CHAPTER 39

The Greater Addo National Park, South Africa: Biodiversity Conservation as the Basis for a Healthy Ecosystem and Human Development Opportunities

Graham I. H. Kerley, André F. Boshoff, and Michael H. Knight

INTRODUCTION

The recognition that ecosystem health is strongly linked to human welfare, and that many ecosystems have been heavily degraded under human domination — resulting in reduced capacity to support human populations — is a dominant feature of the environmental debate (e.g., Rapport et al., 1998). This has led to a search for ecosystem management strategies to maintain ecosystem health, ranging from water pollution management to disease control and sustainable resource utilization. To some extent this process has been hampered by the inability to look beyond conventional management strategies in order to recognize and develop new opportunities for extracting resources from ecosystems, while maintaining these systems in a healthy and functional state. This deficit is particularly apparent in rangeland ecosystems that traditionally have been used for domestic herbivore production through pastoralism, despite considerable evidence of the threats to ecosystem health that this strategy imposes (e.g., Fleischner, 1994). We present here the background of ecosystem degradation and loss of ecosystem resources due to pastoralism in the Eastern Cape Province (hereafter "Eastern Cape") in South Africa (Figure 39.1), an area of spectacular biodiversity, and assess the consequences of alternate management strategies. We show how an initiative to address these problems, based on the recognition that biodiversity conservation yields tangible human development opportunities that include the full range of ecosystem services, is developing.

DESERTIFICATION OF THE THICKET BIOME

The Thicket Biome, one of the seven terrestrial biomes in South Africa (Low and Rebelo, 1996), is largely confined to the hot, dry valleys of the Eastern Cape, hence its alternative name of Valley Bushveld (Acocks, 1975). In the pristine state, thicket is characterized by dense, low-growing (3 to 5 m) vegetation that includes small trees, woody and succulent shrubs, grasses, lianas, forbs, and geophytes (Low and Rebelo, 1996). These plants tend to be evergreen; succulence and/or spinescence is common, and they form a virtually impenetrable, spiny thicket (Everard, 1987). The high diversity of growth forms reflects the transitional nature of these thickets, which occur at the interface of four major phytochoria or phytogeographical regions

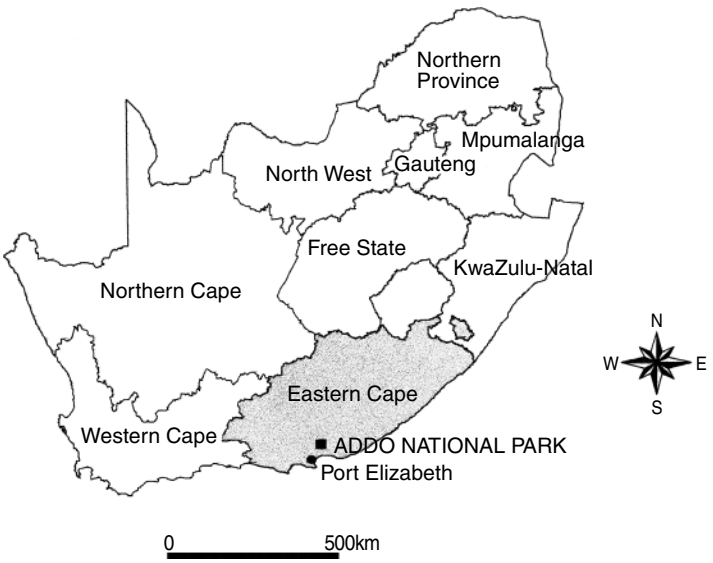

Figure 39.1 The nine provinces of South Africa and the location of the City of Port Elizabeth and the Addo Elephant National Park.

(Cowling, 1984; Lubke et al., 1986). The wealth of growth forms and the transitional nature of the thicket result in very high plant diversity, and these may be the most species-rich formations of woody plants in southern Africa (Hoffman and Everard, 1987). In addition, these thickets form part of the IUCN-recognized Albany center or *hot spot* of biodiversity (Cowling and Hilton-Taylor, 1997). At a regional level these thickets have the highest endemism (30%) within the Eastern Cape (Lubke et al., 1986). This endemism is not symmetrical across the growth forms; it is highest among the succulent forbs and shrubs and geophytes (Hoffman and Cowling, 1991; Moolman and Cowling, 1994).

In addition to the high floristic diversity, the Thicket Biome historically supported a high diversity of vertebrate herbivores, including charismatic species such as the African elephant, *Loxodonta africana,* and black rhinoceros, *Diceros bicornis,* as well as a range of smaller species such as Cape buffalo, *Syncerus caffer;* eland, *Taurotragus oryx;* kudu, *Tragelaphus strepsiceros;* bushbuck, *T. scriptus*; bushpig, *Potamochoerus porcus;* and common *Silvicapra grimmia* and blue duikers, *Philantomba monticola* (Skead, 1987). Associated with these herbivores was the full complement of large predators, including lion, *Panthera leo*; leopard, *P. pardus*; African wild dog, *Lycaon pictus;* brown hyena, *Hyaena brunnea;* and spotted hyena, *Crocuta crocuta*. This high faunal diversity extends also to the birds (more than 300 species), herpetofauna, and probably invertebrates (Kerley and Boshoff, 1997).

Fire plays a minor role in the natural dynamics of the Thicket Biome, and drought, another major form of disturbance, appears to have little impact on the flora. Hence, animal/plant interactions appear to constitute the most important process to generate and maintain the high floristic diversity (Kerley et al., 1995). Animal-driven seed dispersal is a common feature of the reproductive strategies of many of the plants (Cowling, 1984); in addition, the evergreen, nutritious, and spinescent nature of the vegetation supports the hypothesis that herbivory is an important process in structuring the vegetation, with strong co-evolution between the flora and associated herbivores. The megaherbivores (elephant and rhinoceros) are thought to be particularly important in terms of herbivory, patch creation, and seed and nutrient dispersal (Kerley et al., 1995).

Whatever the role of the fauna in structuring the floristic communities, these processes were severely disrupted by the extirpation of many of these species, coincident with the arrival of modern pastoralists of European and African origin (Skead, 1987). Large predators (lion, cheetah, hyenas)

were exterminated in an attempt to protect domestic herbivores, and leopards managed to survive in only the most remote areas. Herbivores were actively hunted for meat, leather, and ivory, and suffered the familiar loss of habitat. Elephants were reduced to a population of 11 individuals in 1931 and did not receive full protection until 1955. The black rhinoceros was extirpated by 1858, remaining so until reintroduced in 1961; buffalo persisted under the umbrella of elephant conservation (Kerley and Boshoff, 1997). The medium-sized herbivores (kudu, bushbuck, duiker) managed to persist in the dense thickets.

