SW250 Estimating the impact of elephants on habitat in Welgevonden Reserve, South Africa

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Elephant habitat 'damage' and the effects on other organisms is a subject of great importance in southern African wildlife management, and yet it is also a subject full of ambiguities. Wildlife managers and landowners have tended to notice, over the past few decades, very visible changes to reserve habitats that they link to increases in elephant population sizes. The visible impacts of elephant foraging include broken branches and trunks of shrubs and trees, stripped bark, trees pushed over or uprooted, and a general increase in the amount of dead woody vegetation coupled with a decrease in plant species richness and vegetation cover (Lombard *et al,* 2001; Mapaure and Moe, 2009; Levick and Rogers, 2008). These immediate impacts contribute to the reputation that elephants have for converting woodland and thickets into grassland. Ribeiro *et al* (2008) describe the process of conversion as being the combined effect of fire and elephant foraging damage; the removal of mature trees by elephants leaves young trees and shrubs to constitute a greater part of the vegetation, which creates a situation in which fire is allowed to be more frequent and intense, leading to grasses dominating the landscape. This pattern is evident in some cases, where there is a correlation of elephant presence and fire with grass biomass, and a negative correlation of elephant presence and fire with woody plant biomass (Ribeiro *et al,* 2008), but in other cases elephants are seen as responsible for removing young, immature trees and thus affecting recruitment and the ability of tree populations to regenerate (e.g. Edkins *et al,* 2007). It has also been demonstrated that the impact of elephant browsing differs enormously between tree species, with some species unaffected or stimulated by browsing, others being structurally altered or severely suppressed (Levick and Rogers, 2008). The overall picture is that elephant impacts on habitats occur through complex interactions of factors that are as yet poorly understood.

The historical datasets from the Welgevonden Reserve that have been made available to Operation Wallacea research teams, along with the long-term datasets collected in the reserve since 2009, provide a unique opportunity to investigate the relationships between elephant habitat use and the determinants of habitat use, and the associated impacts on vegetation. The results of this research will help to inform the management choices that the reserve and many others face. The current options are based on the need to minimize changes to the habitat, and these include invasive population management (e.g. contraception or culling), manipulation of space and meta-population management through fence dropping and corridor creation, and management of key resources such as water. An understanding of how elephants use the space available to them and what determines their distribution is important for making management decisions if the aim is to limit or alter the use of habitat by elephants in the reserve, whether this is done by increasing space available, decreasing population size or changing the relative quality of the area by manipulating resources. A quantifiable link between habitat use and impacts at the plant and habitat level is something that is largely missing from published literature, which will help to tease apart the key influences on the changes that may be taking place as a result of elephant foraging and other pressures.

The impacts on habitat and mechanisms by which elephants may alter the structure, composition and distribution of vegetation are likely to be influenced by several factors, including the distribution of key resources that determine elephant habitat use and distribution, terrain, habitat type and local

plant species (Smit *et al,* 2007; Ribeiro *et al,* 2008). The availability of water is a key determinant of elephant habitat use, whether artificial or natural, as their need to drink regularly constrains their options for movement within their range (Smit *et al,* 2007; Grant *et al,* 2007). In smaller reserves where natural surface water is readily available and perennial, this constraint may well be relaxed, which means that the determinants of habitat use in Welgevonden may be different to elsewhere. Elephants are generalist foragers, eating grass, leaves, bark, roots, fruit and pith of plants, and as such their food is widely and fairly evenly distributed. However, forage quality and preferred foods may influence their seasonal pattern of distribution as resources are more abundant in the wet season and are restricted in the dry season, and differential energetic requirements of bulls and herds means that forage quality and selectivity affects their habitat use in different ways (Shannon *et al,* 2006a and b). Potential dissertation topics within the sub-topic of determinants of elephant distribution could look at the relative effects of water (natural and artificial), human features and ecological features (e.g. habitat type, terrain…) on elephant distribution, home range and intensity of use.

Further factors that can have an impact on vegetation structure, composition and distribution and can confound the effect on vegetation that elephants have are fire and other browsing and grazing herbivores, particularly megaherbivores, or those with a body size over 1000kg. Black rhino, for example, have been shown to kill almost as many trees as elephant (Birkett and Stevens-Wood, 2005), although their foraging damage is not so visible. Further to this, browsing by giraffe affects the growth of trees, which has an effect on in-growth and biomass production, affecting the ability of woody plants to replenish lost biomass (Birkett, 2002). Fire has long been known to be a key component of savannah ecosystems, and as such is important to consider when looking at habitat level relationships and changes over time. Fire management regimes are implemented in most reserves and protected areas, and the combined effects of herbivore foraging and periodic fire on structural components of vegetation are known to be significant (Ribeiro *et al,* 2008). Potential dissertation topics in this area could focus on quantifying herbivore damage and looking at the effects on vegetation structure, composition and distribution over the study period. Projects could also address the question of acceptable levels of habitat change, and what level of browsing damage this would constitute, which could then be linked to degrees of elephant presence.

The data collected on vegetation during the season will be a combination of plot samples and transects at 40 sites throughout the reserve. Structural variables will be measured on grass and woody vegetation, including predictors of biomass, along with species of each woody plant in the sample. Each woody plant will also be assessed for browsing damage by herbivores using the Walker scale, and fire damage also using the Walker scale. GIS shapefiles of reserve features will also be available to be used for analysis, these include water sources, roads, lodges, habitat and vegetation types and others, depending on project needs. GPS collar data is also available for two of the eight elephant herds in the reserve. Spatial locations of the matriarch of each herd have been taken four times daily for a number of years, which allows detailed analysis of elephant spatial ecology. Datasets of spatial locations of other mammals collected using standardized sampling methods since 2010 can be made available as appropriate. Depending on the support available to dissertation students at their University, remote sensing data may also be used to parameterize models and analyse habitat use.

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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Smit, I., Grant, C. And Whyte, I. (2007) Landscape-scale sexual segregation in the dry season distribution and resource utilization of elephants in Kruger National Park, South Africa. *Diversity and Distributions* **13:** 225–236

van Aarde, R., Ferreira, S., Jackson, T. and Page, B. (2007) Elephant population biology and ecology. In: *Assessment of South African Elephant Management, 2007.*

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