	0.98	0.15	574	565
13	Bandipur TR	1.13	0.10	827	935
14	Madikeri	0.32	0.05	1052	337
15	Virajpet	0.69	0.13	116	81
16	Ramnagara	0.05	0.02	744	37
17	Shivamogga	0.08	0.01	1126	89

Direct Count Elephant Population Estimation – Kerala

Elephants are found in 37 forest divisions (data combined for some FDs) at a density of 0.35 animals/km^2 extrapolated to a distribution area of 9606 km^2 for a total of 3322 elephants (Kesavan et al. 2017)

Sl. No	State / Division Name	Elephant density/km^2	Std. Error	Elephant distribution area in km^2	Elephant Population
	Kerala	**0.35**	**0.01**	**9606**	**3322**
1	Aralam WLS	0.00		85	0
2	Kannur	0.04	0.02	112	4
3	Wyanad North	0.30	0.06	180	55
4	Wyanad South	0.27	0.03	316	85
5	Wyanad WLS	1.35	0.04	343	462
6	Kozhikode	0.07	0.02	281	19
7	Mannarkad	0.15	0.03	396	60
8	Nilambur North	0.25	0.05	379	93
9	Nilambur South	0.85	0.24	318	269
10	Palakkad	0.31	0.11	177	56
11	Silent Valley	0.14	0.05	238	33
12	Chalakudy	0.07	0.02	264	19
13	Idukki WLD + Thattekad	0.77	0.29	81	62
14	Kothamangalam	0.06	0.02	297	18
15	Kottayam	0.17	0.04	165	28
16	Malayattoor	0.98	0.17	521	510
17	Mankulam	0.12	0.06	90	11
18	Munnar FD + WLD	0.28	0.03	880	245
19	Marayoor	0.45	0.16	53	24
20	Parambikulam	0.58	0.22	262	151
21	Peechi WLD	0.11	0.04	73	8
22	Vazhachal	1.01	0.23	369	374
23	Nemmara	0.15	0.04	319	48
24	Achankovil	0.43	0.11	285	124
25	Periyar TR (East and West)	0.30	0.04	891	266
26	Punalur	0.14	0.04	46	6
27	Ranni	0.37	0.05	802	293
28	Konni	0.09	NA	326	29
29	Sherdurney WLS	0.69	0.29	150	104
30	Thiruvananthapuram	0.22	0.05	323	72
31	Thiruvananthapuram WL	0.11	0.02	197	21
32	Thenmala	0.86	0.27	121	104

Direct Count Elephant Population Estimation – Tamilnadu

- Tamilnadu Forest Department estimated a population of 2761 elephants by sample block count method with estimates also made for each of the forest divisions harbouring elephants (TNFD 2017).
- These numbers will have to be interpreted with caution when compared to the 2012 estimate because the severe drought of 2016 had resulted in large numbers of elephants from Tamilnadu moving into adjoining states with moister forests. These elephants began to move back to Tamilnadu only with the onset of the monsoon in mid-2017 after the census operations were over.

Sl. No.	State / Division Name	Elephant density/km^2	Std. Error	Elephant distribution area in km^2	Elephant Population
	Tamil Nadu	**0.37**	**NA**	**7562**	**2761**
1	Dharmapuri	0.58	NA	315	184
2	Hosur	0.77	NA	646	499
3	Coimbatore	0.14	NA	693	97
4	Nilgiri North	0.32	NA	565	180
5	Nilgiri South	0.53	NA	102	54
6	Gudulur	0.51	NA	117	60
7	Mudumalai TR	0.92	NA	321	294
8	Sathyamangalam TR	0.59	NA	1312	772
9	Theni	0.00	NA	201	0
10	Erode	0.25	NA	448	113
11	Srivilliputhtur WLS	0.21	NA	345	74
12	Tirunelveli	0.28	NA	252	70
13	Kalakad Mundanthurai TR	0.11	NA	548	58
14	Anamalai TR	0.25	NA	958	237
15	Dindigul	0.06	NA	138	8
16	Kodaikanal	0.70	NA	27	19
17	Kanniyakumari	0.06	NA	234	14
18	Megamalai WLS	0.08	NA	340	27
19	Madurai	NA	NA	NA	0
20	Tirupattur	NA	NA	NA	1

Note: 1. Standard error was not provided in 2017 elephant population estimation report submitted by Tamilnadu forest department, 2. NA- not available

Direct Count Elephant Population Estimation – Maharashtra

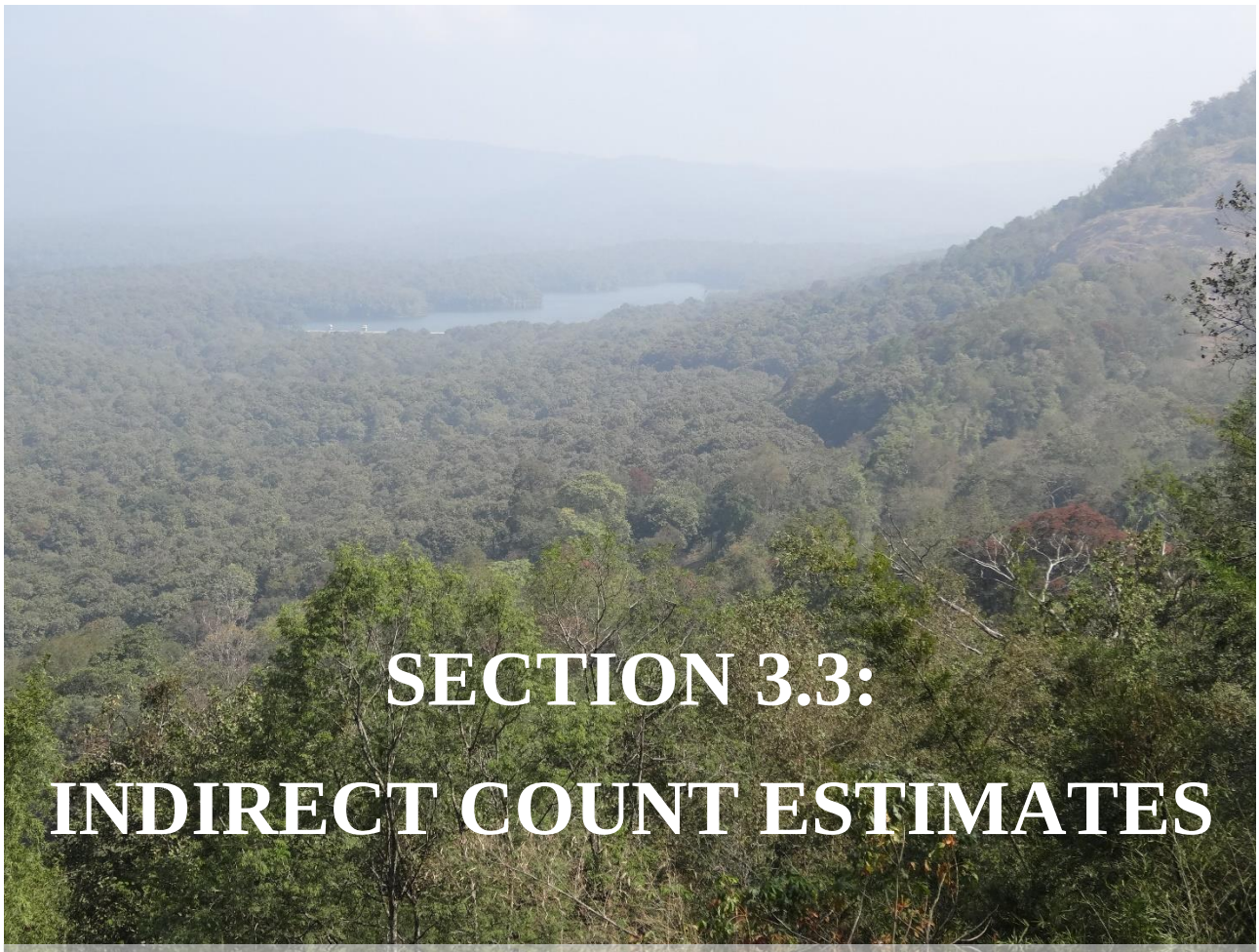
In Maharashtra elephant population estimation was carried out in southern region where six elephants were counted in Kolhapur and Sawantwadi divisions of Kolhapur Forest Circle. These elephants have moved in recent times from Karnataka into Maharashtra.

Sl. No.	State / Division Name	Elephant density/km^2	Elephant distribution area in km^2	Elephant Population
1	**Maharashtra**	NA	NA	**6**

Direct Count Elephant Population Estimation – Andhra Pradesh

- A total of between 55 and 65 elephants are reported for the state of Andhra Pradesh. Elephants regularly move between Tamil Nadu and Karnataka in southern region of the state (area belonging mainly to Chittoor West division) and also from Odisha into northeastern Andhra Pradesh (Srikakulam Division). In Chittoor West division, elephant numbers range from 25 to 30 elephants. In Tirupati Circle a video captured 24 elephants near Kalyani Dam, Chamala Range. In addition to this, 4 elephants are estimated in Pathapatnam Range, Srikakulam Division.

Sl. No.	State / Division Name	Elephant density /km^2	Elephant distribution area in km^2	Elephant Population
	Andhra Pradesh	**0.01**	**6317**	**65**
1	Chittoor West	NA	NA	30
2	Tirupati	NA	NA	24
3	Srikakulam Division	<0.01	505	4



SECTION 3.3:
INDIRECT COUNT ESTIMATES

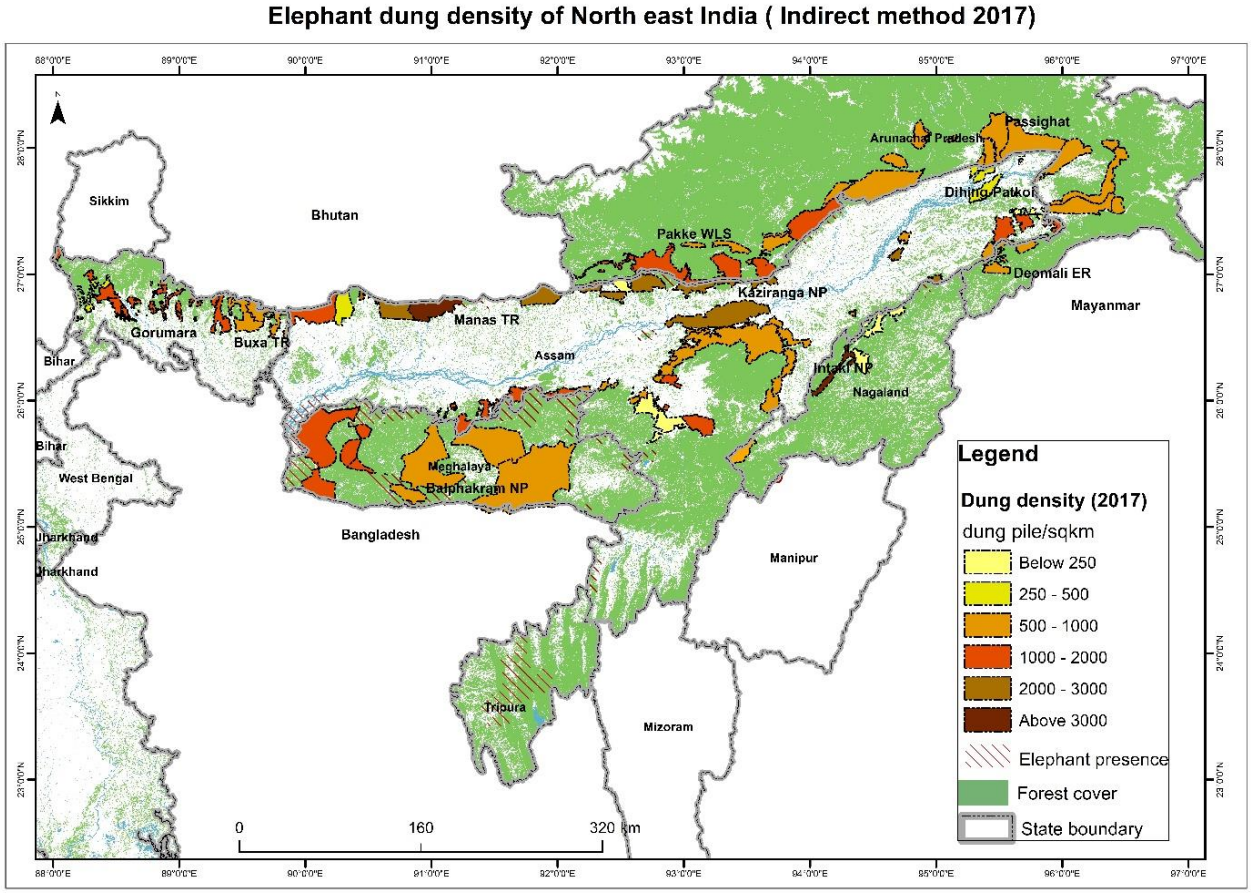
SECTION 3.3: RELATIVE DENSITY ESTIMATES OF ELEPHANT POPULATION USING THE INDIRECT DUNG-COUNT METHOD