The dominant land use in the Thicket Biome is now pastoralism, particularly the husbandry of goats, *Capra hircus*. Pastoralism has led to not only the loss of a large proportion of the indigenous fauna but also to a collapse of ecosystem health. These changes can be expressed at a number of different levels. At the landscape level, pastoralism is associated with a loss of landscape heterogeneity, which reflects a loss of landscape elements critical for hosting a range of habitats and other resources for species of plants and animals (Fabricius, 1997). At the floristic level, pastoralism has led to a loss of plant cover and phytomass, a replacement of dominant species by less palatable species, a decrease in the cover of perennial plants, and an increase in the cover of annuals, as well as invasion by alien plant species and extirpation of plant species (Hoffman and Cowling, 1990, 1991; Kerley et al., 1999; Moolman and Cowling, 1994). These localized plant extinctions are not random among growth forms; succulents and geophytes, many of which are endemics, suffer the most (Moolman and Cowling, 1994). Soils also are affected, with pastoralism leading to large-scale erosion; loss of soil organics, N, Mg, Ca, and moisture; and an increase in soil Al (Kerley et al., 1999; La Cock, 1992; Palmer et al., 1988). These observed indicators of ecosystem degradation also are expressed in terms of productivity: degraded thicket habitats can support fewer herbivores. In addition, forage production is more variable in degraded thickets, virtually collapsing during drought (Stuart-Hill and Aucamp, 1993). Finally, these changes are apparently irreversible within normal management time frames, and therefore this loss of ecosystem resources and productivity can be characterized as desertification (Kerley et al., 1995).

The mechanisms of the degradation, through pastoralism, of a system that evolved with high levels of herbivory appear to occur through the management and specific foraging behavior of domestic herbivores, chiefly goats. Goats are stocked at high densities in response to the economic constraints of farmers (Kerley et al., 1995). In addition, goats are able to overcome the physical plant defenses that protect the plants from the indigenous herbivores with which they have co-evolved (Haschick and Kerley, 1999). Goat feeding behavior also exposes the soil to erosion (Kerley et al., 1999) and prevents vegetative regeneration of some plants (Stuart-Hill, 1992). In addition, goats are poor dispersers of seeds compared to the indigenous herbivores (Sigwela, 1999).

The degradation of the Thicket Biome can be expressed in terms of the three indicators of ecosystem health listed by Rapport et al. (1998): vigor (i.e., loss of productivity, soil resources); organization (loss of biodiversity, keystone species); and resilience (shift in herbivores and the increased response of the system to drought). Ecosystem services, although not well documented, also are strongly affected. Loss of phytomass — ~150,000 kg wet plant mass/ha (Penzhorn et al., 1974) — and soil carbon — ~20,000 kg C/ha in the top 10 cm (Kerley et al., 1999) — indicates a reduced ability of the system to counter global warming through carbon sequestration. Similarly, the reduction in productivity has consequences for human resource extraction and leads to an increase in rural poverty and increased urbanization (Geach, 1997).

LAND USE OPTIONS: ECOLOGICAL AND ECONOMIC SUSTAINABILITY

Although pastoralism is the dominant form of land use in the Thicket Biome at present, it is fraught with problems, as discussed earlier. Game ranching and ecotourism/conservation, based on

the indigenous fauna (primarily herbivores) are the other major land use options. The desirability of these alternative land use options has to be evaluated in terms of ecological and economic sustainability — i.e., in terms of the consequences of pastoralism, game ranching, and ecotourism/conservation to ecosystem health.

Although pastoralism is apparently financially rewarding in the short to medium term, it cannot be considered to be economically sustainable, given the observed erosion of the natural resource capital upon which it is based (Birch, 1991; Kerley et al., 1995). However, government subsidy policies and artificially inflated land prices have contributed to maintaining pastoralism. Associated with ecosystem degradation has been an observed depopulation of rural areas (urbanization) and increased rural poverty. Ecosystem services (soil stabilization, primary productivity, carbon sequestration, biodiversity, and economic opportunities) suffer under pastoralism (Kerley and Boshoff, 1997).

More and more previously pastoral operations are switching to game ranching, relying on the diversity of medium-sized herbivores (particularly kudu) to produce venison and to attract local and foreign hunters. All available evidence indicates that the indigenous, medium-sized herbivores are ecologically sustainable (Stuart-Hill, 1992). There are some indications that areas from which megaherbivores are excluded do tend to lose some patch diversity (Fabricius, 1997; Stuart-Hill, 1992), although the amount of such patch diversity before the extirpation of the megaherbivores is unknown. Game ranching therefore appears to maintain healthy ecosystems.

In financial terms, game ranching is not as lucrative as pastoralism, generating only about 40% of the income that a comparably sized pastoral operation would generate (Kerley et al., 1995). The critical issue here is that, although game ranching generates less income in the short term, it is ecologically sustainable and hence can continue operating long after a pastoral operation has collapsed due to the loss of the natural resources (Kerley et al., 1995). Attention needs to be paid to the problems of appropriate scale and technology, efficient marketing, and adding value to the products through producer-based processing (Kerley et al., 1995) in order to improve the economic opportunities of game ranching if this form of land use, with its associated ecosystem health benefits, is to thrive. Given the benefits accruing to society through the ecological and economic sustainability of game ranching, consideration should be given to developing incentives (e.g., tax rebates, advice) to encourage and assist landowners in making the transition from pastoralism to game ranching.

The third major land-use option in the Thicket Biome is that of ecotourism/conservation. Under this model, tourists pay to experience the indigenous biodiversity, particularly the megaherbivores, within formal conservation areas. The best developed and studied of these is the Addo Elephant National Park (AENP), northeast of Port Elizabeth (Figure 39.1). Although elephants (78% of vertebrate herbivore biomass in the AENP) do have a significant impact on the vegetation, they are ecologically sustainable in the Thicket Biome at densities of much less than two elephants/km (Stuart-Hill, 1992). In the process of protecting elephants, conservation is also conferred upon the full suite of biodiversity (excluding the large predators at present) as well as maintaining ecosystem services (Kerley et al., 1995, 1999).

Ecotourism is also highly desirable in financial and economic terms: for example, in 1994 the AENP generated a profit and employed twice as many staff members at four times the salary of a comparably sized pastoral operation (Kerley et al., 1995). The benefits also extend well beyond the borders of the AENP. For example, a travel cost study estimated a recreational value of approximately $60 million for the nearly 100,000 tourists who visited the AENP in 1996, which clearly represents significant economic activity (Geach, 1997). Furthermore, it has been estimated (Kerley and Boshoff, 1997) that the visitors to the AENP generate at least 4000 additional employment opportunities in the tourism-related industry. Ecotourism/conservation in the Thicket Biome is therefore a winning option in both ecosystem health and sociopolitical terms.

THE EASTERN CAPE AS A BIODIVERSITY HOT SPOT

Southern African Biodiversity in the World Context

A comparison of the world's 18 biological hot spots (areas with high species richness, a high concentration of endemics, and a high degree of threat) highlights the importance of the temperate Mediterranean climatic areas (Myers, 1990). In particular, southern Africa and its Cape Floristic Region were identified as one of the hottest of all hot spots in terms of plant diversity and threats (Myers, 1990). On a subcontinental scale, southern Africa registers in the upper quarter of the world's 12 megabiodiversity countries (McNeely et al., 1990). Subsequently, an additional hot spot, the Succulent Karoo, has been recognized in South Africa (Mittermeier et al., 1999).

Yet within southern Africa, South Africa is distinct as one of the most biologically diverse countries in the world. Its 23,404 recorded vascular plant species, at an average density of 8.1 species/106 km^2, exceeds species-rich countries such as Brazil, Ecuador, Madagascar, and other countries in southeast Asia, all of which have rich tropical forests (Cowling et al., 1989; Gibbs Russel, 1985). In addition, South Africa has an exceptionally large proportion of endemic vascular plants (80%), exceeded only marginally by New Zealand with 82% endemic species (Cowling and Hilton-Taylor, 1994).

