Chapter 5
Biodiversity and ecosystem health

At a glance

This chapter begins by emphasizing the point that our lives and well-being depend directly on healthy ecosystems for air, water, food, and shelter, as well as for recreation and aesthetic, cultural, and spiritual needs. It outlines the main factors having an adverse impact on the country's ecosystem health, which include the over-exploitation of natural resources and climate change. It then describes the current state of our rivers, wetlands, estuaries, and marine ecosystems, as well as the status of species in major ecosystems. The last section details our responses in addressing the loss of biodiversity and ecosystem health, and it identifies climate change and genetically modified organisms as key emerging issues.

5.1 INTRODUCTION

Biodiversity[a] refers to genes, species (plants and animals), ecosystems, and landscapes, and the ecological and evolutionary processes that allow these elements of biodiversity to persist over time[1]. It is the activities of plants, animals, and microorganisms and their interactions with their environment that determine many of the properties of ecosystems, such as how much plant material is produced and how rapidly waste matter is decomposed or nutrients made available. These activities provide the ecosystem services that directly benefit humanity[2].

South Africa's biodiversity provides an important basis for economic growth and development. For example, it underpins our fishing industry, the horticulture and agriculture based on indigenous species, tourism, aspects of our film industry, and the commercial and non-commercial medicinal applications of indigenous resources, and it provides the rangelands that support commercial and subsistence farming. Keeping our biodiversity intact is also vital for ensuring ongoing provision of ecosystem services such as the production of clean water though good catchment management, prevention of erosion, carbon storage (to counteract global warming), and clean air. Loss of biodiversity puts aspects of our economy and quality of life at risk, and reduces socio-economic options for future generations.

People's lives and well-being depend directly on healthy ecosystems, which, in addition, yield food and shelter, as well as providing for recreation, aesthetic, cultural, and spiritual needs (se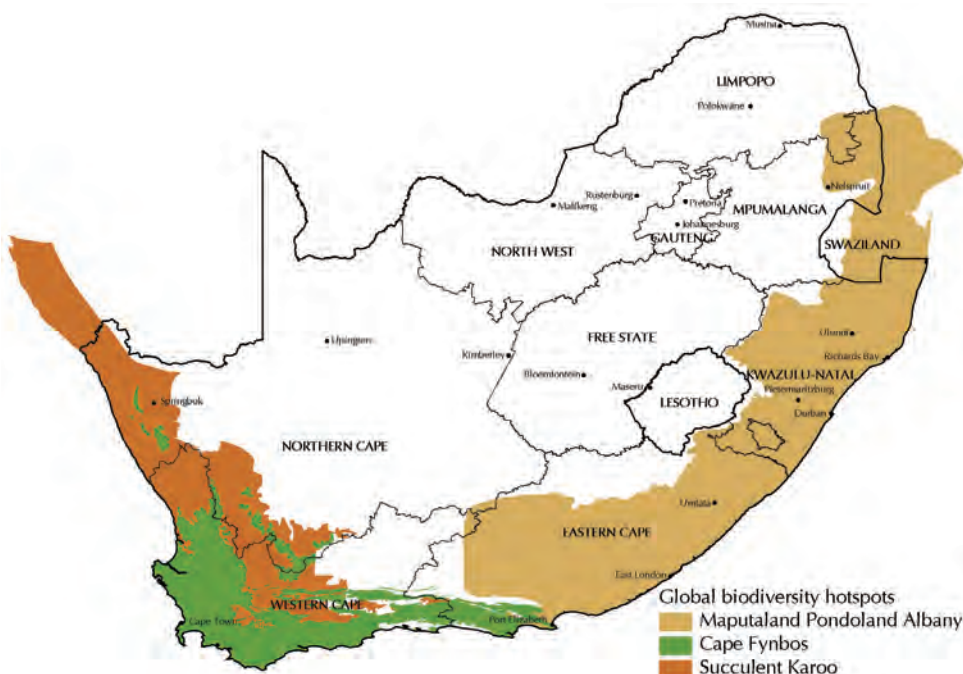e Boxes 5.1 and 5.2). Human well-being relates to resource security and the basics for sustaining life, health, social, and cultural relations, and the freedoms and choices that are available. Figure 5.1 shows the relationships between biodiversity, ecosystem services, and human well-being. Although placing a financial value on these services is complex and contentious, studies have demonstrated that ecosystem services are of enormous value to modern economies.

A synthesis of more than 100 studies attempting to assess global ecosystem services estimated that their aggregated annual value lies in the region of between US$20 trillion and US$60 trillion, with an average of about US$40 trillion[4] (updated to mean 2000 US$ value). This value is similar to the world's total gross national product (GNP). The economic value of unconverted, intact, and conserved ecosystems is much greater (from 14% to almost 75% higher than the value of natural areas that have been converted for agriculture, housing, and other uses[10].

People's dependence on living, healthy ecosystems and the services they provide is often particularly apparent in rural communities, where lives are directly affected by the availability of common property resources such as food, water, medicinal plants, and firewood[5]. Urban and wealthier sectors of society are somewhat buffered from changes in ecosystem services, as they purchase basic necessities and scarce commodities made available with the help of technology. For example, towns and cities use water treatment plants to perform the water cleaning services normally undertaken by healthy rivers and wetland systems[5].

South Africa is one of the world's most biologically diverse countries, with a rich and spectacular array of terrestrial, aquatic, and marine ecosystems[6, 7]. It occupies only 2% of the world's land surface, yet contains a disproportionately large share of global biodiversity, being home to nearly 10% of the planet's plant species and 7% of the reptile, bird, and mammal species[8] (see Figure 5.2). The country contains three globally recognized biodiversity hotspots: the Cape Floristic Region; the Succulent Karoo, shared with Namibia; and the Maputaland–Pondoland–Albany hotspot, shared with Mozambique and Swaziland (see Map 5.1). The Cape Floristic Region is the smallest (<90 000km²) and is the only floral kingdom to occur exclusively within the geographical boundaries of one country[9].

Its extraordinary plant diversity helps to rank South Africa as the country with the fifth highest number of plant species in the world. Our seas, which support many livelihoods, include the Atlantic, Indian, and Southern Oceans, with a wide range of habitats from kelp forests to coral reefs[10]. In addition, our coast is home to 15% of the world's coastal species[7], which contribute significantly to the country's economy[11]. Nevertheless, South Africa's biodiversity is increasingly threatened by human activities, which in turn threaten the very resource base upon which we depend[7].

> *People's dependence on living, healthy ecosystems and the services they provide is often particularly apparent in rural communities, where lives are directly affected by the availability of common property resources such as food, water, medicinal plants, and firewood.*

Global biodiversity hotspots
- Maputaland Pondoland Albany
- Cape Fynbos
- Succulent Karoo

Map 5.1: Biomes and biodiversity hotspots of South Africa

Box 5.1 Traditional medicine: Silverglen medicinal nursery, Durban, and Barberton Commercial Medicinal Plant Initiative

South Africa has a large and active trade in traditionally used indigenous plants. Over 70% of South Africans are thought to use traditional medicine as their primary form of health care and, in KwaZulu-Natal alone, approximately 4 000 tonnes of plants are traded each year, with considerable benefits to the economy. In 1995, the annual expenditure on medicinal plants in South Africa was R768 million – which promoted additional economic activity and job creation, with several hundred thousand people directly employed in the industry. Increasing demand for plants for medicinal and other purposes, however, has resulted in over-exploitation of wild populations, reduction in supply, and increased cost. It is widely acknowledged that wild populations need to be used sustainably and that further supplies of plants should be provided through cultivation.

Several projects in South Africa promote the cultivation of local plants. In Durban, the Silverglen medicinal plant nursery cultivates about 250 at-risk species, many of which are supplied to other nurseries and private buyers. This nursery covers an area of 3 hectares (ha) in the Silverglen Nature Reserve in Chatsworth and is run by the Durban Parks Division of eThekwini municipality. Although relatively little is produced for commercial trading, the nursery can provide growers with 'starter kits' and is conducting research into methods of harvesting medicinal plants sustainably and resuscitating traditional conservation practices. It is hoped that their work will assist conservationists and users of the resource to develop management guidelines for collecting these species.

The national Department of Environmental Affairs and Tourism has also invested in the establishment of a commercial medicinal plant project in Barberton, Mpumalanga. Located in the Umjindi local municipality, this project is funded under the department's poverty relief programme and involves partnership between the Mpumalanga Parks Board, the provincial Department of Agriculture and Land Administration, the South African Essential Oil Producers Association, the Siyaphambili Development Trust, the Tinjojela Trust, and other local stakeholders. Since its establishment in May 2003, the project has acquired land for two nurseries and food gardens and hopes to benefit over 200 local people. It should also help to alleviate pressures in the area caused by the collection of rare and endangered medicinal plants from wild populations.

Sources: Department of Environmental Affairs and Tourism (2004). Deputy Minister Rejoice Mabudafhasi at the launch of commercial indigenous plant project, Barberton. South African Government Information: Speeches and Statements. http://www.info.gov.za/speeches/2004/04092015451003.htm

eThekwini Metropolitan Municipality (2005). Durban's Muthi Nursery. http://www.durban.gov.za/eThekwini/services/parks/nurseries/muthi_nursery

Mander, M., Mander, J., and Breen, C. (1996). Promoting the cultivation of indigenous plants for markets: experiences from KwaZulu-Natal, South Africa. Submission to International Conference on Domestication and Commercialisation of Non-Timber Forest Products in Agroforestry Systems, Nariobi.

5.2 WHAT CAUSES LOSS OF BIODIVERSITY AND DECLINES IN ECOSYSTEM HEALTH?

Current and predicted future pressures on declining ecosystem health include loss of natural habitat (which includes land-use changes, loss of coral reefs, and damage to sea floors due to trawling), climate change, invasion by alien species, modification of rivers, water abstraction, external inputs of nutrient loading and pollution, over-exploitation (of, for example, fish stocks), and others. The relative importance of these pressures differs considerably amongst ecosystems[12], but all are likely to contribute to the continued decline of species' populations and loss of biodiversity over the next few decades. Human activities currently dominate all ecosystem functions in South Africa. This section outlines the main drivers of change and their impacts on the country's ecosystem health. (Some pressures are dealt with more extensively in other chapters. For example, for pollution and water abstraction see Chapter 6, section 6.2.2; Chapter 7, section 7.3.6; and Chapter 8, section 8.2.3.)
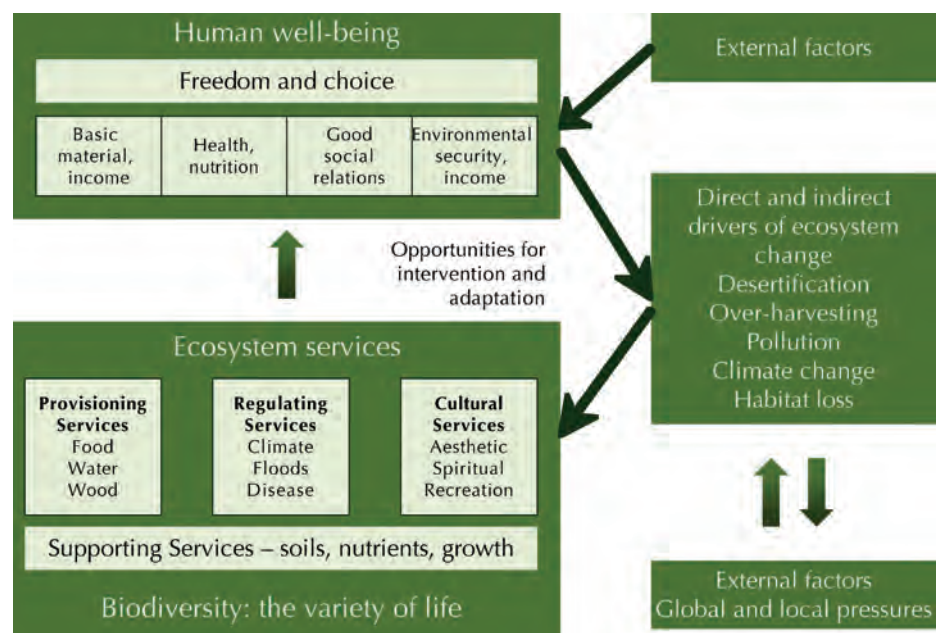

Figure 5.1: Ecosystem services and human well-being

Box 5.2 — Valuing open space in Durban

Open spaces in cities provide many ecosystem services and goods that are undervalued by most of the public who benefit from them. This could be because such goods and services are supplied free of charge and not measured in monetary terms. In recent years, advances have been made in international research that focus on ecosystem valuation. A case study in the eThekwini municipality illustrates these principles.

In the eThekwini municipality, many diverse open spaces and ecosystems supply benefits that, in turn, contribute to the economic value of the specific systems. For example, it has been estimated that wetlands are annually worth around R200 000 per ha and forests around R21 000 per ha. The value of an ecosystem increases according to its richness in diversity, which enables that ecosystem to supply a broader variety of services. The total replacement value of the ecosystem services supplied by the 63 000 ha of open space mapped in the 2002 spatial plan/open space system for the eThekwini municipality is an estimated R3.1 billion per year. It is noteworthy that this figure excludes the value of the role of open space in the tourism industry of Durban, which alone was estimated to be worth R3.3 billion in 2001.

Ecosystem	Rand value (millions)
Beaches and rock outcrops (1 039 ha)	30.2
Alien vegetation (3 787 ha)	24.8
Forest (10 581 ha)	195.3
Disturbed woodlands (2 823 ha)	29.5
Field crops (741 ha)	0.7
Dry valley thicket/ broadleaved woodland (18 306 ha)	267.5
Grassland (2 828 ha)	6.8
Tree crops (14 ha)	0.2
Recreational (1 712 ha)	4.1
Utility (289 ha)	0.5
Wetland forest (201 ha)	33.7
Wetland (non-woody) (5 485 ha)	1 108.8
Near shore ocean (i.e. the ecosystem in the area of ocean just off the shore) (50 000 ha)	837.2
Water (3 093 ha)	428.8
Wooded grasslands (11 145 ha)	116.4
Settlements (865 ha)	6.4
Total value – R3.1 billion	**3 090.9**

Source: eThekwini Municipality (2002). Durban Environmental Services Management Plan. http://www.durban.gov.za/eThekwini/Services/Downloads/dmoss_pop_doc_1

The conversion of natural ecosystems for other uses is one of the most significant causes of biodiversity loss in South Africa.

5.2.1 Loss, fragmentation, and degradation of natural habitat

The conversion of natural ecosystems for other uses is one of the most significant causes of biodiversity loss in South Africa. Land-cover change alters or destroys natural habitat, frequently with secondary consequences of degradation and fragmentation of remaining habitats, all of which result in losses of biodiversity, declines in ecosystem health, and changes in the provision of ecosystem services.

Along rivers, the removal of riparian vegetation for cultivation and to create access to rivers, for example, undermines the ecological integrity of fresh water ecosystems because of the important role of such vegetation in maintaining channel stability and as a source of food (through leaf-fall, for instance) into the aquatic system. Degradation of habitat quality through inappropriate land-use management (such as overgrazing) also occurs in these ecosystems.

Terrestrial ecosystems

In the terrestrial environment, loss and degradation of natural habitat is the biggest cause of biodiversity loss and decline in ecosystem functioning. Nearly 18% of South Africa's land-cover is transformed[b], mainly through cultivation (10.46%), urbanization (1.51%) and plantation forestry (1.41%) (see Chapter 4).

Land-cover change also causes declines in the populations of species. Based on a Biodiversity Intactness Index (BII)[13], non-mobile species, such as plants, are affected to a greater extent than mobile species, such as birds. Larger organisms and predators are more affected by human activity than are smaller, non-predatory species. Abundance of mammals and reptiles tends to respond closely to habitat changes, whereas birds and frogs respond less predictably. Provincially, levels of intactness are lowest in the grasslands, fynbos, and forest, and Gauteng is the province with the lowest BII score, owing to its high level of

urban development. The Free State is particularly affected by cultivation, and plantations have a major impact in Mpumalanga.

Other than the magisterial district-level estimates of land degradation by Hoffman *et al.* (1999)[14] (see Chapter 4), we do not have adequate data to assess the state of land degradation throughout the country at a finer scale. This data gap is critical, as the impacts of degradation on biodiversity are significant[7]. The Southern African Millennium Ecosystem Assessment[5] identified the expansion of degraded areas into areas currently under sustainable use as the most immediate threat to biodiversity. We do know that both vegetation and soil degradation are most severe in the Limpopo, KwaZulu-Natal, and Eastern Cape provinces, and that the communal rangelands are particularly adversely affected.