3.3.1 Indirect Dung-Count Method – Learning and Results

- The line transect exercise for estimating dung density was largely carried out satisfactorily across most states in the country. The same was not true for the experiments to estimate dung decay rate, a key variable in translating dung density into elephant density.
- Even though dung decay rate experiments were planned to be carried out at 30 sites across the country, they were eventually set up and carried out only at 16 sites across all regions.
- Data from the dung decay rate experiments gave mixed and inconsistent results. Laing et al. (2003) recommended that to obtain an unbiased estimate of dung decay rate, about 90% of the dung piles marked at the outset should have decayed by the time of the dung density survey.
- Only the **Hosur Forest Division (Tamilnadu) came close to the criterion of about 90% decay** of the initial set of piles marked; 83.3% of the first set and 86.7% of the second set had decayed by the time of the census.
- Satyamangalam Tiger Reserve (Tamilnadu) also fulfilled the 90% decay criterion, but the data were overall extremely anomalous with very high proportions of dung piles marked at every stage decaying (e.g. 64% of the last set of piles marked had also decayed, a figure much higher than any other site) making it difficult to obtain a reliable decay rate.
- **Biligiri Rangaswamy Temple (BRT) Tiger Reserve (Karnataka) carried out the dung decay experiments with perfection**, including taking photographs of every set of pile marked and attaching these to the data set provided. This would be an ideal model to emulate in future exercises of this kind. However, only 46.7% of the first set marked decayed.
- **Two sites in Kerala (Periyar Tiger Reserve and Shendurney Wildlife Sanctuary) with 80% decay of the first set also practically met the criterion** for use of the data in a logistic regression.
- Tamilnadu with 5 sites and Kerala with 4 sites carried out the dung decay rate experiments comprehensively. Karnataka also carried out the experiments at two key sites (Bhadra, BRT) but missed other important representative sites (Bandipur, Nagarahole). Jharkhand (Palamau TR), Meghalaya (Khasi Hills and Nongpo), and Nagaland (Wokkah) were other states which carried out the experiments diligently and satisfactorily. At some of the latter sites, very few dung piles decayed; for instance, at Nongpo only 20% of the first set of dung piles marked had decayed by the time of the census.
- When all the data sets were assembled and scrutinized from the 16 sites, **only 4 sites (Hosur-Tamilnadu (0.0095); Periyar-Kerala (0.0074); Shendurney-Kerala (0.0061); Palamau-Jharkhand (0.0086)) seemed to satisfactorily meet the criteria of adequate sampling and greater than about 80% decay** of the initial sets of dung piles by the time of the field census for dung density estimation.
- **We therefore do not translate the dung density estimates to elephant density estimates (as this could lead to wrong interpretations and comparisons) but report dung densities only as an index of relative elephant abundance at the regional scale**. Only Kerala results are given as per their report.
- The major lesson learnt from this exercise is that the **dung decay rate experiments have to be diligently carried out at 30 or more sites across the country, and begin about 8-10 months prior to the line transect dung density survey**.

3.3.2 Indirect Count Elephant Population Estimation – North East Region

Figure 3.7: The relative density of elephant population division-wise in North Eastern India by the indirect count method



1. One obvious advantage of the indirect dung count method is that it helps to record elephant presence in states with low elephant densities, regions within a state with low elephant numbers, and in states such as Nagaland, Tripura, Meghalaya and Arunachal Pradesh where direct sightings of elephants is difficult because of dense forest cover or very hilly terrain. Therefore, statistically robust data on elephant dung densities can be established over a period of time to infer trends.
2. Many states in the Northeastern region have forest divisions with high (>2000 dung piles/km^2), moderate (>500 to 2000 dung piles/ km^2) and low (< 500 dung piles/ km^2) elephant dung density levels.
3. High elephant dung density (more than 2000 dung piles per km^2) divisions from the Northeastern region are- Manas NP, Western Assam WL, Guwahati WL, Eastern Assam WL (Kaziranga), Dhansiri, Chirag, Sivsagar, Sonitpur East (all in Assam state), Wokha (Nagaland), and Tura WL (Meghalaya).

Indirect Count Elephant Population Estimation – Arunachal Pradesh

Sl. No.	State / Division Name	Number of transects	Distance covered (in km)	Number of dung piles detected	Dung density /km^2	SE (Dung density)
	Arunachal Pradesh	**141**	**222**	**1824**	**727.1**	**22.3**
1	Shergaon-Khellong-Bomdila-Pakke-Banderdewa	53	50	733	1089.4	331.0
2	Sagalee-Hapoli-Likabali-Along-Yingkiong	20	61	393	643.9	145.4
3	Pasighat-Pasighat WLS-Dibang-Lohit	44	59	515	623.4	242.6
4	Anjaw-Namsai-Namdapha-Nampong-Changlang-Deomali-Khonsa	24	52	183	859.0	272.8

Indirect Count Elephant Population Estimation – Meghalaya

Sl. No.	State / Division Name	Number of transects	Distance covered (in km)	Number of dung piles detected	Dung density /km^2	SE (Dung density)
	Meghalaya	**153**	**129**	**823**	**898.2**	**107.8**
1	Balphakram National Park Division	50	49	215	684.7	135.6
2	East and West Garo Hills Wildlife Division	22	22	264	1274.7	304.8
3	Khasi Hills	80	57	306	875.8	123.3
4	Tura Wildlife	1	1	38	2640.9	124.5

Indirect Count Elephant Population Estimation – Assam

Sl. No.	State / Division Name	Number of transects	Distance covered (in km)	Number of dung piles detected	Dung density /km^2	SE (Dung density)
	Assam	**597**	**776**	**11868**	**2761.6**	**181.6**
1	Dibrugarh	22	33	156	935.1	193.2
2	Digboi	14	28	201	1160.0	307.0
3	Doomdooma	20	38	61	157.4	84.9
4	Sivsagar	10	20	282	2317.2	953.4
5	Chirang	35	35	534	2489.6	356.8
6	Dhansiri	32	32	729	2637.8	438.5
7	Kachugaon	5	5	111	1737.5	235.1
8	Haltugaon	12	12	83	485.8	122.8
9	Manas NP	127	154	5137	6945.6	735.8
10	Guwahati WL	6	6	251	3904.6	478.1
11	Goalpara	9	9	97	556.4	255.3
12	Hamren	9	12	40	225.5	102.2
13	Karbi Anglong East	30	36	164	507.4	214.1
14	Kamrup East	20	20	166	1157.7	294.8
15	Kamrup West	5	5	37	995.9	741.8
16	Nagaon	30	57	330	611.4	160.4
17	Nagaon South	25	33	444	1769.8	446.9
18	Nagaon Wildlife	6	12	45	332.4	68.4
19	Sonitpur West	10	20	34	164.5	36.4
20	W. Assam WL (Nameri and Sonai-Rupai WLS)	16	26	528	4334.4	698.6
21	Jorhat	5	5	26	518.8	360.9
22	Tinsukia Wildlife+Dhemaji	84	113	301	270.5	52.8
23	Sonitpur East	8	10	71	2204.1	912.7
24	E. Assam WL (Kaziranga)	57	57	2040	2731.0	319.9

Indirect Count Elephant Population Estimation – Tripura

Sl. No.	State / Division Name	Number of transects	Distance covered (in km)	Number of dung piles detected	Dung density /km^2	SE (Dung density)
	Tripura	**61**	**80**	**168**	**187.5**	**50.0**
1	Khowai	48	62	132	238.9	72.6
2	Gumati+South	13	18	36	114.5	63.1

Indirect Count Elephant Population Estimation – Nagaland

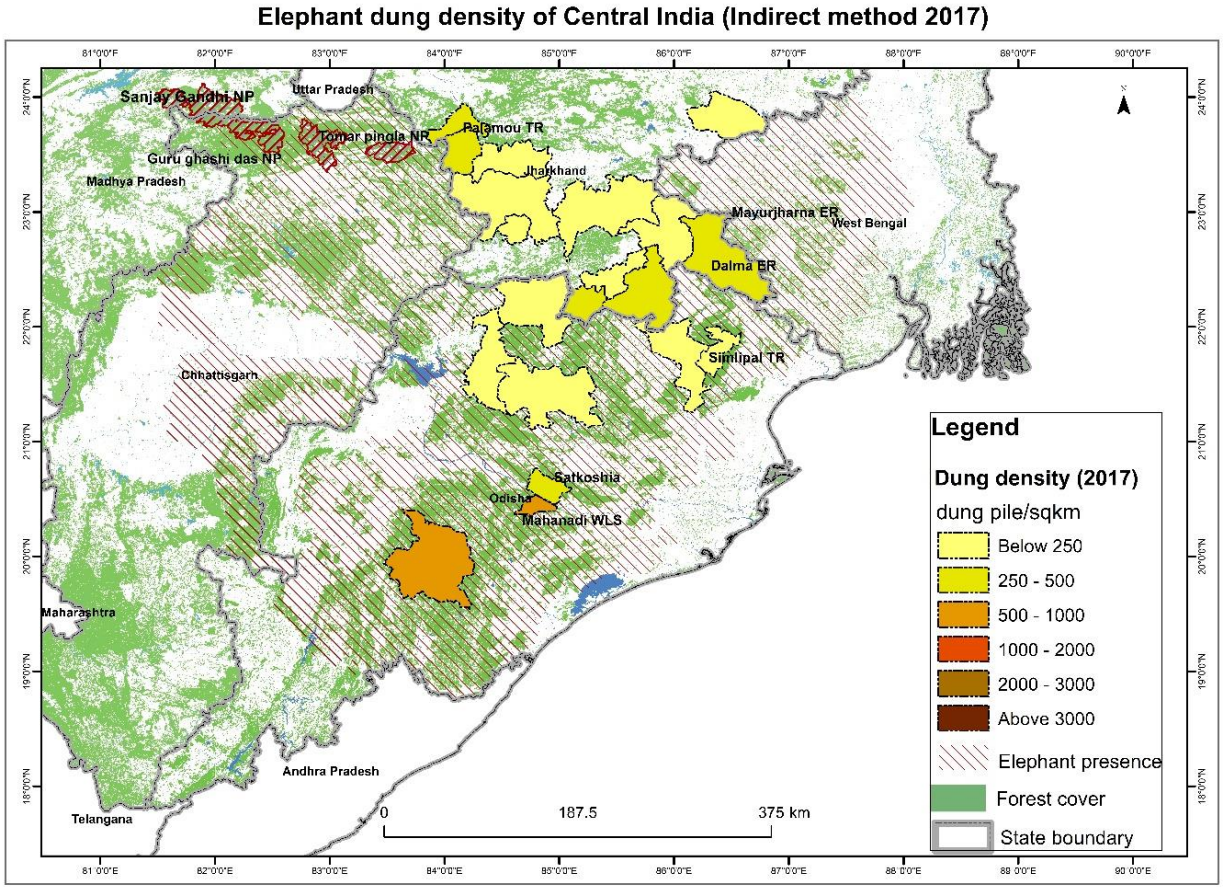
Sl. No.	State / Division Name	Number of transects	Distance covered (in km)	Number of dung piles detected	Dung density /km^2	SE (Dung density)
	Nagaland	**39**	**48**	**562**	**1247.3**	**404.2**
1	Intanki NP	5	4	27	598.4	269.8
2	Mokokchung	18	31	42	93.0	36.9
3	Wokha	16	14	493	3961.6	1081.6

Indirect Count Elephant Population Estimation – Northern West Bengal

Sl. No.	State / Division Name	Number of transects	Distance covered (in km)	Number of dung piles detected	Dung density /km^2	SE (Dung density)
	Northern West Bengal	**186**	**251**	**2005**	**947.9**	**79.2**
1	Buxa TR East	27	33	229	796.3	128.4
2	Buxa TR West	22	23	284	724.5	98.6
3	Jaldapara National Park	31	61	446	1206.9	234.9
4	Baikunthapur	24	24	167	1006.3	119.2
5	Gorumara Wildlife Division	21	21	137	545.5	94.8
6	Jalpaiguri Division	25	43	351	1066.1	138.1
7	Kurseong Division	10	20	97	484.4	93.4
8	Darjeeling WL	26	26	294	1683.0	301.1

3.3.3 Indirect Count Elephant Population Estimation – East Central Region

Figure 3.8: The relative density of elephant population division-wise in East Central India by the indirect count method



1. East Central region overall had the lowest elephant dung densities of all regions in the country. Most forest divisions had dung density level <250 dung piles/ km2 followed by divisions with dung density level of > 250 to 500 dung piles/km2 and very few divisions with dung density of 500-1000 dung piles/ km2. There were no divisions in this region with dung density of more than 1000 dung piles/km2.