Among the vertebrate fauna of southern Africa, a similar species-rich picture emerges. The region's amphibian, reptilian, avian, and mammalian faunas account for about 2, 6, 7, and 6%, respectively, of the world's total species for each taxon (Siegfried, 1989). On average, the density of these southern African taxa exceeds the African and world species densities by 6.6 and 5.5 times, respectively (Siegfried, 1989). Faunal endemicity in southern Africa shows marginal congruence between taxa with the amphibians and reptiles (44 and 31%, respectively) having relatively high levels of endemic species, while the mammals and birds are relatively less well endowed with 6 and 15%, respectively (Drinkrow and Cherry, 1995; Siegfried, 1989; Skinner and Smithers, 1990).

To a large degree, southern Africa's rich biodiversity and high numbers of endemics can be attributed to contemporary ecological conditions (Lombard, 1995). Southern Africa offers transitional climates between the subtropical summer rainfall and temperate winter rainfall, in combination with complex topography, geology, pedology, biomes, vegetation types, and habitats, all situated at the base of the continent (Branch et al., 1995; Coe and Skinner, 1993; Cowling and Hilton-Taylor, 1994; Gelderblom and Bronner, 1995). The complexity of the region is reflected in the description of five phytochoria (White, 1983), seven biomes (Low and Rebelo, 1996; Rutherford and Westfall, 1986), 68 vegetation types (Low and Rebelo, 1996), and 5.2% of the world's vertebrates, on 0.8% of the land area (Siegfried, 1989).

Yet this rich biodiversity is also under great threat; about 47% of South Africa's natural vegetation already has been transformed (Low and Rebelo, 1996). South Africa has the third highest number of threatened reptile, amphibian, and invertebrate species (IUCN, 1996). Although only 13% of its diverse mammalian fauna is considered threatened, the country is still noted to be among those areas under severe threat of extinctions (IUCN, 1996). Among the vascular plants, southern Africa records the highest number of Red Data Book species (2575 species) per area, exceeding Australia, India, and Mexico (McNeely et al., 1990). Thus, in the global context, South Africa, with its rich biodiversity and increasing levels of threat, is worthy of conservation attention. South Africa contains multiple hot spots, of which the Eastern Cape clearly stands out.

The Eastern Cape Biodiversity Hot Spot

The Eastern Cape of South Africa sits in a transition zone of topographical, geological, pedological, and climatic complexity (Lubke et al., 1986). The wide range of habitats is conducive to supporting a wide diversity of plants and animals. The diversity of abiotic conditions prevalent in the Eastern Cape has made the region the most botanically diverse area of the

country. Of the subcontinent's five major phytochoria, the Eastern Cape forms a major transition or tension zone between four of them: the Cape, Afromontane, Karoo-Namib, and Tongaland-Pondoland (Werger, 1978). That tension zone is characterized by the convergence within the Eastern Cape of all (Nama Karoo, Succulent Karoo, Fynbos, Savanna, Grassland, Forest, and Thicket) of the seven recognized biomes in the country (Low and Rebelo, 1996) (Figure 39.2). Furthermore, within these biomes in the Eastern Cape, a total of 27 different vegetation types are represented, more than any of the other eight provinces of South Africa (Low and Rebelo, 1996). Thus, at the level of the vegetation type and biome, biodiversity in the Eastern Cape is the highest in southern Africa.

The Albany plant diversity hot spot in the Eastern Cape has been identified as one of the subcontinent's eight biodiversity hot spots (Cowling and Hilton-Taylor, 1997). Although the approximately 2000 species and endemism (10%) within the Albany hot spot is not particularly high, the species-to-area relationships compare with the other southern African hot spots, which together should be ranked among the world's most conservation-worthy areas. In addition, the transitional

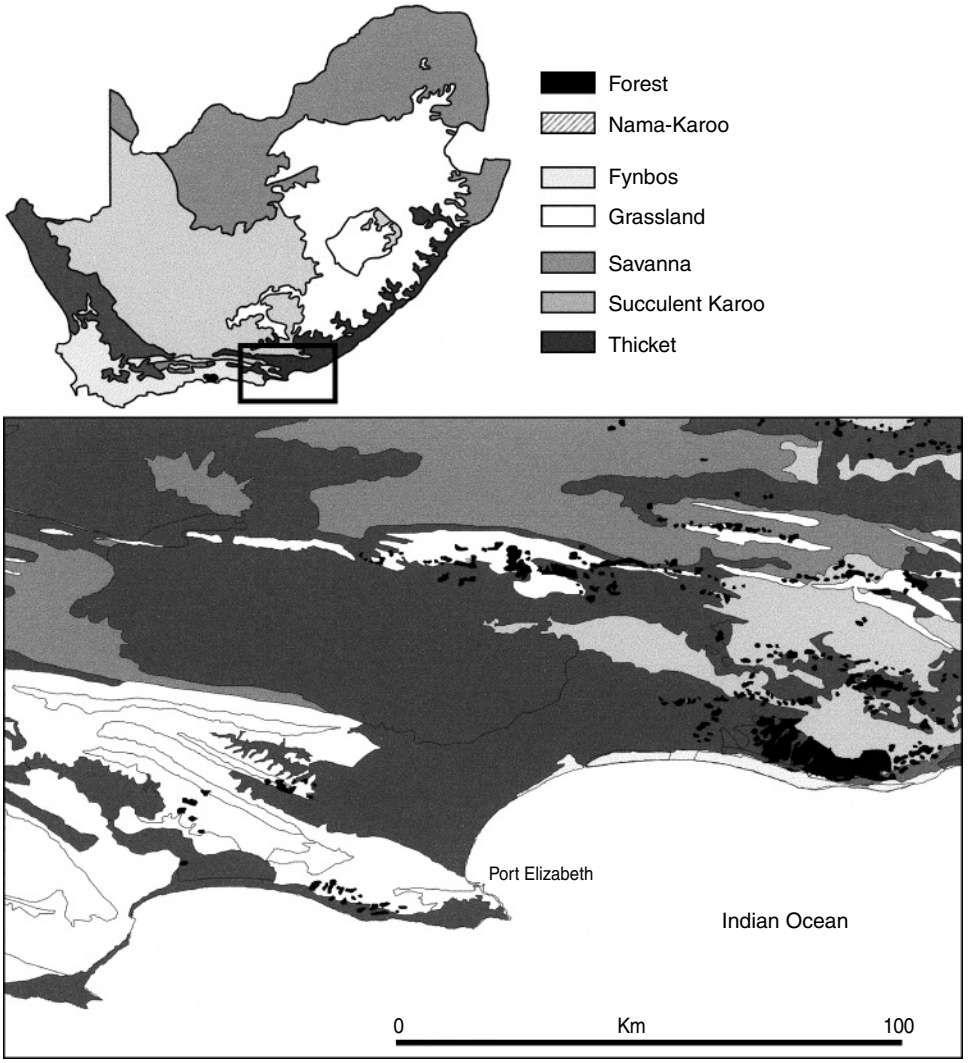

Figure 39.2 The seven South African biomes (bioclimatic regions), with details of the area in the vicinity of the Addo Elephant National Park.

nature of the vegetation types within the Albany area — where many of the species are at their distributional limits — is unique. This phenomenon likely accounts for the relatively low endemicity in the Albany hot spot because most of the species tend to be generalists rather than specialists. Endemics within the Albany hot spot typically are succulents from the succulent thicket vegetation types. For example, 30% of southern Africa's succulent *Euphorbia* species are represented in the Eastern Cape, of which 48% are endemic to the region (Court, 1988). In addition to the diverse terrestrial elements, the Eastern Cape also includes the coastal, marine, and estuarine components, further adding to the biodiversity of the area.

