

SP248 Calculating the carrying capacity of the Pongola reserve for elephant, South Africa

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The 'elephant problem' is one of the foremost conservation issues in southern Africa. Elephants are known as ecosystem engineers because of their ability to shape their habitat; their large size and nutritional demands mean that through trampling paths, seed dispersal and destructive foraging they have the capability to change the structure, composition and distribution of vegetation. The current accepted wisdom is that when elephants become 'over-populated' in an area, their over-utilisation of the resources leads to habitat degradation. Populations of free-ranging elephants and those in fenced reserves reached a level that has caused concern from the 1970s onwards. Researchers and wildlife managers alike have linked the conversion of woodland and thickets to grass-dominated landscapes, and in extreme circumstances desertification, to the growth in elephant populations. Although it is clear that elephants have an impact on their habitat, it is far from clear whether or not this impact is detrimental. However, there is a huge amount of pressure to reduce elephant population sizes because of the perceived 'damage' to habitat, and the subsequent potential effects on biodiversity and ecosystem level processes.

Two issues underpin this conundrum: the regulation of elephant population size by density-dependent factors, and the impact elephants have on their habitat at higher and higher densities before reaching equilibrium levels. The ecological definition of carrying capacity is based on the availability of resources and competition effectively limiting the number of individuals that a given area can sustain. When a population grows beyond this maximum number the resource depletion and competition that ensues leads to population reduction as individuals die, bringing the number of individuals down below the carrying capacity, which then enables the population to begin growing again as resources permit, and the cycle continues. This equilibrium cycle has not been historically recorded in elephant populations, the longevity of elephants and slow growth and maturity makes the collection of long-term population data problematic. The scientific community is hence fairly ignorant of the level at which elephant populations will self-regulate by density-dependent factors. Further to this, there isn't yet any published evidence that survival rates, competition, mortality, body condition or any other potential indicator that populations are above sustainable levels are increasing at the current population levels, despite the fact that these population levels are deemed to be too high in most reserves in South Africa and other parts of southern Africa. Wildlife managers seldom entertain the notion of allowing the populations to reach equilibrium as the perceived level of damage is already causing concern, and the process of reaching equilibrium would mean increasing density and increasing the impact on the habitat. In artificially limited systems, including fenced reserves, the 'do nothing' approach is not deemed to be an optimal option, as the understanding of management is not advanced (van Aarde and Jackson, 2007). The important management issues that arise from this are all based on limiting or mitigating the impacts that elephants have on their habitat, even at below-equilibrium population sizes.

Pongola Game Reserve is a small, fenced, privately owned reserve in Kwa-Zulu Natal, South Africa. It was established in 1993 by the dropping of fences between adjacent farm properties. Elephants were first introduced in 1997, with an original population size of 14 individuals. Subsequent introductions of bull elephants and a break-in in 2000 further increased the population size, and

since then the population has experienced an extremely high growth rate, leading to a current population size of around 73 individuals. The 'carrying capacity' of the Reserve is estimated at 37, so the current population size is double what the Reserve can supposedly sustain. There is no evidence that density-dependence is taking effect – no reduction in body condition aside from normal seasonal fluctuations, and no increase in mortality – and so this calls into question how the carrying capacity was calculated and what factors were deemed to be the priority.

The figure of 0.37 per km² has been postulated as the level above which the elephants of the Kruger National Park would have begun to be regulated by density-dependence (van Aarde *et al.* 1999, cited by Slotow *et al.*, 2007), unfortunately since the moratorium on culling in Kruger densities have reached much higher levels but no data have been recorded on criteria that could indicate the effect of density-dependence, e.g. survival rates. The figure of 0.5 per km² has been postulated as the level at which elephants can convert a savannah woodland to a shrubland (Cummings *et al.*, 1999, cited by Smit *et al.*, 2007), and this is most likely the figure that is used to make a crude estimate of carrying capacity. It is becoming more and more apparent that the distribution of key resources determines the differential use of resources by elephants across a landscape (e.g. Smit *et al.* 2007), and may also be a limiting factor to the growth of elephant populations. The provision of artificial water has altered habitat use patterns by allowing access to areas previously unavailable (Shannon *et al.*, 2009; see van Aarde and Jackson, 2007, for summary). The availability of water and food patches appear to be the primary determinants of elephant distribution (Smit *et al.* 2007). Hence the non-random use of resources by elephants rather than an overall size of the area is a key factor underpinning both sustainable population sizes and the intensity of use that is observed.

There is enormous pressure from the stakeholders in the Pongola Game Reserve to reduce the amount of visible habitat degradation the Reserve is experiencing. This is a common problem that many reserves are experiencing across southern Africa. Anecdotal evidence, including opinions of game rangers in the Reserve, indicates that certain plant species have started to dominate areas that were once much more polyspecific, and these species are those that are less preferred by elephant and other browsing and grazing herbivores (grasses, shrubs and trees). The impact of other herbivores is often overlooked due to the fact that elephant damage is far more visible. Pongola Game Reserve has high densities of species that may be contributing to the homogenization of the habitats, such as warthog, giraffe, black rhino and various antelopes. In addition to the potential ecological issues, the visible damage to the habitat is a serious problem for many of the landowners; large expanses of the reserve have a very high proportion of dead, broken and bark-stripped trees which is deemed to be unacceptable.

In 2012 Operation Wallacea teams will collect data on habitat in the Pongola Game Reserve in order to link the use-levels of vegetation, along with structure and composition, with habitat use by the elephants. Data on vegetation structure and composition will be collected from transects. Elephant impacts on woody plants will be recorded and quantified using the standardised Walker scale, along with the impacts of other browsing herbivores and fire, which can contribute enormously to habitat level changes and may either confound or add to the impacts of elephants. Vegetation maps of the reserve can be updated with the information collected in habitat sampling, and the spatial distribution of artificial water sources and roads will be recorded and can then be used in conjunction with the vegetation maps to produce maps of key resources. The spatial location of the

two herds and bull elephants in the Reserve has been recorded almost daily since mid 2008, this data will also be available to use in investigating elephant habitat use in relation to the distribution of vegetation types and other key resources. Projects could be based on linking elephant presence to use-levels, and looking at the issue of carrying capacity, potentially determining a scale of use-levels that can be used to inform the future management of the elephant population. Projects could also look at determining preferred habitat characteristics, which can be used by the Reserve managers to evaluate the suitability of areas for range expansion. Other potential projects could investigate habitat structure and composition across areas of the reserve in relation to impact levels of various herbivores, including elephants, and the intensity of use by elephants using the daily location points.

References and suggested reading

Please note: the following is intended as a starting point only, and students are expected to read more widely on their chosen topic to inform their project background and planned analysis.

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