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Mortality Patterns of Asian Elephants in Odisha, Eastern India

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Abstract. We examined data on elephant mortality from the year 2001 to 2018. Elephant deaths greatly increased over the last eight years. From 2001–2018, 1061 elephants died in 943 incidents with an average of 58.94% deaths per year. Elephant deaths peaked in winter and mostly occurred outside protected areas in human dominated landscapes. Disease was the major cause of death, followed by accidents and unknown reasons. The highest mortality was in the age class 21–40 years while 58.15% of deaths were of individuals less than 20 years.

Introduction

Human-elephant conflict, ivory poaching, habitat loss and fragmentation of natural habitats are the major threats to elephants in India (Baskaran *et al*. 2011). Human-induced mortality is a major factor affecting many threatened species. Mortality caused by poaching, poisoning, accidents, disease, electrocution etc. can seriously affect elephant populations, because elephants have low reproductive rates, low densities and limited distribution (Sukumar 2006). Each year, nearly 400 people and 100 elephants are killed in conflict related incidents in India (Rangarajan *et al*. 2010).

Asian elephants (*Elephas maximus*) are categorised as endangered (IUCN 2021), listed on Appendix I of CITES and in Schedule I of the Indian Wildlife (Protection) Act, 1972. The state of Odisha supports a relatively stable population of elephants (Sar & Varma 2004). As per the elephant census of 2017, there were 1976 wild elephants consisting of 344 tuskers (males), 1092 females, 38 whose sex could not be determined due to poor visibility and 502 calves, in the state (Palei & Rath 2017). The elephant population of Odisha represents about 72% of the population in eastern India and 7% of the Indian population (Palei 2017).

The intent of this study was to document the elephant deaths and causes of death in Odisha.

Methods

Study area

Odisha is situated in south-eastern India between 17º 47' to 22º 34' N latitude and 81º 22' to 87º 29' E longitude (Fig. 1). It has a geographic area of 155,707 km^2, with a forest cover of 51,345 km^2, which constitutes 28.78 % of the state. The state of Odisha consists of 30 districts and 52 forest divisions. The human density of the state is 269 per km^2 (Anon. 2011). Three seasons could be differentiated, summer (March to June), monsoon (July to October) and winter (November to February). Most of the precipitation occurs during the monsoon season, and the annual average rainfall is 1451 mm. The temperature varies between 2ºC in winter to 45ºC in summer. The majority of the people are farmers. The principal crop is rice, which is mainly cultivated in the monsoon season.

Data collection

Data on elephant deaths were obtained from Odisha Forest Department records from 2001 to 2018 and reports from office of the Principal Chief Conservator of Forest (Wildlife) & Chief Wildlife Warden, Government of Odisha, Bhubaneswar. Field visits were carried out from July 2016 to July 2018 in 28 districts, to verify data by conducting informal interviews with

