elephants alive!

Science & Survival

Report on the development of a field collection strategy for the long-term sighting/resighting methods used as output in mark-resighting models

2014

by
Michelle Henley
(PhD)

MANAGEMENT SUMMARY

No studies, to our knowledge, have used mark-resighting models to estimate population size in an expanding open system as large and over as long period as this study, strategic approaches need to be evaluated and adapted over time. However, 'robust designs' have been described as ideal for long term studies where population size and density can be estimated for each season (e.g. annually) using closed model data and combining this with open model data across seasons to obtain a reliable understanding of elephant population dynamics (Karanth et al. 2012a). With highly mobile species within open systems, a situation arises where sampling cannot easily be divided into distinct sampling occasions where individuals can only be seen once (Cooch & White 2013). Hence sampling occurs with replacement. In this study sampling also occurred on a continuous basis from 2003 until January 2014 which does not represent standard practice but is a newly developing requirement for current mark-resighting models. Thereafter field days occurred once a week in agreement with the chairman and while in consultation with experts on mark-resighting models.

Prof. Jason Marshal from the University of the Witwatersrand will by means of mathematical modelling and as his proposed sabbatical for 2015, derive abundance and density estimates for age-specific elephant categories using the historical 10 year dataset. He will also provide advice in consultation with other experts in the field, on the planning and testing of optimal field strategies for the years to come.

The following additional capture methodologies (re-sighting) are recommended for investigation of future re-sighting strategies and for comparison with the continuous re-sighting methodology currently used:

Option 1
Traversing of a set route throughout the APNR over a four day period (for each of the reserves) on a monthly basis. The concern would be the movement of elephants between reserves between days, the changes in visibility with a change in season and accounting for a difference in activity patterns and hence sightability of elephants at different times of the day while traversing the routes. This methodology has been documented in past " capture" studies and has literature reference for study.

Option 2
Spending intense sampling periods at strategic waterholes located within particular vegetation types in each of the reserves together with setting up camera traps to get an indication of what proportion of nocturnal sightings are being missed. Constraints would be sufficient manpower and man hours to conduct the surveys simultaneously at the different waterholes. This option is unfortunately a financially expensive model and a funding source will have to be found for the payment of staff to carry out this method, before it can be included in the study.

The above two options will, over time, be compared with the results obtained from continuous data collection methods. Mathematical modelling adaptations of the Robust models in the "Mark - 2013" statistical software will probably be used as the statistical software of choice, as the "Mark" software currently represents the most up-to date modelling software available (Cooch & White 2013). The resulting studies will be used to determine if there are differences in the different collection methodologies.

INTRODUCTION

Repeated mark-resighting surveys have proved to yield population trends for closed populations of elephants or in situations where all elephants are known (Whitehouse & Hall-Martin 2000; Moss 2001; Morley & Van Aarde 2006). Once established, closed populations of elephants have required three to four resighting surveys per year to sufficiently monitor population size with narrower confidence intervals than aerial census results (Morley & Van Aarde 2006). Acoustic surveys have also been employed to obtain population estimates of abundances for elephants in remote areas and diverse habitats (Thompson et al. 2009). Irrespective of the technique employed, capture-recapture models have proved to have the following advantages above other wildlife monitoring approaches:

(1) They provide powerful tools that address and quantify imperfect detection squarely instead of ignoring it.
(2) Estimation methods have a long-established theoretical basis that has undergone extensive validation via simulation and field studies on a variety of species.

Hence capture-recapture models have been strongly recommended to monitor elephant population size, trends and ecology (Karanth et al. 2012a). Individual identification studies of elephants in conjunction with age distribution data can been used to indicate population health and the effects of exposure to hunting or poaching pressure over time (Goswami et al. 2007; Turkalo 2013, Turkalo et al. 2013). This report serves as an introduction to the methods that were used in the collection of the historical data and the development of a field strategy after examination of the historical data collected over the past decade.

METHODS

Individual identification

Individual identification records of sighted animals (bulls and cows) were recorded by collecting detailed photographs based on unique patterns of tears, nicks, holes and veins in the ears of all elephants encountered when searching for collared elephants on a rotational basis throughout the APNR. An encounter was defined as an occasion where the observer had sufficient time to take clear photographs of one ear and the frontal nose pattern, the frontal nose pattern only under optimal lighting conditions or both ear outlines together or without the frontal nose pattern, for identification purposes. The method of using individual physical features of ear patterns in combination with any other feature such as scars to the body, tail hair features and tusk shapes, are well established and have been employed by various studies throughout Africa (Douglas-Hamilton 1972, Croze 1974, Jachmann 1980, Whitehouse & Hall-Martin 2000, Moss 2001, Wittemeyer 2001, Turkalo et al. 2013).

