CHAPTER 1

General Introduction

> *"The worst thing that can happen - will happen ...- is not energy depletion, economic collapse, limited nuclear war, or conquest by a totalitarian government. As terrible as these catastrophes would be for us, they can be repaired within a few generations. The one process ongoing that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats.. This is the folly our descendants are least likely to forgive us."*
>
> *- E. O. Wilson, 1985*

Biological diversity or "Biodiversity" is an umbrella term for the total degree of variety found in nature (McNeely *et al.*, 1990), and encompasses diversity at all levels of the biological hierarchy, from genes to species to ecosystems, and including the ecological processes that they are part of. The implied value that conservation biologists place on biodiversity may not be as obvious to many laypeople. In the words of Thomas E. Lovejoy: "Conservation is sometimes perceived as stopping everything cold, as holding whooping cranes in higher esteem than people. It is up to science to spread the understanding that the choice is not between wild places or people. Rather, it is between a rich or an impoverished existence for man". Subsequently, it is necessary for the conservation biologists to be able to fully explain and clarify this value to the broad public, since they are the people who's support is needed in conservation issues. Biological diversity adds abundant value to society, amongst others the goods derived from nature used for human consumption and in the medical industry, services like pollination and recycling, as well as the wealth of information that can be used in the fields of genetic engineering and applied biology (Meffe and Carroll, 1994). In addition, biodiversity has aesthetical, ethical as well as intrinsic value.

Since the beginning of the last decade, conservation biologists have been providing evidence that we are in the opening phase of a mass extinction (Ehrlich and Ehrlich, 1981; Wilson, 1992), where, if unchecked by appropriate conservation action could surpass in extent any of the prehistoric past mass extinction episodes. This will lead to genetic and species loss with accompanying loss of ecosystem diversity and irreparable damage will be done to the wealth of our planet's resources – to the detriment of our own species.

The establishment of national parks and other nature reserves, as a conservation strategy, are often conceived as being adequate for the protection of our biological resources. However, protected areas, managed exclusively for biological conservation comprise an area of only around 3% of the terrestrial land base world-wide (McNeely, 1994). The fact that land-use intensification is increasingly irreversibly depleting the world's biological heritage, accentuates the growing demand and urgency for extending the currently extant conservation area networks. Heightening this urgency is the growing competition that exists between alternative land uses, which is further limiting future opportunities to extend these conservation networks (Flather *et al.*, 1997). It is therefore imperative that the correct choice be made when setting aside additional conservation areas, in such a way as to guarantee extensive and complementary protection of every region's biota, i.e. trying to incorporate all elements of biodiversity, with special emphasis on those elements not presently under protection. How to best allocate limited conservation resources available has not been adequately resolved, but has been the main focus of many studies over the past decade (see Davis *et al.*, 1990; Vane-Wright *et al.*, 1991; Bedward *et al.*, 1992; Church *et al.*, 1996; Faith and Walker, 1996a, b; Csuti *et al.*, 1997; Flather *et al.*, 1997). One of the main factors hindering the identification of priority sites for conservation is the lack of robust data on species', as well as ecosystem distributions (Davis *et al.*,1990, Lombard, 1995; Balmford *et al.*, 1996a, b). Nevertheless, pressures from land transformation rates demand that existing biodiversity data, albeit not sound, be used as effectively and as soon as possible in conservation area decision making.

