# Synchronized Elephant Population Estimation India 2017

August 2017

**Project Elephant Division**

**Ministry of Environment, Forest and Climate Change**

**Government of India**

हाथी परियोजना
भारत सरकार

AE28 गजराज

PROJECT ELEPHANT
GOVT. OF INDIA

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(all other photographs)

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वन महानिरीक्षक एवं विशेष सचिव
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MINISTRY OF ENVIRONMENT, FOREST AND
CLIMATE CHANGE

Dated, 9th August, 2017

## Message

India's Heritage Animal, the elephant, has not only been a cultural icon for centuries but also a keystone species in the tropical forests of the country. From the ancient Harappan civilization through the Mauryan and Mughal periods to modern times, the elephant has fascinated the minds of kings and commoners alike. Estimating the number of elephants those might have roamed through the subcontinent has been an important enterprise. Perhaps the earliest estimates of elephants comes from the Arthashastra that speaks about the Bodhisattva being the leader of a population of 80000 elephants in the Himalaya.

Since 1950, the size of elephant population of the country has been enumerated at regular intervals by various States. After the launch of Project Elephant in 1992, the estimation of the elephant population is being coordinated at the National level by the Ministry of Environment, Forest and Climate Change. The 2017 all-India synchronized elephant population estimation, coming after a gap of five years is unique and important for several reasons. For the first time, all states have agreed to adopt a uniform set of methodologies covering elephant distribution, estimation of wild elephant population by direct and indirect dung count methods and assessment of the structure of the population for their demographic health. The 2017 elephant census is thus a landmark in terms of scientific methods of monitoring elephant population of the country. In this task, the Project Elephant Directorate and the state forest departments have been assisted suitably by Asian Nature Conservation Foundation (ANCF) based at Indian Institute of Science, Bengaluru, several regional NGOs and conservationists.

The field census operations concluded in late May 2017 and data from various states are being compiled, collated and analysed. Given the enormity of data generated, complete analysis and interpretation of results and present report released on World Elephant Day is a preliminary report which presents the first estimates based data using the direct count method. In the coming months, ANCF in coordination with the state forest departments will be refining the results from the direct count, analyzing the data from the dung count method, producing high resolution maps in a GIS domain, and compiling information on elephant population profile across various regions. The final Report that is expected to be ready later this year will provide a firmer basis for management of the elephant population of our country.

(SIDDHANTA DAS)

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B. K. SRIVASTAVA, I.F.S.

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CLIMATE CHANGE

## MESSAGE

Asian elephant has been identified as Endangered Species by IUCN in view of the fact that its population has declined by more than 50 percent over the last three generations, estimated to be 60-75 years. India is home to about 60 percent of the global population of Asian Elephants. Hence India has to assume world leadership in setting up standards for conservation of elephants.

The Project Elephant Division, in the Ministry has records of elephant population since 1993 after every 4-5 years. In past the population data was estimated by State Forest Departments at varying timings and using various methods, which were found suitable and convenient by them. Estimation of elephant population accurately is of utmost importance in view of effective conservation of elephants and scale of Human-Elephant Conflicts in the country.

In a meeting, chaired by Director General of Forests & Special Secretary, held on 15th July, 2016 it was decided to plan and organize elephant census in four regions namely [i] North Eastern Region (Assam, Meghalaya, Arunachal Pradesh, Nagaland, Tripura and North Bengal), (ii) Southern Region (Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Maharashtra, Goa and A&N Islands), (iii) Eastern Region (Bihar, Jharkhand, Chhattisgarh, Odisha, South Bengal) and (iv) Northern Region (Uttarakhand and Uttar Pradesh). Field operations of elephant census within each region were synchronized, to avoid double counting of elephants.

It was also decided to collect elephant population data using following methods

1. Direct Count or Block Count
2. Indirect Count or Line Transect
3. Elephant Distribution Mapping and
4. Waterhole Count

In order to familiarize the staff of SFDs with elephant census methods and techniques two regional workshops were organized in all four regions. All elephant range States were also asked to collect dung decay experiments for estimation of dung decay rates for different areas within four regions, from October 2016 to December, 2016. Field operations for actual elephant census were carried out during March, 2017 in NE Region and for other three regions during April – May, 2017.

