Short Communication

Mortality of the Endangered Asian elephant *Elephas maximus* by electrocution in Odisha, India

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Abstract Elephants are threatened globally by habitat loss, poaching and accelerating levels of human–elephant conflict. In the state of Odisha, east India, electrocution by domestic electric power lines is causing mortality of the Asian elephant *Elephas maximus*. We collated data on elephant mortality from such electrocution in the villages surrounding elephant habitat for a period of 12 years (2001–2012). During this period 118 elephants were killed in 91 incidences. Most deaths (73.68%) were a result of accidental contact with electric power lines whilst elephants were moving into agricultural areas for crop raiding. The increasing human population, poor electrical infrastructure and ivory poaching pose serious threats to the continued survival of these elephants. To reduce elephant mortality from electrocution and to ensure the long-term survival of this population of elephants we recommend strengthening of the electrical infrastructure, minimizing habitat destruction, increasing public awareness of the problem, and stronger law enforcement.

Keywords Electrocution, elephant, *Elephas maximus*, human–elephant conflict, India, Odisha

Human-induced mortality has been identified as a major factor affecting threatened species (López-López et al., 2011; Seshadri & Ganesh, 2011; Palazón et al., 2012). This includes mortality arising from the development and expansion of power grids (Sundar & Choudhury, 2005; Guil et al., 2011; López-López et al., 2011; Lucas et al., 2012). Although overhead electric power lines are known to be one of the factors causing the decline of the Asian elephant *Elephas maximus* (Gubbi, 2009), there are few studies in India that address this problem.

The Asian elephant is categorized as Endangered on the IUCN Red List (Choudhury et al., 2008), and listed on Appendix I of CITES (CITES, 2013) and Schedule I of the Indian Wildlife (Protection) Act, 1972. Habitat loss, fragmentation and illegal killing for ivory are believed to be the main causes of the decline of this species (Sukumar, 2006). The state of Odisha supports the largest population (c. 1,930 elephants) in central India (Elephant census report 2012, unpubl. data). The aim of our study was to examine the degree to which electrocution is a significant cause of elephant mortality in Odisha, which has an area of 155,707 km^2 of which forest covers 58,136 km^2.

In 2011 the total human population of Odisha was 41,974,358, with a density of 269 km^{-2}, the majority of whom (80%) are rural (Anon., 2011). The principal crop is rice, mainly cultivated in the monsoon (July–October) and harvested from October to December. Most precipitation falls during the monsoon, with a mean annual total rainfall of 1,451 mm; temperatures range from a minimum of 2 °C in winter to a maximum of 45 °C in summer (Anon., 2012). There are two types of power lines in the state. Supply power lines consist of two parallel wires at a height of 5.5 m, carrying 220–440 volts. High-tension power lines consist of three sets of parallel wires, with the lowest set at a height of 6.5 m, carrying 11,000–44,000 volts (Odisha Electricity Regulation Commission, Bhubaneswar, pers. comm.). The network of above-ground power lines has increased in the last 30 years, accompanied by an increase in infrastructure, including roads, canals, railway lines and power generation and distribution facilities (Dash & Sangita, 2011).

We searched local and English language media sources and reports of government and non-governmental organizations for information on elephant deaths from electrocution during a 12-year period (2001–2012). All data were verified by visits to sites and by conducting informal interviews with government officials, local people and local community leaders.

Mortalities were coded by location (categorized into four broad habitat types: agricultural areas, reserve forests, sanctuaries and near highways), time of death and information on the age and sex of the elephants. Mortalities from power lines were categorized into intentional and unintentional electrocution. Intentional describes an elephant killed by a power line used to protect a crop field, or for poaching. The technique used for such killing consists of a wire, with an insulated rod or dry bamboo cane, attached to a high-tension power line running through a known

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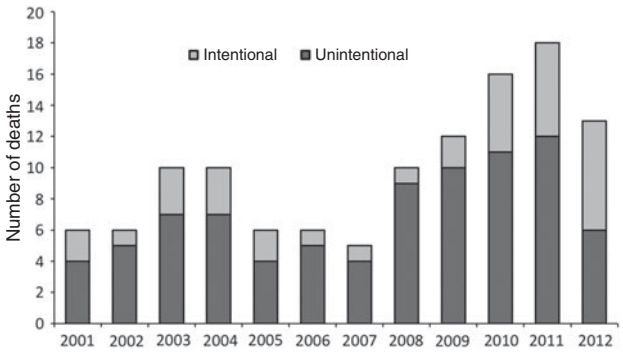