Biodiversity at the Biome Level

Table 39.1 shows that the Eastern Cape is particularly important in terms of the representation, and hence conservation, of the biomes and vegetation types of South Africa. All seven biomes are represented in the province.

Biodiversity at the Landscape Level

The Eastern Cape encapsulates a broad ecological and geomorphic diversity within relatively short distances. This diversity ranges from the grass-covered escarpment to the flat semiarid Karoo plains on the African erosion surface with its previously large herds of springbok; to the folded sandstone Zuurberg and Baviaanskloof Mountains, with their accompanying high rainfall vegetation types on the south-facing slopes; to drier rain-shadow north-facing slopes that are home to the endemic Cape mountain zebra, *Equus zebra zebra.* It also encompasses the more nutrient-rich post-African surface south of the mountains, with its dense succulent vegetation and rich mammalian browsing community; the marine and coastal aeolian sediments on the coast; and the marine province with its continental islands (Kerley and Boshoff, 1997). In the aggregate, these terrestrial and marine landscapes comprise the most biologically diverse area in southern Africa.

The Eastern Cape marine component includes a diversity of sandy and rocky shores and two island groups (Bird Island and St. Croix), adding to the biological diversity of the region. This section of the South African coast falls within the South Coast marine biogeographical province — one of three identified (Hockey and Buxton, 1989) — and has been independently identified as

Table 39.1 The Conservation Status of Biomes and Their Vegetation Types in South Africa and Specifically in the Eastern Cape

	Biomes		Vegetation types		
Biome	Percent Conserved Nationally	Percent Conserved in Eastern Cape	Number and Percent in Eastern Cape	Approximate Percent Transformed	Restricted to the Eastern Cape
Thicket	4.50	4.20	5 (100)	45	Xeric succulent thicket, Mesic succulent thicket
Nama Karoo	0.47	0.01	3 (50)	?	None
Succulent Karoo	2.82	17.40	1 (0.25)	?	None
Fynbos	11.84	21.40	3 (30)	47	None
Forest	17.90	15.80	2 (67)	44	Coastal forest
Savanna	9.40	0.33	4 (16)	46	Eastern thorn bushveld, sub-arid thorn bushveld
Grassland	2.23	0.30	9 (60)	58	Coastal grassland, Southeastern mountain grassland

Data adapted from Low, A.B. and Rebelo, A.G., *Vegetation of South Africa, Lesotho and Swaziland*, Department of Environment Affairs and Tourism, Pretoria, South Africa, 1996.

a region in need of protection (Payne and Crawford, 1989). Much like the terrestrial areas in proximity to Algoa Bay, this section of the coast appears to be a transitional area of marine species from the cool temperate west coast and warm tropical elements, and it is particularly important for its diversity of bivalves, limpets, and endemic fish species. East of Algoa Bay, the proportion of endemic fish species rapidly declines (Hockey and Buxton, 1989).

Biodiversity at the Species Level

Invertebrates

Little is known about the invertebrate fauna of the Eastern Cape, although researchers believe that the conservation of the larger mammalian species as flagship species within conservation areas will benefit the invertebrates (Fabricius, 1997). For example, conservation of the larger mammalian herbivores in Addo has been beneficial to the endemic flightless dung beetle, *Circellium bacchus* (Kerley and Boshoff, 1997).

Vertebrates

Comparisons between the distribution of total species richness, endemics, and rarity across six vertebrate taxa (fish, tortoises, frogs, snakes, birds, and mammals) in South Africa revealed little congruence within and between taxa, indicative of the different environmental conditions necessary for each taxon (Lombard, 1995). However, the general trend to emerge is one of species richness in the northeastern subtropical areas of the country, with centers of endemism in the more remote south and southwestern temperate regions, and the rare species split between the two. The Eastern Cape emerges as a species-rich transitional area. Analysis of each of the six taxa revealed the following:

1. *Fish*: The northeastern subtropical low-lying areas of South Africa have the greatest diversity of freshwater fish species, yet the majority of the country's 33 endemic species are restricted to the southern regions, with the Sundays River area identified as one of 10 national endemic species hot spots (Skelton et al., 1995). The Zuurberg Mountains of the Eastern Cape provide protection to two indigenous species of minnows, *Barbus pallidus* and *B. anoplus*, both of which are considered in need of conservation (Skelton, 1987).
2. *Frogs*: Southern Africa has a particularly rich amphibian fauna; and the Eastern Cape, with 10 to 18 amphibian species, of which 5 to 8 are endemic, is considered to be one of the country's amphibian hot spots (Drinkrow and Cherry, 1995).
3. *Reptiles*: The Eastern Cape harbors a high diversity of reptiles, particularly snakes and lizards, 9% of which are endemic to the Eastern Cape. Such reptiles include the Tasman's girdled lizard, *Cordylus tasmani,* the Cape legless burrowing skink, *Scelotes anguina,* and southern dwarf chameleon, *Bradypodion ventrale ventrale* (Branch, 1988a,b). In this regard the Algoa basin is a minor center of endemicity (Branch, 1988b). The Eastern Cape also has the most diverse tortoise fauna in the world — five species, three endemics (Branch et al., 1995).
4. *Birds*: More than 500 bird species have been recorded in the Eastern Cape, with more than 300 species breeding in the area (Harrison et al., 1997; Skead, 1967), 13 of which are Red Data Book species (Brooke, 1984). The Eastern Cape also has an endemic hot spot located in the coastal areas west of Algoa Bay (Lombard, 1995). Unique features include the presence of four of southern Africa's five large eagle species: namely, the black eagle *Aquila verreauxii*, crowned eagle *Stephanoaetus coronatus*, martial eagle *Polemaetus bellicosus*, and the fish eagle *Haliaeetus vocifer.* Additionally the region hosts three species of large bustard: the Kori *Areotis kori*, Stanley's *Neotis denhami,* and Ludwig's *N. ludwigii* bustards (Kerley and Boshoff, 1997).
5. *Mammals*: Although the Eastern Cape is neither species rich nor an endemic mammalian hot spot, it does register as an important hot spot for endemic insectivore species that are associated with the indigenous forests (Gelderblom and Bronner, 1995; Lombard, 1995). The Eastern Cape is

home to the second-largest population of elephants *Loxodonta africana* in South Africa (Kerley and Boshoff, 1997). In addition, the Eastern Cape, particularly in the Thicket Biome, supports the second-largest population of the threatened black rhinoceros *Diceros bicornis* in South Africa (Hall-Martin and Knight, 1994).

Flora

The juxtaposition of the seven biomes within the Eastern Cape provides for great botanical diversity yet relatively low endemism, led by the grassy fynbos and succulent thicket vegetation types (Cowling, 1983). Within the latter, most of the endemics are geophytes and succulents, and these are predominantly restricted to the understory layer. This makes them particularly prone to grazing pressure mainly from domestic stock, although high densities of elephants also have a deleterious affect (Cowling and Holmes, 1991; Johnson, 1992; Moolman and Cowling, 1994; Stuart-Hill, 1992).