These assessments highlight the current pressures facing ecosystems but say very little about change or about trends in these pressures. A significant gap exists in our knowledge about trends in land-cover change (see Chapter 4). Some indication of the extent of the problem can be deduced from the fact that the area under cultivation in South Africa has more than trebled in the last 50 years, while plantation areas have increased tenfold.

Aquatic ecosystems

Organisms in many aquatic ecosystems are adapted to highly variable flows of water and, in some cases, to variable water quality. With the increased control of flows, however, by means of weirs and dams (which lead to reductions of flow and changes in the seasonal patterns of river flow), the result is loss of biodiversity and productivity as well as the introduction or increase of invasive species. Degradation and reduced productivity in aquatic ecosystems through pollution and poor land management has implications for food security and economic activities. Disturbance and loss of wetlands due to the pressures of land transformation and over-abstraction of groundwater reduces their storage capacity, water purification ability, fish populations, and wildlife habitats. Loss of water storage capacity reduces the availability of water in rivers during the dry season, resulting in longer drier periods and, conversely, more intense flows in the wet season, which exacerbate flooding.

Coastal ecosystems

Development pressure and land-use change are major causes of coastal habitat modification and loss. As much as 40% of South Africa's population lives within 100 km of the coast. The result has been substantial development pressure for infrastructure, such as housing and roads, even though there was only a small change in the density of the population within coastal provinces at a municipal level between the 1996 and 2001 Censuses.
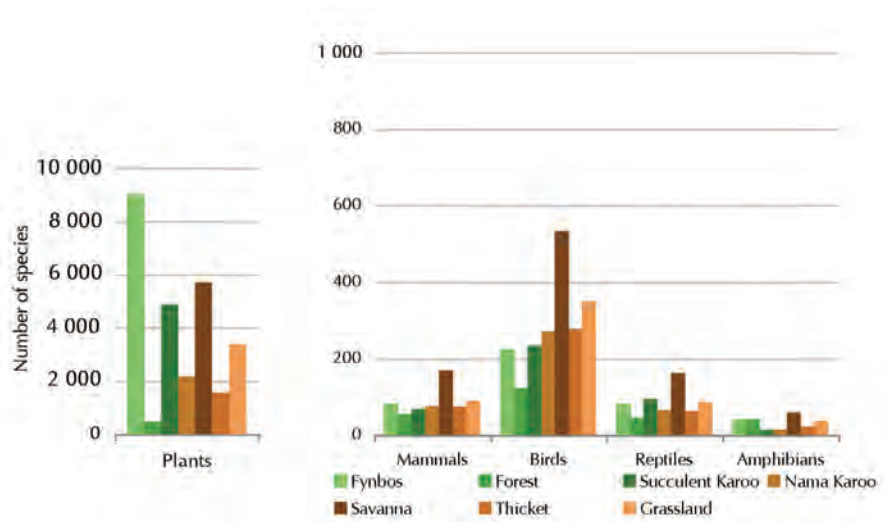
Figure 5.2: Species richness per taxonomic group of the biomes of South Africa
Source: Endangered Wildlife Trust, 2002[8]

The National Land Cover Database[15] classifies the current state of coastal land in South Africa as natural, degraded, urban, and agricultural. Not surprisingly, the sparsely populated Namakwa region has the largest proportion of natural land cover (98%), with Cacadu (92%), Eden (76%), Amatole (75%), and Nelson Mandela (74%) districts also having high percentages of natural land. The Nelson Mandela, Namakwa, and Overberg regions have only 1% degraded land, while on the west coast a mere 2% of the total land cover is classified as degraded. By contrast,

A humpback whale off Hermanus, the world's best land-based whale watching spot. *Photography: South African Tourism*

the O.R. Tambo region in the Eastern Cape has South Africa's highest proportion of degraded land (20%).

The areas of natural or undeveloped coastal land in South Africa are increasingly under threat from:

- Large-scale urban developments, mostly residential or recreational estates (such as golf estates)

- The construction of new harbours and ports or the expansion of existing ones

- Industrial development (for example, the Coega Industrial Development Zone, a new export-processing zone being built on a greenfields site in combination with the new, deep-water Ngqura harbour, whose development will require the dredging of an estuary).

5.2.2 Invasive alien species

An 'alien' species is one that has been introduced by humans, deliberately or accidentally, into an area in which it did not previously occur ('indigenous' species, by contrast, are native to a given place). In today's globalized world (where travel and transport of goods are fast, easy, and increasing), species spread effortlessly among countries and continents. While not all alien species thrive in their new environments, some do, becoming 'invasive', that is, spreading at the expense of indigenous species and causing significant changes to habitats and ecosystem functioning.

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One of the main reasons why alien species flourish is that "they are no longer controlled by their natural predators and pathogens (diseases) with which they have co-evolved in their natural range"[16]. Correspondingly, indigenous species are at a competitive disadvantage when they encounter such alien species (having had no evolutionary history of them) and are easily out-competed.

Invasive alien species can occur on land, in the ocean, or in freshwater systems, and can be drawn from any group of organisms. Our knowledge of them, however, is best by far for terrestrial species and ecosystems. Invasive alien plants have invaded over 10 million hectares (ha) of our country. Over 750 tree species and 8 000 herbaceous species have been introduced, with some 1 000 introduced species now naturalized (that is, neither indigenous nor invasive) and 200 considered invasive. Of those considered invasive, 117 are categorized as 'major invaders', and 84 are considered 'emerging invaders'[17]. 'Major invaders' are those species that are well established, and that already have a substantial impact on natural and semi-natural ecosystems.   'Emerging invaders' currently have less influence, but have attributes and potentially suitable habitat that could result in increased range and consequences in the next few decades.

Plants constitute most of the invasive species in South Africa, making up 63% of the 319 species listed as harmful, and they threaten 55% of the Red Data-listed plants in the country[18, 19]. According to the Working for Water Programme, the impacts of invasive alien plant infestations are expected to double within 15 years if left uncontrolled (see the web site of the Department of Water Affairs and Forestry at http://www.dwaf.gov.za/wfw).

Our knowledge of the distribution of alien invasives is limited to plants, and even for this group the data are not updated frequently enough. (See Map 5.2 for the proportion of each quaternary catchment that is infested with alien plant species.) Most of these species are located in the water catchment areas of the South-western Cape, on the east coast, and in the northeast grasslands and savanna regions, with some areas being over 80% infested. Other data do exist for some parts of the country (see, for example, Lloyd *et al.* [1999][20], Cowling *et al.* [1999][21], and the Southern African Plant Invaders Atlas [SAPIA] database). Efforts have also been made to improve our knowledge of the impacts of invasive aliens through modelling the potential distribution of 71 of the most important and emergent invasive plant species[22] (see Map 5.3). This figure highlights the high invasion potential of the eastern coastal regions and of the grasslands and savannas of the interior of the country.

Studies of invasive aliens in South Africa have tended to concentrate on plants, neglecting other taxa, but attention is now being directed towards the threat posed by other taxonomic groups of alien species. This is exemplified in the case studies presented by McDonald *et al.* (2004)[18],
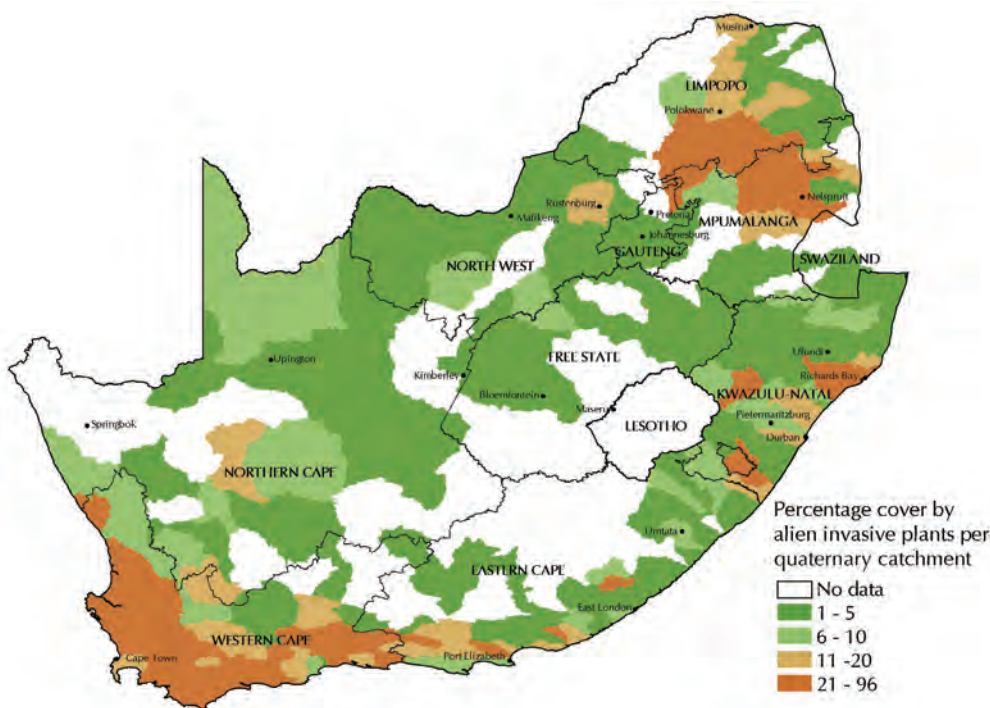
Map 5.2: Percentage cover by alien invasive plants per quaternary catchment
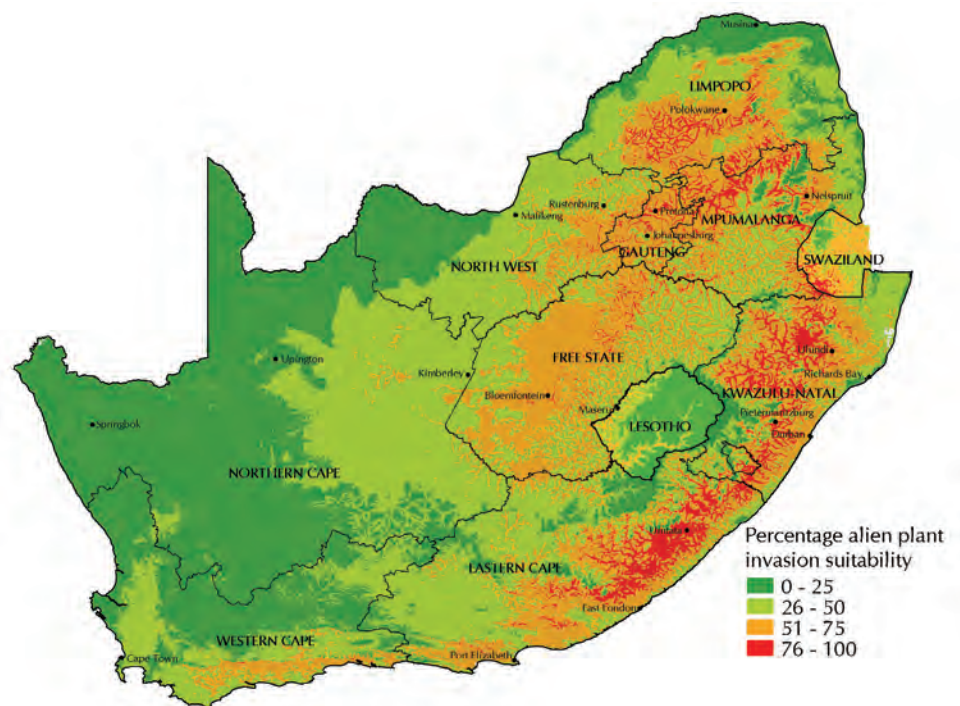*National Spatial Biodiversity Assessment 2004*[7]

which describe the introduction of alien freshwater fish (such as trout [*Parasalmo mykiss, Salmo trutta*] and bass [*Micropterus* spp.]) that threaten rare indigenous fish such as red-fin minnows (*Pseudobarbus sp.*) and Treur River barbs (*Barbus treurensis*). Alien pests associated with these introduced species, such as ribbon-worm (*Nemertea sp.*), have caused large-scale infestations of indigenous fish species. In addition, the breakdown of bio-geographical barriers in aquatic systems, arising from inter-basin transfers and other forms of flow manipulation, have given some opportunistic species a foothold in catchments where they are not otherwise found. At least four species of native South African fish, not naturally found there, have been introduced to the Great Fish River from the Orange River. These include the smallmouth yellowfish, the Orange River mudfish, the sharptooth catfish, and the rock barbel[23], which now compete with naturally occurring, local fish species. The introduction to local species of closely-related species and sub-species of birds and mammals, such as the mallard duck (*Anas platyrhynchos*) and domesticated guineafowl (*Numida meleagris*), as well as the movement of a large number of antelope species to areas outside their natural ranges, has led to hybridization and loss of genetic integrity and diversity within various indigenous species. The Varroa mite (*Varroa jacobsoni*), as well as an invasive wasp, *Vespula germanica*, have recently been introduced into South Africa and are seriously affecting the health and status of the country's indigenous honey bees and, consequently, the vital pollinating service that these bees provide[18].

Invasive alien species also threaten biodiversity in the coastal and marine environments. Marine fauna and flora have intentionally, or more often accidentally, been transported around the globe by humans[24], most often through the ballast water of ships discharged, along with any surviving organisms, when cargo is loaded at ports or harbours. The highly dynamic nature of South Africa's marine environment seems to have prevented many marine alien invasive species from becoming established. Of the ten currently known marine invasive species, only two (the Mediterranean mussel, *Mytilus galloprovincialis*, and the ascidian, *Ciona intestinalis*) are considered to have major adverse ecological or economic effects, while one (the European green crab, *Carcinus maenas*) has the potential for negative impact. Invasion by the Mediterranean mussel has displaced indigenous intertidal species along much of South Africa's coastline. Since 2001, one ascidian species, one anemone, one oyster, and one red algae (almost half the total number of recorded alien invasive species) have been recorded as invasive species in South Africa.

Microscopic algae (phytoplankton) are also easily transported around the world in ship ballast water and, once discharged, can become invasive. There is some indication that two species of toxic phytoplankton responsible for red tide blooms in South-western Cape waters in recent

Fly-fishing opportunities continue to increase due to the abundance of trout. *Photography: South African Tourism*

Percentage alien plant invasion suitability
- 0 - 25
- 26 - 50
- 51 - 75
- 76 - 100

Map 5.3: Potential distribution of alien invasive plant species
National Spatial Biodiversity Assessment 2004[7]

years are alien species that were introduced from foreign parts.

5.2.3 Over-exploitation

Economies and human settlements depend in diverse ways on the exploitation of natural resources, and this is rapidly becoming over-exploitation as populations and consumption grow.

- Trade-driven exploitation is on the increase on the local as well as the global scale, as nations consume plant and animal products and their derivatives (such as those of freshwater and marine fisheries) and trade them at home and abroad. In a multibillion rand industry, wildlife and wildlife commodities are traded legally and illegally around the world, including food, medicines and cultural artefacts, live animals for the food and pet markets, and timber and ornamental plants. In South Africa, the national value of trade in medicinal plants alone (approximately 20 000 tonnes), is estimated at an annual R270 million[25, 26].

- Natural resources are used to support human settlements, including the abstraction of fresh water for domestic and agricultural purposes, generation of electricity (involving modifications to rivers through hydropower development, or acid rain caused by coal-fired power stations), deforestation for timber products, and agricultural over-use of soils. These kinds of over-exploitation take place at regional and sometimes global scales, as these resources are often supplied from places that are geographically remote from the area where the demand exists. In parts of South Africa, much of the population is urbanized, (in Gauteng, for

Trade in medicinal plants is valued at R270 million annually.
Photography: Janet Peace

example, 94% of the population is currently urbanized, with a population density of 375 people per km^2)[11].

- In South Africa and other African countries, the uncontrolled use of natural resources on a local scale for subsistence purposes creates significant pressure on ecosystems. Included in this form of over-exploitation are unsustainable levels of: grazing by livestock, fuel-wood harvesting, collection of building materials (such as thatch, wood, and reeds), bushmeat hunting, and the harvesting of medicinal plants. At the community level, over-exploitation can have severe consequences on biodiversity, and the combined effects of deforestation and subsistence agriculture are expected to denude natural woodlands totally in southern Africa's communal areas by 2020[27].

The natural resources that currently support a large proportion of the population are rapidly declining because of over-exploitation. This decline is not evenly spread across South African ecosystems, but is concentrated in the forests, grasslands, KwaZulu-Natal coastal belt, and the Cape Floristic Region – all areas of high biodiversity and conservation priority. A 2004 study of the trade and economic value of forest and woodland resources in the medicinal plant market in Johannesburg estimated that these resources accounted for approximately 63% of the species traded, with 10% of those species shared with the grassland biome[26].