FIG. 1 Annual number of elephant *Elephas maximus* deaths by intentional and unintentional electrocution (see text for further details) in the state of Odisha, India, from 2001 to 2012.

elephant path. The wires are secured at the approximate chest height of an elephant, and the animal normally dies instantly.

We collated reports of a total of 118 elephants killed in 91 incidences of electrocution during 2001–2012, in 28 of 30 elephant range districts in Odisha. The mean annual mortality was 9.8 ± SD 4.2 elephants, with a maximum of 18 deaths in 2011 (Fig. 1). Of these 91 incidences, 34 (37.4%) were intentional electrocution by poachers. In 48 cases the time of the incidence was available, and 44 incidences (91.7%) occurred during the night. Mortality varied seasonally, with the highest mortality in the monsoon (59.3%), followed by winter (November–February, 26.4%) and summer (March–June, 14.3%). The greatest number of electrocutions (62.6%) were recorded when crops were being harvested (October–December). The majority of mortalities occurred while the elephants were in agricultural areas (75.8%), followed by reserve forests (18.7%), sanctuaries (3.3%) and close to highways (2.2%). Most electrocutions were of lone elephants (75.8%), although groups of two (18.7%) or three (5.49%) elephants were also electrocuted. Of the 118 recorded deaths 68 were males (66 adults, two juveniles) and 50 females (49 adults, one juvenile).

The increase in the number of elephants killed by electrocution (Fig. 1) is probably related to the increase in the human population of Odisha, which rose from 3.67 million in 2001 to 4.19 million in 2011 (Anon., 2011). The growth of the human population has led to encroachment on elephant habitat, forcing elephants to move into agricultural fields to forage (Gubbi, 2009), particularly during the harvest period, when raiding by elephants is most common (Sar & Lahiri-Choudhury, 2006).

When an elephant continuously raids a crop the local community may deliberately kill it using an electric power line, poisoning or a firearm. Gubbi et al. (2014) also reported electrocution of elephants on farms in the state of Karnataka. In addition, the financial lure has caused some local people to turn to elephant poaching. The current management strategy attempts to address poaching by taking action under the Indian Electricity Act, 2003, and Indian Wildlife (Protection) Act, 1972. The state forest department has taken steps to reduce the electrocution of elephants by collaborating with the state energy department to improve electrical infrastructure in elephant habitats. There are plans to increase the height of high-tension power lines, provide earth-leakage circuit breakers in forested areas and clear vegetation on both sides of power lines.

To prevent electrocution of elephants we recommend several strategies. Joint patrolling in high-risk agricultural and forest areas by forest department staff and participatory programmes involving NGOs and local communities could reduce mortality from electrocution. The relevant authorities could tackle poaching by electrocution through gathering and sharing intelligence between forest departments and law enforcement agencies. Where feasible, the electricity supply could be interrupted during the night in high-risk areas, with the cooperation of local people and the local administration. In remote high-risk areas alternative power sources such as solar panels could be installed. Guard spikes could be added to electric poles at suitable heights, to discourage rubbing by elephants, and there needs to be monitoring of damage to electrical infrastructure. We support the recommendation of Rangarajan et al. (2010) for greater use of low-tension electric wires and increasing the height of high-tension power lines through elephant habitats. Local communities could be encouraged to cultivate less palatable species near electric power lines. Securing the goodwill, trust and support of the local communities residing near elephant habitats could be ensured by adoption of simple and rapid compensation schemes, community insurance schemes, awareness programmes and provision of enhanced alternative livelihood options.

We have communicated these recommendations to the forest department. Such measures, either singly or in various combinations, depending on the local situation, would help reduce elephant mortality by electrocution from power lines.