Of the indigenous forest patches, the Alexandria forest is particularly important, given its mix of Cape and Tongaland-Pondoland species. A total of 27 (16%) of its species are found either exclusively in this forest or within a single other forest patch in the area (Phillipson and Russell, 1988). Three species are endemic to this forest — the Cape wing-nut *Atalaya capensis*, the buig-my-nie *Smelophyllum capense,* and the Cape star-chestnut *Sterculia alexandria.* The region harbors seven (25%) of South Africa's 28 species of cycad *Encephalartos* spp. (Giddy, 1974) and the endemic Willowmore cedar *Widdringtonia schwarzii* (Van Wyk et al., 1988). Many of the indigenous trees such as the cycads are now not only under threat by collectors but also through the harvesting of their products for medical purposes (Cunningham, 1988; La Cock and Briers, 1992; Simelane, 1996).

Three main points emerge from the evidence presented in this section. First, the Eastern Cape, and particularly the region encompassing Algoa Bay and its hinterland, possesses an immense diversity of plants, animals, and landscapes. Second, much of this biodiversity is under threat due to desertification and to poorly planned urban and rural development. Third, the region holds great potential for increased conservation action as well as for underpinning a vibrant tourism industry, based on its spectacular natural assets.

THE PROPOSED GREATER ADDO NATIONAL PARK

Emerging from the considerations of the ecological and economic sustainability of land-use options in the Thicket Biome is the recognition that conservation/ecotourism is the best form of land use for ecosystem health and that conservation should be expanded in order to take advantage of the opportunities presented (Kerley et al., 1995). This area boasts spectacular biodiversity from the species to the landscape level, providing further opportunity to combine conservation and tourism. The region is also well placed to exploit the steady growth in the number of tourist arrivals in South Africa since the ground-breaking 1994 democratic elections. In addition, the territory (terrestrial and marine) acquired for national parks in the Eastern Cape has been increased significantly during the last 20 years. This combination of factors led to a proposal to develop a major conservation area that would have explicit human development opportunities (Kerley and Boshoff, 1997).

This vision sees the amalgamation of two large protected areas with one small, existing protected area — the Addo Elephant National Park (60,000 ha), the Woody Cape (24,142 ha), and Tootabie (343 ha) Nature Reserves — to form a core conservation area, The expansion of this core area would create a Greater Addo National Park (GANP) (Figure 39.3), thereby providing an opportunity for a viable regional and national development and conservation initiative. The selection of the footprint of the proposed GANP (Figure 39.3) is based on 11 recognized criteria and on national and international environmental legislation and treaties. These criteria encompass issues related to

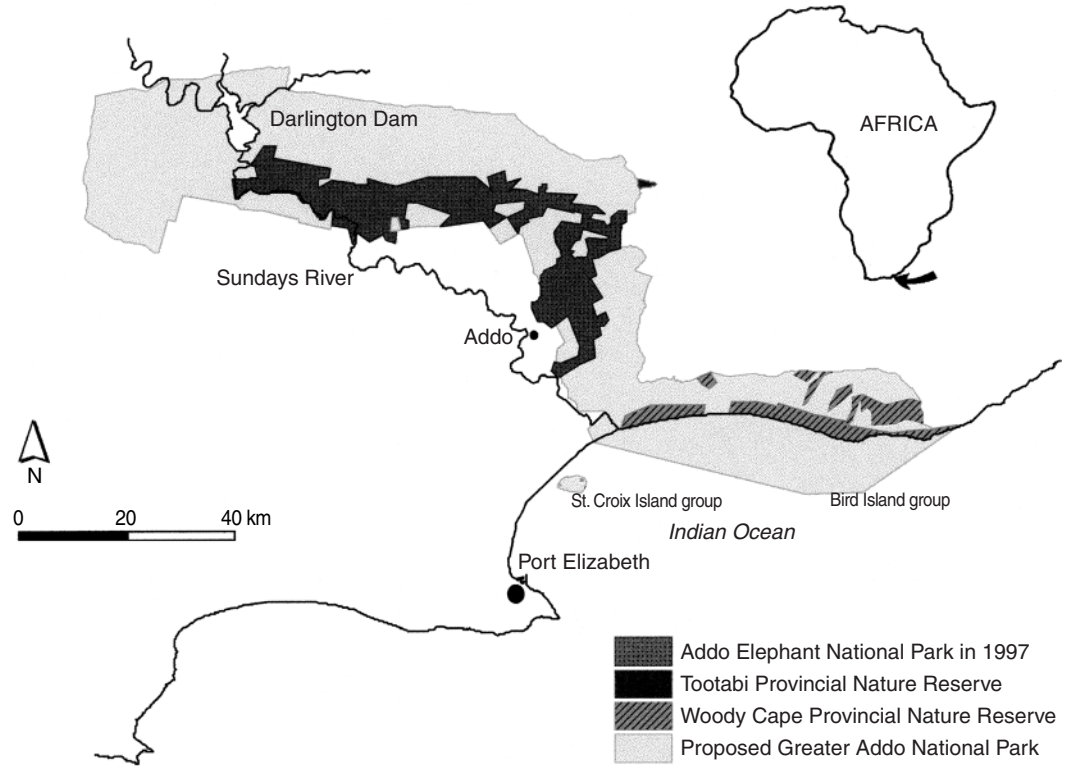

Figure 39.3 The proposed Greater Addo National Park: the core conservation areas in 1997.

biodiversity, spatial complexity and representativeness, ecosystem functioning, naturalness and uniqueness, protection of flagship species, multipurpose (buffer) zones, financial viability, economic potential, ecotourism, and management factors. The vision for the proposed GANP is fully motivated on the basis of sound conservation, ecotourism, and economic principles, perspectives, and information. Space precludes the inclusion of a fully referenced account of the GANP proposal here. However, details are available in Kerley and Boshoff (1997) and at the Web site http://www.upe.ac.za. A brief synopsis of the key features and advantages of the proposed GANP follows.

The proposed GANP is some 398,000 ha in size, consisting of a 341,000-ha terrestrial zone and a 57,000-ha marine zone. The former includes the Darlington Dam and almost 90 km of the Sundays River, and the latter includes the Bird and St. Croix island groups in the Indian Ocean (Figure 39.3). The proposed park, which forms a continuous conservation area more than 200 km in length, will be the third largest national park in South Africa. It will be geomorphologically and biotically the most diverse conservation area in South Africa, and probably one of the most diverse in the world. In addition it will create enormous potential for socioeconomic development in the economically depressed Eastern Cape, a province identified by the government as a priority for development.

In terms of its conservation value, the GANP will contribute significantly to South Africa's conservation requirements. It will be unique through the inclusion of examples of six of the seven biomes identified in South Africa (Low and Rebelo, 1996) as well as a diverse marine component. Major landscapes included are the Zuurberg Mountain range, part of the former African land surface, the Alexandria coastal dune field, fossil dune ridges, and karstic landforms. The Alexandria coastal dune field is the largest, most impressive, and least degraded coastal dune field in South Africa, and one of the most spectacular in the world. The GANP also will offer some protection to fragile and threatened river systems, with the Sundays River estuary of particular conservation significance.

The Bird and St. Croix island groups are of immense conservation value; they support, for example, the largest population of the threatened African penguin *Spheniscus demersus* and the largest Cape gannet colony *Sula capensis* in the world, as well as a range of other species of special conservation significance, notably the Cape fur seal *Arctocephalus pusillus*. The marine zone also supports populations of threatened and ecologically and economically important species, e.g., reef and game fish, bottle-nosed *Tursiops truncatus* and humpback *Sousa plumbea* dolphins, southern right *Eubalaena glacialis* and Bryde's *Balaenoptera edeni* whales, and great white sharks *Carcharadon carcharias,* all of which are also important ecotourism resources.