Indirect Count Elephant Population Estimation – Odisha

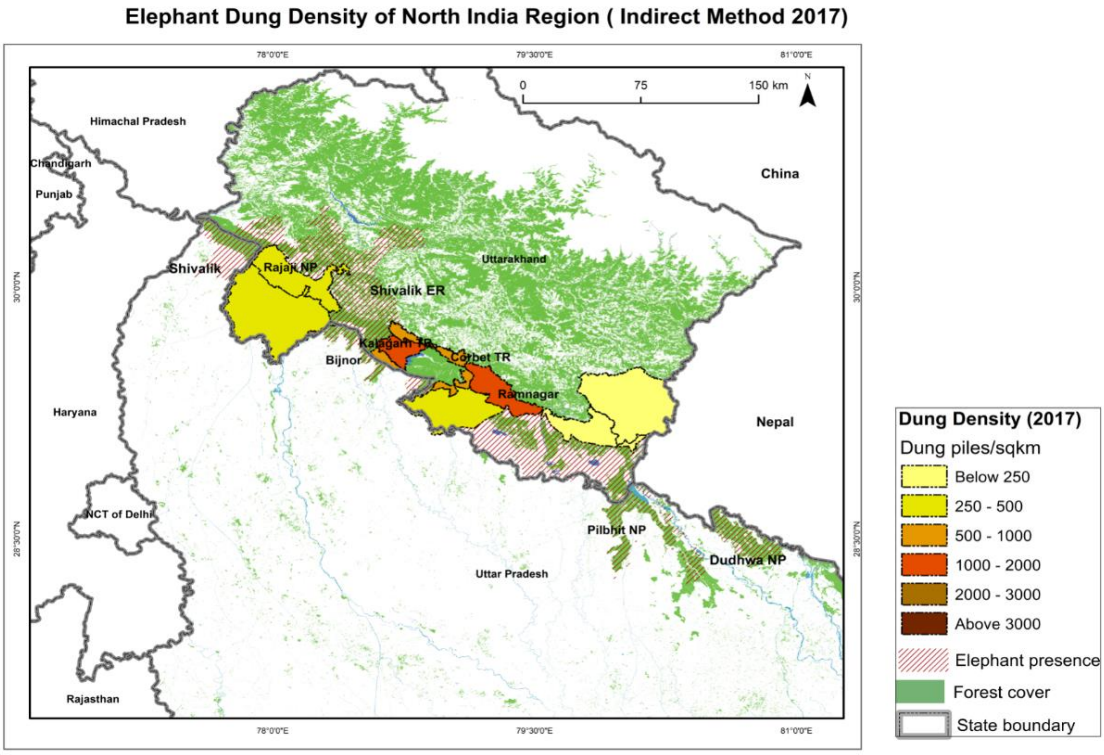
Sl. No.	State / Division Name	Number of transects	Distance covered (in km)	Number of dung piles detected	Dung Density/km^2	SE (Dung density)
	Odisha	**512**	**885**	**1468**	**169.3**	**17.8**
1	Simlipal Tiger Reserve	109	217	335	149.7	22.0
2	Karanjia	47	94	27	16.4	44.7
3	Satkosia	36	72	295	365.3	59.3
4	Mahanadi ER	25	50	446	602.0	18.9
5	Bamra WL	128	130	203	103.8	19.7
6	Baliguda	16	20	75	547.8	196.8
7	Deogarh	53	106	36	27.0	11.7
8	Rourkella	98	196	51	25.7	39.9

Indirect Count Elephant Population Estimation – Jharkhand

Sl. No.	State / Division Name	Number of transects	Distance covered (in km)	Number of dung piles detected	Dung density/km^2	SE (Dung density)
	Jharkhand	**191**	**295**	**1153**	**340.5**	**39.1**
1	Palamau Tiger Reserve	105	210	551	325.7	50.4
2	Chaibasa Forest Division	26	24	233	446.2	91.6
3	Saranda Forest Division	13	18	235	482.6	116.9
4	Dalma WLS & Jamshedpur	30	27	93	339.6	106.6
5	Kolhan Forest Division	10	10	20	68.1	43.9
6	Khunti Forest Division	7	7	21	191.9	50.7

3.3.4 Indirect Count Elephant Population Estimation – Northern Region

Figure 3.9: The relative density of elephant population division-wise in Northern India by the indirect count method



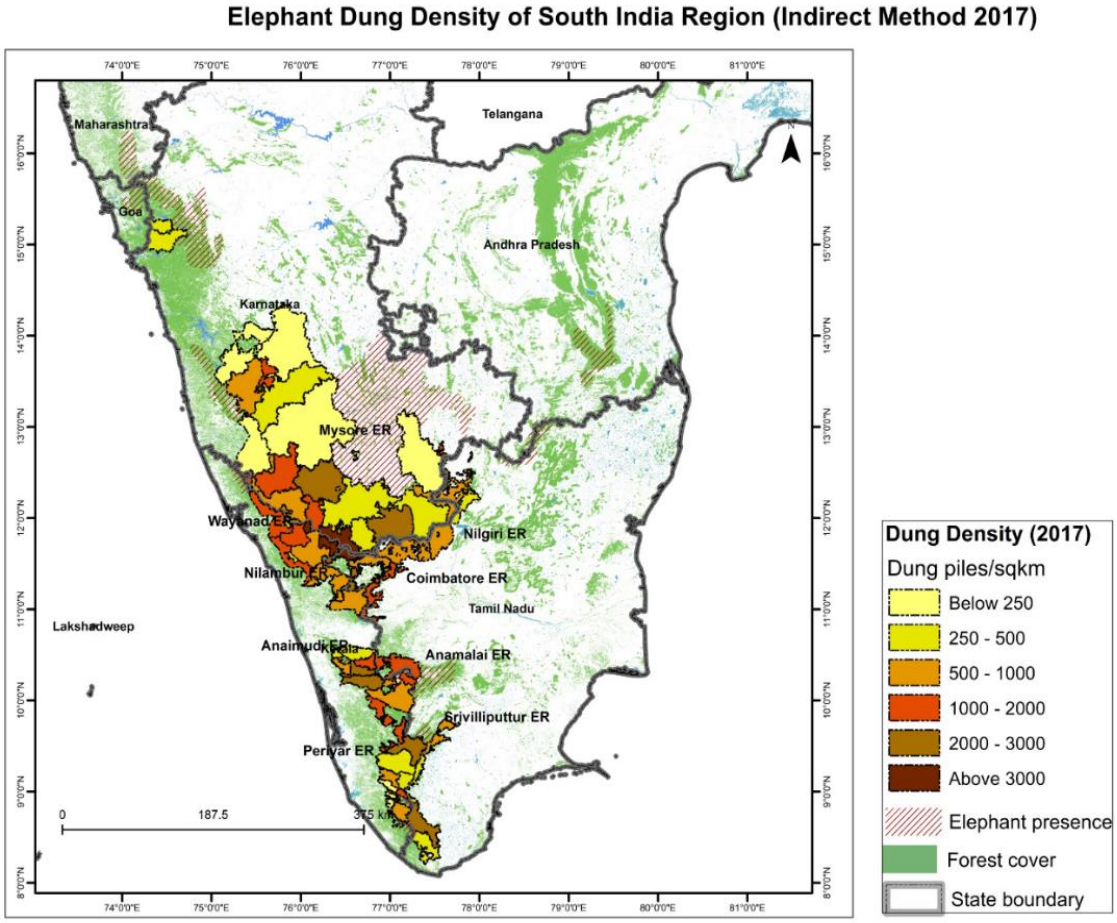
1. The highest density elephant populations were recorded in Corbett and Kalagarh Tiger Reserves (>800 dung piles per km^2). Rajaji National Park was at a medium level with close to 500 dung piles per km^2. Other divisions such as Champavat, Terai West, Ramnagar and Haldwani recorded lower dung densities >500 piles per km^2. Data was not available from Lansdowne Division.

Indirect Count Elephant Population Estimation – Uttarakhand

Sl. No.	State / Division Name	Number of transects	Distance covered (in km)	Number of dung piles detected	Dung density /km^2	SE (Dung density)
	Uttarakhand	**334**	**343**	**2092**	**399.4**	**48.0**
1	Champavat	21	27	25	64.8	31.7
2	Corbett TR	31	31	313	855.2	203.9
3	Haridwar	28	28	88	259.4	22.1
4	Kalagarh TR	44	44	558	1047.6	14.5
5	Rajaji NP	75	77	686	485.9	12.2
6	Terai West	37	37	165	265.8	20.0
7	Ramnagar	39	39	166	285.1	48.8
8	Haldwani	59	60	91	163.0	38.4

3.3.5 Indirect Count Elephant Population Estimation – Southern Region

Figure 3.10: The relative density of elephant population division-wise in Southern India by the indirect count method



1. The Protected Areas in the southern region, as expected, showed some of the highest densities of elephant dung piles in the country. For example, Bandipur Tiger Reserve, Bhadra Wildlife Sanctuary, Rajiv Gandhi National Park in Karnataka, Periyar Tiger Reserve, Parambikulam National Park, Shendurney Wildlife Sanctuary and Wyanad Wildlife Sanctuary in Kerala, and Anamalai Tiger Reserve, Mudumalai Tiger Reserve and Kalakkad-Mundanthurai Tiger Reserve in Tamilnadu, all of which had >1000 dung piles/km^2. It was not just the Protected Areas, however, which showed high levels of dung density. Territorial forests such as Hunsur and Madikeri divisions in Karnataka, Idukki, Kannur, Kottayam and other divisions in Kerala, and Coimbatore, Gudalur and Nilgiri South divisions in Tamilnadu also showed high elephant dung density.

Indirect Count Elephant Population Estimation – Karnataka

Sl. No.	State / Division Name	Number of transects	Distance covered (in km)	Number of dung piles detected	Dung density/km^2	SE (Dung density)
	Karnataka	**864**	**1641**	**12326**	**865.7**	**40.3**
1	Anshi-Dandeli TR	31	61	248	405.9	155.7
2	Bandipura Tiger Reserve	112	167	2183	3158.4	1057.0
3	Bangalore Rural	NA	NA	NA	NA	NA
4	Bannerghatta National Park	70	133	1561	999.1	132.8
5	Belgaum	86	139	28	NA	NA
6	Bhadra Wildlife Sanctuary	29	58	952	1728.3	255.0
7	Bhadravati	33	66	106	87.5	35.0
8	BRT Tiger Reserve	44	88	925	2195.6	510.0
9	Cauvery Wildlife Sanctuary	66	133	767	497.9	65.3
10	Chikamagalur FD	29	58	213	389.8	116.7
11	Hassan FD	19	30	100	174.6	76.4
12	Haveri	NA	NA	NA	NA	NA
13	Hunsur (T)	14	28	463	2080.3	348.3
14	Koppa	13	26	181	584.6	137.9
15	Kundapura	31	62	0	NA	NA
16	Madikeri (WL)	30	60	551	755.1	108.4
17	Madikeri (T)	38	80	730	1127.7	250.8
18	Malai Mahedeshwara Hills, Kollegal	55	110	627	356.5	43.7
19	Mandya	NA	NA	NA	NA	NA
20	Mangalore	32	64	212	193.6	33.5
21	Mysore (T)	14	18	91	332.8	98.9
22	Nagarahole National Park	90	204	2283	1501	151.4
23	Ramanagara	12	24	38	155.0	40.0
24	Sagar	NA	NA	NA	NA	NA
25	Shimoga (W)	4	8	6	25.0	14.4
26	Sirsi	2	4	0	NA	NA
27	Virajpet	10	20	61	321.1	75.2