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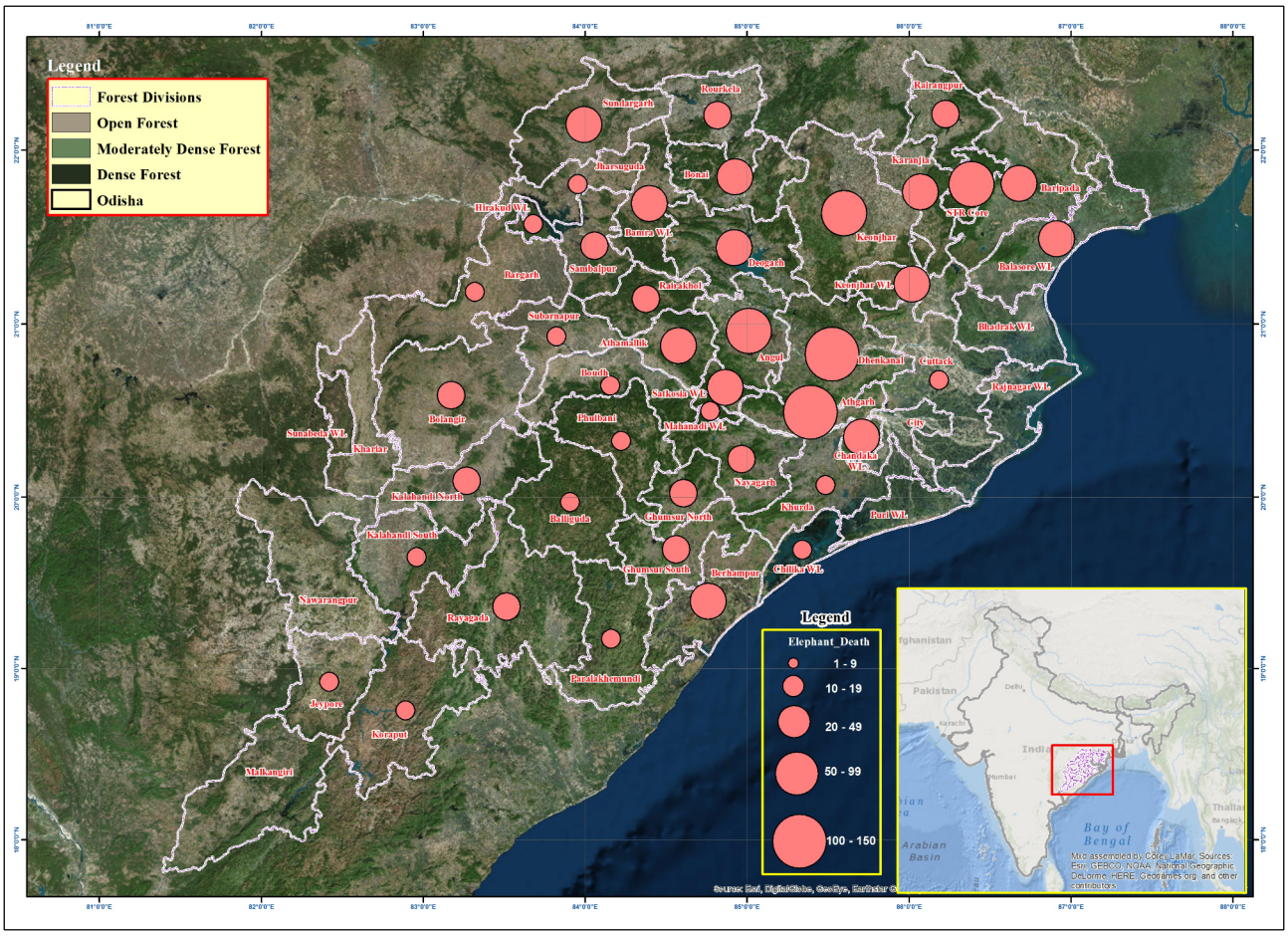

Figure 1. Map showing elephant deaths from 2001–2018 by Forest Divisions of Odisha.

government officials, local people and community leaders.

Classification of elephant mortality

Disease: Diseases such as tuberculosis, haemorrhagic septicaemia, foot and mouth disease and anthrax.

Natural death: Death on account of old age.

Poaching: Elephant death by shooting with guns or bows and arrows for ivory trade.

Electrocution: Electrocution can be accidental or intentional. Accidental incidents were caused by elephants coming into contact with energy transmission lines passing through forest areas. Deliberate electrocution of elephants was due to connecting main grid power to fences around crop fields.

Poisoning: Elephant death due to accidental consumption of insecticides or due to people poisoning vegetables, water holes and saltlicks targeting elephants.

Accident: Road and train accidents, falling from hilltop, falling into wells etc. and being struck by lightning.

Unknown reason: Decomposed/undetermined due to late detection.

Results

From 2001 through 2018, 1061 elephant deaths were recorded. The average number of deaths per year was 58.9 ± 19.0, range 20–85. The highest number of deaths occurred in 2016 (Fig. 2). The average number of annual elephant deaths from 2001–2009 was 46.00 ± 15.64 and from 2010–2018 it was 71.88 ± 12.17 ($P = 0.0015$).

In 75.8% of incidents the number of elephants dying was one, while the deaths of two (18.7%) and three (5.4%) elephants were also recorded.