A particular attraction in the proposed GANP will be the megaherbivores (elephant, black rhinoceros) and other charismatic animals, ranging from the large predators such as lion *Panthera leo* and cheetah *Acinonyx jubatus*, to an endemic flightless dung beetle. The GANP will be a true *Big Five* (lion, leopard, elephant, rhinoceros, buffalo) park, a critical feature for tourism success. It will ultimately be able to carry genetically viable populations of most of the large species. With more than 400 species within its boundaries, it will provide habitat for almost half of the bird species recorded in South Africa, and it will play a significant role in conserving the region's reptiles and amphibians.

The proposed GANP also will contribute significantly to the conservation of a range of threatened freshwater and estuarine fish species as well as to the conservation of a number of threatened invertebrates — e.g., rare butterfly species *Aloeides clarki* and *Lepidochrysops bacchus*, an endemic dune grasshopper *Acrotylos hirsutus,* and the flightless dung beetle.

The proposed GANP will conserve an impressive array of plant species, ranging from the desert-adapted succulents in the Karoo to the stately trees of the Alexandria coastal forest. It is characterized by a wide range and high diversity of plant species and by the proximity of several very different and unrelated vegetation types. Part of the Albany hot spot, recognized by the WWF–IUCN as a global center of plant biodiversity, falls within the GANP footprint. The GANP also will provide increased protection for 25% of South Africa's cycad species.

The proposed GANP and its surrounds additionally have an important and interesting paleontological record, consisting of a range of plant and animal fossils; these include dinosaur bones and unique fossil fish deposits. The fact that the GANP includes areas of six biomes ensures that at least some of these bioclimatic regions will persist there in the face of global climate change; in this regard the marked altitudinal variation over a relatively short distance — sea level to 1000 m above sea level over 50 km — within the proposed boundary is noteworthy.

The proposed GANP is located in an area with an extensive and interesting archaeological and historical record. This region includes an important Late Stone Age site; remains of Khoi/San settlements; and sites of conflict between early African and European pastoralists, and between the Boers and the British. The two island groups also have a particularly interesting and valuable history of whaling and shipwrecks.

All the above features and attractions will combine to ensure the success of the proposed GANP as national and international ecotourism destination. Available evidence clearly indicates that ecotourism/conservation is an ecologically sustainable form of land use and that it is successful in terms of wealth generation, economic activity, and job creation. In terms of ecotourism and its economic role, the proposed GANP has enormous potential and would be ideally located to exploit the fast-growing ecotourism market. It will offer a wide and exciting range of attractions, from lions to penguins, from forests to deserts, and from mountains to beaches. The climate of the region is ideally suited to ecotourism, the area has a good tourist safety record, and it is free of malaria. The GANP would be well serviced in terms of tourism infrastructure, such as an airport, transport, surfaced roads, and hospitality facilities. The GANP would provide opportunities for linkages with private conservation areas within the context of the creation of a biosphere reserve, and it is thus obvious that it would be a highly desirable form of land use and development in the region.

The development and operation of a major national park such as the GANP will undoubtedly provide a number of socioeconomic benefits at the local, regional, and national levels. For example, numerous permanent and casual jobs will be created within the GANP and within service and peripheral industries. The potential for the long-term viability of these jobs is considered to be good, and local communities stand to gain most from the economic activity that the GANP will foster. The Mayibuye Ndlovu Crafts Project, involving communities neighboring the present Addo Elephant National Park, has laid a solid foundation for further community relationships with respect to a GANP. A wide range of institutional, social, and management issues were identified and discussed at a GANP Stakeholders Workshop held in February 1999; workshop delegates unanimously endorsed the GANP concept in 1999 (Boshoff and Kerley, 1999).

The potential of the proposed GANP as a national development opportunity has been accepted by the South African government. At a presidential jobs summit organized by the national government in October 1998, one of the three areas in the country singled out was the Algoa Bay region. As a key part of the overall plan for this region, emphasis was laid on "the development of tourism centred on an enlarged Greater Addo [Elephant] National Park" (*Eastern Province Herald,* 3 November 1998). A GANP is now regarded as an integral part of the Fish River Spatial Development Initiative — a development project of the national Department of Trade and Industries, which commissioned an economic viability analysis of the proposal by an independent firm of chartered accountants. The proposed GANP was named as a provincial achievement by Premier of the Eastern Cape Province Government, Mr. M. Stofile, in his speech at the opening of the Provincial Legislature on 12 February 1999; President Thabo Mbeki confirmed the government's commitment to the concept at the opening of the South African Parliament in February 2001.

In November 1998, the Global Environment Facility (GEF) Operational Focal Point, attached to the Department of Environmental Affairs and Tourism in Pretoria, provided formal country endorsement of the proposal in a letter to the World Bank Biodiversity Program in Washington, D.C. On the strength of this, the World Bank, operating as an agent of GEF, invited the submission of a formal project proposal to World Bank/GEF for the establishment of GANP. This will include all aspects of park planning and development except land purchase. The required process has been initiated, and the first step was the previously mentioned inclusive participatory GANP Stakeholder Workshop in February, 1999. The workshop, which attracted more than 150 delegates representing a wide range of stakeholders (Boshoff and Kerley, 1999), was followed by the submission of a proposal to the World Bank for a Project Development Fund grant. This project development phase was initiated in November 2000, with GEF funding, and was completed in 2002. The full project, supported by GEF, will commence in January 2003.

Since the GANP proposal was launched in September 1997, the expansion of the Addo Elephant National Park (AENP) has proceeded apace. By the end of 2001 the AENP had increased in size by some 36,000 ha, with units of land acquired in the south, in the Zuurberg Mountains in the western part, and in the noorsveld to the northwest of the Zuurberg Mountains. Negotiations are under way or have been completed for the use or purchase of a further 30,000 ha of land. In November 2001, the Woody Cape Provincial Nature Reserve (24,142 ha) was handed over to South African National Parks for inclusion into the GANP. The latter acquisition completed the link between the present AENP and the coast and, with this extension, the AENP had effectively doubled in size since the proposal was developed.

It is noteworthy that a substantial proportion of the funds used for the purchase of additional land is in the form of donations from the private sector, in particular from the International Fund for Animal Welfare and the Leslie Hill Succulent Karoo Trust. The Worldwide Fund for Nature–South Africa also has indicated its willingness to purchase land for the GANP as funds become available. Furthermore, the GANP proposal, with its explicit linkages between conservation and socioeconomic development opportunities, has provided the incentive for the South African government to budget funds for the purchase of land for the expansion of the AENP.

THE PROPOSED GANP AND ECOSYSTEM HEALTH

Environmental degradation, as documented earlier, is not restricted to the Thicket Biome; the other biomes that fall within the GANP footprint also exhibit various levels of degradation. Problems include overgrazing, soil erosion, invasion by alien plants, and poorly planned rural and industrial development (Low and Rebelo, 1996). Although the ecosystem health benefits of the proposed GANP will be confined largely to the GANP footprint, the proposal serves as a model and catalyst for other similar initiatives elsewhere in South Africa.