Since such an exercise was carried out for the first time in the country, many problems were faced and many lessons were also learnt during All India Synchronized Elephant Census, 2017. I am hopeful that this exercise will set new standards in population estimation of elephants in India and other countries as well. Quality of data collected during the elephant census will be high. It will be helpful in effective planning of various issues relating to elephant conservation in the country.

8.8.2017

(R.K. Srivastava)

Date:8th August, 2017

Place: New Delhi.
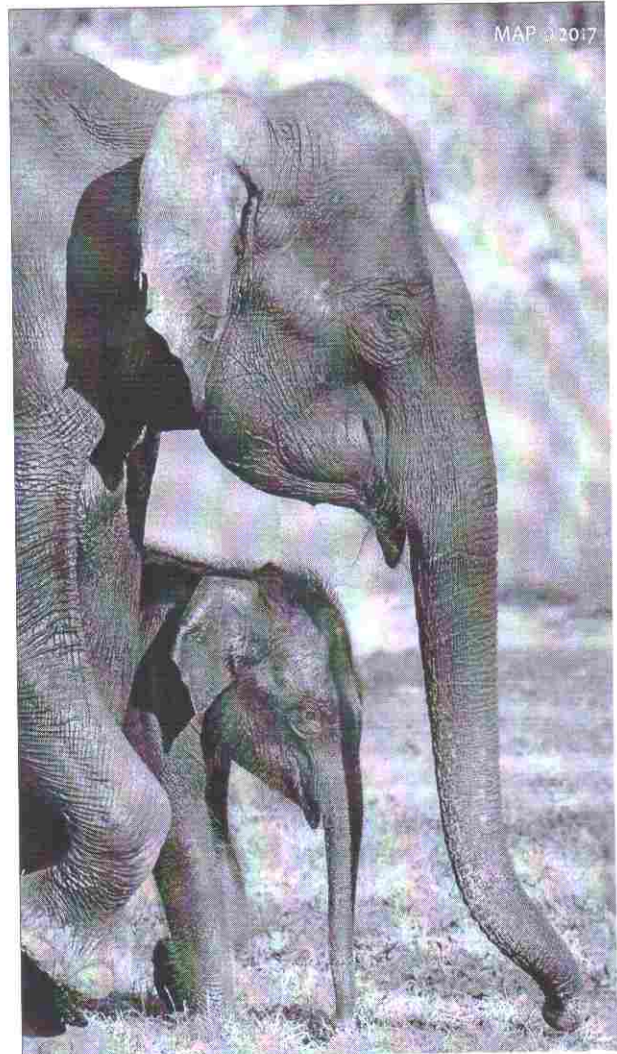
## All-India Synchronized Elephant Population Estimation 2017

### Introduction

Wild elephants in India have been recorded in the following geographical regions of the country:

1) Northern region (Uttarakhand, Uttar Pradesh, Haryana, Himachal Pradesh)
2) East-Central region (Odisha, Jharkhand, Bihar, southern Bengal and Chhattisgarh)
3) Northeastern region (Assam, Arunachal Pradesh, northern Bengal, Meghalaya, Nagaland, Tripura, Mizoram and Manipur)
4) Southern region (Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Maharashtra and Andaman & Nicobar)

As elephants are long ranging animals and distributed across landscapes covering different states in India, it is 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. In recent years, wild elephants have also been dispersing from forests into agricultural landscapes, and into states where they have not been present in past years.

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 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. In the southern states, the indirect dung count method was introduced in 2002, while the conventional "total count" method, that has limited or no scientific basis for large landscapes and elephant populations, was modified to "sample block counts" with restricted area (about 5 km$^2$) to maximize the probability of detection of elephants by a small team of enumerators.

The choice of population estimation methods should be broadly uniform across the country or at least within the elephant distribution region. It should also give scope for adequately training a large number of frontline forest staff quickly. It is also desirable to maintain some level of continuity with the previous population estimations in order to make meaningful comparison 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 has serious limitation 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 ensure maximum detection.

Planning for the all-India synchronized population estimation exercise began in 2016 itself with a national-level meeting held at New Delhi on 15th July 2017. Officials from 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. These were the following:

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) by 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 defaecation 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 to more accurately determine the sex and age class of elephants.

The above methods have been 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.

Following this, two rounds of regional workshops were conducted during 2016, 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.