One possible way to address this problem, and one that has been investigated numerous times in the past, is the use of surrogate measures for biodiversity when conducting reserve selection (Balmford *et al.*, 1996a; Faith and Walker, 1996a, b;

Van Jaarsveld *et al.*, 1998; Wessels *et al.*, 1999). When making use of a surrogate, one has to identify a scale of surrogacy within which suitable indirect measures can be identified that will reflect species richness and species complementarity. For this reason we made use of an array of scales in the present study to establish the best possible scale for the four surrogates used here. A surrogate must be able to predict diversity (Humphries *et al.*, 1995) so that one can exploit a predictive relationship between the surrogate variable and the target variable to reduce costs and maximise the possibility of including as many elements of the biodiversity estate as possible. The study area comprises the Kruger National Park, South Africa (Figure 1), where we made use of vegetation types (Low and Rebelo, 1996), landscapes (Gertenbach, 1983), land types (Venter, 1990) and land systems (Venter, 1990) as possible surrogates for viable populations of 12 large herbivore species in the Kruger National Park. Environmental surrogates are frequently a more appropriate option than indicator groups or higher taxon richness since information on physical variables is already available for many areas, and is relatively easy and inexpensive to acquire for other areas. Furthermore, these surrogates integrate more of the functional processes important for maintaining ecosystem viability and species (Williams and Humphries, 1996). Vegetation types have been identified in previous studies as being a predictive measure of biodiversity (Woinarski *et al*, 1988; Hull, 1999). Furthermore, it has been shown that mammal diversity (as measured by species richness) is positively correlated with vegetation type diversity (Turpie and Crowe, 1994), and that using vegetation types as the primary factor influencing distribution and diversity patterns in mammals, can be justified as being "...the most meaningful ecological summary of the influences of soil, climate, topography and other static and dynamic environmental factors" (Davis, 1962). Likewise landscapes, land types and land systems were developed on the basis of a variety of environmental variables and should be able to predict diversity accurately.