Subsistence and commercial over-harvesting of indigenous plants is driving some species to extinction locally and even nationally, especially rare and slow-growing species with medicinal value, such as some endemic bulbs and succulents[28]. Taxa threatened by commercial exploitation include cycads, colophon beetles, the Knysna seahorse, and the southern bluefin tuna.

There is still lack of awareness and information regarding the threats to many plant and animal species that are harvested for trade in bushmeat, medicinal plants, bioprospecting, or the pet industry, or collected just for rarity value by overzealous collectors (as is the case with colophon beetles). With the currently inadequate levels of baseline data about the distribution and abundance of organisms, it is at present virtually impossible to assess the overall impacts of biodiversity exploitation[29].

In the coastal and marine environments, commercial exploitation of species is of enormous economic value to the country and in some cases directly causes over-exploitation (for details, see Chapter 7, section 7.4). Abalone (perlemoen), for instance, faces severe crisis, and extreme management measures have been implemented in an attempt to prevent the targeted species, *Haliotis midae*, from commercial extinction. A combination of extremely high international demand and exorbitant prices, coupled with insufficient enforcement capacity within South Africa, has led to the establishment of highly organized

illegal abalone fishery syndicates. Illegal harvesting of abalone has always been a factor (abalone occur in shallow water, are easily removed and thus do not require expensive fishing gear), but, since 2000 the levels of abalone poaching have escalated dramatically, to the extent that recent data indicate that the fishery is unlikely to remain sustainable, unless improvements in compliance occur immediately. Even more dramatic was the complete closure of the recreational abalone fishery for the first time in history for the 2003/2004 abalone fishing season.

Compounding the effects of abalone poaching is the ecological change occurring at the centre of the most productive abalone region, between Cape Hangklip and Hermanus in the South-western Cape. An increase in rock lobster (*J. lalandii*) abundance in this region was initially detected in 1994[30]. Rock lobsters consume small invertebrates, including sea urchins (*Parechinus angulosus*) which provide essential shelter for juvenile abalone[31, 32]. Decreasing abundance of sea urchins, due to increased predation by rock lobster, results in reduced recruitment to the abalone fishery.

By-catch from commercial fishers is another serious problem in the marine environment, leading to incidental mortality of non-target species. Such mortality rates can vary between 5% and 70% of the total catch. A serious by-catch issue is the mass mortality of seabirds killed by long-line fishing operations. (For details of other pressures on freshwater and coastal and marine ecosystems, see Chapter 6, section 6.2.2 and section 6.3.3, and Chapter 7, section 7.3 and section 7.4.)

5.2.4 Climate change

Possibly the greatest looming threat to biodiversity is climate change induced by human activities. Cyclical climate change over very long time-horizons is a natural phenomenon and has occurred in the prehistoric past. Current, human-induced warming of the global atmosphere, however, linked to the 30% increase in atmospheric carbon dioxide concentration since the start of the industrial revolution, is different in that it is happening 10 times faster than in the earlier instances, and over a landscape already fragmented by human activities[33].

The Intergovernmental Panel on Climate Change (IPCC) states that global average surface temperatures have increased, global mean sea level is rising, and the concentration of ozone in the stratosphere has decreased. Annual average precipitation has also changed and the intensity and frequency of extreme weather events seem to have increased[34]. Data from the monitoring of sea-surface temperature, mean sea level, and rainfall in South Africa suggest that changes in the local environment are echoing global patterns. Across the world, ecosystems are showing the effects of a changing climate[35]. Several South African studies completed during the 1990s strongly indicated that

the biodiversity of southern Africa is at risk[5, 36, 37, 38] from the effects of climate change, and quantitative evidence of impacts on species in the region is now emerging. For example, populations of *Aloe dichotoma* are declining in the northern (drier) part of its range, but they appear more stable in the southern part[39]. There is also evidence to suggest that expansion of tree cover into formerly open grasslands and savannas (bush encroachment), beginning around the 1960s, may have been predisposed by steadily-rising global carbon dioxide concentration[40].

In 2001, the South African Country Study on Climate Change predicted that the most dramatic responses to climate change would be in the biodiversity and human health sectors[41]. The area that climatically suits South Africa's seven existing terrestrial biomes could shrink by 40% by 2050[42] (see Map 5.4). Much of the area currently occupied by grasslands could decrease and, through increasing susceptibility to invasion by savanna species, expand the extent of the savanna biome. A disturbing prediction is the likelihood that the country could lose its succulent Karoo biome from South Africa, home to the world's largest diversity of succulent flora and arguably the world's most botanically diverse arid region.

Countrywide, habitats are expected to shift along a west-to-east gradient of aridification, leading to an increased probability of extinction, as available intact habitat is today greatly restricted. This is due in part to the fragmentation of landscapes and ecosystems by human activities such as agricultural, urban, and industrial expansion. Forty-four per cent of plant and 80% of animal species will undergo some alteration to their existing distribution ranges. Most range shifts in South Africa in both plant and animal species are predicted to take place in an easterly direction towards the eastern highlands, a pattern consistent with the predictions of significant future increases in aridity in the western parts of the country and less intense aridification in the east.

Adding to the likelihood of local extinctions is the fact that these predicted range shifts would require species to move into the currently more transformed landscapes of South Africa where habitat availability is restricted. Such movements, especially for larger species, are further constrained by infrastructure such as roads, fences, and towns. The existence of intact ecological corridors linking different parts of the landscape, will help to mitigate the impacts of climate change and should be seen as a crucial element of South Africa's climate change adaptation strategy[1].

In estuarine, coastal, and marine environments, tide gauge measurements from South Africa indicate that sea levels have risen by approximately 1.2 mm each year over the last three decades[45]. This trend is expected to accelerate in future, with recent estimates suggesting a 12.3-cm rise by 2020, a 24.5-cm rise by 2050, and a 40.7-cm rise by 2080[44]. The potential impacts include increased coastal erosion, sea water flowing into estuaries

Possibly the greatest looming threat to biodiversity is climate change induced by human activities.
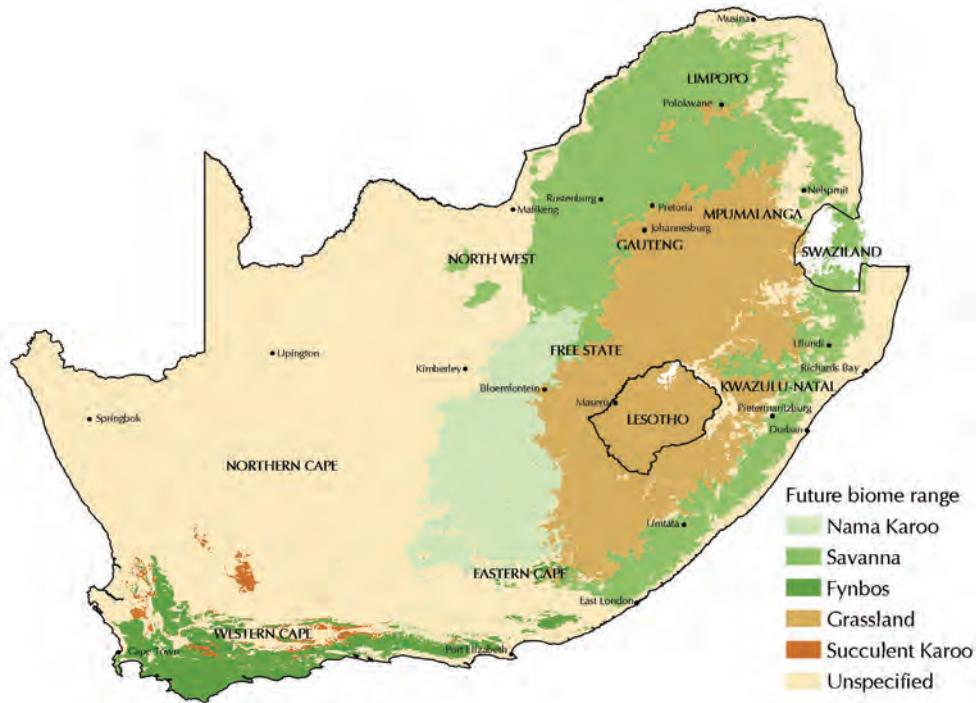
Map 5.4: Predicted reduction in existing biomes of South Africa due to climate change

Source: National Spatial Biodiversity Assessment 2004[7]

Future biome range
- Nama Karoo
- Savanna
- Fynbos
- Grassland
- Succulent Karoo
- Unspecified
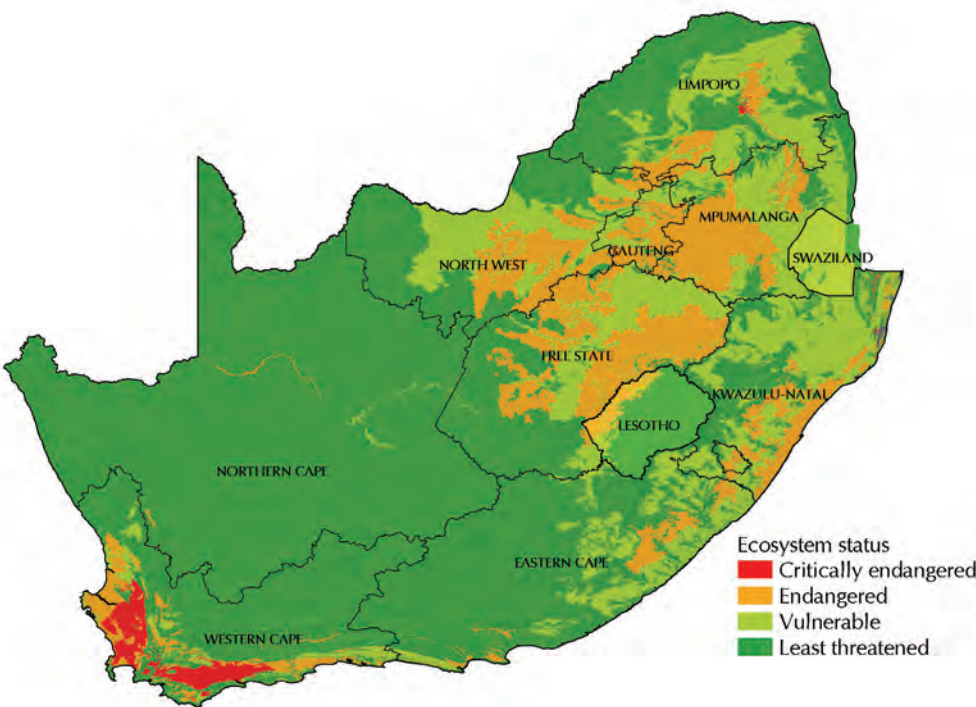
Map 5.5: Ecosystem status of terrestrial ecosystems

Source: National Spatial Biodiversity Assessment 2004[7]

Ecosystem status
- Critically endangered
- Endangered
- Vulnerable
- Least threatened

and land, increased salt-water intrusion into estuaries and groundwater, raised groundwater tables (causing surrounding areas to flood more easily), and increased vulnerability to extreme storm events[45]. The direct effects of rising sea levels on the ecological functioning of marine biota are less obvious: some regions might be adversely affected (such as salt marshes), whereas others are predicted to undergo a shift in distribution patterns and/or zones (for example, rocky shores).

Rainfall fluctuations change the amount of freshwater runoff. This is significant in the marine environment, as any reduction in freshwater flow has direct impacts on estuaries and the marine biota that utilize these systems (such as estuarine dependent fish species)[46]. Reduced freshwater flow also decreases the extent to which wastewater discharges are diluted before they reach estuaries, thereby increasing the concentration of pollutants in the coastal zone and limiting the capacity of estuarine systems to support natural biota[46].

Migrant birds, fish, and prawns use South African estuaries extensively as sheltered areas that provide feeding and nursery grounds. Most of the country's estuaries have already been severely degraded (mainly through reduced freshwater input, pollution, and habitat destruction), resulting in harmful effects on many species that depend on estuaries[47, 48].

The anticipated further reductions in the amount of freshwater entering estuaries in South Africa are likely to damage these systems even more. Comparison of the natural (that is, before human activity) Mean Annual Runoff (MAR) with current conditions in the major estuaries around the coast shows that the most drastic reduction in freshwater flow has occurred in the Orange River (reduced MAR of 39% since records began) with similarly severe reductions in other West Coast systems (reduced MAR of 30%)[49]. Other major water-catchment areas along the coast show a reduction in MAR of between 4% and 21%.

5.3 THE STATE OF SOUTH AFRICA'S ECOSYSTEMS

This section describes the status of the ecosystems and species as well as the protection levels of South Africa's terrestrial, riverine, estuarine, and marine ecosystems. In some cases, data are not readily available. The coverage of terrestrial systems is given here in some detail; for freshwater and marine ecosystems, details are presented below, and in Chapters 6 and 7, respectively.

5.3.1 Terrestrial ecosystems

The National Spatial Biodiversity Assessment (NSBA) assessed the state of South Africa's terrestrial ecosystems in relation to the pressures outlined above. (See Map 5.5 for the NSBA results.) It categorizes ecosystems into four

classes of threat based on their degree of habitat loss, relative to the biodiversity targets[c, 50] that have been set for these ecosystems.

- **Least threatened** ecosystems are still largely intact (>80% natural habitat).

- **Vulnerable** ecosystems are reasonably intact (<80% and >60% natural habitat), but are nearing the threshold beyond which they will start to lose ecosystem functioning.

- **Endangered** ecosystems have lost significant amounts of their natural habitat (<60% but still containing more natural habitat than the biodiversity target), which impairs their functioning.

- **Critically endangered** ecosystems have so little natural habitat left that their functioning has been severely impaired (they have less natural habitat than their biodiversity targets), and species associated with this ecosystem class are in decline or becoming locally extinct.

These categories of threat align with those used internationally for assessing the extinction risk of species.

Of South Africa's terrestrial ecosystems, 34% are threatened (that is, those classified as vulnerable, endangered, and critically endangered). These lie primarily within the South-western Cape's fynbos biome, the central grasslands, and the eastern coastal regions of the country. Of these:

- 21 terrestrial ecosystems (5%) are critically endangered: of these, 14 are in the fynbos biome, 5 in the forest biome, 1 in the grassland biome, and 1 is a wetland vegetation type

- 58 terrestrial ecosystems (13%) are endangered, most of which are in the grassland and savanna biomes

- 70 terrestrial ecosystems (16%) are vulnerable: most of these are in the fynbos and grassland biomes.

There are 17 vegetation types in South Africa that have been assessed as being highly fragmented, occurring especially in the Western Cape (most are fynbos vegetation types, such as Renosterveld) and in the grasslands and KwaZulu-Natal coastal belt[51] (see Table 5.1).

The protection from threat of vulnerable components of biodiversity through the establishment of conservation areas is widely accepted as one of the primary ways to conserve biodiversity directly.

South Africa's conservation areas include the formal statutory protected areas (PAs) (Type 1); the less formal PAs, such as mountain catchment areas and state forests of the Department of Water Affairs and Forestry (DWAF) (Type 2); and informal landowner activities such as game farms and conservancies (Type 3). Currently, just under 6% of land in South Africa is formally protected in Type 1 and

Type 2 PAs. The conservation estate consists of 479 Type 1 PAs (representing 77% of the total protected area in Types 1–3) and 471 Type 2 PAs. Only a few PAs are greater than 100 000 hectares (ha) in area, and most of them cover between 1 000 and 10 000 ha[7].

South Africa has a long history of proclaiming conservation areas, but the traditionally ad hoc establishment of conservation areas focused on land with low agricultural or high tourism potential. The resultant conservation area network is therefore biased towards certain ecosystems, and is far from wholly representative of the country's diversity of biomes and habitat types.

The 2004 NSBA[7] measured the proportion of the conservation target of each ecosystem (in terms of vegetation types) that had been achieved in Type 1 protected areas. (For NSBA protection level assessment results, see Map 5.6.) It reveals that 110 South African vegetation types out of 447 are not protected at all, and that an additional 90 vegetation types, with less than 5% of their biodiversity target protected, are not adequately conserved. More than 300 vegetation types have less than half of their biodiversity target conserved in statutory PAs. Only 67 vegetation types are adequately conserved (in relation to their biodiversity targets): 22 types of fynbos, 18 types of savanna, and 7 types of forest. No grassland types are adequately conserved.