The census operations were conducted in each region during the following periods:

1. Northeastern region: 26th to 29th March 2017
2. East-central region: 8th to 12th May 2017
3. Southern region: 16th to 19th May 2017
4. Northern region: 23rd to 26th May 2017

The present "first report" of the elephant population estimation 2017 presents **results only from the direct count method**. The figures provided below 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 by the state forest department. This is ongoing work that would require more inputs from the states, detailed analyses, and interpretation. In particular, mapping elephant distributions in a GIS domain, analyzing data from the indirect dung count method, and compiling more accurate population structure data from photographs would require several months of work as large volumes of data have to be collated, corrected and processed. Even for the direct count method, reliable information on elephant distribution area is lacking in the case of some states or forest divisions within a state.

The results presented here should therefore be interpreted with caution. At this stage, comparisons should not be made between results from the 2017 census and the earlier 2012 census, the reason being that the earlier census results were based on a mixture of direct and indirect count methods as reported by different states. In particular, no trend information should be made for individual forest divisions or states from these results. In 2017 there were major shifts in dry season habitat use by elephants in the south because of a severe drought in the previous year.

Other population estimation methods (line transect direct count, camera trapping using a mark-recapture framework, DNA-based profiles, occupancy models and so on) require substantial research and development and cannot be 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 population in selected areas of each of the four regions.

A population of 27312 elephants has been estimated from 23 states in India by direct count method using random block sampling and the results for individual states are given in Table 1:

Table 1: Elephant population estimated for India by direct block count method during March-May 2017

| | INDIA | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|---|
| | | | | Northeast Region |
| 1 | Arunachal Pradesh | 0.23 | 7000 | 1614 |
| 2 | Assam | 0.38 | 14050 | 5719 |
| 3 | Meghalaya | 0.16 | 11119 | 1754 |
| 4 | Tripura* | 0.10 | 987 | 102 |
| 5 | Nagaland* | 0.45 | 1000 | 446 |
| 6 | North Bengal | 0.25 | 1933 | 488 |
| 7 | Manipur | | | 9 |
| 8 | Mizoram | | | 7 |
| | | | | Total: **10,139** |
| | | | | East Central Region |
| 9 | Odisha | | | 1976 |
| 10 | Jharkhand | 0.16 | 4156 | 679 |
| 11 | Chhattisgarh | | | 247 |
| 12 | Bihar | | | 25 |
| 13 | Madhya Pradesh | | | 7 |
| | South Bengal | | | 194 |
| | | | | Total: 3128 |
| | | | | Northwest Region |
| 14 | Uttarakhand | 0.45 | 4087 | 1839 |
| 15 | Uttar Pradesh | | | 232 |
| 16 | Haryana | | | 7 |
| 17 | Himachal | | | 7 |
| | | | | Total: **2085** |
| | | | | Southern Region |
| 18 | Karnataka | 0.67 | 8976 | 6049 |
| 19 | Kerala | 0.32 | 9675 | 3054 |
| 20 | Maharashtra | | | 6 |
| 21 | Andhra Pradesh | | | 65 |
| 22 | Andaman & Nicobars* | 0.14 | 133 | 19 |
| 23 | Tamil Nadu | | | 2761 |
| | | | | Total: **11960** |
| | **Total** | | | 27312 |