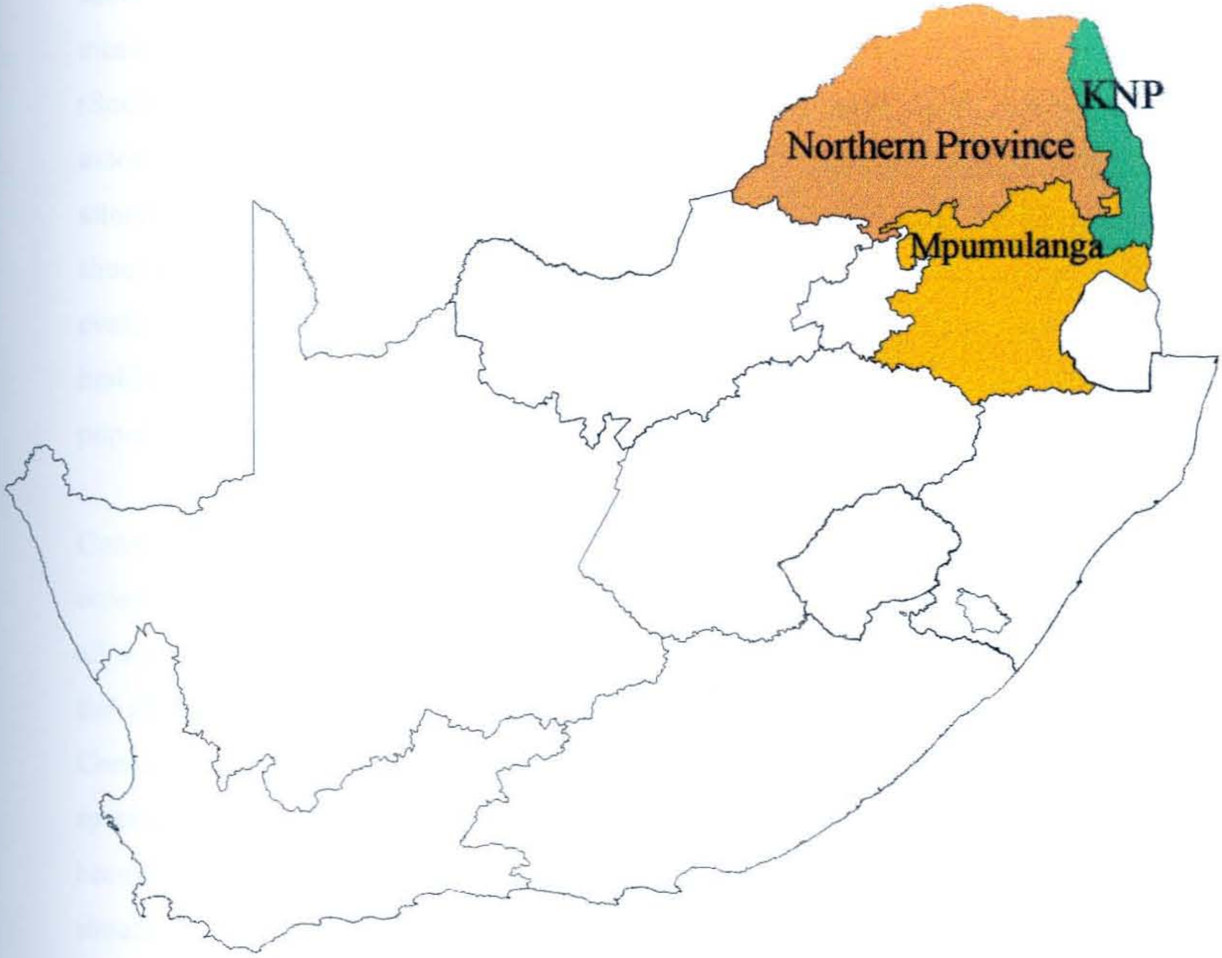

Figure 1: A map of South Africa showing the study area, the Kruger National Park (KNP), situated in the Northern and Mpumalanga Provinces

Planning for conservation includes planning for the long-term persistence and survival of all species within conservation areas. It is important to realise that any minimum viable population (MVP) will need a minimum area in which to survive (Soulé and Simberloff, 1986) and that national parks and reserves do not automatically protect the species within them (Grumbine, 1990). MVP theory attempts to determine threshold levels for species survival over the long term, and should inevitably be included in conservation planning. In the present study, we evaluate the land area needed to sustain combined viable populations of 12 large herbivore species, and we quantify the number of species for which viable populations are included at different degrees of surrogate selection.

Conservation should ideally aim at conserving ecosystems, not species, since the ecosystem approach is a much more rigorous and effective way to do conservation. If all ecosystems within all ecoregions can be successfully represented and maintained, the majority of species would be saved (David Olson (WWF) in Schmidt, 1996). Conserving the total variety of the earth's biomes is necessary to conserve all extant species. Without sufficient quantities of their natural habitats, species are bound to become extinct in the wild (Orions, 1994). But what area of each ecoregion (or biome) should be afforded protection if viable populations of all resident species are to be included?

In Chapter 2, we selected for viable populations of each of 12 large unmanaged herbivore species in the Kruger National Park using an iterative algorithm. Viable population sizes ranged from 50 to 10 000 individuals per species. The areas needed to jointly sustain these populations were quantified for each of the four land classification systems respectively, and at three grain sizes. Furthermore, differences in the distribution pattern of species in relation to changes in habitat quality was established.

Chapter 3 focuses on establishing whether viable populations are included when 10% of each land classification unit is selected. A total of 10% of the study area is thus selected, using an iterative reserve selection algorithm. Here we selected10% and up to

50% of each classification unit at different scales, and quantified the number of individuals per species fortuitously included through this selection process. This number was used to establish the number of species for which viable populations were captured in the given land surface area.

Chapter 4 explores the usefulness of setting aside a fixed area for nature conservation. We verify whether it is cost-effective to dedicate equal areas of all classification systems to nature conservation. We set up a model to determine the effectiveness of representing viable populations when setting aside a fixed percentage (ranging from 10% – 50%) of each land classification unit within a land classification system.

A detailed explanation of each of the four surrogates is given in Appendix 1, providing the area in the Kruger Park occupied by each classification unit within each classification system.

In Appendix 2, a related article on the land classification systems in the Kruger National Park, emanating from this study, is presented.

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