Correcting these biases in coverage as well as ensuring proper management of biodiversity and ecosystem processes in these conservation areas are essential ingredients for ensuring conservation success.
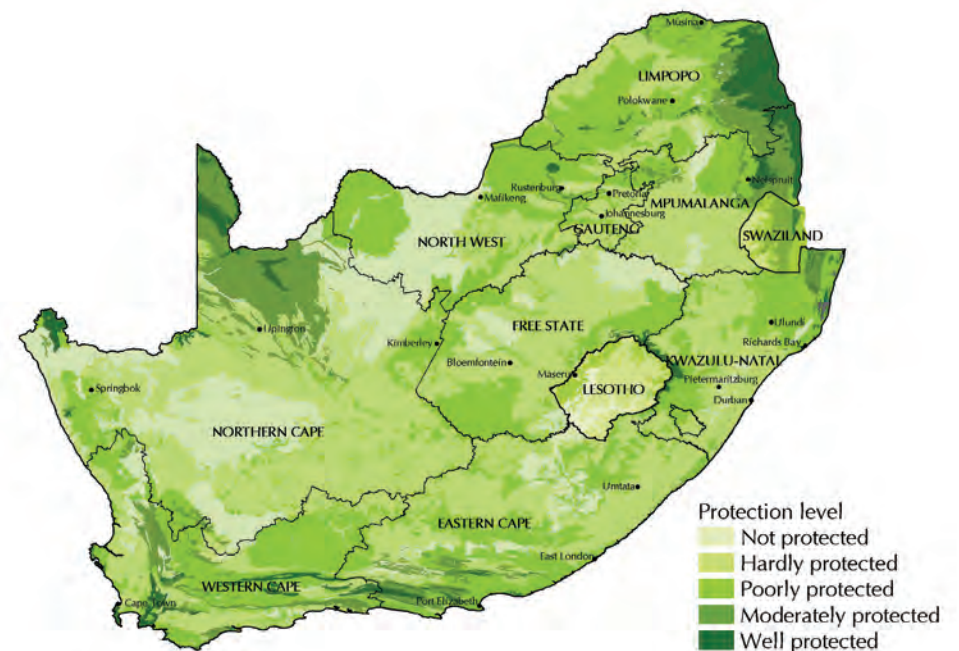
Map 5.6: Protection levels of terrestrial ecosystems
Source: National Spatial Biodiversity Assessment 2004[7]

Table 5.1: Critically endangered vegetation types in South Africa

Vegetation type	Biome	Remaining area (%)	Biodiversity target (%)	Protected (%)
Piketberg Quartz Succulent Shrubland	Fynbos	0	26	0.0
Lourensford Alluvium Fynbos	Fynbos	7	30	4.2
Swartland Shale Renosterveld	Fynbos	9	26	0.5
Swartland Silcrete Renosterveld	Fynbos	10	26	0.6
Cape Vernal Pools	Wetlands	12	24	0.0
Central Ruens Shale Renosterveld	Fynbos	13	27	0.4
Western Ruens Shale Renosterveld	Fynbos	14	27	0.0
Elgin Shale Fynbos	Fynbos	18	30	5.9
Cape Flats Sand Fynbos	Fynbos	19	30	0.1
Eastern Ruens Shale Renosterveld	Fynbos	19	27	0.4
Swartland Granite Bulb Veld	Fynbos	20	26	0.6
Ruens Silcrete Renosterveld	Fynbos	22	27	0.1
Peninsula Shale Renosterveld	Fynbos	23	26	18.7
Swartland Alluvium Fynbos	Fynbos	25	30	1.7
Woodbush Granite Grassland	Grassland	26	27	0.0
Cape Lowland Alluvial Vegetation	Fynbos	31	31	0.7
Swamp Forest	Forest	95	100	100.0
Mangrove Forest	Forest	96	100	46.9
Lowveld Riverine Forest	Forest	97	100	100.0
Sand Forest	Forest	98	100	100.0
Ironwood Dry Forest	Forest	100	100	100.0

Note: These were identified based on extent of habitat transformation and biodiversity target. For all of them, the percentage of remaining natural habitat is less than the biodiversity target (set to represent 75% of the plant species associated with the vegetation type).

Source: Taken from Rouget et al. (2005)[22]

5.3.2   River ecosystems

Owing to the water-scarce nature of most of South Africa, our rivers are vulnerable to over-exploitation and modification, which has implications for aquatic ecosystem functioning and biodiversity. Biodiversity conservation can be particularly challenging in water-limited countries such as South Africa, where the main rivers are heavily used, with multiple demands from urban settlements, agriculture, and industry.

A 2004 integrity assessment of South Africa's rivers[52] demonstrated that 48% are moderately modified, 26% are largely to critically modified, while 26% are intact. Insufficient data on river integrity at a national scale is a major limitation to this assessment, however. The results are based on an assessment of main rivers only, and ignore the substantial conservation potential of numerous tributaries within catchments where the main river is not intact.   This

highlights the importance of healthy tributaries as refuges for conserving biodiversity.

The status of river ecosystems was derived in a similar way as that of terrestrial ecosystems, based on the extent of remaining intact (that is, natural or near-natural) river length of each main river ecosystem in relation to its biodiversity target[52]. Main river ecosystems were combined spatially with river integrity data to calculate the intact length of each main river ecosystem. Intact length was compared to the total length of each main river ecosystem to derive conservation status categories of each ecosystem, defined as follows:

- **Least threatened** (LT) river ecosystems have an intact length >60% of their total length

- **Vulnerable** (VU) river ecosystems have an intact length >40% of their total length

- **Endangered** (EN) river ecosystems have an intact length below their biodiversity target (in this case, 20% of their total length)

- **Critically endangered** (CR) river ecosystems have an intact length below their biodiversity target (this target is 10 % of their total length).

The results (see Map 5.7) indicate that 82% of main river ecosystems are threatened. Water management areas in the south of the country (Berg, Breede, and Gouritz), and those associated with the middle and upper Vaal River are most in need of protection, that is, these rivers risk irreversibly losing the ability to support their biodiversity components (natural river habitat, plants, and animals). These ecosystems have lost so much of their original natural habitat that ecosystem functioning has broken down and species associated with the ecosystem have been lost or are likely to be lost. Of the 82% of river ecosystems that are threatened, 44% are critically endangered, 27% are endangered, and 11% are vulnerable.

When the river ecosystem status outputs are compared with those of terrestrial ecosystems (compare Maps 5.2 and 5.7), it becomes clear that the state of river biodiversity in the country needs urgent attention. The results show that the state of terrestrial biodiversity in the country (despite itself needing attention) is generally better than that of river and marine ecosystems[7].

Formal protected areas in South Africa focus primarily on conserving terrestrial ecosystems and, in the process, inadvertently capture portions of river ecosystems that run through them. Little emphasis has been placed on proclaiming protected areas for the primary purpose of conserving entire river lengths (mainly because this is not a practical management option for rivers, which generally traverse great distances in the landscape) or that encapsulate important catchment areas. Statutory reserves or conservation agreements protect only 7% of the total

Orange River below van der Kloof Dam. *Photography: South African Tourism*

river length in South Africa (this does not include privately owned areas). Approximately one third of South Africa's main rivers define the boundaries of protected areas rather than occurring within them, and therefore they cannot be considered protected. This situation emphasizes the polarity between conservation approaches to terrestrial and
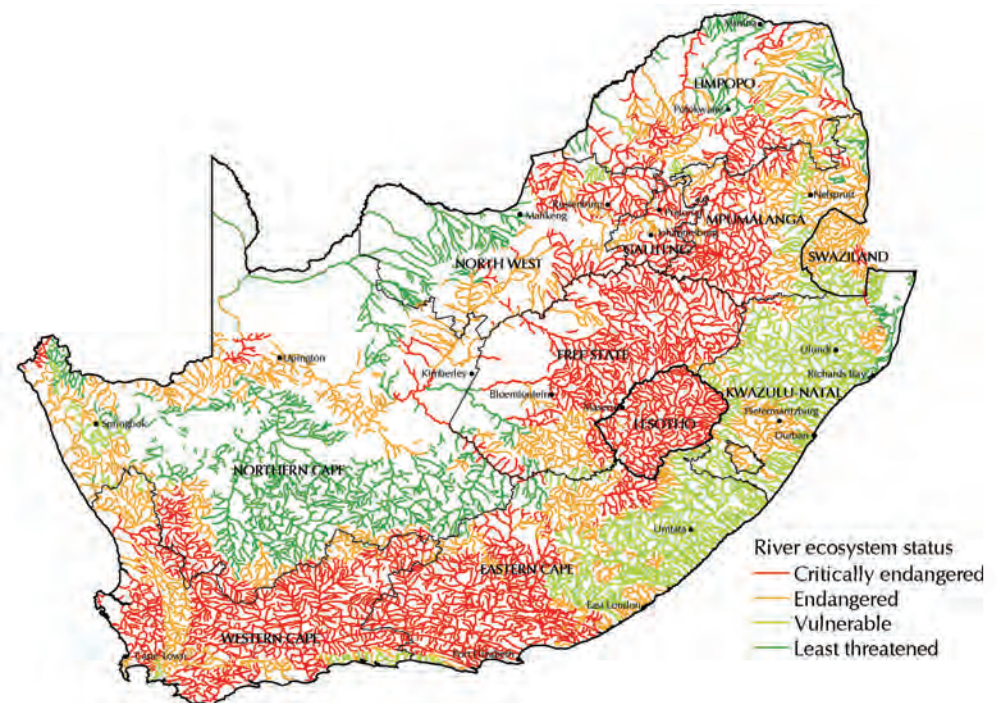
Map 5.7: Ecosystem status of South African rivers

freshwater biodiversity over the past century[52], but there is evidence that significant recovery of river system health can occur downstream of protected areas.

5.3.3   Wetlands

The National Water Act (No. 36 of 1998) defines a wetland as "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil". There are many wetland types including springs, mires, bogs, floodplains, vleis, seeps, coastal lakes, estuaries, and mangrove swamps.

Wetlands perform many essential functions such as the "enhancement of water quality, erosion control, water storage, streamflow regulation, flood attenuation, and maintenance of biodiversity" and supply many essential goods and services[53, 54]. They have significant social and economic value, providing food, plant, water, medicinal resources, and livelihood to rural communities, and contribute in important ways to tourism, subsistence farming, grazing, and environmental education and awareness[54]. More important, a healthy wetland system indicates a healthy functioning ecosystem. Most wetlands are either fed by groundwater inflows, or they lose water by seepage into the subsurface, or both. During drier months, groundwater is generally the only source of water for many of these ecosystems[56].

Wetlands are essential in an arid, water-scarce country such as South Africa, yet an estimated 50% of South Africa's wetlands have been destroyed[57, 58]. This serious

loss is caused, for example, by the building of dams, incorrect burning and overgrazing, invasive alien species, the use of wetlands for waste disposal and the abstraction of water, the drainage of wetlands for agricultural cultivation or urban development, and inappropriate land management. The exploitation and degradation of South Africa's wetland ecosystems is set to rise as the human population grows and increases its demand for water and land for settlement in and around urban areas[59].

Little reliable information exists on the distribution and state of wetlands. The NSBA used data from 1995 and the latest vegetation map to identify 740 wetlands divided into 17 wetland types and 12 wetlands/estuaries of international significance. Cowan's (1995)[60] wetland dataset is the best available for the country, although the NSBA identified significant gaps in this dataset, especially in some parts of the country, for example the Eastern Cape. For reliable future assessments of the state of South Africa's wetlands, a more comprehensive wetlands map as well as information on the state of wetlands are required (such a map is in development through the National Land Cover 2000 Project).

About 10% of the number of wetlands in South Africa are fully protected and another 8% are partly protected; 16% of the country's wetlands have no legal protection, and there is no available information on about 66% of them, which is a serious impediment to our ability to protect and manage this valuable resource adequately.

Possibly the most important factor in the conservation of South African wetlands is South Africa's participation as a founding member of the Ramsar[d] Convention on Wetlands (it was the fifth contracting party in 1975). To meet its Ramsar obligations and to promote the conservation of wetlands throughout southern Africa, the country implemented the South African Wetlands Conservation Programme. Since 1975, South Africa has had 17 sites added to the Ramsar List of Wetlands of International Importance (see Table 5.2).

The international importance of wetlands is demonstrated by their visitors, such as the wading birds from as far away as the Russian tundra that winter in the wetlands of southern Africa, and the fact that some southern-breeding birds fly to other parts of the world as part of their life cycles. According to the Ramsar Information Pack (available at http://www.ramsar.org), "These [wetland] functions, values and attributes can only be maintained if the ecological processes of wetlands are allowed to continue functioning. Unfortunately, in spite of important progress made in recent decades, wetlands continue to be among the world's most threatened ecosystems, owning mainly to ongoing drainage, conversion, pollution, and over-exploitation of their resources". The protection of wetlands needs to combine water resource management with land-use management.

Highmoor wetland near farmland. *Photography: Janet Peace*

To date, implementation of catchment management planning in South Africa has been weak, owing to fragmented institutional arrangements, confusion about overlapping jurisdiction and areas of responsibility, and lack of appropriate management strategies that bring wetlands to the fore in the water and natural resource sectors[61].

5.3.4 Estuarine ecosystems

An estuary is a portion of a river system that has, or can have, interaction with the sea. Concern about the state of South Africa's 259 estuaries stretches back to at least the 1970s, when few estuaries were found to be in their original state, especially in KwaZulu-Natal[62, 63, 64]. A DWAF national assessment of the condition of South African estuaries in the 1980s[65, 66] found that about a quarter of KwaZulu-Natal's estuaries and a fifth of those in the then Cape Province were in a poor condition.

In 2000, an assessment by Whitfield[67] on the condition of South African estuaries (including those of the old Ciskei and Transkei) classified them as follows:

- **Excellent:** estuary in near pristine condition (negligible human impact)

- **Good:** no major negative anthropogenic influences on either the estuary or catchment (low impact)

- **Fair:** noticeable degree of ecological degradation in the catchment and/or estuary (moderate impact)

- **Poor:** major ecological degradation arising from a combination of anthropogenic influences (high impact).

The NSBA used the Whitfield (2000)[67] results with some adjustments (as more recent assessments were subjective or geographically biased). Ecosystem status (from least threatened to critically endangered) was determined on the basis of the proportion of estuaries in each type within each zone that were in a good or excellent state of health[68].

South Africa's estuaries are in relatively good health. The condition of 28% of them is considered to be excellent; that of another 31% is good; 25% is classified as fair and 15% as poor. Estuaries along the south and southeast coast tend to be healthier than those in the rest of the country (see Map 5.8) and the estuaries along the Wild Coast are healthiest of all. On average, health is also relatively good for the major systems on the west coast and in northern KwaZulu-Natal. Estuaries tend to be in fair to poor health along the intensively developed areas of the Cape southwest coast, around Port Elizabeth, and along most of the KwaZulu-Natal coast.

In terms of ecosystem status for estuary types, most of the groups occurring in transition zones between ecoclimatic areas are endangered or critically endangered. In the subtropical zone, all but permanently open estuaries are endangered or critically endangered, and all estuary types

Table 5.2: South African Ramsar sites

Province	Ramsar sites
Free State	Seekoeivlei Nature Reserve
Gauteng	Blesbokspruit
KwaZulu-Natal	Kosi Bay System
	Lake Sibaya
	Ndumo Game Reserve
	St Lucia System
	Turtle Beaches & Coral Reefs of Maputoland
	Ukuhlamba Drakensberg Park
Limpopo	Nylsvley Nature Reserve
Mpumalanga	Verloren Valei Nature Reserve
North West Province	Barberspan
Northern Cape	Orange River Mouth
Western Cape	De Hoop Vlei
	De Mond State Forest
	Langebaan Lagoon
	Verlorenvlei
	Wilderness Lakes

in the cool temperate zone are endangered or critically endangered. In the warm temperate zone, permanently open estuaries are endangered, but other estuary types are in better condition.