*Results are based on indirect (dung) count method as direct counts could not be carried out.
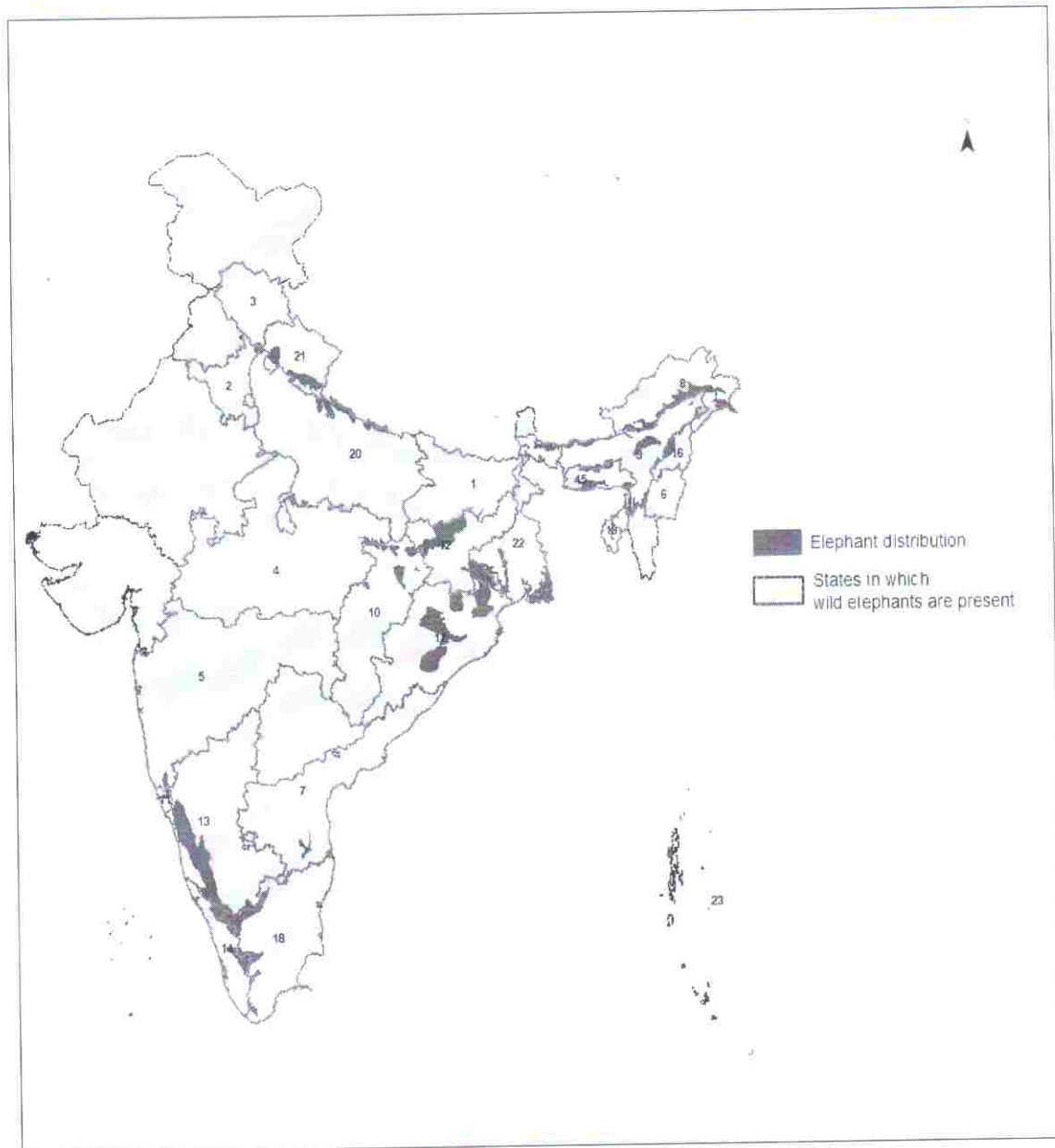
Elephant distribution for India in 2017

1: Bihar, 2: Haryana, 3: Himachal Pradesh, 4: Madhya Pradesh, 5: Maharashtra, 6: Manipur, 7: Andhra Pradesh, 8: Arunachal Pradesh, 9: Assam, 10: Chhattisgarh, 11: Goa, 12: Jharkhand, 13: Karnataka, 14: Kerala, 15: Meghalaya, 16: Nagaland, 17: Odisha, 18: Tamil Nadu, 19: Tripura, 20: Uttar Pradesh, 21: Uttarakhand, 22: West Bengal 23: Andaman & Nicobar.

A small group of elephant also moves into Mizoram seasonally.

MAP © 2017

*A total of 10,139 elephants are estimated in Arunachal Pradesh, Assam, Mizoram, Manipur, Meghalaya, Nagaland, north Bengal and Tripura of northeast region of India.*

## Arunachal Pradesh

Elephants are distributed over 22 forest divisions in Arunachal Pradesh, and 30-60% of the elephant distribution area from each division was selected was selected for sampling by the direct count method. 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 actual elephant distributions area for Arunachal Pradesh is yet to be determined; for the present a figure of 7000 km$^2$ has

been obtained based on the information published from the website http://www.wildlifeofindia.org/projectelephant.html. This gives a population 1614 elephant for the state (Table 2).