Indirect Count Elephant Population Estimation – Kerala

Sl. No.	State / Division Name	Number of transects	Distance covered (in km)	Dung density (km^2)	SE (Dung density)	Elephant density (km^2)	Elephant number
	Kerala	**615**	**1162**	**1381.9**	**82.9**	**0.59**	**5706**
1	Achencovil	17	31	285.3	68.2	0.13	37
2	Aralam WLS	7	14	449.3	119.3	0.20	17
3	Chalakkudy	12	24	856.5	274.1	0.37	97
4	Idukki WLD (+Thattekad BS)	9	17	1473	407.3	0.64	52
5	Kannur	8	15	1127	532.8	0.50	56
6	Kasargod	2	4	6614	NA	2.95	224
7	Konni	21	39	888.9	121.5	0.40	130
8	Kothamangalam	9	16	1082	410.2	0.46	137
9	Kottayam	17	32	1027	434.7	0.44	216
10	Kozhikode	25	47	415.4	175.5	0.18	124
11	Malayattoor	33	62	2071	357.8	0.89	462
12	Mankulam	6	11	905.4	432.9	0.39	35
13	Mannarkkad	20	38	1480.6	298.3	0.63	251
14	Marayur	9	17	1820.5	814.0	0.78	42
15	Munnar FD	40	75	584.4	113.9	0.25	155
16	Munnar WLD (Chinnar WLS, Eravikulam NP, etc)	23	43	363.8	135.6	0.16	41
17	Nenmara	13	25	408.6	145.1	0.17	56
18	Nilambur North	23	43	914.2	215.8	0.39	148
19	Nilambur South	13	25	698.6	187.1	0.30	95
20	Palakkad	10	19	385.0	76.2	0.16	29
21	Parambikulam TR	8	16	1002	344.9	0.43	112
22	Peechi WLS	10	19	227.7	102.3	0.10	7
23	Periyar TR (East & West)	52	98	2271	217.8	1.02	906
24	Punalur	15	28	156.9	61.3	0.07	3
25	Ranni	49	93	472.2	71.2	0.21	171
26	Shendurney WLS	7	7	1315	377.3	0.59	89
27	Silent Valley NP	10	19	612.4	132.2	0.26	62
28	Thenmala	11	21	1730	421.7	0.78	94
29	Thiruvananthapuram	25	48	446.1	94.6	0.20	65
30	Thiruvananthapuram WLD	20	43	805.2	145.3	0.36	71
31	Thrissur	6	12	369.7	199.7	0.16	5
32	Vazhachal	21	40	3634	658.8	1.56	575
33	Wyanad North	27	51	1325	252.5	0.59	106
34	Wyanad South	16	30	556.7	131.3	0.24	97
35	Wyanad Wildlife	21	41	6409	1071.0	2.86	980

Indirect Count Elephant Population Estimation – Tamilnadu

Sl. No.	State / Division Name	Number of transects	Distance covered (in km)	Number of dung piles detected	Dung density/km^2	SE (Dung density)
	Tamil Nadu	**347**	**429**	**3562**	**990.5**	**NA**
1	Anamalai-TR	43	43	391	1439.5	NA
2	Coimbatore	24	24	245	1566.9	NA
3	Dharmapuri Division	14	28	104	327.8	NA
4	Dindigul	NA	NA	NA	NA	NA
5	Erode Division	20	20	139	823.9	NA
6	Gudalur Division	13	17	94	1333.9	NA
7	Hosur Division	35	50	444	718.6	NA
8	Kanniyakumari	10	20	52	337.5	NA
9	KMTR	24	24	276	2000.0	NA
10	Kodaikanal	NA	NA	NA	NA	NA
11	Madurai	NA	NA	NA	NA	NA
12	Megamalai WLS	29	58	204	730.4	NA
13	Mudumalai TR	28	28	823	4726.7	NA
14	Nilgiri North Division	16	16	141	513.9	NA
15	Nilgiri South Division	3	3	25	2784.0	NA
16	Sathyamangalam TR	49	49	351	669.7	NA
17	Srivilliputhur	26	26	218	921.1	NA
18	Theni	NA	NA	NA	NA	NA
19	Thirunelveli	13	24	55	365.5	NA
20	Tirupattur	NA	NA	NA	NA	NA

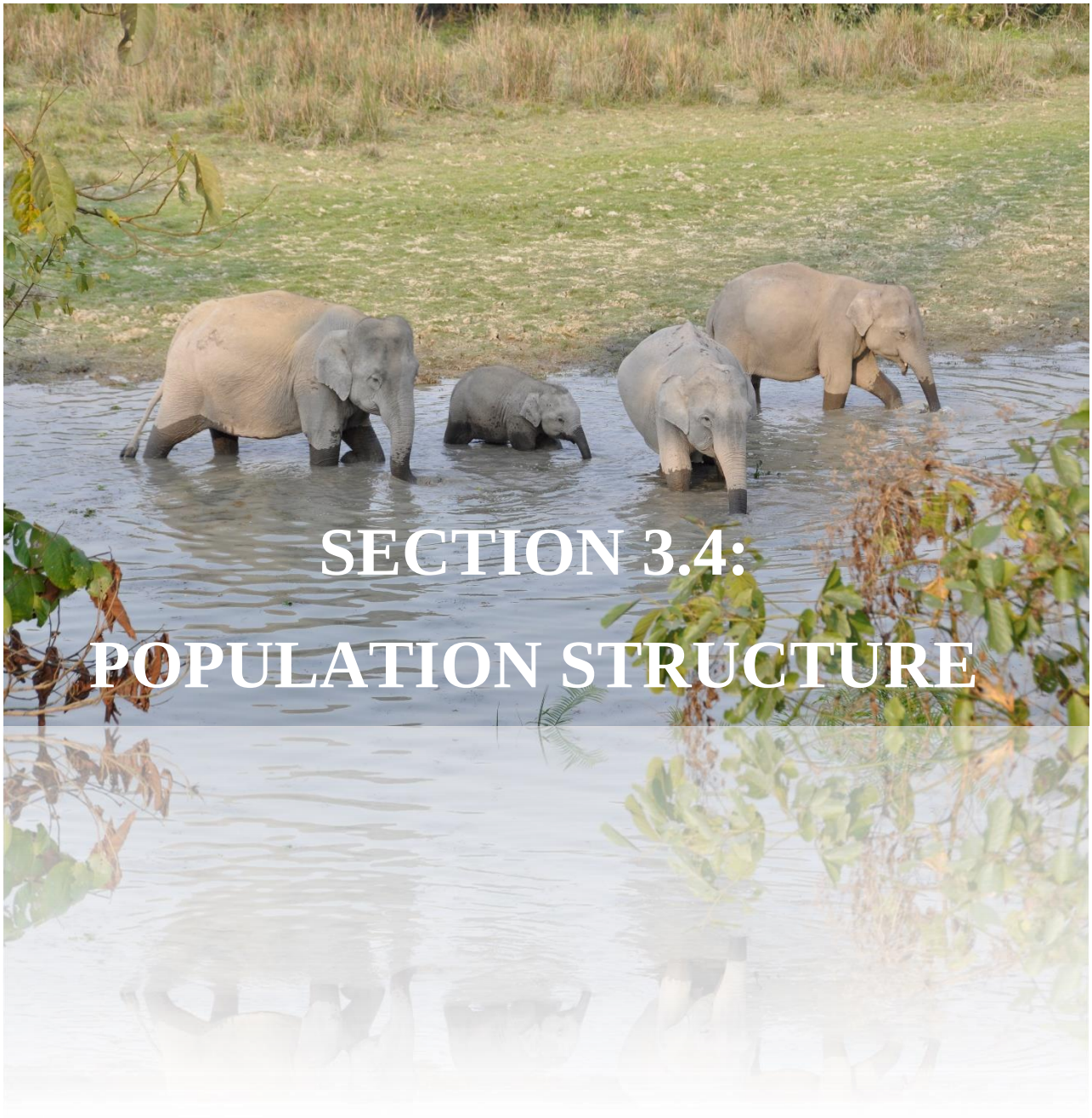
Note: 1. Standard error for estimates of elephant dung density was not provided in 2017 elephant population estimation report submitted by Tamilnadu forest department, 2. NA- not available

Indirect Count Elephant Population Estimation – Andhra Pradesh

Sl. No.	State / Division Name	Number of transects	Distance covered (in km)	Number of dung piles detected	Dung density/km^2	SE (Dung density)
1	**Andhra Pradesh**	83	148	110	27.7	5.1

Indirect Count Elephant Population Estimation – Andaman and Nicobars

Sl. No.	State / Division Name	Number of transects	Distance covered (in km)	Number of dung piles detected	Dung density/km^2	SE (Dung density)
1	Mayabunder Wildlife	11	11	34	358.0	198.8



SECTION 3.4:
POPULATION STRUCTURE

SECTION 3.4: POPULATION STRUCTURE – AGE AND SEX CLASSIFICATION

3.4.1 Elephant Population Structure at State-Level

Table 3.3: Region and state-wise population structure of elephants by age and sex classes

Sl. No.	State	Number of individuals sighted (classified)	Percent Age and Sex Classes (% classified individuals)							
			AF	SAF	JF	AM	SAM	JM	Calf	UI
North East Region										
1	Arunachal Pradesh	464 (426)	22.6 (24.7)	10.8 (11.7)	9.3 (10.1)	13.1 (14.3)	11.0 (12.0)	9.5 (10.3)	15.5 (17.0)	8.2
2	Assam	4435 (3394)	26.3 (34.4)	12.5 (16.3)	6.0 (7.9)	9.0 (11.8)	4.7 (6.2)	4.5 (5.9)	13.5 (17.7)	23.5
3	Meghalaya	220 (160)	24.1 (33.1)	13.6 (18.8)	8.6 (11.9)	9.1 (12.5)	5.9 (8.1)	3.2 (4.4)	8.2 (11.3)	27.3
4	West Bengal (North Region)	584 (459)	26.2 (33.3)	7.2 (9.2)	4.5 (5.7)	18.8 (24.0)	6.2 (7.8)	4.1 (5.2)	11.6 (14.8)	21.4
East Central Region										
5	Odisha	1976 (1938)	41.3 (42.1)	14.0 (14.2)	0.0	11.2 (11.5)	6.2 (6.3)	10.3 (10.5)	15.1 (15.4)	1.9
6	Jharkhand	565 (494)	22.5 (25.7)	6.5 (7.5)	4.3 (4.9)	32.2 (36.8)	5.7 (6.5)	5.3 (6.1)	11.0 (12.6)	12.6
7	West Bengal (South Region)	122 (69)	13.9 (24.6)	3.3 (5.8)	0.0	23.8 (42.0)	4.9 (8.7)	1.6 (2.9)	9.0 (15.9)	43.4
Northern Region										
8	Uttarakhand	1528 (1122)	28.8 (39.2)	9.0 (12.2)	5.5 (7.5)	13.6 (18.5)	2.9 (4.0)	2.6 (3.6)	11.0 (15.0)	26.6
9	Uttar Pradesh	190	31.6	6.8	4.2	36.3	2.6	2.6	15.8	0.0
Southern Region										
10	Karnataka	1846 (1740)	39.3 (41.7)	12.0 (12.8)	5.5 (5.9)	16.1 (17.1)	4.7 (4.9)	3.4 (3.6)	13.2 (14.0)	5.7
11	Kerala	2339 (2054)	31.3 (35.4)	11.8 (14.2)	6.3 (6.8)	17.0 (21.7)	6.6 (6.7)	3.3 (3.2)	11.5 (13.2)	12.3
12	Tamilnadu	1322 (1243)	28.5 (30.3)	21.3 (22.7)	6.6 (7.0)	10.8 (11.5)	7.6 (8.1)	4.2 (4.4)	15.0 (15.9)	6.0

Notes:

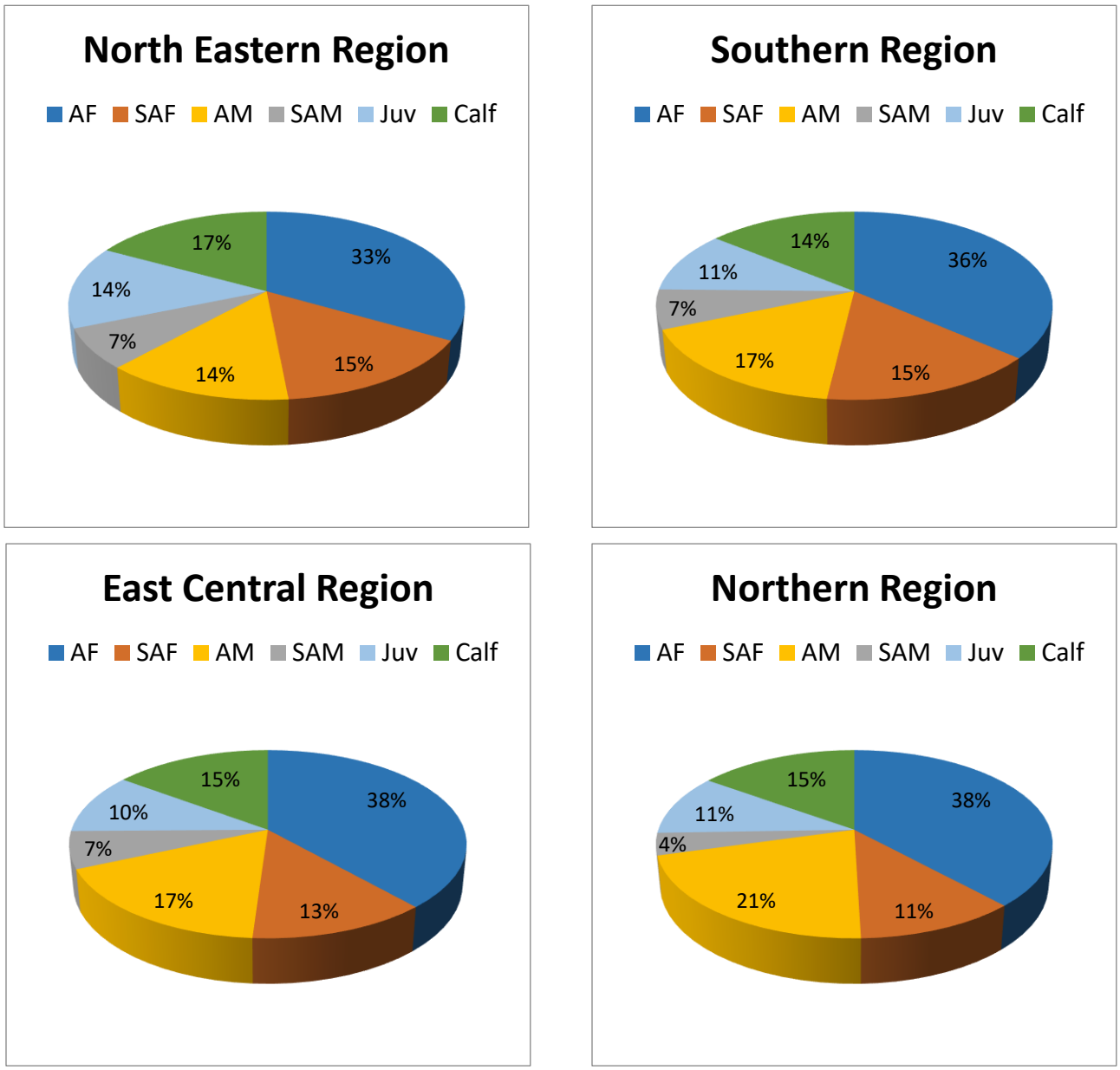
1. ***AF**: Adult Female, **SAF**: Sub-adult Female, **JF**: Juvenile Female, **AM**: Adult Male, **SAM:** Sub-adult Male, **JM**: Juvenile Male, **UI**: Unidentified.*
2. *All values are in percentages based on the number of individuals observed during the field enumeration.*
3. *The state Forest Departments recorded data on age and sex of the animals during the direct block counts as well as elephants specifically observed at waterholes, salt licks and open areas. The exception is Tamilnadu where the records were only from the direct block count (Source: report submitted by Tamilnadu Forest Department, 2017). Kerala figures are based on Kesavan et al. 2017.*

In total, 14,939 individual elephants were sighted by the data collection teams while conducting direct block count and waterhole count within forest areas. Although this exercise has been carried out by most states, the compilation provided below in terms of percentage of different age classes and sex of the animal is based on data received from only 12 states. These figures would have to be compared to population structures published by researchers in some of these forest divisions in order to assess their reliability. In particular, the past experience with population estimation in southern India has shown that there is a distinct tendency to overestimate the percentage of adult males (>15 yr) in the population because of wrong classification of the older sub-adult males (10-15 years) as adult males. Other errors are also possible when determining age class and sex of elephants in the field as, for instance, failure to distinguish between females and tuskless males especially in the subadult and juvenile age classes.

The following observations can be made on the data compiled from various regions:

1. The proportion of adult female (AF) is generally in the range of 26% to 31% of total population of wild elephants, the exceptions being 39.3% from Karnataka and 41.3% from Odisha. These are generally within the range reported from research studies; the lower percentages of adult female are usually reflective of growing populations while the higher percentages indicative of a more stable population. However, such inferences can only be made on the basis of additional information about the population (Sukumar 1989).
2. In the case of adult males (AM), on an average these are in the range of 11% to 20%, the exception being 36.8% from Jharkhand and 36.3% from Uttar Pradesh. Any figure greater than about 15% is highly unlikely and may reflect bias in classification of subadult males as adult males, or a bias towards recording male elephants which disproportionately come out of forests into agricultural areas. West Bengal (south) has also reported a figure of >40% adult males which may be an artifact of the large proportion (43%) of unclassified elephants (which are likely to be family groups).
3. The percentage of calves in the population ranged between 11.3% (Meghalaya) to 17.7% (Assam) across all the states, indicating relatively high birth rates (Sukumar 1989). The higher figures are likely to reflect both calves (<1 year) and younger juveniles which have been misclassified.
4. Several states such as West Bengal (South- 43.4%; North- 21.4%), Meghalaya (27.3%), Assam (23.7%), and Uttarakhand (26.6%) reported high proportions of unclassified individuals. This could possibly be attributed to dense forest conditions (northeastern states) or the tendency of elephants to bunch into tight clusters (southern West Bengal) when they become aware of human presence, making it difficult to classify them.
5. In addition, one of the major limitations was that the photographs obtained during this exercise, which would have been used to age and also sex classify the elephants, were not received for analysis and, hence, the above estimation of population structure could at most be considered as a subjective assessment which needs to be substantially refined.

Figure 3.11: Region-wise population structure of elephants by age and sex classes



AF: Adult Female, SAF: Sub-adult Female, AM: Adult Male, SAM: Sub-adult Male, JUV- Juvenile UI: Unidentified

SECTION 4:

DISCUSSION

SECTION 4.1: POSITIVES, LIMITATIONS/CHALLENGES AND LEARNING

4.1.1 The Positives or Success Factors

This was the first ever attempt to execute a mammoth exercise of synchronised elephant population estimation using a standard set of methods across all 23 states in the country with reported elephant presence. Given the scale of the exercise, multiple stakeholders had to be brought to the table, which facilitated cross-fertilization of ideas and strengthened the mutual recognition for the need of this vital exercise. In addition, data from these stakeholders had to be collected, modified to suit the current estimation process, data extracted and analysed to ascertain the status and distribution of elephants in India.

The multiple stakeholders were from different government departments and institutions which worked together to implement the field operations successfully. At the same time, there were many lessons learnt during the planning as well as the implementation phases that would help to make this exercise more robust in the future. Below are a few important factors that aided in the successful implementation of this exercise.

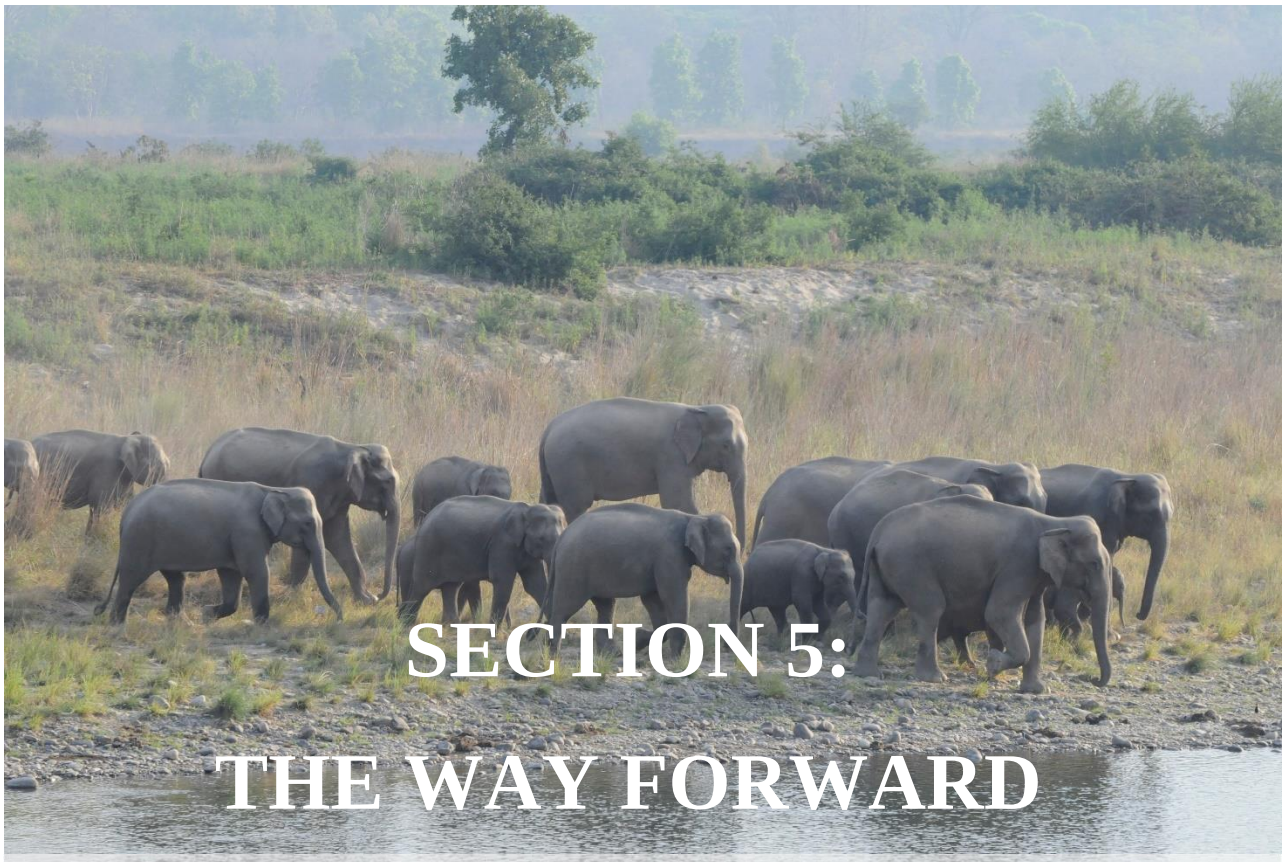
1. Getting several elephant stakeholders in one room for deliberating synchronized elephant population estimation exercise and planning the way forward.
2. Availability of human resources in terms of skill-sets and capability at different levels: Officials from Project Elephant and Ministry of Environment, Forests and Climate Change provided access to available resources for designing the synchronized elephant population exercise. Forest departments provided available resources for management and administration, data-collection and monitoring of the implementation of the exercise. They also helped bring together elephant field researchers with many years of experience for designing research methods, formulating guidelines to collect data and in conducting workshops/briefings.
3. Involvement of elephant researchers and conservation supporters: This exercise also resulted in considerable capacity building among civil society members and the forest staff through multiple training sessions, especially for direct/block count and indirect/dung count exercises, and classification of elephants. The full-time involvement of the forest department staff over a 5-6 months period for dung decay rate exercise in some of the states is also worth mentioning here.
4. Checks and balances during this entire exercise were moderated by Asian Nature Conservation Foundation, the operational team along with state forest department administrative offices during training, data collection (direct, indirect, age and sex classification exercise), dung decay rate exercise, data entry, scrutiny, processing, analysis and report writing.
5. Importantly, partial support was extended for data entry by some state forest departments, while digitized maps, shape files and relevant information were also provided by the GIS team of IT cell of these departments.
6. This exercise has provided, for the first time, relative density estimates of elephants in a GIS format across the elephant range states in the country, thus making it possible to compare these densities across elephant states, regions and divisions.

4.1.2 Challenges Faced and Possible Solutions

This sub-section provides perspective on the challenges faced and the learning from the synchronized exercise which would be useful for future population estimation exercises in India.