The benefits of a healthy ecosystem, expressed in terms of the contribution of the proposed GANP, are characterized by the provision of clean water and air, the sequestration of carbon, the maintenance of stable soils, enhanced plant productivity, and enhanced biodiversity conservation (species, ecosystems, and landscapes) (Rapport et al., 1998). In addition, the latitudinal and altitudinal variations within the GANP footprint will promote biodiversity persistence in the face of global climate change. We consider that the proposed GANP will presently more than adequately satisfy all three of the indicators of ecosystem health — vigor, organization, and resilience (Rapport et al., 1998).

CONCLUDING STATEMENTS

We contend that the conservation/ecotourism type of land use espoused in the GANP proposal, and based on the tenets of sustainable utilization of natural resources, holds the greatest potential for the meaningful improvement of human communities, especially in the vicinity of the park. There are ultimately only two choices for the region: one that will enable a healthy ecosystem, providing ecosystem services and concomitant opportunities for socioeconomic development, or desertification followed by loss of these services and exacerbated human poverty. Lackey (1998) contends that ecosystem management is a society-driven process. In this regard, the stakeholder endorsement of the GANP concept, and the tangible support for its implementation, indicates the recognition of the benefits of ecosystem health by society.

Our overriding conclusion is that ecosystem health can generate political and financial support, if couched in both conservation and human terms — *conservation for the people*.

ACKNOWLEDGMENTS

This research has been funded by the National Research Foundation (Pretoria), South African National Parks, and the University of Port Elizabeth, South Africa.

REFERENCES

Acocks, J.P.H., Veld types of South Africa, *Mem. Bot. Surv. S. Afr.,* 40:1–128, 1975.

Birch, T., A farmer's perspective of Fish River Valley Bushveld, in Zacharias, P.J.K., Stuart-Hill, C.G., and Midgley, J., Eds., *Proc. First Valley Bushveld/Subtropical Thicket Symp.,* Grassland Society of Southern Africa, Pietermaritzburg, South Africa, 1991, pp. 14–16.

Boshoff, A.F. and Kerley, G.I.H., Eds., *Proc. Greater Addo Natl. Park Stakeholders Workshop,* Terrestrial Ecology Research Unit, Report 25, University of Port Elizabeth, South Africa, 1999.

Branch, W.R., Distribution and diversity of reptiles and amphibians of the Eastern Cape, in Bruton, M.N. and Gess, F.W., Eds., *Towards an Environmental Plan for the Eastern Cape,* Rhodes University, Grahamstown, South Africa, 1988a, pp. 218–245.

Branch, W.R., *South African Red Data Book – Reptiles and Amphibians,* South African National Science Programme Report*,* 151:1–241, 1988b.

Branch, W.R., Benn, G.A., and Lombard, A.T., The tortoises (*Testudinae*) and terrapins (*Pelomedusidae*) of southern Africa: their diversity, distribution and conservation, *S. Afr. J. Zool.,* 30:91–103, 1995.

Brooke, R.K., South African Red Data Book – Birds, *S. Afr. Natl. Sci. Prog. Rep.,* 97:1–213, 1984.

Coe, M.J, and Skinner, J.D., Connections, disjunctions and endemism in the eastern and southern African mammal faunas, *Trans. R. Soc. S. Afr.,* 48:133–254. 1993.

Court, G.D., The genus *Euphorbia* in the Eastern Cape, in Bruton, M.N. and Gess, F.W., Eds., *Towards an Environmental Plan for the Eastern Cape,* Rhodes University, Grahamstown, South Africa, 1988, pp. 144–148.

Cowling, R.M., Phytochorology and vegetation history in the southeastern Cape, South Africa, *J. Biogeogr.,* 10:393–419, 1983.

Cowling, R.M., A syntaxonomic and synecological study in the Humansdorp region of the Fynbos biome, *Bothalia,* 15:175–227, 1984.

Cowling, R.M. and Hilton-Taylor, C., Patterns of plant diversity and endemism in southern Africa: an overview, in Huntley, B.J., Ed., *Botanical Diversity in Southern Africa*, *Strelitzia,* 1, National Botanical Institute, Pretoria, South Africa, 1994, pp. 31–52.

Cowling, R.M. and Hilton-Taylor, C., Phytogeography, flora and endemism, in Cowling, R.M., Richardson, D.M., and Pierce, S.M., Eds., *Vegetation of South Africa,* Cambridge University Press, Cambridge, U.K., 1997, pp. 43–61.

Cowling, R.M. and Holmes, P.M., Subtropical thicket in the southeastern Cape: a biogeographical perspective, in Zacharias, P.J.K., Stuart-Hill, G.C., and Midgley, J., Eds., *Proc. First Valley Bushveld/Subtropical Thicket Symposium,* Grassland Society of Southern Africa, Pietermaritzburg, South Africa, 1991, pp. 3–4.

Cowling, R.M., Gibbs-Russel, G.E., Hoffman, M.T., and Hilton-Taylor, C., Patterns of plant diversity in southern Africa, in Huntley, B.J., Ed., *Biotic Diversity in Southern Africa: Concepts and Conservation,* Oxford University Press, Cape Town, South Africa, 1989, pp. 19–50.

Cunningham, T., Overexploitation of medicinal plants in Natal/Kwazulu: root causes, *Veld Flora*, 74:85–87, 1988.

Drinkrow, D.R. and Cherry, M.I., Anuran distribution, diversity and conservation in South Africa, Lesotho and Swaziland, *S. Afr. J. Zool.,* 30:82–90, 1995.

Everard, D.A., A classification of the subtropical transitional thicket in the Eastern Cape, based on syntaxonomic and structural attributes, *S. Afr. J. Bot.,* 53:329–338, 1987.

Fabricius, C., The Impact of Land Use on the Biodiversity in Xeric Succulent Thicket, South Africa, Ph.D. thesis, University of Cape Town, South Africa, 1997.

Fleischner, T.L., Ecological costs of livestock grazing in western North America, *Conserv. Biol.,* 8:629–644, 1994.

Geach, B.G.S., The Addo Elephant National Park as a Model of Sustainable Land Use through Ecotourism, M.Sc. thesis, University of Port Elizabeth, 1997.

Gelderblom, C.M. and Bronner, G.N., Patterns of distribution and current protection status of the endemic mammals of South Africa, *S. Afr. J. Zool.,* 30:127–136, 1995.

Gibbs Russel, G.E., Analysis of the size and composition of the southern African flora, *Bothalia,* 15:613–629, 1985.

Giddy, C., *Cycads of South Africa*, Purnell, Cape Town, South Africa, 1974.

Hall-Martin, A.J. and Knight, M.H., Conservation and management of black rhinoceros in South African national parks, in Penzhorn, B.L. and Kriek, N.P.J., Eds., *Rhinos as Game Ranch Animals*, University of Pretoria, Onderstepoort, South Africa, 1994, pp. 11–19.

Harrison, J.A., Allan, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V., and Brown, C.J., *The Atlas of Southern African Birds, including Botswana, Lesotho, Namibia and Zimbabwe, Vol. 1, Non-Passerines* and *Vol. 2, Passerines,* BirdLife South Africa, Johannesburg, 1997.

Haschick, S.L. and Kerley, G.I.H., Plant spinescence and biodiversity: responses of indigenous and domestic browsers to plant defenses, in *Proc. VI Intl. Rangeland Congr.,* 1:544–546, 1999.