Table 2: Elephant population estimated for Arunachal Pradesh

| Arunachal Pradesh | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| Arunachal Pradesh | 0.23 | 7000 | 1614 |
| Arunachal Pradesh (without Pakke TR) | 0.18 | | |
| Pakke TR | 0.48 | | |
| Shergaon, Bomidila, Itanagar, Khelong, Sagalee & Banderdawa | 0.29 | | |
| Along, Anjaw, Dering, Daporijio, Dibang, Hopoli, Kamlang WLS, Lokabali, Lohit, Mehao WLS, Namdapha TR, Nampong, Pasighat WLS, Deomali, Khonsa & Chanlong forest divisions | 0.10 | | |

## Assam

Elephant are found in 36 forest divisions in Assam. A total area of 11601 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 (Table 3).

Table 3: Elephant population estimated for Assam

| Assam | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| Assam (Overall) | 0.38 | 15,050 | 5719 |
| Nameri- Sonitpur- Dhemaji | 0.33 | | |
| Kamrup W & E- Golpara | 2.20 | | |
| Kaziranga- Karbianglong- Nagoan | 0.16 | | |
| Manas- Ripu-Chirang | 2.50 | | |

## 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 2.6km$^2$ to 8.8km$^2$ sampled. This translated to an overall density of 0.16 elephants/km$^2$. The elephant distribution area for Meghalaya is estimated by the forest department to be 11,185km$^2$ and the population estimate is 1754 elephants (Table 4).

Table 4: Elephant population estimated for Meghalaya

| Meghalaya | Elephant density/km² | Elephant distribution area in km² | Elephant Population |
|---|---|---|---|
| Meghalaya | 0.16 | 11118 | 1754 |
| Balpakaram NP | 0.54 | | |
| Jainta Hills | 0.03 | | |
| Khasi Hills | 0.12 | | |
| Garo Hills | 0.02 | | |

## Tripura

Results of elephant numbers estimated by indirect dung indirect count is presented in the Table 4: Indirect count results are reported as the block count method did not provide sufficient sample size. Dung density estimation was carried out by indirect line transect dung method in the three forest divisions of Tripura and dung decay rate estimated from the experiment carried out in Meghalaya. The daily elephant defecation rate of 18.1/day was used from a study carried out at Dehing Patkai Wildlife Sanctuary Assam. Based this, an elephant density of 0.10/ km² was estimated for the state and the same was extrapolated to 987km² of the elephant distribution area. This provides an estimate of 102 elephants for the state (Table 5).

Table 5: Elephant population estimated for Tripura

| Tripura | Elephant Density/km² | Elephant distribution area in km² | Elephant Population |
|---|---|---|---|
| Tripura | 0.10 | 986 | 102 |

## Nagaland

For Nagaland state also the results from indirect count method was used. Dung decay rate results are from the experiments carried out in Wokka Forest Division in Nagaland and the daily defecation rate from Dehing Patkai WLS Assam. An elephant density of 0.45 elephants is estimated and the same was extrapolated to an elephant distribution area of 1000km². This gives a population estimate of 446 elephants (Table 6).

Table 6: Elephant population estimated for Nagaland

| Nagaland | Elephant density/km² | Elephant distribution area in km² | Elephant Population |
|---|---|---|---|
| Nagaland | 0.45 | 1000 | 446 |

## North Bengal

Elephants are distributed over 9 forest divisions in north Bengal. A total of 153 blocks were sampled for the direct count method for north Bengal. An elephant density of $0.25/km^2$ was estimated for this region and a total number of 488 elephants estimated using 1933 $km^2$ area of elephant distribution for north Bengal (Table 7).

Table 7: Elephant population estimated for North Bengal

| North Bengal | Elephant Density/km² | Elephant distribution area in km² | Elephant Population |
|---|---|---|---|
| | 0.25 | 1933 | 488 |
| Buxa TR East | 0.10 | | |
| Buxa TR West | 0.37 | | |
| Jaldapara | 0.26 | | |
| Gorumara | 1.06 | | |
| Jalpaiguri | 0.15 | | |
| Baikunthapur | 0.27 | | |
| Darjeeling | 0.12 | | |
| Kurseong | 0.08 | | |

## Mizoram

A group of 5-7 elephants is 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.

Table 8a: Elephant population estimated for Mizoram

| Mizoram | Elephant Density/km² | Elephant distribution area in km² | Elephant Population |
|---|---|---|---|
| | | | 7 |

## Manipur

A group of 8 to 9 elephants 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.

