Chapter 1

General introduction

The influence of elephants (*Loxodonta africana* Blumenbach, 1797) on biological diversity is of conservation significance (e.g. Cumming *et al*. 1997; Trollope *et al*. 1998; van de Vijver *et al*. 1999; Whyte *et al*. 2003; Wiseman *et al*. 2004; Goheen *et al*. 2004; Skarpe *et al*. 2004). This is particularly true where elephants are confined, and even more so, when protected areas are small and support sensitive vegetation. The Tembe Elephant Park (TEP) in northern KwaZulu-Natal, South Africa, presents such a scenario.

TEP is one of two conservation areas in the Maputaland Centre of Endemism (van Wyk 1996) that support remnants of a previously widely distributed elephant population (see Morley 2005). The other conservation area is the 'Reserva Especial de Maputo' (here after; the Maputo Elephant Reserve [MER]) situated in southern Mozambique. Maputaland is known for its species richness and high levels of endemism (e.g. Küper *et al*. 2004) and has recently been recognised as part of the Maputaland-Pondoland-Albany biodiversity hotspot (www.biodiversityhotspots.org). Conservation in Maputaland stands to be affected by these developments, not only inside but also outside formal conservation areas (Reid 1998; Myers *et al*. 2000; Cincotta *et al*. 2000).

The TEP is fenced, small (300 km^2), and supports a unique sand forest ecotype that contributes greatly to the overall levels of endemism (Kirkwood & Midgley 1999; van Rensburg *et al*. 1999, 2000; Matthews *et al*. 2001). The fencing of the Park made intuitive sense to conservation authorities that wanted to protect these forests from human-induced damage (Sandwith 1997). The authorities also wanted to prevent elephant poaching, and limit elephant contact with humans. However, confining

elephants to the Park may create a new conflict, should they destroy the sand forests, and negatively affect the associated endemic species (e.g. Kirkwood & Midgley 1999; van Rensburg *et al*. 1999, 2000; Matthews *et al*. 2001; McGeoch *et al*. 2002).

Not all of the elephants living in Maputaland are restricted to conservation areas. The MER in southern Mozambique is unfenced and elephants living here roam freely onto communal lands along the Futi River (de Boer & Baquete 1998; de Boer *et al*. 2000; Soto *et al*. 2001) that extends all the way to the TEP.

The restriction of range use by elephants is not the only human-induced problem that the managers of the TEP may face. The establishment of artificial water sources represents another disturbance, since it may alter the way elephants use landscapes and vegetation (e.g. de Beer *et al*. in press). Furthermore, it affects elephant demography (Shrader *et al*. in review), adding to the disruptive effects elephants may have for the ecosystem. This scenario is not unique to the Tembe Elephant Park, as most elephant populations across South Africa are confined by fences to areas less then 1 000 km^2, where their numbers increase at rates exceeding 7% per year (see Slotow *et al*. 2005).

In 2000, the Conservation Ecology Research Unit (University of Pretoria) initiated a number of studies focussing on Maputaland's elephants. The research programme was directed at investigating the consequences of fragmentation for this elephant population and for the landscapes where they live. My study deals specifically with the consequences that elephant confinement may have for the vegetation of the Tembe Elephant Park. My study aims to contribute to the future management of elephants in Maputaland and elsewhere.

Elephants in Africa are closely linked to conservation issues. Here, some consider elephants as flagship species (Western 1987), while others treat them as

umbrella or focal species (e.g. Roberge & Angelstam 2004) and project them as icons for conservation. The underlying premise is that biological diversity will benefit when suitable areas are set aside for the protection of elephants (Caro & O'Doherty 1999). Elephants are also considered by some as a keystone species (Power *et al*. 1996), a term that often extends to 'ecological engineers' (Jones *et al*. 1994). This implies that their removal from a system may have consequences for other components (Mills *et al*. 1993). The concept also implies that elephants have the capacity to transform their environment and manipulate the living conditions for other species (Jones *et al*. 1994; Power *et al*. 1996).