The overall level of protection of South African estuaries is low. Of the 41 estuaries within protected areas, only 14 (5.4%) have a high level of protection and, of these estuaries, most are very small. This is a long way from the minimum target of 30% of estuaries protected at a high level as recommended by Turpie *et al.* (2004)[68]. Several well-protected estuaries occur in KwaZulu-Natal, including some of the country's largest estuaries (St Lucia and Kosi). A series of small estuaries has high-level protection within the Tsitsikamma National Park in the Eastern Cape. Further west along the coast, the Heuningnes and Kromme estuaries also fall within securely protected areas. For the remaining estuaries, protection is only partial (that is, only parts of the estuary are protected, or only areas below the high tide mark), as is the case for the estuaries within the Pondoland Marine Protected Area.
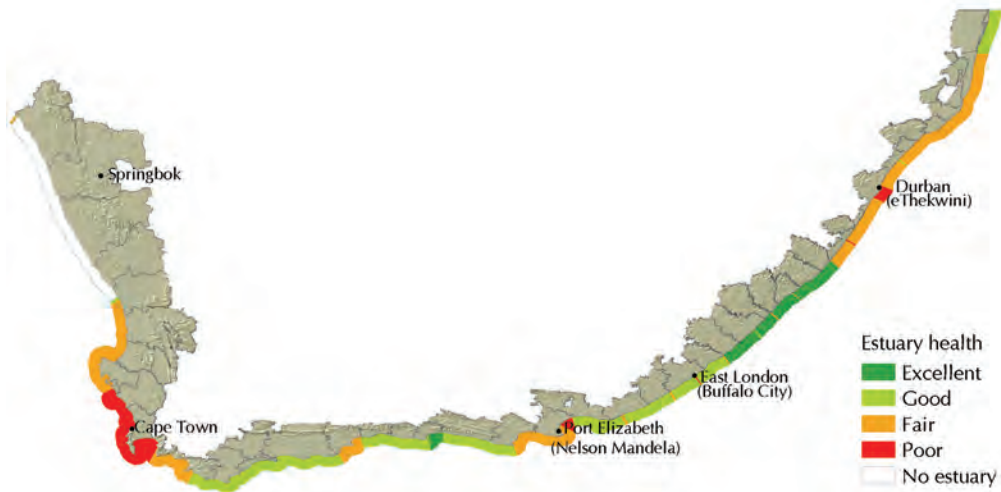
Map 5.8: Estuary health in South Africa
Source: National Spatial Biodiversity Assessment 2004[7]

The extraction of living marine resources is the overriding threat to South African marine biodiversity and affects all depth strata and all bioregions.

5.3.5 Marine ecosystems

The NSBA was the first national spatial assessment of marine ecosystems. It mapped 34 biozones (broad marine ecosystems), defined as depth zones (moving from the coast to the abyss), subdivided by bioregions (moving from west to east). (For the threat status of these biozones, see Map 5.9.) The assessment found that 65% of South Africa's marine biozones are threatened. Of these, 12% are critically endangered, 15% are endangered and 38% are vulnerable.

The extraction of living marine resources is the overriding threat to South African marine biodiversity and affects all depth strata and all bioregions. Pollution and mining are the next most serious threats, but mining is restricted to particular biozones, especially on the west coast. Mining and commercial fishing are responsible for the critically endangered status of the west-coast biozones (see Map 5.9). All threats are predicted to increase in the next ten years, especially those posed by invasive alien species and mariculture. Owing to the high number of

species (some 250) targeted by South African commercial fisheries, more species-level interventions may be required in the marine environment than in the terrestrial environment.

The assessment of priorities needing most urgent attention showed that the west-coast biozones not only have the least protection (zero), but also currently experience the greatest threats. Immediate conservation intervention in these biozones is required to prevent irreversible negative impacts.

The NSBA's spatial evaluation of existing marine protected areas (MPAs) in South Africa shows that, while 23% of the coastline is protected by MPAs, only 9% of the area of these MPAs are fully protected (that is, classified as no-take zones). In addition, MPAs are not distributed evenly along the coast and therefore do not represent the full spectrum of South Africa's coastal marine biodiversity. The entire Namaqua bioregion on the west coast has no MPA, whereas more than 20% of the Delagoa bioregion (on the Mozambique border) is protected in no-take MPAs. The state of the offshore environment is worse, with less than 1% of South Africa's Exclusive Economic Zone (EEZ) within MPAs and, of this tiny proportion, less than 0.2% is no-take. A proposed Namaqualand MPA would more than double the sea-surface area under protection, but would still fall far short of the 20% internationally recommended target[69].

Protection status data in the NSBA (see Map 5.10) show that 23 of its 34 biozones have zero or little protection. These include the Namaqua biozones, the lower slope, and the abyss in South Africa's EEZ. Well-protected biozones include many of the supratidal biozones and the biozones of the Delagoa bioregion. The NSBA cautions that MPAs do not always ensure adequate protection of biodiversity, and that more effort is needed to ensure compliance within MPAs.

5.4 THE STATUS OF SPECIES

5.4.1 Terrestrial species

Threatened species constitute a widely used indicator of the status of biodiversity. Red Data Books and lists based on World Conservation Union (IUCN) criteria are used to highlight species at high risk of extinction. These assessments are excessively time- and resource-demanding, however, and are therefore infrequently conducted, particularly at a regional or local scale. As a result, the indicator is often based on outdated or global assessments.
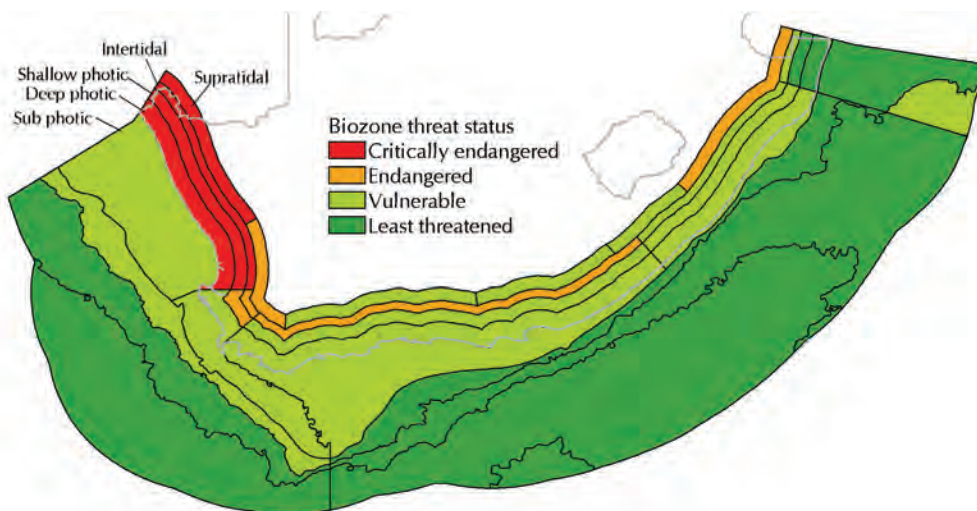
Recent South African assessments of the status of birds, mammals, and frogs have demonstrated that almost 10% of South Africa's birds and frogs are threatened, and 20% of its mammals are threatened (Figure 5.3)[70, 71, 72]. The country's plants are currently being assessed by the

Map 5.9: Ecosystem status of marine biozones
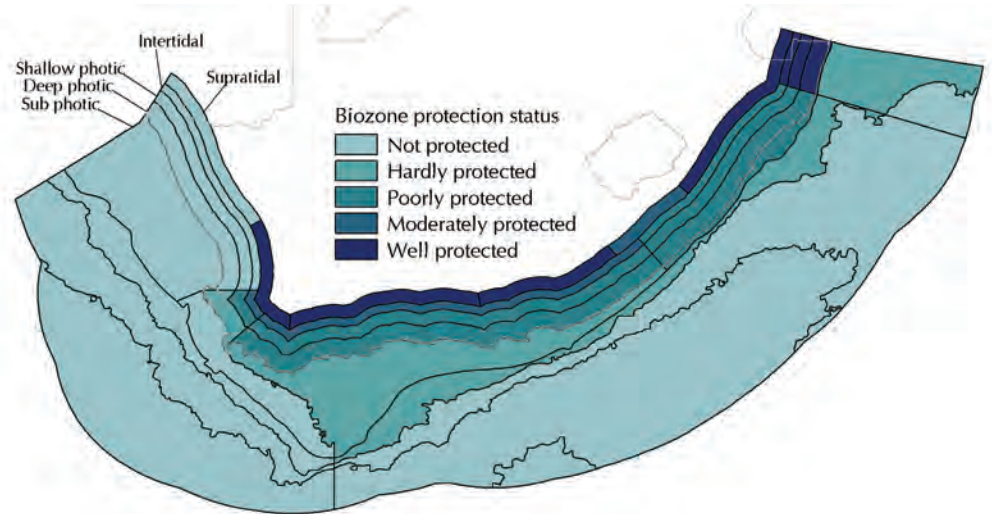*Source: National Spatial Biodiversity Assessment 2004[7]*

South African National Biodiversity Institute's threatened species programme. Previous assessments show over 10% of plant species threatened with extinction in South Africa[8].

The threatened species indicator becomes most useful when it is spatially explicit (that is, when it is possible to locate the area where threatened species occur). The 2002 national assessment by the Endangered Wildlife Trust (EWT) attempted to correlate the numbers of threatened species (excluding plants) with biomes (see Figure 5.4). It found that no particular biome contains more threatened species than any other, but if the plants had also been fully assessed, the fynbos would probably have been highlighted.

5.4.2   Freshwater species

Although many taxa inhabit our rivers, most conservation information is limited to fish. No known fish species have become extinct in South Africa, but there are records of some species being eliminated from certain river systems, and many species showing range reductions[1]. Approximately 36% of freshwater fish are threatened, but there is a need to reassess their conservation status[1]. A summary of the status of six flagship species is presented below[8]:

- Nile crocodile (*Crocodulus niloticus*): distribution has declined and is largely confined to conserved areas, owing to habitat destruction and indiscriminate slaughter. Nile crocodiles are important as top predators of fish such as barbel. (No detailed predation data currently available.)

- Cape clawless otter (*Aonyx capensis*): the main threats to the survival of this clear freshwater-dependent mammal are water extraction, construction of dams, and invasive aquatic plants. Their numbers and distribution are declining steadily, with some local extinctions caused by loss and degradation of habitat.

- African jacana (*Actophilornis africanus*): this bird is associated with aquatic habitats that contain floating hydrophytes, typically seasonal pans and floodplains, and slow-moving rivers. Wetlands suitable for breeding are increasingly threatened by water management and extraction schemes. (No detailed data currently available.)

- East coast rocky (*Sandelia bainsii*): This freshwater fish occurs only in short sections of several rivers in the Eastern Cape. It is now considered critically endangered (in the past 30 years its population numbers have dropped exponentially), the main threats being habitat change, alien fish through inter-basin transfers (notably the sharptooth catfish), dam building, and excessive water extraction.

- Small scale redfin minnow (*Pseudobarbus asper*): unlike their redfin minnow cousins confined to the Cape fold belt, this species has adapted to several Karoo streams
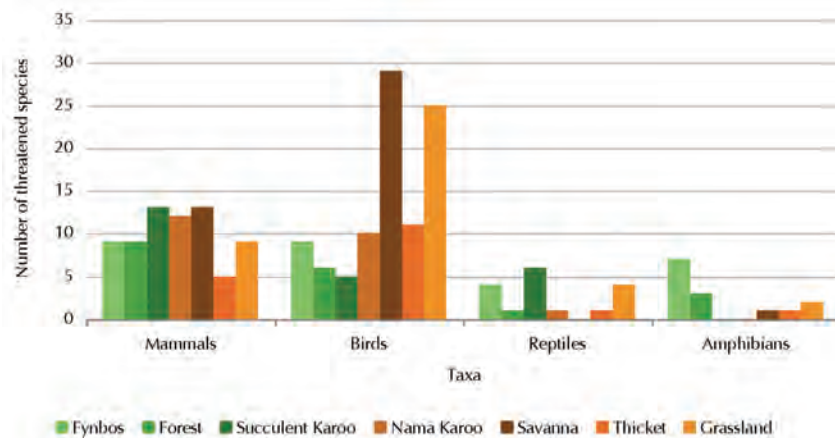

Map 5.10: Protection levels of marine biozones
Source: National Spatial Biodiversity Assessment 2004[7]
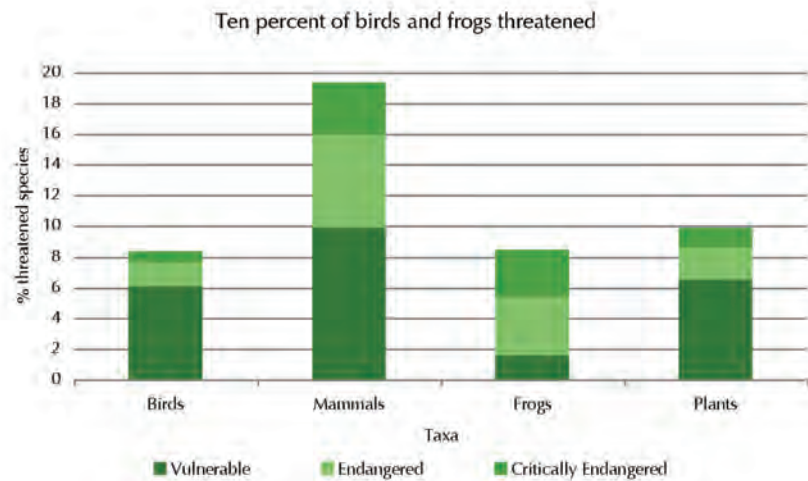
Figure 5.3: Threatened species per taxonomic group
Source: Endangered Wildlife Trust, 2002[8]

Figure 5.4: Number of threatened species per taxonomic group per biome
Source: Endangered Wildlife Trust, 2002[8]

Box 5.3 Rare antelope declines in the Kruger National Park

Between 1986 and 1995, populations of three rare antelope species declined drastically in the Kruger National Park. Only about 25 roan antelope, 500 sable antelope, and 250 tsessebe remained. These low numbers threaten the possible loss of a substantial part of the park's large herbivore diversity.

Decline of antelope species

What has caused this decline?

All three species are at the limits of their distribution range in the Kruger National Park, and occur more commonly in wetter savannas to the north. Hence the persistently low rainfall in this period with extreme droughts associated with El Niño conditions in 1982/3 and in 1991/2 is an obvious factor to consider. Despite the dry conditions – and while numbers of kudu, waterbuck and warthog also decreased drastically – zebra, wildebeest, giraffe and impala maintained high abundance levels.

Why were the latter species more resistant to the dry conditions? Calf production had remained unchanged during the period of the declines for all of the species affected. Changes in population trends must therefore have resulted from a decrease in survival of adults. If decreases in abundance resulted from reduced food production because of low rainfall, juveniles would have been affected most. Could predators, in particular lions, play a role? Although there was no information on lion numbers, the prey base for lions (mainly zebra and buffalo) had increased. If the lion population had increased as a consequence, other ungulates would have incurred a higher risk of predation, simply because there was a greater chance that they would encounter lions. The pattern was clear in the north of the Park. Following the 1982/3 drought, zebra numbers doubled in the north and rangers reported seeing more lions here, where lions had not formerly been very numerous. An increase in the prey base had enabled lions to move in and establish pride territories, thus increasing the exposure of roan, tsessebe, and sable in this region to predation.

But why then were the populations of zebra, wildebeest, and buffalo, the three main prey species for lions, unaffected? A previous analysis showed that numbers of wildebeest and zebra tend to increase under dry conditions, because they are less vulnerable to predation owing to the reduction of grass cover to hide stalking lions. Buffalo, however, are more vulnerable to being killed when rain is low, and they helped to support the supposed increase in lion abundance after 1983. The species that declined after 1986 all seemed to do best when the rainfall was high, so the dry conditions through the late 1980s probably contributed to their susceptibility to predation.

However, the doubling in numbers of zebra seemed largely to be a response to the widened distribution of surface water throughout the park, as a consequence of the policy of adding additional waterpoints in the form of boreholes, dams, and weirs. This seemed to have benefited mainly the common, water-dependent ungulates at the expense of less common species, and, in particular, the abundance of lions through the expansion in their prey base.

This picture shows how the effects of changing rainfall ramify through an ecosystem by affecting different species in different ways. The more fundamental message is that the augmentation of surface water caused the loss of regions where other ungulate species could escape high predation risks and thus, in the past, persist through drought conditions. Park managers are currently removing many of the artificial waterpoints that had previously been established, but have to consider also the attraction that these provide for tourists.

Sources: Text by Norman Owen-Smith (University of the Witwatersrand) and based on research by Ogutu and Owen-Smith (2005)[73], Owen-Smith (in press)[74], Owen-Smith and Mills (in press)[75], Owen-Smith (2005)[76], Owen-Smith and Mason (2005)[77], Owen-Smith et al., (2005)[78], Ogutu and Owen-Smith (2003)[79], Harrington et al., (1999)[80].