Table 8b: Elephant population estimated for Mizoram

| Manipur | Elephant Density/km² | Elephant distribution area in km² | Elephant Population |
|---|---|---|---|
| | | | 9 |

10

*A total of 3128 elephants are estimated in Odisha, Jharkhand, Chhattisgarh, Bihar Madhya Pradesh and south Bengal of east-central region of India.*

## 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 Table 9. Apart from the Elephant Reserves the remaining elephants are found in other territorial forest divisions and revenue lands.

Table 9: Elephant population estimated for Odisha

| Odisha | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| | | | 1976 |
| **Odisha** | | | 635 |
| Mayurbhanj ER | | | 694 |
| Mahanadi ER (proposed) | | | 207 |
| Sambalpur ER (proposed) | | | |

## Jharkhand

Elephants are found in 12 forest divisions in the state. A total of 311 blocks were sampled for Jharkhand. Based on an overall elephant density of 0.16 km$^2$ a population of 678 elephants for the state was estimated (Table 10). A more precise figure of elephant distribution area in the state is needed.

Table 10: Elephant population estimated for Jharkhand

| Jharkhand | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| | 0.16 | 4155 | 678 |
| **Jharkhand** | 0.22 | | |
| Palamau TR | 0.44 | | |
| Saranda | 0.17 | | |
| Chaibasa | 0.10 | | |
| Saraikela (Dhalbum & Dalma) | 0.07 | | |
| Ranchi, Lohardaga & Khunti | 0.03 | | |
| Gumla | 0.54 | | |
| Dhanbad | 0.06 | | |
| Jamshedpur | | | |

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 (Table 11).

Table 11: Elephant population estimated for Chhattisgarh

| Chhattisgarh | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| Chhattisgarh | | | 247 |
| Sarguja | | | 108 |
| Bilaspur | | | 122 |
| Raipur | | | 17 |

According to the state forest department, the forests in 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 India and from the forest regions around Kosi Tappu and Parsa Wildlife Sanctuary in Nepal were reported.

These elephants stayed for short durations 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 has been made by the forest department (Table 12).

Table 12: Elephant population estimated for Bihar

| Bihar | Elephant Density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| | | | 25 |

Seven elephants (Table 13) 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.

Table 13: Elephant population estimated for Madhya Pradesh

| Madhya Pradesh | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| | | | 7 |

## South Bengal

Elephant groups in southern west Bengal area are primarily "migratory" elephants from Jharkhand since about 1986-87. There are 3 to 4 different groups and several solitary bulls that move into West Medinipur, Bankura, Purulia, Birbhum and Jhargram regions. Over time the numbers have increased and several elephants seem to have become resident in south 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 elephant population estimation period of a total of 47 elephants were encountered in 57 beats. However, a density estimate of 0.05/km$^2$ gives a figure of 194 elephants during the census period in 2017 (Table 14). This number will have to be fine-tuned based on results from the dung count as well as better estimate of elephant habitat area in this region.

Table 14: Elephant numbers estimated for South Bengal

| South Bengal | Elephant Density/km$^2$ | Elephant distribution area in km$^2$ | Elephant population estimation |
|---|---|---|---|
| | 0.05 | 4067 | 194 |

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

## 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 0.45elephants/km$^2$ was estimated for the state by this method. Based on the 4087km$^2$ elephant distributions area estimated by Varma and Sukumar (2012), a population number of 1811 elephant can be made for the state (Table 15).

Table 15: Elephant population estimated for Uttarakhand

| Uttarakhand | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| Uttarakhand | 0.45 | 4087 | 1811 |
| Corbett TR | 0.83 | | |
| Haridwar | 0.17 | | |
| Rajaji NP | 0.58 | | |
| Lansdowne | 0.22 | | |
| Kalagarh | 1.32 | | |
| Ramnagar | 0.17 | | |
| Terai Central | 0.07 | | |
| Haldwani | 0.14 | | |

## Uttar Pradesh (UP)

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. (Table 16).

Table 16: Elephant population estimated for Uttar Pradesh

| Uttar Pradesh | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| Uttar Pradesh | | | 232 |
| Nazibabad | | | 102 |
| Bijnur | | | 64 |
| Shivalik | | | 24 |
| Dudhwa TR | | | 42 |

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## 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 (Table 17).