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References

ANON. (2011) *India 2011. A Reference Manual*. Publications Division, Ministry of Information and Broadcasting, Government of India, New Delhi, India.

https://doi.org/10.1017/S003060531400012X Published online by Cambridge University Press

Anon. (2012) *Statistical Handbook 2012*. Directorate of Economics and Statistics, Government of Odisha, Odisha, India.

Choudhury, A., Lahiri Choudhury, D.K., Desai, A., Duckworth, J.W., Easa, P.S., Johnsingh, A.J.T. et al. (IUCN SSC Asian Elephant Specialist Group) (2008) *Elephas maximus*. In *IUCN Red List of Threatened Species v. 2013.2*. Http://www.iucnredlist.org [accessed 2 April 2014].

CITES (2013) *Convention on International Trade in Endangered Species of Wild Fauna and Flora. Appendices I, II and III*. Http://cites.org/eng/app/appendices.php [accessed 25 June 2014].

Dash, B.C. & Sangita, S.N. (2011) *Governance Reforms in Power Sector: Initiatives and Outcomes in Orissa*. The Institute of for Social and Economic Change, Bangalore, India.

Gubbi, S. (2009) Elephant deaths due to electrocution: a consequence of inappropriate habitat management? *Oryx*, 43, 326–327.

Gubbi, S., Swaminath, M.H., Poornesha, H.C., Bhat, R. & Raghunath, R. (2014) An elephantine challenge: human–elephant conflict distribution in the largest Asian elephant population, southern India. *Biodiversity Conservation*, 23, 633–647.

Guil, F., Fernandez-Olalla, M., Moreno-Opo, R., Mosqueda, I., Gómez, M.E., Aranda, A. et al. (2011) Minimising mortality in endangered raptors due to power lines: the importance of spatial aggregation to optimize the application of mitigation measures. *PLoS ONE*, 6(11), e28212.

López-López, P., Ferrer, M., Madero, A., Casado, E. & McGrady, M. (2011) Solving man-induced large-scale conservation problems: the Spanish imperial eagle and power lines. *PLoS ONE*, 6(3), e17196.

Lucas, de L., Ferrer, M., Bechard, M.J. & Muñoz, A.R. (2012) Griffon vulture mortality and wind farms in southern Spain: distribution of fatalities and active mitigation measures. *Biological Conservation*, 147, 184–189.

Palazón, S., Melero, Y., Gómez, A., De Luzuriaga, J. L., Podra, M. & Gosàlbez, J. (2012) Causes and patterns of human-induced mortality in the Critically Endangered European mink *Mustela lutreola* in Spain. *Oryx*, 46, 614–616.

Rangarajan, M., Desai, A., Sukumar, R., Easa, P.S., Menon, V., Vincent, S. et al. (2010) *Gajah–Securing the Future for Elephants in India*. The Report of the Elephant Task Force, Ministry of Environment and Forests, New Delhi, India.

Sar, C.K. & Lahiri-Choudhury, D.K. (2006) Man–elephant conflict: the Keonjahr (Orissa) experience. *Journal of the Bombay Natural History Society*, 103(2–3), 286–293.

Seshadri, K.S. & Ganesh, T. (2011) Faunal mortality on roads due to religious tourism across time and space in protected areas: a case study from south India. *Forest Ecology and Management*, 262, 1713–1721.

Sukumar, R. (2006) A brief review of the status, distribution and biology of wild Asian elephants. *International Zoo Yearbook*, 40, 1–8.

Sundar, K.S.G. & Choudhury, B.C. (2005) Mortality of sarus cranes (*Grus antigone*) due to electricity wires in Uttar Pradesh, India. *Environmental Conservation*, 32, 260–269.

Biographical sketches

Nimain Charan Palei is studying human–elephant conflict management and implementation of corridor management for safe passage of elephants between fragmented habitats. For the past 5 years he has been studying elephant migration to Odisha from the neighbouring states of Jharkhand and West Bengal. Himanshu Shekhar Palei has a particular interest in mammalian population dynamics and human–animal conflict. Bhakta Padarbinda Rath is responsible for database management, censusing and website management for improved conservation of elephants in Odisha. Chandra Sekhar Kar was involved for 35 years in wildlife research, monitoring and conservation activities in Odisha. He passed away in April 2014.

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