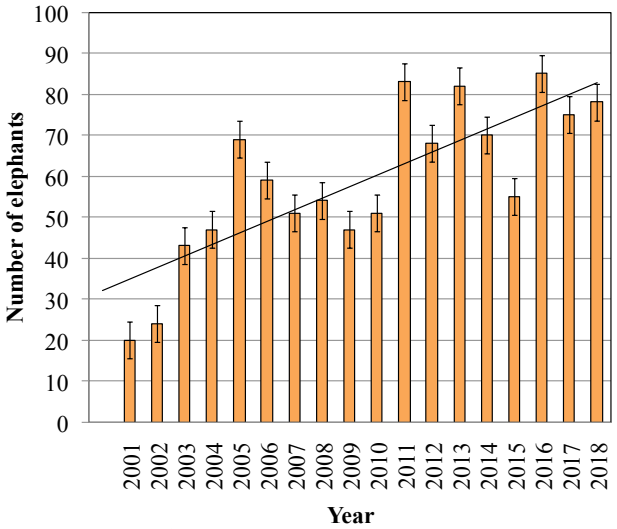

Figure 2. Annual elephant deaths in Odisha from 2001 to 2018.

The majority of deaths occurred while elephants were raiding crops in agricultural areas (35.2%), followed by sanctuaries (23.2%), village areas (18.5%), reserve forest (15.5%), and close to highways (5.4%) and railway lines (2.3%).

A total of 397 (37.4%) deaths were recorded in winter. The month with the highest deaths was December (n = 120, 11.3%, P = 0.00051).

During last eighteen years 246 (24%) elephant deaths were reported in 11 out of 19 protected areas in Odisha. Similipal had the highest number with 82 elephant deaths, while Satkosia Wildlife Sanctuary had 39 deaths, Kuldiha Wildlife Sanctuary 29 deaths, Khalasuni and Badrama Wildlife Sanctuary 26 deaths, Chandaka Wildlife Sanctuary 25 deaths, Hadgarh Wildlife Sanctuary 24 deaths, Kotgarh Wildlife Sanctuary 8 deaths, Karlapat Wildlife Sanctuary 4 deaths, Lakhari Valley Wildlife Sanctuary 4 deaths, Baisipalli Wildlife Sanctuary 4 deaths and Debrigarh Wildlife Sanctuary 1 death.

Division wise the highest was 134 deaths in the Dhenkanal Forest Division followed by Athgarh Forest Division with 119 and Keonjhar Forest Division with 91 deaths.

Disease was the commonest cause of death (n = 277, 26.1%), followed by accidents (n = 169, 15.9%), unknown (n = 167, 15.7%), electrocution (n= 160, 15.1%), natural (n = 143, 13.5%), poaching (n = 128, 12.1%) and poisoning (n = 17, 1.6%) (Fig. 3).

Electrocution

The 160 electrocution deaths occurred in 118 incidents, out of which 34 (21.0%) were deliberate killing by poachers for tusks. Elephant mortality due to electrocution varied seasonally and was highest in winter, with 51.9%, followed by monsoon 28.1% and summer 20.0% ($F_{2,51}$ = 1.455, P = 0.243). The mean annual mortality due to electrocution was 8.8 ± 4.11 elephants, with the highest number of 18 recorded in 2011.

Train accidents

A total of 20 elephant deaths (2% of total deaths) were due to train accidents and they occurred in 14 incidents. The dead elephants comprised of 4 adult males, 12 adult females, 3 male calves and 1 female calf. Of these, 11 deaths occurred in 2012.

Age and sex specific mortality

Of the dead elephants, infants comprised 20.75%, juveniles 10.00%, sub-adults 12.72%, young-adults 14.70%, mature-adults 29.96%, post prime age 6.32%, old age 3.68% and very old age 1.89%.

Age specific elephant deaths are given in Table 1.