Table 17: Elephant population estimated for Haryana

| Haryana | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| | | | 7 |

## 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 (Table 18).

Table 18: Elephant numbers population for Himachal Pradesh

| Himachal Pradesh | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| | | | 7 |

*A total of 11960 elephants are estimated in Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Maharashtra and Andaman & Nicobars of southern region of India*

## 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 (Table 18). Thus, during the 2017 population estimate, Karnataka retains its position as the state with the highest elephant population in the country.

Table 19: Elephant population estimated for Karnataka

| Karnataka | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| **Karnataka** | **0.67** | 8976 | 6049 |
| *Hassan* | 0.15 | | |
| *Hunsur* | 0.62 | | |
| *Nagarahole TR* | 1.54 | | |
| *Dandeli* | 0.04 | | |
| *Madikeri WL* | 0.24 | | |
| *Dandeli WL* | 0.04 | | |
| *Kollegal* | 0.24 | | |
| *Mangaluru* | 0.08 | | |
| *Bannerghatta NP* | 0.63 | | |
| *Bhadra TR* | 1.12 | | |
| *Chickamagalur* | 0.29 | | |
| *Cauvery WL* | 0.50 | | |
| *Biligiri Rangaswamy Temple TR* | 0.98 | | |
| *Bandipur TR* | 1.13 | | |

## Kerala

Elephants are found in 37 forest divisions in the state. A total of 673 blocks were sampled for the block count in Kerala. An elephant density of 0.32 animals/km$^2$ was estimated and this density was extrapolated to a elephant distribution area of 9670km$^2$ for a total of 3054 elephants in the state (Table 20). We must mention here that during the 2012 census, the figures reported by Kerala to the national census figure were 6117 based on the indirect dung count method. However, the direct count results for 2012 gave an estimate of only 2735 elephants. Thus, the 2017 census results from direct count method for Kerala

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should not be compared to the 2012 census results from the indirect count method that would otherwise result in erroneous conclusions.

Table 20: Elephant population estimated for Kerala

| Kerala | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| **Kerala** | **0.32** | 9670 | 3054 |
| *Anaimudi ER* | 0.41 | | |
| *Periya ER* | 0.31 | | |
| *Wyanad ER* | 0.25 | | |
| *Nilambur ER* | 0.25 | | |

## Tamil Nadu

Tamil Nadu Forest Department estimated a population of 2761 elephants by sample block count method and the results of number estimated for the state and some of the important elephant divisions for the states are given in Table 21. 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 Tamil Nadu moving into adjoining states with moister forests. These elephants began to move back to Tamil Nadu only with the onset of the monsoon in mid-2017.

Table 21: Elephant population estimated for Tamil Nadu

| Tamil Nadu | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| **Tamil Nadu** | | | 2761 |
| *Dharmapuri* | | | 184 |
| *Hosur* | | | 499 |
| *Coimbatore* | | | 97 |
| *Nilgiri North* | | | 180 |
| *Nilgiri South* | | | 54 |
| *Gudulur* | | | 60 |
| *Mudumalai TR* | | | 294 |
| *Satyamangalam TR* | | | 772 |
| *Erode* | | | 113 |
| *Srivilliputhtur WLS* | | | 74 |
| *Tirunelveli* | | | 70 |
| *Kalakad Mundanthurai TR* | | | 58 |
| *Anamalai TR* | | | 237 |
| Dindigul | | | 8 |
| Kodaikanal | | | 19 |
| Megamalai | | | 27 |
| Kanniyakumari | | | 14 |
| Tirupattur | | | 1 |

## 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 (Table 22). These elephants have moved in recent times from Karnataka into Maharashtra.

Table 22: Elephant population estimated for Maharashtra

| Maharashtra | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| | | | 6 |

## 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 (Table 23).

Table 23: Elephant numbers estimated for Andhra Pradesh

| Andhra Pradesh | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| | | | 65 |
| Chittoor West | | | 30 |
| Tirupati | | | 24 |
| Srikakulam Division | | | 4 |

## Andaman & Nicobars

Feral elephants are found on Interview Island and Diglipur Forest Division in northern Andamans. The indirect (dung) count method was employed in Interview Island, and direct count method in Diglipur. Dung density was estimated based on line transects, and an exclusive dung decay rate experiment carried out in Interview Island. This translates into an elephant density of 0.14 elephants/km$^2$ and a population of 19 elephants in Interview Island. In addition, 6 elephants were counted in Diglipur (Table 24).