Hockey, P.A.R. and Buxton, C.D., Conserving biotic diversity on southern Africa's coastline, in Huntley, B.J., Ed., *Biotic Diversity in Southern Africa: Concepts and Conservation*, Oxford University Press, Cape Town, South Africa, 1989, pp. 289–309.

Hoffman, M.T. and Cowling, R.M., Desertification in the lower Sundays River Valley, South Africa, *J. Arid Environ.,* 19:105–117, 1990.

Hoffman, M.T. and Cowling, R.M., Phytochorology and endemism along aridity and grazing gradients in the lower Sundays River Valley: implications for vegetation history, *J. Biogeogr.,* 18:189–201, 1991.

Hoffman, M.T. and Everard, D.A., Neglected and abused — the eastern Cape subtropical thickets, *Veld Flora,* 73:43–45, 1987.

IUCN, *1996 IUCN Red List of Threatened Animals*, IUCN, Gland, Switzerland, 1996.

Johnson, S.D., Plant–animal relationships, in Cowling, R.M., Ed., *Fynbos: Nutrients, Fire and Diversity*, Oxford University Press, Cape Town, South Africa, 1992, pp. 289–309.

Kerley, G.I.H. and Boshoff, A.F., A Proposal for a Greater Addo National Park: A Regional and National Development and Conservation Opportunity, Report 17, Terrestrial Ecology Research Unit, University of Port Elizabeth, 1997.

Kerley, G.I.H., Knight, M.H., and De Kock, M., Desertification of subtropical thicket in the Eastern Cape, South Africa: are there alternatives? *Environ. Monitoring Assessment,* 37:211–230, 1995.

Kerley, G.I.H., Tongway, D., and Ludwig, J., Effects of goat and elephant browsing on soil resources in Succulent Thicket, Eastern Cape, South Africa, *Proc. VI Intl. Rangeland Congr.,* 1:116–117, 1999.

Lackey, R.T., Seven pillars of ecosystem management, *Landscape Urban Plann.,* 40:21–30, 1998.

La Cock, G.D., The Conservation Status of Subtropical Transitional Thicket and Regeneration through Seeding of Shrubs in the Xeric Succulent Thicket of the Eastern Cape, Report, Port Elizabeth, Eastern Cape Nature Conservation, 1992.

La Cock, G.D. and Briers, J.H., Bark collecting at Tootabie Nature Reserve, South Africa: Eastern Cape, *S. Afr. J. Bot.,* 58:505–509, 1992.

Lombard, A.T., The problems with multispecies conservation: do hotspots, ideal reserves and existing reserves coincide? *S. Afr. J. Zool.,* 30:145–163, 1995.

Low, A.B. and Rebelo, A.G., *Vegetation of South Africa, Lesotho and Swaziland*, Department of Environment Affairs and Tourism, Pretoria, South Africa, 1996.

Lubke, R.A., Everard, D.A., and Jackson. S., The biomes of the eastern Cape, with emphasis on their conservation, *Bothalia,* 16:251–261, 1986.

McNeely, J.A., Miller, K.R., Reid, W.V., Mittermeier, R.A., and Werner, T.B., *Conserving the World's Biological Diversity*, IUCN, WRI, CI, WWF-US, WB, Gland, Switzerland, 1990.

Mittermeier, R.A., Myers, N., Gil, P.R., and Mittermeier, C.G., *Hotspots: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions*, CEMEX, Conservation International, Mexico City, Mexico, 1999.

Moolman, H.J. and Cowling, R.M., The impact of elephant and goat grazing on the endemic flora of South African succulent thicket, *Biol. Conserv.,* 68:53–61, 1994.

Myers, N., The biodiversity challenge: expanded hotspots analysis, *Environmentalist,* 10:243–255, 1990.

Palmer, A.R., Cook, B.J.S., and Lubke, R.A., Aspects of the vegetation and soil relationships in the Andries Vosloo Kudu Reserve, Cape Province, *S. Afr. J. Bot.,* 54:309–314, 1998.

Payne, A.I.L. and Crawford, R.J.M., *Oceans of Southern Africa,* Vlaeberg Publishers, Cape Town, South Africa, 1989.

Penzhorn, B.L., Robbertse, P.J., and Olivier, M.C., The influence of the African elephant on the vegetation of the Addo Elephant National Park, *Koedoe,* 17:137–158, 1974.

Phillipson, P.B. and Russell, S., Phytogeography of the Alexandria Forest (southeastern Cape Province), *Monogr. Syst. Bot. Miss. Bot. Gardens,* 25:661–670, 1988.

Rapport, D.J., Costanza, R., and McMichael, A.J., Assessing ecosystem health, *Trends Ecol. Evol.,* 13:397–402, 1998.

Rutherford, M.C. and Westfall, R.H., Biomes of southern Africa — an objective categorization, *Mem. Bot. Surv. S. Afr.,* No. 54, Department of Agriculture and Water Supply, Pretoria, South Africa, 1986.

Siegfried, W.R., Conservation status of terrestrial ecosystems and their biota, in Huntley, B.J., Ed., *Biotic Diversity in Southern Africa: Concepts and Conservation,* Oxford University Press, Cape Town, South Africa, 1989, pp. 186–201.

Sigwela, A.M., Goats and Kudu in Subtropical Thicket: Dietary Competition and Seed Dispersal Efficiency, M.Sc. thesis, University of Port Elizabeth, 1999.

Simelane, T.S., The Traditional Use of Indigenous Vertebrates, M.Sc. thesis, University of Port Elizabeth, 1996.

Skead, C.J., Ecology of birds in the Eastern Cape Province, *Ostrich,* Suppl. 7:1–103, 1967.

Skead, C.J., *Historical Mammal Incidence in the Cape Province, Vol. 2: The Eastern Half of the Cape Province, including the Ciskei, Transkei and East Griqualand*, Chief Directorate of Nature and Environmental Conservation, Cape Town, South Africa, 1987.

Skelton, P.H., South African Red Data Book — Fishes, *S. Afr. Natl. Sci. Prog. Rep*., 137:1–199, 1987.
Skelton, P.H., Cambray, J.A., Lombard, A., and Benn, G.A., Patterns of distribution and conservation status of freshwater fishes in South Africa, *S. Afr. J. Zool.,* 30:71–81, 1995.
Skinner, J.D. and Smithers, R.H.N., *The Mammals of the Southern African Subregion,* University of Pretoria, Pretoria, South Africa, 1990.
Stuart-Hill, G.C., The effects of elephants and goats on the Kaffrarian succulent thicket of the Eastern Cape, South Africa, *J. Appl. Ecol.,* 29:699–710, 1992.
Stuart-Hill, G.C. and Aucamp, A.J., Carrying capacity of the succulent bushveld of the Eastern Cape, *Afr. J. Range Forage Sci.,* 10:1–10, 1993.
Van Wyk, B.E., Novellie, P.A., and van Wyk, C.M., Flora of the Zuurberg National Park. 1: characterization of major vegetation units, *Bothalia,* 18:211–220, 1988.
Werger, M.J.A., Biogeographical division of southern Africa, in Werger, M.J.A., Ed., *Biogeography and Ecology of Southern Africa*, Vol 1., W. Junk, The Hague, 1978, pp. 301–462.
White, F., The vegetation of Africa: a descriptive memoir to accompany the UNESCO/AETFAT/UNISO vegetation map of Africa, *Natl. Resour. Res.,* 20, UNESCO, Paris, 1983.