Photographs were also collected of the frontal line patterns of the face from the base of the tusks to the forehead to make allowance for individual identification via pattern recognition software which is currently being developed and tested. Where field photos were collected during suitable lighting conditions and the aspect of the elephant frontal view was considered appropriate, wrinkle patterns of the face were extracted to slowly build up an individual elephant identification library using the pattern recognition software (Conservation Research Ltd.; Extract Compare V1.18, Cambridge; L. Hiby 2011). With time and the extension of the facial line-pattern library, the software was also used to call up the closest match of a newly photographed individual but final checks were still confirmed via the manual method while the software is under development.

The date, time and GPS location of each sighting was noted in addition to the group size, social context, the reaction index of the animal to the researcher as well as the reproductive status of bulls (musth or non-musth). Drawings were made of each individual elephant based on the photographs collected in the field. All photos taken in the field of individual elephants were manually compared with a library of elephant drawings to find the drawing with the closest match. A potential match was then double-checked by comparing the photographs of the newly found individual with those kept in the photo library of a specific individual. Only if the library photographs confirmed a match between a library drawing and a newly photographed individual, was the encounter of a particular individual recorded as a resighting. All bulls were categorised into various age categories (Appendix 1) by using a combination of characteristics based on size, physical development, eruption of tusks, the length and circumference of the tusks and body shape and proportions (Moss 1996, Poole 1987, Henley 2012).

For the study period December 2002 until August 2014 a total of 9690 individual encounters with either bulls or a breeding herd were made. These exclude sighting information obtained from landowners or other interested parties. Over the years 1516 breeding herds sightings have been recorded of which 8% of the breeding herds still need to be identified to known herd level. Bulls have been encountered 8174 times with 39% of the individuals encountered, still requiring identification. Overall bulls were encountered far more frequently than breeding herds (84:16).

DEVELOPMENT OF A FIELD COLLECTION STRATEGY

The established methods of elephant identification will remain the same. However, a new cost effective strategy will be developed to collect elephant identikits in the years to come. Various mark-resight models are available for estimating population size. Each model has certain assumptions associated with its use. A general assumption applicable to all models is that the subset of the population selected for marking is representative of the entire population in terms of resighting probabilities. Furthermore, marks themselves must not affect sightability. Standard practices with mark-resighting models involve marking (making of ID drawings in this instance or adding facial wrinkles to the software library) individuals prior to sampling with subsequent sampling consisting of discreet sighting surveys.

In this study we can make use of two ‘marked’ subsets of the population to arrive at overall population estimates which would account for emigration and immigration into the APNR. Firstly, we can use the smaller subset of individuals with GPS tracking collars to provide information on movement patterns which could be incorporated or provide background information on emigration patterns of the larger sample size of individually identified elephants during model predictions. Analysis of GPS radio collared individuals clearly showed that once collared, they could move out of the study area for set periods of time, depending on their age group. Furthermore, collared elephants’ movements indicated that only one out of 34 individuals that were originally collared had not returned to the APNR on an annual basis. Four out of five other individuals did not return to their capture site due to death outside of the APNR whilst one of these individuals’ collars was retrieved outside of the reserve before battery failure. Hence permanent emigration from the study site appears to be minimal but models that incorporate temporary immigration and emigration are required in the analysis as geographic closure could not be assumed. Any model developed to arrive at estimates of abundance and density for elephants in particular age categories would therefore need to consider that:

- The population is not geographically closed. Certain restricted scenarios under which robust design models can accommodate movement in and out of the study area will need to be applied (Kendall et al. 1997)

- Primary sampling sighting occasions exist which can be taken to be annual events from 2003 until 2013.
- Estimates are needed for the population actually within the study area during the period of interest (APNR) so secondary sampling periods could concentrate around the times at which annual aerial census is conducted and the results compared (late dry season of each year).
- Alternatively intense secondary sampling sighting occasions could correspond to seasons within each year i.e. early dry-season (April-June), late-dry season (July-September), early wet-season (October-December) and late wet-season (January-March).
- Estimates of the super population (N^*) within the greater study area would also be of interest. These data would depend on aerial counts conducted by the Kruger National Park.
- Individuals could move freely in and out of the study area under consideration (APNR) between secondary occasions of each primary interval but intense secondary sighting occasions with limited possibilities of movement need to be planned.
- Sampling without replacement within secondary sampling sessions could be upheld by pooling possible multiple sightings of an individual within short time periods to ensure that a single individual is only sighted once during the sampling occasion.
- Information can be provided on whether or not each marked or identified individual was available for resighting within the study area for each secondary sampling occasion by considering the data obtained from GPS collared individuals.
- Marks (ear patterns and facial wrinkles) are individually identifiable
- New marks may be introduced at any time either during primary or secondary sampling occasions.
- Marks (drawings) themselves have not influenced sightability. Care was therefore taken to not only photograph elephants with characteristic ear patterns, but all elephant bulls present at a sighting and within a certain age bracket were photographed, including individuals with indistinct ear patterns. Upon careful inspection of the photographs taken in the field, unique patterns in the veins of the ears were used to distinguish these particular individuals. It should however be noted that no ear patterns were collected from any individuals younger than five years of age as their distinguishing features were thought to still appear later in life and as these individuals were also not easily sighted within breeding herds compared to the more mature bulls in older age categories.
- The APNR only consisted of Timbavati-, Umbabat- and Klaserie Private Nature Reserves from 2003 until 2006. Thereafter the Balule Private Nature Reserve was incorporated with elephant IDs collected on an *ad hoc* basis by Transfrontier Africa since 2008. Since 2013, Jejane Private Nature Reserve has been incorporated into the APNR with the removal of the fences and elephant IDs have been collected on a regular basis as part of an intern programme. Hence the APNR has increased in size since the study was initiated on a full time basis in 2003.