Sl. No.	Challenges Faced	Learning	Solutions
1	Preparedness for the workshop/ briefings/ review meetings	It was challenging to convey the details of the enumeration exercise to the ground-level staff as the officials were of different ranks, from different geographies and at times were present in large numbers	• Adopt a 2-tier approach to the training programmes • The first workshop should aim at discussions with senior to mid-level officers to arrive at decisions • A second workshop should be aimed at field level officers and frontline staff. Material distributed to them should be translated into local language where required
2	Digitized maps of divisions at the time of workshops/ briefings/ review meetings	Good quality maps of forest divisions were not available in many instances. Either forest departments are in process of digitizing the maps or in process of forming the Geo Informatics System (GIS) software cell in their department or may not have such a facility	• Prior to the workshops and training programmes, the respective state forest departments or divisions should compulsorily assemble the best available maps as well as bring digitized map files along for the meeting
3	Technical discussions during training	Since at times both volunteers from the public and forest division staff were trained together, this led to technical discussions without focus or creating boredom among the attendees	• Relevant, simplified and precise information to be included in the training manual • Training manual with precise instructions/ steps to be prepared and shared with all staff attending training & eventually to those who would be involved in actual field execution and data collection.
4	Roles and responsibilities among researchers and field staff for monitoring	At places researchers were not only responsible for training but also for monitoring (for instance, dung decay). This created some ambiguity between researchers and forest staff with respect to their specific roles and responsibilities.	• Training procedures and data collection monitoring to be mapped with clear roles and responsibility of the various players involved

Sl. No.	Challenges Faced	Learning	Solutions
6	Consistency in data collection and change of hands involved in this exercise	On account of staff transfers, new personnel were appointed to monitor dung piles. Ambiguity of knowledge/data transfer in case of change of hands is possible.	• Training manuals to clearly lay out the data collection and recording protocols • Forest departments to give the responsibility of ensuring quality in data collection to DFO/DCF level officers who should compulsorily attend the workshops • Teams carrying out good work should be recognized and rewarded in suitable fashion • Device a process of knowledge transfer or re-training for those who have joined the exercise in between
7	Data repository at decentralized level	Although data collection had been done at different levels/ geography, there wasn't enough emphasis given on procedures of data submission, checking and repository.	• Guidelines to be included for data submission, responsibility and ownership by doers and checkers
8	System and process of data scrutiny, processing and analysis at different levels	Ambiguity in processes of data scrutiny, processing and analysis	• Guidelines to be included for data scrutiny, processing, analysis and deliberations regarding trends about the data
9	Clarity in chain of command at the official level	In some states there was no clear chain of command in the executive of the census operations from start to finish	• Each state forest department to appoint a senior-level officer as the head of the census operations. He/she should be empowered to take decisions without following other hierarchical structures.



SECTION 5:

THE WAY FORWARD

SECTION 5: THE WAY FORWARD

The successes, failures, special challenges and learning experiences from the 2017 elephant population estimation exercise should be taken into account in planning and implementing future population estimations and monitoring across the country.

This should ideally be a 2-tiered approach, with the state forest departments carrying out the Tier-1 exercise across the entire distributional range of the elephant, and research institutions entrusted with the Tier-2 task of using scientifically more robust methods to monitor elephant populations in representative forest divisions.

SECTION 5.1: AIMS AND GOALS OF ELEPHANT MONITORING

Mapping elephant distribution across the country, including in reserve forests, community forests, revenue lands, commercial estates, agricultural areas and settlements.

Using a simple direct count method, such as the sample block count, to enumerate the elephant population. This would also provide a basis for comparison with previous "census" exercises going back several decades in the country.

Implement the indirect dung count method with greater field engagement in order to not only determine relative elephant abundance across habitat types and forest administrative units but also provide a more robust estimate of elephant numbers.

The spatial distribution of elephants and relative abundance could be expected to change seasonally, and therefore it would be ideal to sample elephant abundance during at least 2 seasons (dry and wet). This should be carried out during successive dry and wet seasons.

More important than estimating precise numbers of elephants is monitoring changes in elephant population structure in terms of age and sex ratio which would help in assessing the demographic health of the population as well as the possible extent of selective poaching of male elephants.

PLANNING & EXECUTION

Planning and consultations for the next all-India elephant population estimation should begin 15-18 months prior to the start of the first round of field exercises by the state forest departments. This would give sufficient time for Project Elephant Division to consult all the stakeholders and arrive at a detailed plan of action for implementation by the states.

Ensure the standardization of data collection and reporting through preparation of data sheets (including in local languages) in advance, better training and communication to the frontline staff, and perhaps even the exploration of mobile-phone based apps for this purpose.

SECTION 5.2: COMPONENTS OF MONITORING THE ELEPHANT POPULATION

5.2.1 Tier 1: (Primary Responsibility of State Forest Departments)

A. Mapping elephant distribution:

- The first and simplest pre-requisite of any population monitoring programme is to prepare a map of elephant distribution. This map would form the basis for sampling design.
- The state forest departments should mandatorily prepare a beat- or compartment-level map of all forest ranges and divisions in the state, preferably digitized accurately using standard GIS software. The beat-level staff (guards and watchers) may provide information on the presence or absence of elephants in their respective beats, both at present and perhaps in the past (a time period of about 5 years could be taken for past distribution).
- Presence of elephants outside the forest beats should also be mapped from records of elephant crop raiding and by questioning people. This would include the presence of elephants on other categories of land such as revenue land, private lands, agricultural lands, commercial estates (coffee, tea, cardamom, rubber) and even instances of wild elephants moving outside forests into towns and cities. GPS locations of such villages and lands should be compiled.
- ***This basic mapping should be completed by at least 6 months prior to the field enumeration.***

B. The direct count method:

- A direct count method such as the "sample block/beat count" method should be continued for the purposes of making comparisons with similar exercises in earlier years. There were no major challenges faced in getting the frontline staff to carry out this simple enumeration of elephants seen within a defined area. **The only recommendation is that the area is well-defined prior to the day of the enumeration (or even the census training workshop), its boundaries marked on a map, and that the size of the sampled block should be kept to between 4 and 6 km^2**.

C. The indirect dung count method:

- The dung count method has been adopted as the method of choice for estimating elephant populations in tropical forests for both Asian and African elephants by the CITES/MIKE programme. We recommend that the state forest department continue to use this method as the estimation of dung density is relatively simple and frontline staff can be easily trained to carry out line transects.
- Defaecation rates of elephants are available from several research studies. These are not very variable. However, the state forest departments in some regions (e.g. Arunachal/Assam for the northeast; Karnataka/Tamilnadu for the southern region) which hold considerable numbers of captive elephants in forest camps may initiate a fresh round of estimation with the help of researchers.
- ***The key challenge has been to obtain robust estimates of dung decay rate through field experiments*** in different habitat types (such as dry forest, evergreen forest, grassland, and montane

habitats). For this purpose, ***we strongly recommend that states begin setting up dung decay rate experiments at least 8 to 10 months prior to the field exercise of line transects for estimating dung density.***

- ***The line transect exercise for recording dung can be spread out over a period of about one week in each state***. This would make it possible for GPS units to be made available for each enumeration team, and also ensure that more beats/compartments are covered.

D. Classification of elephants through direct sightings and photographs:

- During the synchronized elephant censuses carried out by the state forest departments, the frontline staff have used visual methods of classifying elephants into 4 age categories, namely, adult, sub-adult, juvenile, and calf. In practice, however, there consistently tends to be misclassification of adult category in male elephants, with a distinct tendency to classify subadults as adults. There is also failure to recognize the sex of the animal, particularly in the case of tuskless males (makhnas) among subadult and juvenile elephants in family groups. This is particularly true in the southern states.
- Using photographs could greatly improve the accuracy of classification, in addition to providing a record of the identity of an individual elephant that would be especially useful in the case of adult male elephants that could be subject to poaching.
- Frontline staff should be provided with simple cameras or they can use their mobile phones in taking photographs of elephants they sight during patrolling. For the photographs to be useful they should be categorized and indexed to a particular elephant sighting during the direct count or the waterhole count.
- The use of camera traps set up near waterholes, salt licks, and elephant paths would greatly increase the chances of obtaining pictures of elephants for the purpose of classification of age and sex. As with camera trapping of predators and prey in Tiger Reserves, the method could be extended to other forest divisions in the state, especially in the Elephant Reserves.

5.2.2 Tier 2: (Primary Responsibility of Research Institutions with the Help of Forest Departments)

- Rigorous population estimation methods for long term monitoring: In each elephant region of the country (south, northern, northeast and east-central), a few sites should be selected for intensive scientific monitoring of population size and demography using a combination of state-of-the-art statistical methods and molecular techniques.
- Line transect method using DISTANCE sampling can perhaps be used for direct count of elephants at certain sites of high elephant density (greater than about 1 elephant per sq. km) such as Nagarahole-Bandipur-Wyanad-Mudumalai in the south (Karanth and Sunquist 1992; Jathanna et al. 2015). In many tiger reserves, line transect direct count of prey species is already being carried out, and this can be augmented and modified for also estimating elephant density – this would typically involve increasing the sample size of transects in order to record sufficient numbers of elephant groups.
- In recent years the use of statistically sophisticated “occupancy models” has gained currency in fine-scale understanding of heterogeneous habitat use by animals, including elephants. The basis of such

occupancy modelling is sign surveys of the species using grid-based field sampling at the scale of a landscape.

- Camera traps used to record predator species can be also used to record elephant groups (especially at water holes) or at least bull elephants, and the data analyzed in a mark-recapture framework. Similarly, mark-recapture framework has been used through direct sightings/re-sightings of identified elephants within short time period of a few weeks through intensive sampling in a small area such as Kaziranga, Assam (Goswami et al. 2019).
- In regions of low elephant density or elephant populations in the tens or the hundreds, it may also be feasible to use DNA profiling to come up with minimum numbers or population estimates in a mark-recapture framework (Chakraborty et al. 2014). It is also possible to sex an animal from analysis of DNA extracted from dung which would be especially useful to obtain adult male:female ratios and adult tusker:makhna ratios (Vidya et al. 2003)

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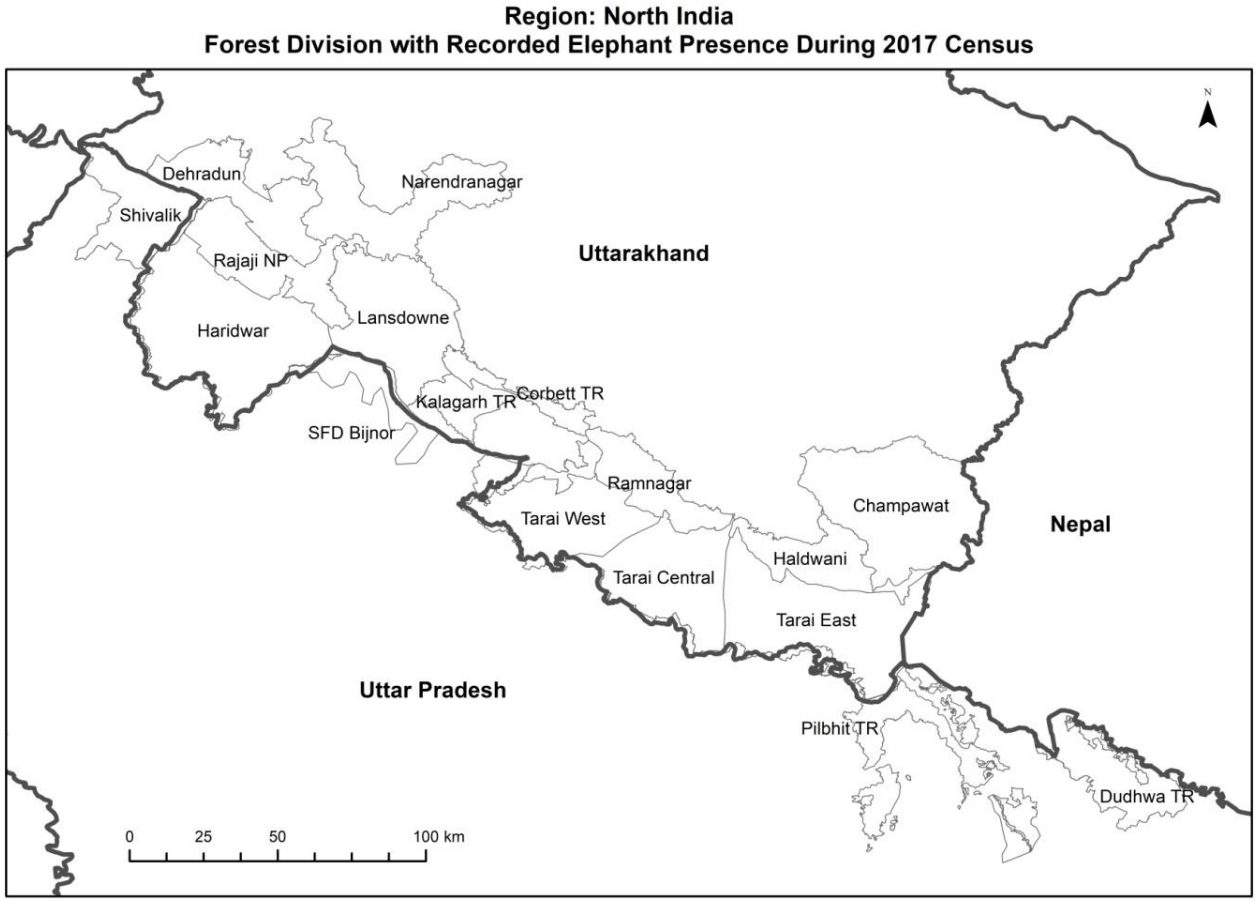
APPENDICES