Table 24: Elephant population estimated for Andaman Islands

| Andaman Islands | Elephant density/km$^2$ | Elephant distribution area in km$^2$ | Elephant Population |
|---|---|---|---|
| | | | 25 |
| Interview Island | 0.14 | 133 | 19 |
| Diglipur | | | 6 |

Elephant population estimates over the past decade (2007-2017)

| State | 2007 | 2012 | 2017 |
|---|---|---|---|
| | | | *Northeast Region* |
| *Arunachal Pradesh* | 1690 | 890 | 1614 |
| *Assam* | 5281 | 5620 | 5719 |
| *Meghalaya* | 1811 | 1811 * | 1754 |
| *Tripura* | 59 | 59 | 102 |
| *Nagaland* | 152 | 212 | 446 |
| *North Bengal* | 325-350 | 647 | 488 |
| *Manipur* | | | 9 |
| *Mizoram* | | | 7 |
| | | | *East Central Region* |
| *Odisha* | 1862 | 1930 | 1976 |
| *Jharkhand* | 624 | 688 | 679 |
| *Chhattisgarh* | 122 | 247 | 247 |
| *Bihar* | | | 25 |
| *Madhya Pradesh* | | | 7 |
| *South Bengal* | | | 194 |
| | | | *Northwest Region* |
| *Uttarakhand* | 1346 | 1346 * | 1839 |
| *Uttar Pradesh* | 380 | 291 | 232 |
| *Haryana* | | | 7 |
| *Himachal* | | | 7 |
| | | | *Southern Region* |
| *Karnataka* | 4035 | 5648-6488 | 6049 |
| *Kerala* | 6068 | '5942-6422 | 3054 |
| *Maharashtra* | 7 | 4 | 6 |
| *Andhra Pradesh* | 28 | 41 | 65 |
| *Andaman &Nicobars* | | | 25 |
| *Tamil Nadu* | 3867 | 4015 | 2761 |
| *Total* | 27657-27682 | 29391 - 30711 | 27312 |

1. Uttarakhand and Meghalaya did not carry out elephant population estimation in 2012 and therefore only the 2007 results have been reported.
2. Karnataka's elephant population estimates for 2012 reflect the direct count (5648) as the lower estimate and the indirect dung count (6488) as the upper estimate.
3. Kerala's figures of 6068 elephants in 2007 and 5942-6422 for 2012 are based on the indirect dung count method. The estimate from the direct count method for 2012 was only 2735 elephants. It cannot be therefore inferred that the elephant population of Kerala has declined since 2012.

# Appendix 1:

## Sample block count method

Sample block count involves direct sighting of elephants by the survey team in each selected block and is conducted simultaneously across different regions of India 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 during 2012 that indicated maximum detection probability for the above range of block areas. 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. It should be noted that block size would be approximate as there are no boundary markers to separate them in the field though the area was marked on maps using natural features such as streams, ridges and roads. In each block, two to three personnel 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 and making sure all elephants detected were counted and, if possible, age-sex classified.

**Data Analysis:** Data collected from the field exercise includes details of number of elephants counted ($y_i$), the area sampled ($x_i$) and total area of the division ($X_i$). Estimates of variance for sample blocks of unequal sizes are provided in Caughley (1977) and by Indian Statistical Institute in Lahiri-Choudhury 1991. The variance estimates for the 2017 census have not been calculated because of incomplete information received from some of the states. This would be provided in future reports.

## References:

Caughley, G. 1977. Analysis of Vertebrate Populations, Wiley, New York.

Lahiri-Choudhury, D.K. 1991. In: Proceedings of a workshop for censusing elephants in forests. Asian Elephant Research and Conservation Centre, c/o CES, IISc, Bangalore.

Varma, S., and Sukumar, R. 2012. The Asian Elephant in Uttarakhand: Population Distribution and Status; Estimation of Elephant Population and its Distribution between the Yamuna and Sarada Rivers in Uttarakhand, Asian Nature Conservation Foundation (ANCF), Innovation Centre, Indian Institute of Science, Bangalore & Uttarakhand Forest Department (UFD), No 5, Chandrabani, Dehradun, Uttarakhand-248001.

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