REFERENCES

Cooch, E.G. & White, G.C. 2013. *Program MARK – a gentle introduction*. Edition 13. New York. 1014pp.

Croze, H. 1974. The Seronera bull problem: I. The elephants. *East African Wildlife Journal* **12**: 1–27.

Douglas-Hamilton, I. 1972. On the ecology and behavior of the African elephant. PhD thesis, University of Oxford.

Henley, M.D. 2012. *Aging elephants – a practical guide.* 17 pp.

Jachmann, H. 1980. Population dynamics of the elephants in the Kasungu National Park, Malawi. *Netherlands Journal of Zoology* **30**: 622–634.

Karanth, K.U., Kumar, N.S., Goswami, V.R., Nichols, J.D. & Hedges, S. 1212b. Estimating abundance and other demographic parameters in elephant populations using capture-recapture sampling: Field practices. Chapter 10. In: *Monitoring Elephant Populations and Assessing Threats-a manual for researchers, managers and conservationists* Ed. Simon Hedges. University Press (India) Private Limited. 354pp.

Karanth, K.U., Nichols, J.D. & Hedges, S. 1212a. Estimating abundance and other demographic parameters in elephant populations using capture-recapture sampling: statistical concepts. Chapter 5. In: *Monitoring Elephant Populations and Assessing Threats-a manual for researchers, managers and conservationists* Ed. Simon Hedges. University Press (India) Private Limited. 354pp.

Kendall, W. L., J.D. Nichols, and J. E. Hines. 1997. Estimating temporary emigration using capture recapture data with Pollock's robust design. *Ecology*, **78**, 563-578.

Morley, R.C & Van Aarde, R.J. 2006. Estimating abundance for a savanna elephant population using mark-resight methods: a case study for the Tembe Elephant Park, South Africa. *Journal of Zoology* 271: 418-427.

Moss, C. 1996. Getting to know a population. In Studying elephants (ed. K. Kangwana), pp. 58-74. Nairobi, Kenya: African Wildlife Foundation.

Moss, C.J. 2001. The demography of an African elephant (*Loxodonta africana*) population in Amboseli, Kenya. *Journal of Zoology* **255**: 145–156.

Poole, J. H. 1987. Rutting behaviour in the African elephants: The phenomenon of musth. *Behaviour*, **102,** 283-316.

Thompson, M.E., Schwager, S.J., Paynei, K.B. & Turkalo, A.K. 2009. Acoustic estimation of wildlife abundance: methodology for vocal mammals in forested habitats. *African Journal of Ecology* 1-8.

Turkalo, A.K. 2013. Estimating forest elephant age. Note and Record. *African Journal of Ecology* 1-5.

Turkalo, A.K., Wrege, P.H. & Wittemyer, G. 2013. Long-term monitoring of Dzanga Bai Forest elephants: forest clearing use patterns. *PlosOne* **8 (12)**: 1-12.

Whitehouse, A.M. & Hall-Martin, A.J. 2000. Elephants in Addo Elephant National Park, South Africa: reconstruction of the population's history. *Oryx* **34**: 46–55.

Wittemyer, G. 2001. The elephant population of Samburu and Buffalo Springs National Reserves. *African Journal of Ecology* **39**: 357–365.

APPENDIX 1

Table 1: Age categories for bulls and behavioural characteristics associated with each category.

Age class	Age category	Broad age class	Age category	Behavioural description
0-4	neonates, yearlings and juveniles			still nutritionally dependent on mother
5-10	sub-adults			nutritionally independent of mother but socially dependent on natal herd
11-15	sub-adults	<15	immatures	nutritionally independent of mother but socially dependent on natal herd
16-20	young adult			becoming socially independent from natal herd, socially dependent on male mentors, no musth
21-25	young adult	15-25	young adults	becoming socially independent from natal herd, socially dependent on male mentors, no musth
26-30	adult		adults	socially independent from natal herd, socially dependent on male mentors, start of musth cycles
31-35	adult	>25-35	adults	socially independent from natal herd, socially dependent on male mentors, start of musth cycles
>35	prime adult	>35-55	prime adults	socially independent from natal herd, male mentor to younger bulls, start of regular, annual musth cycles
>55	senescing adult	>55	senescing adults	Male mentor to younger bulls, musth cycles continue until body condition deteriorates