A group of sable antelope at waterhole. *Photography: South African Tourism*
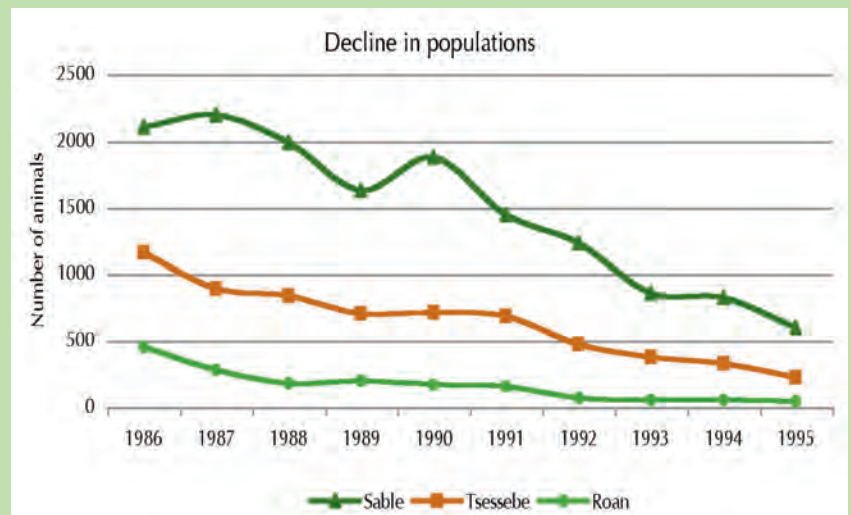
Decline of antelope species

where, in response to intermittent flow patterns, they have evolved to mature early and produce large numbers of eggs to take advantage of 'boom and bust' conditions. Introduction of the alien catfish, however, is severely reducing their numbers in the Gamtoos River system.

- Basking malachite damselfly (*Chloroestes apricanus*): described only in 1975, this damselfly was known from ten locations in the clear, unspoilt streams of the Stutterheim area of the Eastern Cape. It is now known only from two sites, but the removal of alien invasive trees, especially black wattle, is helping this sun-loving species to recover.

5.4.3 Wetland species

Wetlands are crucial habitat for many species, often performing a vital role in the life cycle stage of a species (for example, for migratory stopovers or as breeding grounds). They support high concentrations of birds (especially waterfowl), mammals, reptiles, amphibians, fish, and invertebrates, and they are renowned for their high levels of endemic and specialized species. Unlike terrestrial ecosystems, the richness of freshwater biodiversity is still little known. Identification and classification of wetland species is hampered by the fact that many of them may spend only part of their lives in wetlands. The African jacana flagship species found in freshwater systems could equally be considered a flagship wetland species.

5.4.4 Estuarine species

There is also little information on the status of estuarine species, a serious gap in the overall conservation database. The estuaries of the Western and Eastern Cape are vital in providing a sanctuary for endemic species[8]. Six flagship species include[8]:

- Knysna seahorse (*Hippocampus capensis*): this estuarine fish is endemic to South Africa and is known only from the Knysna and Swartvlei estuaries of the southern Cape coast. It is considered the most endangered seahorse in the world (according to the IUCN Red Data lists). Its threatened status is due to habitat degradation in its extremely limited habitat and to mass mortalities in the Swartvlei estuary that were caused by artificial breaching of the estuary mouth.

- Peringuey's leaf-toed gecko (*Cryptactities peringueyi*): this small gecko was rediscovered in 1992 after being 'lost' for 80 years. The only gecko in the world that lives in salt marshes, it is known only from the Kromme River estuary and a few sites near Port Elizabeth. As salt marshes disappear under bulldozers, so also will this unique gecko.

- White steenbras (*Lithognathus lithognathus*): the once abundant white steenbras is now severely depleted –

The Knysna seahorse (*Hippocampus capensis*) is endemic to Knysna and Swartvlei estuaries.
Photography: IMAGES24.co.za / Beeld / Alan Murdoch

down to 5% of its original biomass – through over-fishing (because of its spawning aggregations, it was vulnerable to heavy fishing pressure and beach seine nets) and habitat degradation (its juvenile nurseries are estuary dependent). Severe fishing restrictions are now in place to save this valuable endemic.

- Estuarine pipefish (*Syngnathus watermeyeri*): an Eastern Cape endemic, this fish was known only from the Bushmans, Kariega, and Kasuka estuaries, with the last known specimens in these estuaries collected in 1963. In 1996, a healthy population was discovered in the East Kleinemonde estuary, however, the only estuary where this species has again been found. Its precipitous decline is due to the absence of the required fresh water pulses into the estuaries, in catchments where upstream impoundments have inadequate environmental flow allocations.

- Burrowing prawn (*Callianassa sp.*): abundant in estuaries from Saldanha on the west coast to southern Mozambique, burrowing prawns are targeted by fishermen for bait. Nevertheless, their populations appear robust and they are more at risk from isolated events, such as salinity fluctuations and pollution.

- Eelgrass (*Zostera sp.*): eelgrass, present in many South African estuaries, binds sediments, shelters juveniles, and serves as a primary food producer. It is threatened by mismanaged catchments, pollution, and disturbance of estuaries. Eelgrass stands remain viable in smaller estuaries, but rehabilitation in larger systems is urgently needed.

Because of habitat degradation and increasing human pressures on estuaries, four South African estuarine fish species are listed as critically endangered on the IUCN Red Data List: doublesash butterflyfish (*Chaetdon marleyi*), Knysna seahorse (*Hippocampus capensis*), St Lucia mullet (*Liza luciae*), and estuarine pipefish (*Sygnathus watermeyeri*).

Leatherback turtle. *Photography: South African Tourism*

5.4.5 Marine species

Some 10 000 species of marine plants and animals have been recorded in South Africa's marine environment[8], that is, almost 15% of global marine species diversity. Some of these represent an important resource base for coastal subsistence communities, as well as for the millions of people who eat them. Little information exists on the status of marine species overall, and available data relate to particular species that are exploited for human use. Although many fisheries are stable and well managed, there are some alarming trends for species such as lobster, abalone, and linefish. One example is the Patagonian toothfish (*Dissostichus eleginoides*), a threatened species found in the waters of South Africa's EEZ around the Prince Edward Islands. Illegal fishing of the Patagonian toothfish in these waters, estimated at over 20 000 tons in 1996[81], has decimated the stocks.

Five critically endangered, 15 endangered, and 26 vulnerable marine animal species have been recorded in South Africa[8]. These numbers are low and reflect the inadequacy of our information on marine species, mostly because collecting such information is difficult, given the limitations on time that can be spent under water. Valuable marine species are for the most part assessed in terms of their commercial status rather than their absolute abundance.

All five species of marine turtles occurring in South African waters are listed on the IUCN Red List as either vulnerable or endangered. Leatherback turtles (*Dermochelys coriacea*) are particularly susceptible to long-line fishing and trawling, but the use of turtle-excluder devices is now mandatory and has assisted in promoting the status of these turtles from critically endangered in 2001 to endangered in 2004. All leatherback turtle nesting sites in South Africa occur within the Greater St Lucia Wetland Park, which is a world heritage as well as a Ramsar site, thus

affording these nesting grounds the country's highest level of protection.

The status of the blue whale (*Balaenoptera musculus intermedia*) is classified as endangered and, although it is now fully protected in South African waters, populations are still struggling to recover from historic exploitation. Four other marine mammal species occurring in South African waters are considered to be vulnerable, namely, the Indian Ocean bottlenosed dolphin (*Tursiops aduncus*), the Indian Ocean humpback dolphin (*Sousa plumbea*), the sperm whale (*Physeter macrocephalus*), and Bryde's whale (*Balaenoptera brydei*).

Oceanic and coastal bird species are primarily threatened by long-line fishing activities, habitat loss, and disturbance while nesting. The bittern (*Botaurus stellaris*) is considered to be critically endangered due to loss of habitat in northern KwaZulu-Natal, and three tern species are listed as endangered, primarily due to habitat loss and disturbance. The Tristan albatross (*Diomedea dabbenena*) and spectacled petrel (*Procellaria sp.*) are listed as endangered and four further albatross species as vulnerable, mostly due to long-line-fishing-induced mortalities. These six species have become listed as 'endangered' or 'vulnerable' within the past decade.

On its Red List, the IUCN lists 53 species of coastal fish found in South African waters, but this is a global assessment and its pertinence to actual fish populations in this country has been questioned[82]. The most recent evaluations of South Africa's marine fish status indicates that up to 20 species of commercial and recreational marine fish are considered over-exploited and/or collapsed[83, 84]. (See Chapter 7, section 7.5.)

The NSBA marine species analyses based on seaweeds, intertidal invertebrates, and fish demonstrated that, although many of these species may exist in marine protected areas (MPAs), their status is uncertain. Surveys of the relevant MPAs are required, as several gaps were

Black wattle infesting the banks of the Klein Brak River. *Photography:Wilma Strydom*

Some 10 000 species of marine plants and animals have been recorded in South Africa's marine environment, that is, almost 15% of global marine species diversity.

identified in terms of species protection in these areas. The study found that if the proposed Namaqualand MPA is proclaimed, it could protect a representative sample of all the species occurring along the Northern Cape coastline. Owing to the fact that the fish fauna are the most exploited and threatened component of marine life, the NSBA stressed that an accurate fish distribution database needs to be compiled, to allow these analyses to be repeated. (See Chapter 7, section 7.4.)

5.5 THE IMPACTS OF BIODIVERSITY LOSS

Destruction of ecosystems and loss of biodiversity can bring significant opportunity costs to social and economic systems through damage to the health, functions, and services that ecosystems provide. For example, according to the Working for Water programme, invasive alien plants use up 7% of South Africa's water resources; restrict and decrease the country's agricultural capacity, intensify flooding and fires, and are the cause of erosion, destruction of rivers, siltation of dams and estuaries, and poor water quality. They can also directly bring about the extinction of indigenous plants and animals. Total economic losses of ecosystem services in the fynbos areas from alien plant invasion amount to almost R700 million per year, that is, an average annual 10% loss of economic opportunity, and growing[85]. Global value of economic losses due to invasive alien species amount to almost 5% of the world economy, or some US$1.4 trillion a year[16]. (See Box 5.2 for some of the opportunity costs of biodiversity loss in Durban.)

In the long term, over-exploitation of natural resources leads to dysfunctional ecosystems and deterioration in their productivity. This problem is compounded by lack of regulation and inadequate understanding of the impacts of over-exploitation. Adverse effects of over-exploitation include indirect effects on non-target species (for example, the killing of albatrosses caught in the by-catch of fishing industries using the long-line method[86]).

5.6 RESPONDING TO BIODIVERSITY LOSS

Responses to the loss of biodiversity and of ecosystem health include measures that aim to conserve biodiversity

Destruction of ecosystems and loss of biodiversity can bring significant opportunity costs to social and economic systems through damage to the health, functions, and services that ecosystems provide.

Box 5.4 **Transfrontier Parks and Transfrontier Conservation Areas (TFCAs)**

One of the boldest and most exciting cross-border initiatives currently unfolding in southern Africa is the establishment, development, and management of Transfrontier Parks and Transfrontier Conservation Areas.

A Transfrontier Park comprises two areas, which border each other across international boundaries and whose primary focus is wildlife conservation. Authorities responsible for the respective areas formally agree to manage the areas as one integrated unit according to a streamlined management plan. The authorities also undertake to remove all human barriers within the Transfrontier Park so that animals can roam freely.

A Transfrontier Conservation Area (TFCA) is defined as a relatively large area, straddling frontiers between two or more countries and covering large-scale natural systems encompassing one or more protected areas. In a TFCA, different component sections have different forms of conservation status, such as national parks, private game reserves, communal natural resource management areas, and even hunting concession areas. Although fences, major highways, railway lines, and other forms of barrier may separate different sections, they nevertheless border each other and are managed jointly for long-term sustainable use. As distinct from

Transfrontier Parks, free movement of animals between the different parts that constitute a TFCA may not always be possible.

Although the establishment and development of Transfrontier Conservation Areas and Parks is a means for conservation and sustainable use of biological and cultural resources, they also aim to facilitate and promote regional peace, cooperation, and socio-economic development. It is envisaged that Transfrontier Parks and TFCAs will enable tourists to drive across international boundaries into adjoining conservation areas of participating countries with minimal obstacles and inconvenience. They are also expected to provide jobs and revenue generating opportunities for many local people.

San family in the Kgalagadi Transfrontier Park.
Photography: South African Tourism

South African National Parks and the Department of Environmental Affairs and Tourism have established a number of Transfrontier Conservation Areas and Parks that include the following:

• Kgalagadi Transfrontier Park – Botswana and South Africa signed a bilateral agreement in 1999

• Limpopo–Shashe Transfrontier Conservation Area – cooperation exists between Zimbabwe, Botswana, and South Africa

• Ai-Ais/Richtersveld Transfrontier Conservation Park – Namibia and South Africa signed a treaty in 2003

• Maloti–Drakensberg Transfrontier Conservation Area – Lesotho and South Africa signed a bilateral memorandum of understanding in 2001

• Lubombo Transfrontier Conservation Area – cooperation exists between South Africa, Mozambique, and Swaziland

• Great Limpopo Transfrontier Park and Resource Area – a joint agreement was signed in 2002 between South Africa, Zimbabwe, and Mozambique.

For further details see ⏚http://www.environment.gov.za/ ProjProg/TFCAs/TFCA_contents.htm

Box 5.5 **World Heritage Sites**

UNESCO's World Heritage Convention recognizes and protects areas of outstanding natural, historical and/or cultural value to humanity. Regardless of the territory in which they are located, they belong to all the peoples of the world, and sites as diverse as the Great Barrier Reef in Australia and Egypt's Pyramids add to our global heritage in different ways.

Their value

Apart from being a source of inspiration and the means of learning about our ancestry and cultural diversity, heritage is also important in socio-economic development. World heritage sites attract many visitors and money spent on their maintenance and conservation are a key investment in tourism. Most visitors from abroad come to South Africa for its natural beauty and wildlife diversity. Many depart cherishing further memories of warm hospitality and rich cultural history. World heritage sites are monuments to our county's natural grandeur and our people's spirit.

Selection criteria

To achieve World Heritage Site status, an area or set of areas must satisfy a range of criteria. Cultural properties, for example, can represent a masterpiece of human creative genius or an important interchange of human values or exceptional architecture. Heritage is the sum total of sites of geological, zoological, botanical, archaeological, and historical importance, and includes national monuments; historic buildings and structures; works of art, literature and music; oral traditions; and museum collections and their documentation, all of which provide the basis for shared culture and creativity. Natural properties are expected to represent major stages in the Earth's history or noteworthy ongoing ecological and biological processes; sites such as the Greater St Lucia Wetlands Park or the Cape Floristic Region are areas of exceptional beauty and also contain important habitats for the conservation of biodiversity. Mixed properties (of which there are only 24 in the world) display characteristics of both cultural and natural value. Equally important, for both cultural and natural sites, is the authenticity of the area and the way in which it is managed and protected.

There are 812 world heritage sites in more than 130 countries around the globe. Since the inclusion of the Vredefort Dome, South Africa has seven sites:

- Robben Island
- Greater St. Lucia Wetland Park
- The Cradle of Humankind
- uKhahlamba Drakensberg Park
- Mapungubwe Cultural Landscape
- Cape Floristic Region
- The Vredefort Dome.

Sizing up Africa's baobab tree in the Mapungupwe National Park. *Photography: South African National Parks*

South Africa's most recent additions

South Africa's seventh world heritage site (and fourth natural heritage site), the Vredefort Dome, is the Earth's oldest and largest meteorite impact site, its 140-km diameter spanning parts of the Free State and the North West Province. It was created an estimated 2 billion years ago, when a giant meteorite hit the Earth, and thus represents an outstanding moment in the planet's history. The impact site offers virtually endless opportunities for geological research in the area. Apart from its scientific value, the Vredefort Dome site is also rich in ancient art forms, helping modern generations to explore and understand the traditional cultures of the Basotho, Batswana, and the Khoi-San.

As it celebrated the addition of the Vredefort Dome to the list of world heritage sites, the World Heritage Committee also added two extensions to the existing Cradle of Humankind site, namely the Taung Skull Fossil site and the Makapans Valley. Although not physically linked to Sterkfontein and its surroundings, these two sites share common features with the original hominid sites. The Makapans Valley in Limpopo has an unbroken record of early human occupation, dating from over three and a half million years ago. The Taung Fossil Site in the North West province is the place where the partial skull of a juvenile ape-man, representing *Australopithecus africanus*, was retrieved from a limestone quarry in 1924. The discovery of the Taung child led to the recognition of a new genus and species of hominid and a new field of scientific study, including African palaeoanthropology.

Sources: Department of Environmental Affairs & Tourism (2005). Bojanala, 11 (September/October). http://www.environment.gov.za/DOCUMENTS_UPLOAD/areasofinterest.aspx http://whc.unesco.org/

or to ensure the sustainable use and equitable sharing of natural resources. These strategies contribute to human well-being, as they conserve current and future ecosystem services and develop synergies and trade-offs with other sectoral needs (for example, agriculture and ecotourism). In South Africa, responses to biodiversity loss and degradation have surged with growing awareness of the importance of ecosystem services to human well-being. The country's responses range from the local to the global levels and are continuously developing. (For the legal framework and institutional arrangements for environmental management and protection, see Chapter 3.) A brief overview follows of the responses most applicable in the area of biodiversity.