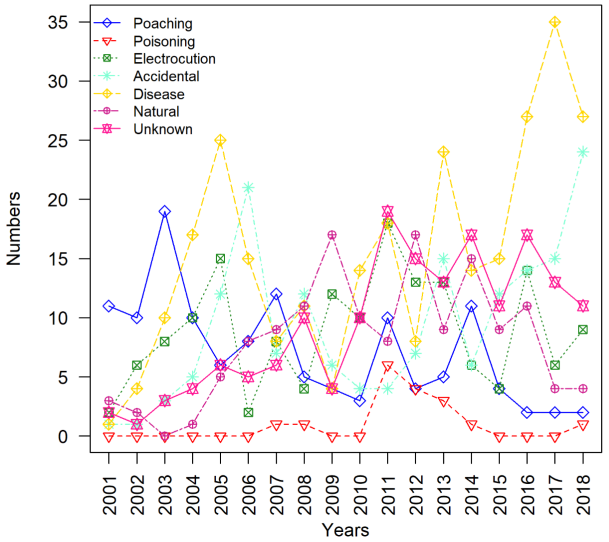

Figure 3. Elephant deaths by cause in Odisha from 2001 to 2018.

Table 1. Age specific mortality of elephants in Odisha from 2001 to 2018.

Age class	Age (in years)	Males		Females		Total	
		n	%	n	%	n	%
Infant	0–4	108	22.27	112	19.44	220	20.75
Juvenile	5–9	52	10.72	54	9.38	106	10.00
Sub-adult	10–15	59	12.16	76	13.19	135	12.72
Young-adult	16–20	71	14.64	85	14.76	156	14.70
Mature-adult	21–40	139	28.66	179	31.08	318	29.96
Post prime	41–50	33	6.80	34	5.90	67	6.32
Old	51–60	12	2.47	27	4.69	39	3.68
Very old	61–80	11	2.27	9	1.56	20	1.89
Total		485	100	576	100	1061	100

Discussion

We found that the number of annual elephant deaths in Odisha increased over the study period with the rate increasing by more than 50% between the first half of the study period and the second half. Possible contributory factors are the increase in human population in Odisha from 3.67 million in 2001 to 4.19 million in 2011 (Anon. 2011), with an associated increase in habitat fragmentation, loss and degradation due to development and encroachment. Comparable increase in elephant deaths has also been reported from Tamil Nadu (Davidar *et al*. 2015). The increase in deaths over time has been higher in Sri Lanka, with a death rate of 61 from 1951–1969 (Santiapillai 1994) and 263 from 2010–2019 (Prakash *et al*. 2020).

The present study found an annual death rate of 59 from 2001–2018 in Odisha. Annual death rates reported in some of the other states of India include, Arunachal Pradesh 4 (in 2010), Assam 6 (1993–2010), Meghalaya 6 (1994–2011), Karnartaka 87 (1990–2010), Uttarakhand 16 (1990–2011), West Bengal 22 (2000–2011), Kerala 32 (1990–2010) and Tamil Nadu 71 (2001–2011) (Arora 2015). Annual elephant death rate in Nilgiri from 1979–2011 was 9 (Davidar *et al*. 2015).

A total of 61.1% of elephant deaths in Odisha from the year 2001–2018 occurred outside forest areas during crop harvesting season. This was mainly because there were extensive agriculture areas adjacent to the forest areas.

The majority of elephant deaths took place during the winter season (37.4%) with a peak in the month of December, which is the winter crop harvesting period. Similarly, in higher mortality was recorded during harvesting time in Sri Lanka (Haturusinghe & Weerakoon 2012).

Elephant deaths due to poaching in Odisha were for ivory. Poaching for meat or hide has not been recorded. Therefore all elephants killed by poachers were males. Ivory poaching is wide spread where substantial proportions of male elephants are tuskers and has been very high in southern India (Sukumar 1989).

Palei *et al*. (2014) reported that an average of 9.8 elephant deaths occurred annually due to electrocution in Odisha. Arivazhagan & Ramakrishnan (2010) reported that in Tamil Nadu more than 50% of elephants died due to electrocution and all such elephants were in the age category of 15–25 years and were males.

The very old age group of elephants (61–80) accounted for 1.9% of deaths during the study period. Of the 20 elephants in this age group, 11 were males and 9 were females. Therefore only 2.3% of the males and 1.6% of the females had lived their full lives. Singh & Arora (2004) reported that in Kaziranga National Park, average elephant survival age in males was 41.3 years and for females was 38.7 years.

While there is a lack of information as well as proven methods for reducing elephant mortality, minimising habitat destruction, increasing

public awareness and strong law enforcement may reduce elephant deaths and ensure their long-term survival.

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