The savanna biome, in which my study area is situated, is characterised by the coexistence of herbaceous and woody plants (Walker & Noy-Meir 1982; Belsky 1990). This biome is inherently complex and continuously in varying states of flux between different stable states (e.g. Walker *et al*. 1981; Noy-Meir 1982; Gillson 2004; Ssemanda *et al*. 2005). Previous reviews (Scholes & Archer 1997; House *et al*. 2003; Sankaran *et al*. 2004) summarised the various models that describe coexistence between grasses and trees and concluded that spatio-temporal scales (e.g. Levin 1992) are key to explanations of the mechanisms that maintain savanna systems. These mechanisms may include competition-based (niche separation, balanced competition, alternate stable states) and demographic-bottleneck models (the 'storage effect') (House *et al*. 2003; Sankaran *et al*. 2004). Ecological events, such as disturbances caused by fire and herbivory may further influence these mechanisms that affect tree densities and shift savanna systems from woody to grasslands states (Dublin *et al*. 1990; Prins & van der Jeugd 1993; van de Koppel & Prins 1998; Bond *et al*. 2005). The role that elephants play in savannas links closely with other disturbance events,

consequently fire and other herbivores, other than elephants, may either mask or amplify the signals of impact left by elephants in areas such as TEP.

I studied the impact elephants may have had on vegetation by following the hierarchical approach by investigating responses at increasing spatio-temporal scales (see Allan & Starr 1982; O'Neil *et al*. 1987). This allowed me to identify the level at which elephants influence the vegetation and how prevailing conditions in the TEP determined the outcomes of the study. I compared plant community variables of areas with and without elephants, and compared space and landscape utilization of elephants in the Park with those of free ranging elephants in southern Mozambique. However, elephants are not the only agents that may influence some of the response variables I measure. Other browsers and fire, may also affect plant species in the Park, but elephants dominate the browsing guild. I therefore often refer to the "Park effect" to accommodate the disturbance role that other browsers and fire, in conjunction with elephants may have on plants.

My dissertation comprises three sections. In the first section (Chapters 1 and 2), I provide a general introduction and describe the study area. The second section (Chapters 3 to 6) provides the scientific content of the study. The first of these chapters addresses the effects elephants may have for plants in the TEP at the smallest scale, followed by separate assessments in the following chapters, each with increasing spatio-temporal scales. In the third section (Chapter 7), I synthesise my findings, and reflect on relevance thereof to elephant management in the TEP.

In Chapter 3, I focus on the effects of elephants on the canopies of tree species that are high in their dietary preference in TEP. I also study how the sub-canopy vegetation associated with these trees may respond to changes in canopy structure. Previous studies on the feeding behaviour of elephants suggest that they alter tree

canopies by breaking branches and/ or displacing entire trees (e.g. Barnes 1982; Lewis 1986; Jachmann & Croes 1991). My research takes this one step further by looking at the community level response as reflected by diversity and evenness indices of grasses, woody seedlings and saplings associated with these altered tree canopies.

At the intermediate scale (Chapter 4), I investigate how the different landscape types (open woodlands, closed woodlands and sand forests) responded to the presence of elephants and the other species living in the Park. Here, I compare densities, species composition, abundance-incidence and species rank-abundance relationships of trees and shrubs noted in the different landscapes inside the Park with those recorded in similar landscapes outside the Park.

At the macro scale (Chapter 5), I focus on space use and landscape selection patterns by elephants in Maputaland. As elephants are fenced in and provided with artificial water, I expected that their use of space in TEP would differ from that of free roaming elephants living in the Maputo Elephant Reserve and along the Futi River Corridor in southern Mozambique. I collected elephant location data provided by satellite collars and projected these onto landscape types derived from satellite images of the region.

To assess the apparent impact of elephants, and to place the impact of elephants in the TEP into a continental context, I performed a meta-analysis on the consequences elephants have for plants, other vertebrates and insects (Chapter 6). A meta-analysis is a quantitative assessment that uses statistical techniques designed to combine the results from different studies to evaluate the overall effect size (Cooper & Hedges 1993). In this case, the overall effect size is the consequences elephants have on other taxa present in the system. This procedure allowed me to partition out

possible explanatory variables relating the overall effect of elephant and to identify the shortcomings in the current scientific literature. This meta-analytical procedure also minimizes site-specific biases in my assessment, which may lead to incorrect conclusions and management recommendations.

The study aims to investigate the consequences of the confinement of elephants may have for plants in Tembe Elephant Park. Instead of focussing on species level alone, I concentrate on the response of plants from the individual tree to the plant community level. This study also uses 'state of the art' remote sensing technology, such as satellite imagery and tracking of elephants to investigate their response to confinement. Finally, this study answers the question of 'How does the current situation in Tembe Elephant Park compare with other elephant populations in Africa? Management decisions regarding elephant's space use patterns, as oppose to elephant numbers *per se*, stand to be affected by outcomes and interpretation of my results.