5.6.1   International agreements and obligations

Political transformation in South Africa in 1994 brought significant policy changes, including those concerning the environment. Furthermore, South Africa played a leading regional and international role in the development and roll-out of the New Partnership for African Development (NEPAD), the World Summit on Sustainable Development (WSSD) in 2002, and the subsequent Johannesburg Plan of Implementation, and this role has been enhanced by the country's strengthening participation in international multilateral forums. There is international interest in the establishment of Trans-boundary Protected Areas (TBPAs), Transfrontier Conservation Areas (TFCAs), World Heritage Sites, contractual parks[e], and a people-centred approach to conservation (see Box 5.4 and Box 5.5). South Africa is also a founding member of the Like-minded Group of Mega-Diverse Countries. At the time of going to press, a Regional Biodiversity Strategy and Action Plan is being finalized with other members of Southern African Development Community (SADC).

South Africa is signatory or party to almost 100 different multilateral environmental agreements (MEAs) ranging from broadly-focused agreements, such as the Convention on Biological Diversity (CBD), to those as specific as the Agreement on the Conservation of African–Eurasian Migratory Waterbirds. This involvement places significant obligations and burdens on South Africa to abide by the terms of each agreement, a challenge shared by the majority of participating countries.

Global concern for biodiversity loss led to the United Nations Conference on the Environment and Development (UNCED), that is, the Rio Earth Summit in 1992, from which the CBD emerged. It is founded on the principles that the well-being of the Earth and its biodiversity are inextricably linked and that human impacts on biodiversity directly affect human well-being. The convention has three main tenets: the conservation of biodiversity, the sustainable use of the

components of biodiversity, and the fair and equitable sharing of benefits arising from the commercial and other utilization of genetic resources. As one of its obligations as a party to the CBD, South Africa has developed a National Biodiversity Strategy and Action Plan (NBSAP), which has formed the basis of a National Biodiversity Framework (NBF). Since the CBD's inception in 1993, biodiversity loss has increased markedly, underlining the fact that political agreements mean little without the commitment of resources and the enforcement of legislation. To take the process further, the WSSD in Johannesburg succeeded in obtaining political commitment to "achieve by 2010 a significant reduction in the current rate of loss of biological diversity" – the so-called 2010 Biodiversity Target. It is generally recognised that achieving the Millennium Development Goals to ensure environmental sustainability and to halve global poverty is impossible without achieving this 2010 Biodiversity Target.

Other biodiversity related conventions include the Convention to Combat Desertification, the Convention on Migratory Species, and the Ramsar Convention on Wetlands of International Importance, which, amongst other things, promotes the wise use and conservation of all wetlands and the special protection of listed wetlands. In terms of its obligations to the Ramsar Convention, South Africa has declared 17 of its sites as Wetlands of International Importance.

International trade in wildlife and wildlife products is regulated through the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which accords varying degrees of protection to more than 30 000 species of animals and plants to ensure that trade does not threaten their survival[f]. South Africa ratified CITES in 1975 and is a significant importer and exporter of CITES-listed species. Social and economic incentives are increasingly being offered to local communities engaging in both legal and illegal utilization of natural resources, so as to promote the principles of sustainable use.

In evaluating responses, it is crucial to recognize that signing political agreements is not sufficient to address or eliminate threats to biodiversity and that significant outcomes depend on these agreements being implemented at both national and local levels.

5.6.2   National policy, legislation and institutions

Policy and legislation

South Africa's progressive constitutional framework enabled the development of innovative national environmental legislation. The Biodiversity White Paper of 1997 set out goals, strategies, and priorities for conservation, sustainable

South Africa is signatory or party to almost 100 different multilateral environmental agreements.

use, and equitable benefit-sharing. The National Environmental Management Act (Act 107 of 1998) (NEMA) introduced a new era of management of the environment, culminating in national legislation on biodiversity use and conservation (NEM: Biodiversity Act [NEMBA] and NEM: Protected Areas Act [NEMPA]). The Marine Living Resources Act (Act 18 of 1998) provides for the conservation, sustainable use and sharing of marine resources and ecosystems. With the impetus provided by the CBD, and if wisely used, these statutes, alongside the National Biodiversity Strategy and Action Plan and the National Biodiversity Framework, are invaluable tools for revolutionising the conservation, use, protection, and management of biodiversity in South Africa at large.

Spheres of government and departments

The Department of Environmental Affairs and Tourism (DEAT) holds the primary responsibility and authority for biodiversity conservation countrywide, but this responsibility is shared with other national departments including the Department of Water Affairs and Forestry and the Department of Agriculture. All spheres of government have responsibilities for environmental management and biodiversity conservation, as much of the implementation of central government policies is devolved to local government. (Certain environmental functions are mandated to local government, which then serves as lead

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Box 5.6   Elephant management in the Kruger National Park – science versus ethics

The issue of whether or not culling elephants in the Kruger National Park should resume in order to protect biodiversity was a heated debate in 2005/2006. It is known that the scale and magnitude of the impacts by elephants on vegetation are far greater than for any other herbivore. As any visitor to Kruger will testify, damage to trees by elephants is widely evident. Aerial photographs show a decline in the abundance of tall trees over much of the park during the past few decades, although shrub cover has increased in places. Conservationists have deplored the destruction of woodlands that has taken place elsewhere in Africa where elephants increased to high densities, notably in Tsavo East in Kenya and Chobe in Botswana. The question therefore arose as to whether action should be taken to stop elephant numbers increasing to the point where damage could threaten the conservation objectives of the Kruger. The park's scientific services division proposed the resumption of culling in parts of the park. But

An elephant stripping bark off a tree in national park. *Photography: South African Tourism*

how should the judgements of scientists be balanced against the ethical issues involved: the killing of highly intelligent animals versus protecting other species and other aesthetic values from rampaging elephants?

A review process, which was one of the most comprehensive reviews of a wildlife management issue anywhere in the world, was started in late 2004. Many people and constituencies were either strongly for or strongly against the culling of elephants. An 'Elephant Science Roundtable' was convened in January 2006 to advise the Minister of Environmental Affairs and Tourism as to the necessity of culling, from a scientific perspective. The scientists who participated drew attention to the following points.

- Culling undertaken up to 1994 (about 400 animals every year) had not halted the declining density of big trees in the Kruger National Park.

- If elephant numbers are allowed to climb to the ecological carrying capacity (that is, to the maximum number that the vegetation can support), limited food and nutrition eventually slow the growth rate. With biochemical contraception being impractical in such a large population, this form of 'natural contraception' may be more logical.

- The destruction of woodlands elsewhere in Africa (such as that in Chobe and Hwange), with higher elephant numbers, did not result in threats to biodiversity.

- The distribution of elephants in the Kruger National Park, rather than the size of population,

will affect biodiversity. The installation of artificial watering points throughout the park has distributed the elephant population across the park. Trees far from rivers, which otherwise would have escaped elephant attention during the dry season, became the targets mainly of bull elephants. So removing the artificial points could limit the extent of damage to upland trees such as baobabs and marulas.

- Assessments of the local consequences of global warming suggest that many plant and animal species currently resident in the Kruger National Park will not find suitable habitat there within a few decades. If such species cannot be saved within isolated parks in the long term, killing elephants now is a futile response.

While scientists agreed that "there is no compelling evidence to suggest the need for immediate, large-scale reduction of elephant numbers in the Kruger National Park", and the Minister announced that culling will not be resumed, many questions remain. For example, should we increase the space available to relieve the local impacts on biodiversity, and if so, how does one address the issue that neighbouring people have inadequate land available to support their families? Does invoking the precautionary principle mean that elephant populations should be left unmanaged until some species have been demonstrably lost, or should we keep elephant numbers low until we are sure that no species are endangered from their impacts?

Source: Text compiled from information provided by Norman Owen-Smith, University of the Witwatersrand.

agent, for example for waste management and coastal development.) Problems of capacity and resources at local government level everywhere affect performance, however, to the extent that in some areas there has been an almost complete collapse of regulatory enforcement.

South African National Biodiversity Institute

In 2004, through the enactment of NEMBA, the previous National Botanical Institute was replaced by the South African National Biodiversity Institute (SANBI). For the first time, a technical body for centralized monitoring and reporting on the status of the country's biodiversity was formally established at national level.

SANBI's responsibilities now relate to the full diversity of South Africa's fauna and flora. It is mandated to act as a comprehensive national consultative and advisory body on the full spectrum of biodiversity issues, and its role includes communication. It operates on the basis of international best practice and research, with special emphasis on outreach programmes.

South African National Parks

South African National Parks (SANParks) was established in terms of the Protected Areas Act (No. 57 of 2003). Today it is South Africa's leading statutory conservation authority, responsible for over 3 750 000 ha of protected land in 21 national parks. The National Parks of South Africa have 3 spheres of focus:

• The conservation of a representative sample of the biodiversity of the country

• To maintain a relationship of community upliftment and capacity building amongst people living in the areas in and around national parks

• To provide a recreational outlet to the public to experience and enjoy the wonders of national parks.

Since 1994, supported by the DEAT, SANParks has worked to make national parks more accessible to the public and tourists, both local and international, to ensure that conservation contributes to overall social and economic development; at the same time it has been maintaining high standards of research and management and has expanded the land under its protection by adding 176 931 ha. SANParks has recently been mandated to begin to generate a large proportion (75%) of its own operating revenue. Debate is raging, however, as to whether or not the country's natural assets should be sold off to concessionaires or remain protected as the last undisturbed examples of South Africa's natural heritage.

5.6.3   Control and rehabilitation programmes

South Africa's many control programmes aimed at conserving and rehabilitating ecosystems and their biodiversity often involve different governmental departments and organizations and contribute to education, community empowerment, capacity building, and employment (such as the measures employed to address the threats posed by invasive alien species). These programmes range from regulatory frameworks (such as the NEMBA) geared towards controlling the importation of potentially invasive species, and eradicating or controlling established invasive alien species. In 1999, for example, Olckers and Hill[87] reported on the success of biological control strategies involving the introduction of "natural pests or predators from the place of origin of the alien species" in combination with direct physical control measures as a way of preventing the proliferation of invasive alien species in South Africa.

Working for Water[g], with its substantial budget, has over 300 projects combating invasive aliens around the country in all the provinces, and is providing work and, to a lesser extent, training opportunities to some 21 000 people, mostly the poor and marginalized. The success of this programme is due to the innovative conjunction of a strategy to remove alien invasive plants from water catchments with a large-scale rural poverty alleviation and job creation initiative[88]. The programme saw exceptional
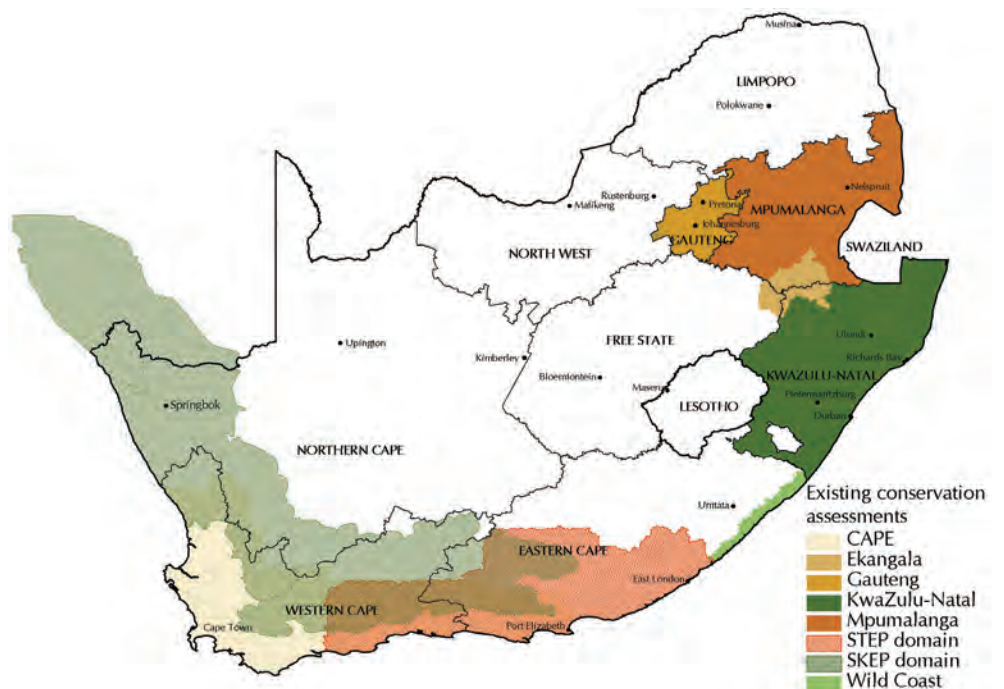
Map 5.11: Existing conservation assessments in South Africa
National Spatial Biodiversity Assessment 2004[7]

budget increases – from R25 million in 1995/6 to R442 million in 2003/4. Although over one million hectares of land have been cleared of invasive alien plants during the past eight years[89], these species are still spreading and growing at a faster rate than the programme can clear them. Controlling them is currently costing South Africa an estimated R600 million a year. A similar investment will need to continue over the next 20 years to be successful. The establishment of the Secretariat for the Global Invasive Species Programme within South Africa has given a further boost to this cause.

Several aligned initiatives have grown out of the Working for Water programme.

- The Working on Fire programme[h] is designed to limit the impact of large veld fires on the environment and on the poor communities exposed to them. In the process, opportunities are created for skills development, capacity building, and jobs for affected communities (such as clearing invading alien plants, creating firebreaks, and reducing fuel-load). Its R20-million annual budget from Working for Water is supplemented by significant support from the private sector.

- The Working for Wetlands programme, a national wetland rehabilitation initiative, was launched in 2000 under the banner of the Working for Water programme, and also provides training and work opportunities in the rehabilitation of wetlands. It is a fine example of cooperative governance, as it works across three national departments (DEAT, DWAF, and the National Department of Agriculture [NDA]), provincial capacities, local government, and the private sector. The Mondi Wetlands Project[i] also addresses the conservation and rehabilitation of wetlands. To assist these efforts, the Water Research Commission (WRC) has produced Guidelines for Integrating the Protection, Conservation and Management of Wetlands into Catchment Management Planning[61].

There is no formalized national assessment procedure to appraise/evaluate wetlands[90] and, although the DEAT is compiling a National Inventory of Wetlands for handing over to Working for Wetlands to carry forward, this inventory focuses more on mapping the locations of the wetlands than on describing their status, health, or level of conservation[91]. South Africa's wetlands need to be assessed and categorized so as to record their status, trends, and biological and resource value, and to allow systematic planning for their effective conservation.

The WRC's research programme under the theme 'Water-linked Ecosystems' is studying wetland processes, wetland rehabilitation, health and integrity, biodiversity restoration in wetlands, and the wise use of wetlands.

5.6.4 Bioregional plans and programmes

The NEMBA has given the legal basis to the DEAT's bioregional planning approach to conservation and protected area management. These plans are normally the outputs of a systematic spatial conservation assessment of the region, which identifies areas of conservation priority and constraints and opportunities for their implementation. The plans form part of multi-sectoral partnership programmes that aim to link biodiversity conservation with socio-economic development[1]. Bioregional programmes include: the Cape Action for People and the Environment (CAPE); The Succulent Karoo Ecosystem Programme (SKEP); the Subtropical Thicket Ecosystem Planning Programme (STEP); Wild Coast Conservation and Sustainable Development Programme; Maloti-Drakensberg Transfrontier Project; National Grasslands Biodiversity Programme; and St Lucia World Heritage Site.

Box 5.7 — Cooperation towards community resource management: The Makuleke Community

The Makuleke community is one of the many rural communities living on the borders of the Kruger National Park. In 1969, the Makuleke people were forcibly removed from the Pafuri triangle (26 500 hectares of land bordering Zimbabwe and Mozambique in the northeastern corner of South Africa) to allow the inclusion of their land within the borders of the Kruger National Park, and were relocated to 5 000 hectares (ha) of less desirable land 150 km south of the Pafuri region, outside the park boundaries.

In 1996, the Makuleke people initiated a land claim against South African National Parks (SANParks) under the Restitution of Land Rights Act (No. 22 of 1994), and in 1998 they regained ownership of their land. The Pafuri Triangle was renamed the 'Makuleke Region of the Kruger National Park', to be managed over a period of 25 years by a joint management board with equal representation from the Makuleke people and SANParks. The land remains within the boundaries of the Kruger National Park and, as such, SANParks is responsible for its day-to-day management. The Makuleke now have significant resource-use rights, however, through tourism development and the commercial use of natural resources through hunting and eco-tourism.