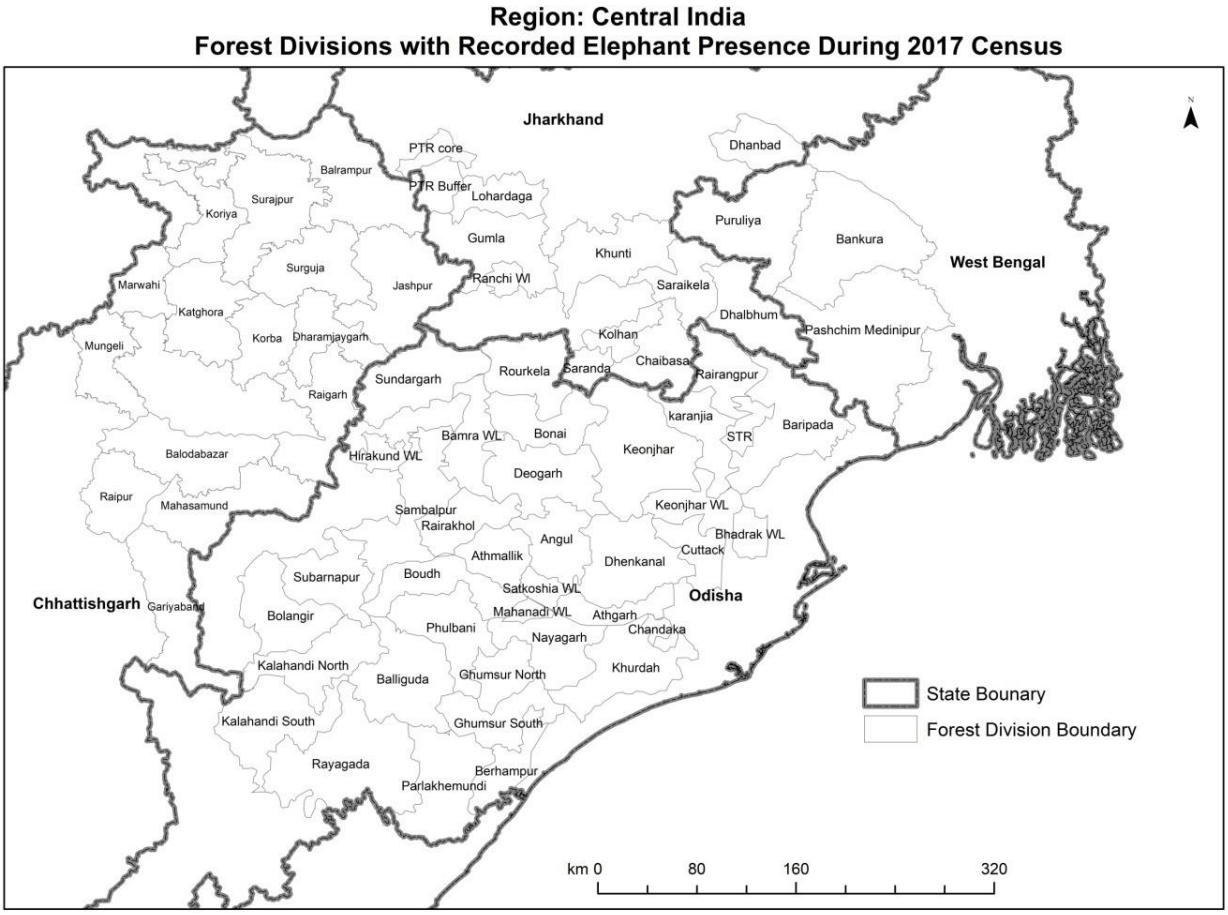
APPENDIX 1:

INDEX OF ALL FOREST DIVISIONS ACROSS THE FOUR REGIONS IN WHICH ELEPHANTS ARE FOUND

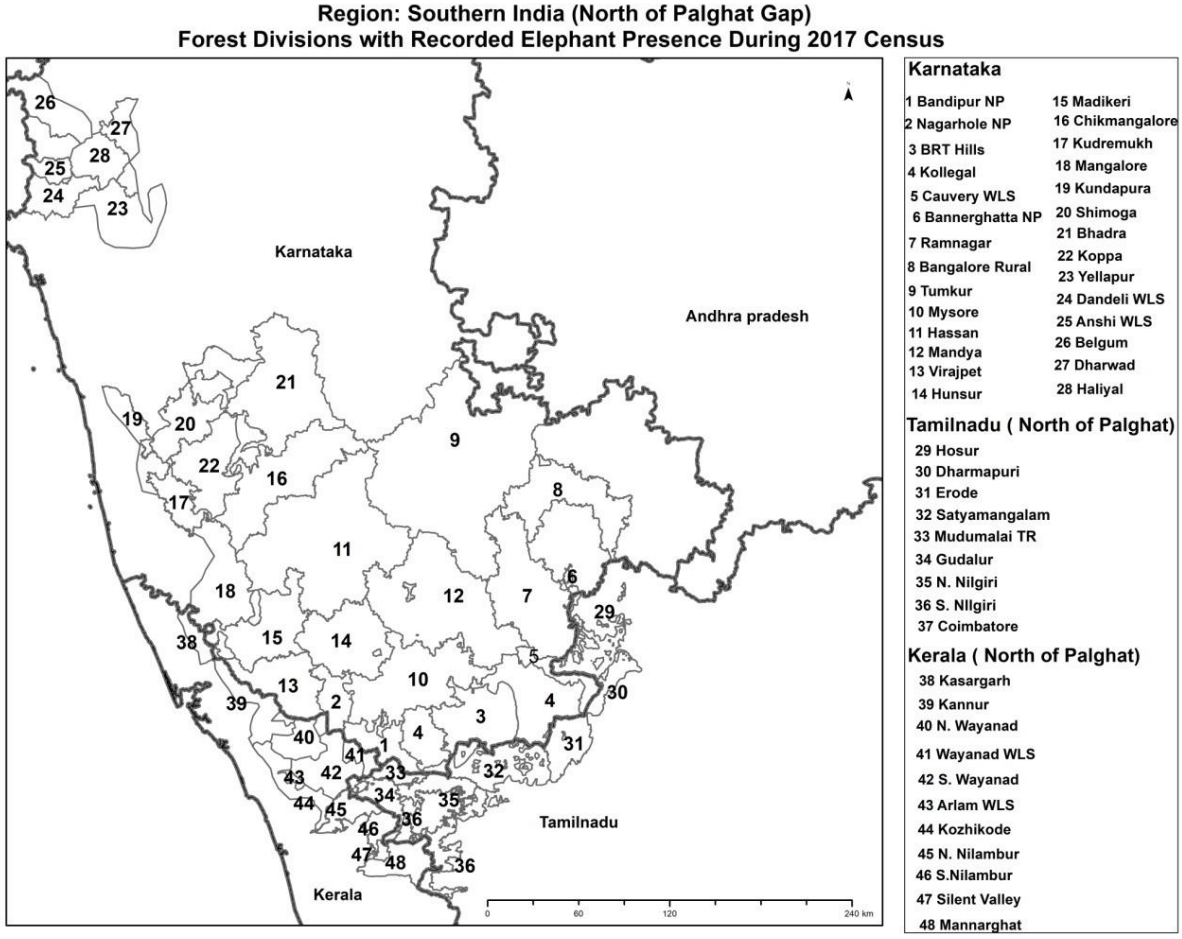
1. Northern India



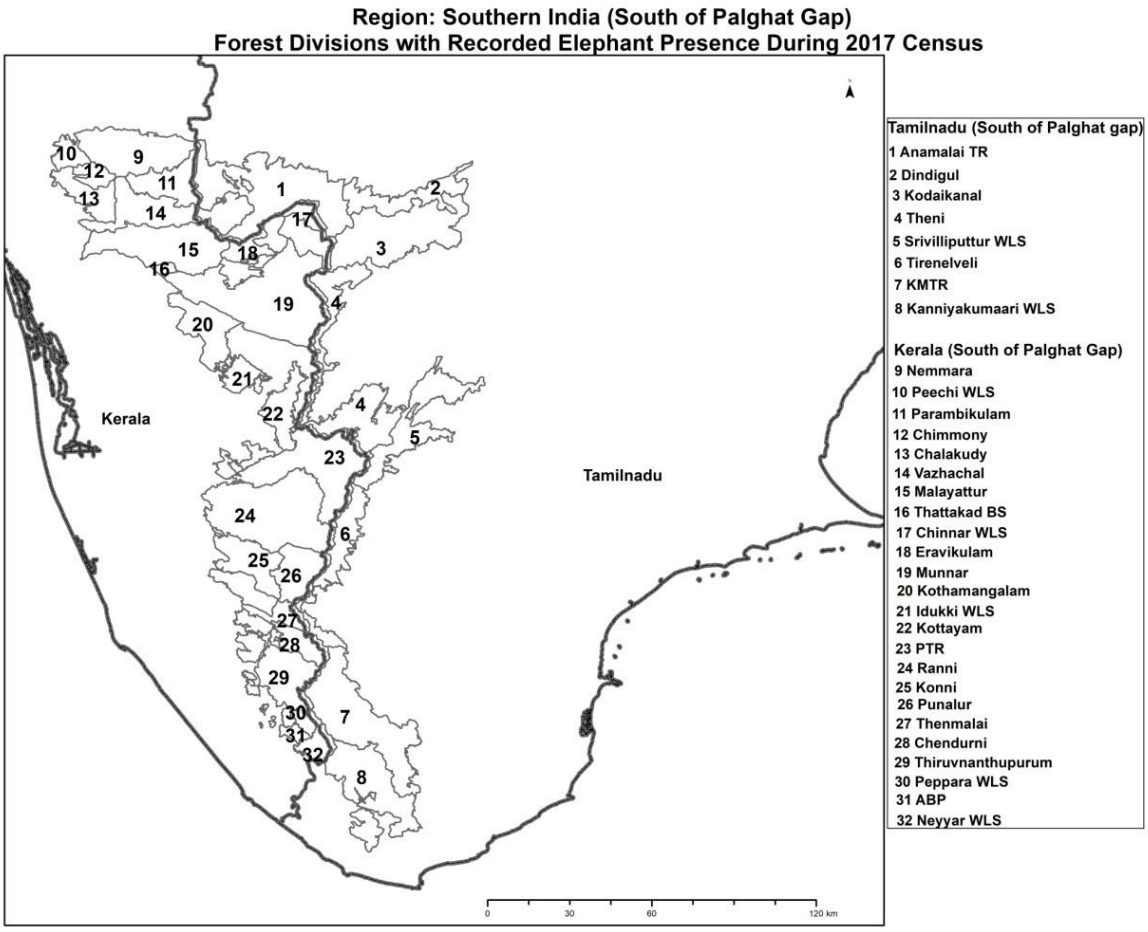
2. East Central region



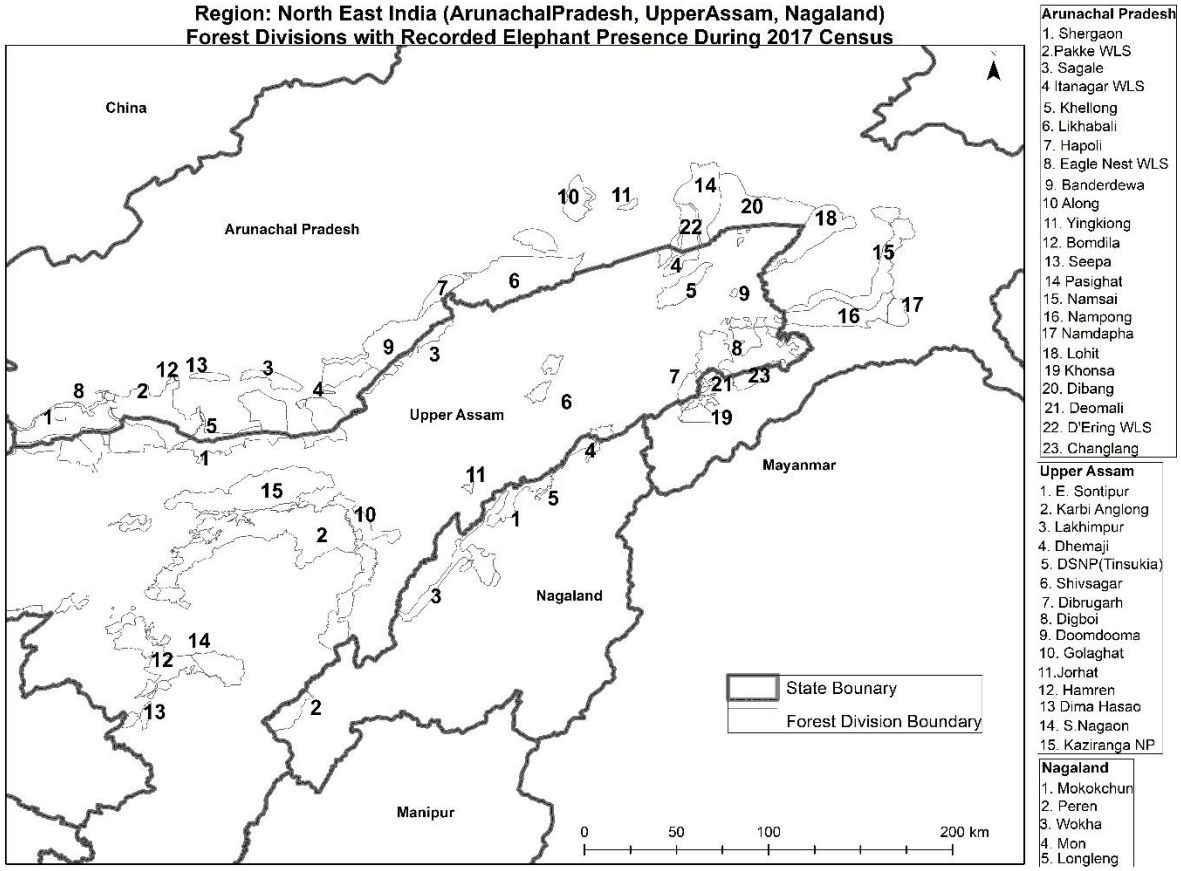
3. Southern region (North of Palghat Gap)



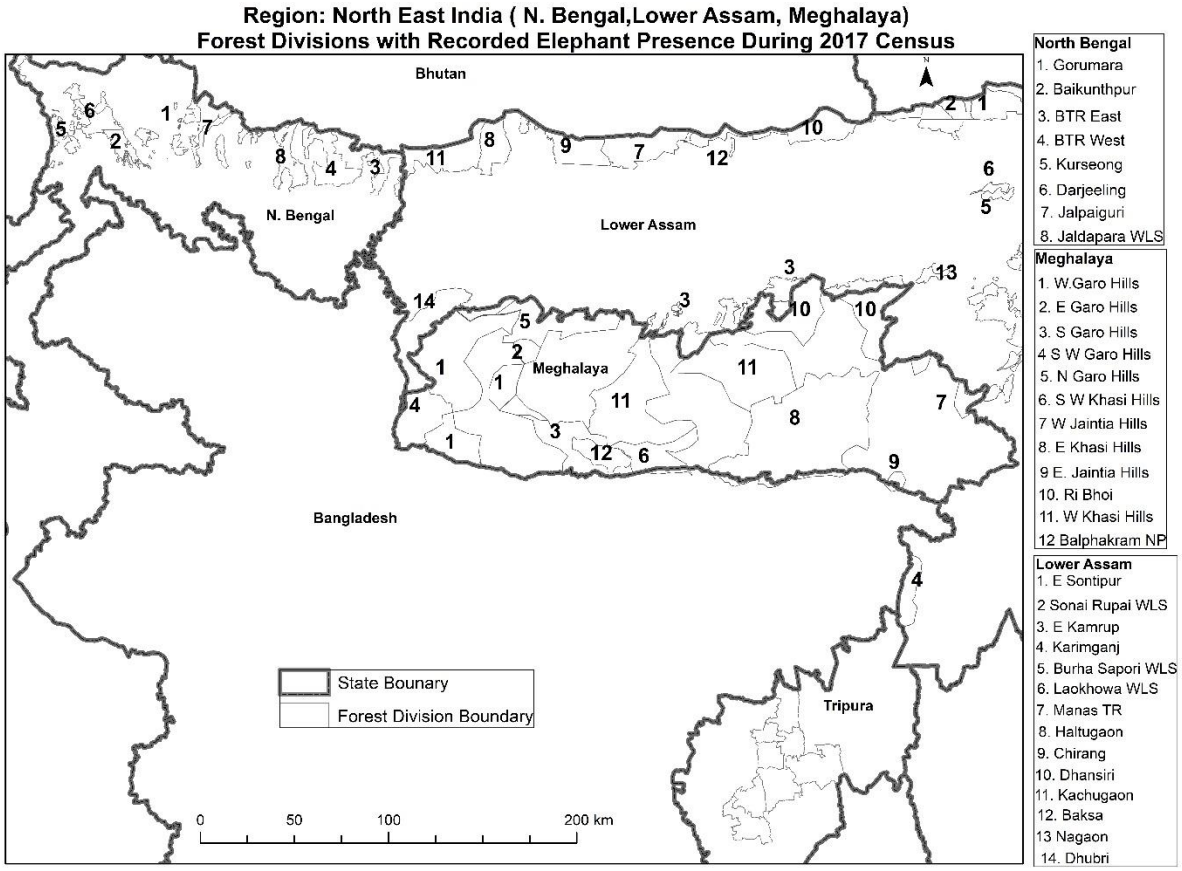
4. Southern region (South of Palghat Gap)



5. Northeast region (Northern)



6. Northeast region (Southern)

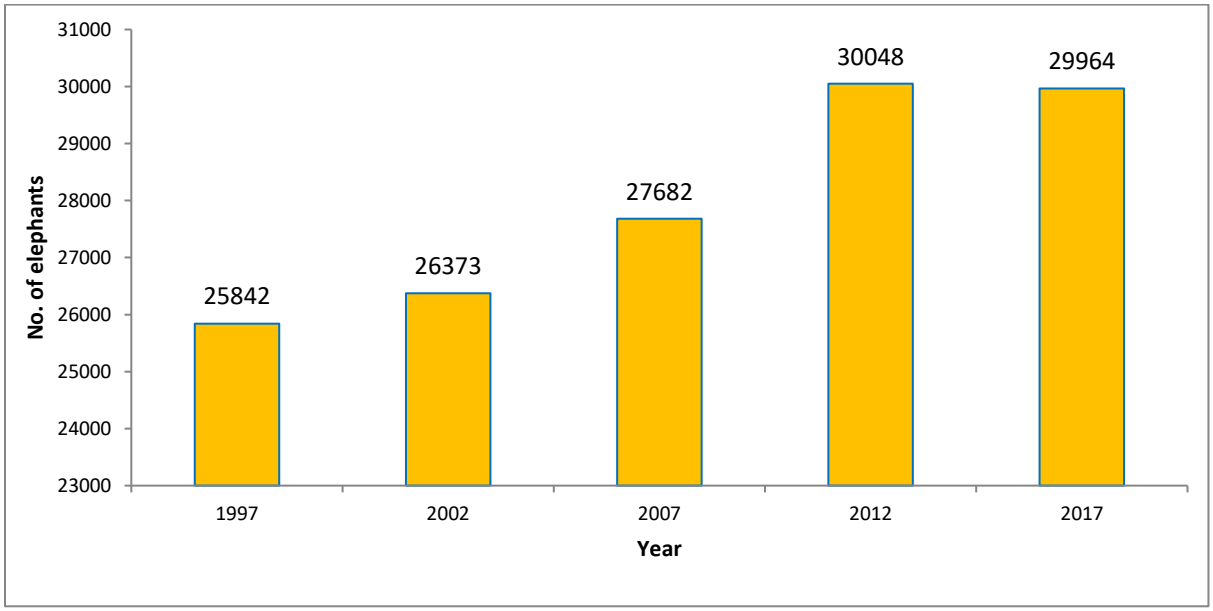


APPENDIX 2:
ELEPHANT POPULATION ESTIMATES FOR 1997-2017

2.1 Elephant population estimates for India by the direct count method during 1997-2017

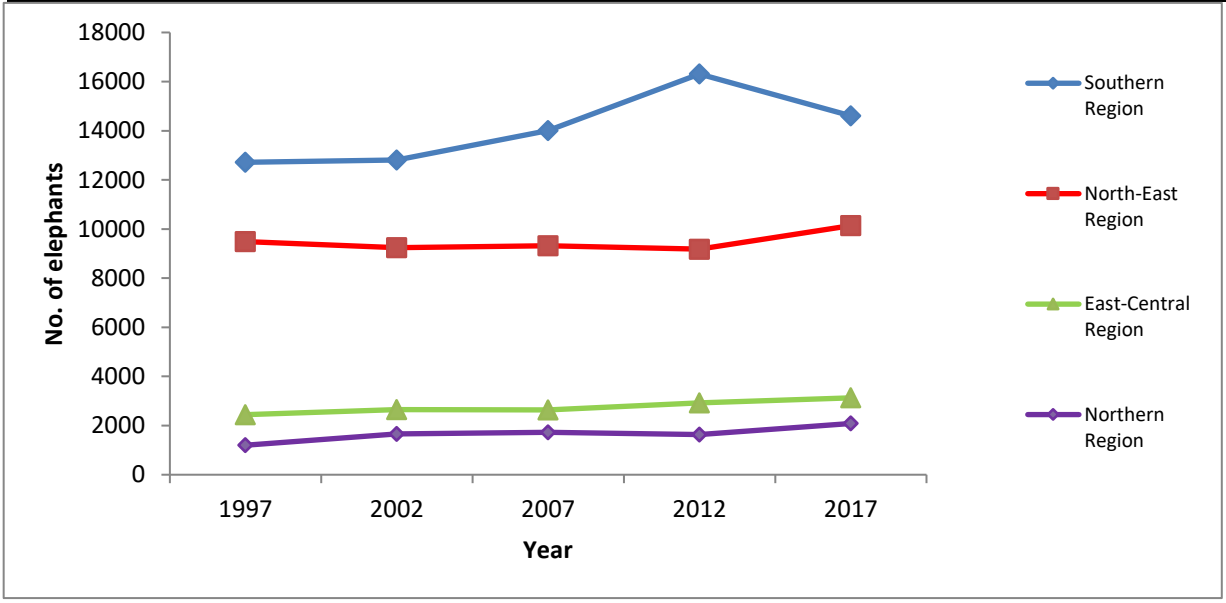
- The elephant population estimates for the past five country-wide exercises are given below in graphical and tabular format.
- These exercises had been conducted separately by each state forest department, as well as conducted using different data collection and data analysis methods. Thus, 2017 is the first ever synchronized elephant population estimation exercise in India where an attempt was made to implement uniform data collection and analysis methods.
- Hence, these results should not necessarily be interpreted to infer elephant population trends without other supporting data.

Elephant population estimates by the direct count method for India during 1997-2017



2.2 Elephant population estimates by the direct count method during 1997-2017 at the regional level for India

Region	Year				
	1997	2002	2007	2012	2017
Southern	12716	12814	14005	16309	14612
North Eastern	9482	9243	9318	9182	10139
East Central	2444	2649	2633	2920	3128
Northern	1200	1667	1726	1637	2085
Total number of elephants	**25842**	**26373**	**27682**	**30048**	**29964**



Source: Project Elephant Division, Ministry of Environment, Forest and Climate Change, New Delhi

Contact: Asian Nature Conservation Foundation, c/o Centre for Ecological Sciences, Biological Sciences Building, Indian Institute of Science, Bengaluru 560012. Email: ancf@asiannature.org