In the past four years, the community have conducted a park-friendly lodge business on their reclaimed land, working with the Johannesburg-based hotel group, The Mix, which currently owns the lodge. It is largely run by Makuleke residents, however, and will be handed over to the Makuleke community in 28 years' time. The community is paid 10% of the revenue generated, and has used this income to build the multipurpose centre in the heart of the village for tourists wishing to experience the Makuleke way of life. This centre includes a bed and breakfast facility, a crafts production unit, and an amphitheatre.

A development programme was established in 1996, funded by donor agencies and non-governmental organizations (NGOs), through which the Endangered Wildlife Trust (EWT) has been running the Makulele Training Project. Working with people from the community, it gives training and opportunities for practical experience in nature conservation and business administration. Students are also prepared for the University of South Africa National Diploma in Nature Conservation and Business Administration and for the examinations of the Field Guides Association of Southern Africa. To date, it has produced five graduates and, by April 2005, 14 Makuleke students had entered the marketplace, most of them as professionals or at junior management level. The increase in income earned by each student before and after involvement in this project was in the region of 600%.

Sources: Van Zyl, A. (2005). Personal communication. Project coordinator, Makuleke Training Project Information, Endangered Wildlife Trust. Koro, E. (2005). New Development Model Spurs Growth in South African Rural Community. World Resources Institute, 3(2). http://newsroomwri.org

Such planning is essential, as it identifies what happens where in the landscape and enables an effective land-use system to be put in place that meets the needs of the development sectors without compromising the needs of the environment. South Africa has been at the forefront of bioregional planning internationally, with many planning initiatives linked to particular biomes/ecoregions in the country that incorporate conservation priorities into proactive planning guidelines for the efficient and suitable selection of sites for conservation management[92, 93]. (See Map 5.11 for areas in South Africa where these plans are under way.) The coverage is impressive but has significant gaps, particularly in the Nama Karoo and savanna biomes. The National Grasslands Biodiversity Programme has been initiated[94] to fill the grassland biome gap.

5.6.5 Non-governmental organizations and the private sector

Civil society plays an important constructive watchdog role in the conservation of biodiversity in South Africa, and an increasingly strong sense of custodianship of the environment and its dynamic synergy with its social context informs the agenda of many organizations outside government, including non-governmental organizations (NGOs), conservancies, and Community Based Organizations (CBOs). Examples include the Wildlife and Environmental Society of Southern Africa (WESSA), the Endangered Wildlife Trust, BirdLife South Africa, the Botanical Society of South Africa, Environmental Justice Network, Resource Africa, the Wilderness Foundation, WWF-SA, Conservation International, and GroundWork.

5.6.6 Conservation on private and communal land

South Africa has some 9 000 privately owned game farms, which are expanding at a rate of approximately 300 000 ha per year. Nature areas that are managed privately or by the community represent capital investments of approximately R6 billion[95]. Therefore, privately owned land (in the form of conservancies, game farms, private game reserves, and mixed game/livestock farms) contributes substantially to national conservation efforts, often creating sustainable employment opportunities that help in the socio-economic upliftment of rural areas[5].

There are about 600 conservancies in South Africa[94] and their growth is gaining ever-increasing momentum and recognition as a vehicle for merging development and social issues with biodiversity conservation. Biosphere Reserves are also becoming more popular and four of them in South Africa have been registered with UNESCO (although this does not yet afford them any special local legal status).

The South African Natural Heritage Programme (NHP),

established in 1985, is being revitalized after a non-operational period. Supported by the NEMBA and NEMPA Act, it focuses on the participation of civil society and, in particular, private landowners, in conserving important privately- and publicly-owned naturally biodiverse areas and exceptional natural features. The revived programme will seek to provide landowners with tax benefits, potential funding, recognition, and other incentives to support their conservation efforts.

The remnants of apartheid continue to affect the way in which we protect and manage our biodiversity. Land restitution claims lodged by communities who still hold title to lands from which they were forcibly dislodged during the pre-1994 government's expansion of protected areas have led to the establishment of contractual parks involving government agencies and these communities. These agreements were flagged as 'world firsts' during the 5th World Parks Congress in 2003. Examples include contracts involving the Makuleke, Khomani San, and Mier communities.

5.6.7 Cross-cutting programmes and projects

The overall goal of the cross-cutting programmes and actions is to incorporate conservation and the sustainable use of biodiversity into relevant sectoral and cross-sectoral plans, programmes, and policies, as required by the Convention of Biological Diversity. Such mainstreaming of biodiversity involves situations where biodiversity can be achieved together with economic gain; others where biodiversity gains exceed biodiversity losses; the recognition that a sectoral activity depends on sustainable use of biodiversity; and the inclusion of biodiversity concerns in sectoral policies[96]. The overall objective is the full-scale integration of conservation values, goals, and priorities into

Privately owned land (in the form of conservancies, game farms, private game reserves, and mixed game/livestock farms) contributes substantially to national conservation efforts, often creating sustainable employment opportunities that help in the socio-economic upliftment of rural areas.

Communities selling craft made with reeds from the Nahoon River near East London.
Photography:Wilma Strydom

Box 5.8 — Genetically modified organisms

What are GMOs?

A genetically modified organism (GMO) is any living organism that contains genes not normally found in it. This genetic material will have been transferred into the organism using genetic modification technology. In 2004, the global area planted with biotech crops was 81 million hectares (ha) in 17 countries (this was a 20% increase over 2003). About 27 million ha are now being planted in 11 developing countries. However, more than 90% of the area planted globally with GMOs in 2004 is located in just four countries, with the United States planting 47 million ha (58%), followed by Argentina (16.2 million ha, or 20%), Canada (5.4 million ha, or 6.6%) and Brazil (5 million ha, or 6.1%). The most popular genetically modified (GM) crops are soybean, maize, cotton, and canola. GM crops currently available in South Africa include insect resistant yellow and white maize, herbicide tolerant soybean, and insect resistant cotton.

How do GMOs benefit us?

GM crops are developed to have certain specific traits, such as drought tolerance, insect resistance, herbicide tolerance, giving a higher yield, or being more tasty or nutritious. This translates into several direct and indirect benefits. For example, an independent survey of smallholder farmers in South Africa designed to explore the economic benefits of their adoption of genetically modified Bt (insect-resistant) cotton was conducted in November 2000. It indicated that, during the 1998/1999, season, farmers experienced an 18% per ha increase in yields compared to non-adopters, and a 13% reduction of pesticide costs compared to non-adopters. These results outweighed the increase in seed costs (100% per ha) to give a substantial increase of 11% in gross margins.

Having to use less insecticide benefits farm workers, farmers, consumers, and the environment. In China, for example, fewer farmers are dying from chemical poisoning since adopting Bt cotton, as it is sprayed 13 times less than is conventional cotton. Benefits to the environment are also significant. It was estimated that in 2000 pesticide usage was reduced by a total of 22.3 million kg of formulated product due to the use of GM crops.

Herbicide resistant GM crops also help to protect the environment in that farmers switch to zero or minimal tillage practices, which save fuel and labour and significantly reduce the loss of topsoil. No-till processes also make the breakdown of crop stubble by soil microorganisms occur more slowly, in this way also reducing carbon dioxide emissions. It has been predicted that herbicide-tolerant GM maize would dramatically lower the herbicide concentrations in vulnerable watersheds, thus diminishing the risks to human health brought about by contaminated drinking.

What are the main concerns regarding GMOs?

Despite the benefits of GM crops, concerns have been raised by scientific, environmental, and consumer groups. The main ones are:

- potential risks to human and animal health
- potential effects on biodiversity and the environment
- effects on developing economies.

Health concerns

Possibly the public's greatest concern is whether or not food from GM crops is safe to eat – whether it contains toxins or causes allergies; whether its nutritional composition or digestibility has been adversely changed; or whether there will be unexpected effects.

Before a GM product is approved for commercial release, the developer has to research such risks. Food safety assessment normally follows national guidelines, and these are typically based on international standards, such as those issued by the Codex Alimentarius Commission. In South Africa, biosafety assessments are carried out under the Genetically Modified Organisms Act (No. 15 of 1997), and, together with existing labelling legislation, they are designed to regulate the safe introduction of GMOs into South Africa. Products are only given a general release permit if they are deemed to be safe and of benefit to South Africa.

The issue of food safety has been investigated through many health studies. In 2005, the World Health Organisation (WHO) published an opinion on GM foods. Its 84-page report, Modern food biotechnology, human health and development: an evidence-based study, suggests that GM foods can contribute positively to human health and development, but stresses the need for continued safety assessments prior to marketing, to prevent risks to health and the environment. The WHO claims that, so far, the consumption of GM foods has caused no known negative health effects, and that GM foods are more rigorously examined than conventional foods for potential health and environmental impacts.

Environmental concerns

The concern has been raised that the introduction of herbicide tolerance in crops will lead to a misuse of herbicides, and that insect resistance in crops may result in a build-up of resistance in target insect populations. (This, however, is also true for most agro-chemicals used to control pests and diseases.) Another worry is the effect on non-target organisms, especially beneficial insects.

Concerns have also been raised that the inserted gene(s) in GM crops can pass into other species, especially weedy wild relatives. Highly domesticated species like maize and soybean are not normally competitive in the wild, however, and are therefore unlikely to become invasive. Less highly domesticated species, such as sorghum, pasture legumes, and cowpea may be more competitive in the wild and could pose a more serious threat of becoming invasive. In South Africa, impact assessments have to be carried out on all GMOs before commercialization is approved and it is expected that they will be monitored even after release. Several long-term studies are currently being conducted in South Africa on the environmental impacts of GM crops.

Socio-economic concerns

The effect of GM technology on developing countries, especially Africa, is often hotly debated. Those in favour of GMO technology have increasingly argued that GMOs can address the problems of malnutrition, hunger, and food insecurity. Several African countries, however, have been reluctant to adopt GMOs in their agricultural systems because of restrictions imposed by trading partners.

Most African food exports are to Europe and Asia, for instance, where GM foods are widely regarded as 'Frankenstein foods' and shunned by consumers. Some European countries request verification from exporting countries that their beef is not fed with genetically modified maize. This places the onus on exporting countries to develop an appropriate labelling and traceability system, and such a system is being developed in South Africa. Most other countries on the continent, however, do not have the legislation or the capacity to implement such a system. If GM foods are introduced into exporting countries without the required labelling and traceability support, grain and beef exports to Europe and Asia could be rejected, with dire potential economic consequences. In Africa, so far, only Kenya, Egypt, and South Africa have formally adopted the use of genetically modified crops.
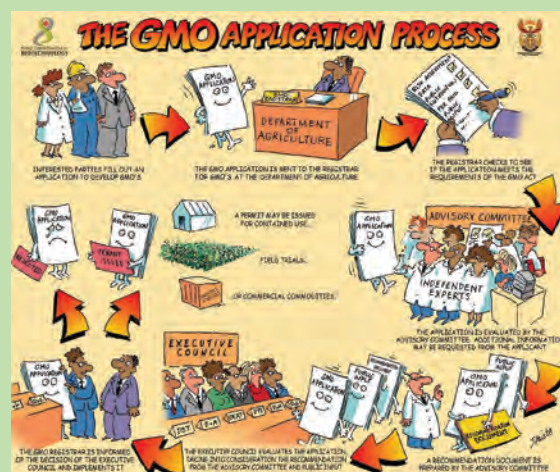
Sources:

Agricultural Research Council: http://www.arc.agric.za/main/biotech.htm

Animal Feed Manufacturers Association: http://www.afma.co.za/AFMA_Template/1,2491,7105_1839,00.html

International Service for the Acquisition of Agri-biotech Applications (ASAAA): http://www.isaaa.org/ World Health Organisation (2005). Modern food biotechnology, human health and development: an evidence-based study. World Health Organization, Geneva.

Ismael, Y., Bennett, R., and Morse, S. (2001). Farm level impact of Bt cotton in South Africa. Biotechnology and Development Monitor No. 48, 15-19

the sectors responsible for ongoing biodiversity loss (that is, into economic sectors and development policies and programmes)[97].

One of the main incentives is the direct contribution of biodiversity to both economic and social development. Although mainstreaming initiatives may be catalysed by conservation agencies, they increasingly often originate within economic sectors, typically involving a wide range of people, and partnerships between NGOs, government, communities, industry, and small, medium, and micro enterprises[98].

The River Health Programme

The River Health Programme (RHP) was initiated in 1994 by the DWAF. Its overall goal is to expand the body of information on aquatic resources, so as to support their rational management in South Africa. Each province is responsible for the RHP activities within its borders. This programme uses numerous factors (indices) to determine the health of a river ecosystem. Its outputs take the form of simplified posters as well as reports that provide detailed analyses of the state of the country's rivers. Eight such state-of-rivers reports have been published and more are being planned. Because only a few rivers have been assessed to date, however, the existing reports are not suitable for use as a national indicator of the state of rivers in the country.

5.7   CONCLUSION

Priority areas

From the assessments available, it is clear that neither biodiversity nor the pressures that threaten it are evenly distributed across South Africa. Areas of high biodiversity, and which contain global biodiversity hotspots, are often also areas under greatest pressure. They include the South-western Cape region, the central grasslands, and the eastern coastal areas.

Although the northern and eastern parts of the country experience some of the greatest pressures, the established bioregional programmes are mostly focused in the southern region, but it is hoped that the newly established Grasslands Biome Programme, Mpumalanga Programme, and Wild Coast Conservation and Development Project will help to correct some of this bias. These parts of South Africa (particularly the Eastern Cape) are home to many poor and rural communities who, indirectly, are even more profoundly affected by the pressures of biodiversity loss, because they rely so heavily on the natural environment and its services. It is a matter of great urgency, therefore, to develop appropriate conservation responses for these important and threatened areas.

Reducing the rate of biodiversity loss (the 2010 Biodiversity Target)

In line with global trends, the decline of South Africa's biodiversity and ecosystem health has been most rapid in the past few decades[99, 100]. Despite the fact that biodiversity benefits many people, at least 60% of the ecosystem health and services that have been measured are declining rapidly worldwide, because of land-use change, climate change, invasions by alien species, and other direct drivers of environmental change. These pressures show no signs of decreasing: they are either constant or growing in strength and are projected to continue or to accelerate in the future[100].

The predictions that drivers of biodiversity change will remain stable or increase implies that for South Africa, as elsewhere on the planet, the goal of reducing the rates of biodiversity loss by 2010 will not be attained[100]. The damaging consequences in terms of opportunity cost cannot be over-emphasized. Sub-components of this target may, however, be within our reach, as, for example, habitat loss is slowing down in some parts of the country. The Millennium Ecosystem Assessment states that "an unprecedented effort would be needed to achieve by 2010 a significant reduction in the rate of biodiversity loss at all levels". It recommends that longer-term goals and targets are also necessary (extending, for example, to 2050), as short-term goals and targets do not align with the characteristic longer response times of political, socio-economic, and ecological systems.

Improving the information base

The indicators presented in this chapter give an overview of the status of South Africa's biodiversity. The validity of some of the indicators is questionable in terms of their age and comprehensiveness but they nevertheless represent an appropriate starting point for action and analysis. There remain some critical indicators for which we have no adequate data and without which our assessment of the current situation is incomplete. The most important of these include up-to-date land-cover information, as well as information at finer scales of the spatial distribution of habitat degradation and sensitive areas. There are, furthermore, several developing trends (such as the increased prevalence of genetically modified organisms (see Box 5.8), which might prove, in the future, to have adverse effects on biodiversity but for which we currently do not have reliable data.

Positive messages

Reporting on the state of biodiversity is often an exercise in 'doom and gloom', because of the pervasive and increasingly negative trends in biodiversity loss and decline in ecosystem health. South Africa has responded in various

Despite the fact that biodiversity benefits many people, at least 60% of the ecosystem health and services that have been measured are declining rapidly worldwide, because of land-use change, climate change, invasions by alien species, and other direct drivers of environmental change.

ways, with varying degrees of success, as described in this chapter. Section 5.6 (above) highlights the many (often cutting-edge) responses that have put South Africa at the forefront of global biodiversity conservation. Their successful implementation will go some way towards achieving goals such as the 2010 target. The establishment of the SANBI, the completion of the first National Spatial Biodiversity Assessment, a robust National Biodiversity Strategy and Action Plan, and the extensive range of bioregional plans (well supported by legislation), attest to a growing awareness, in some sectors, of the importance of biodiversity to humans everywhere. The magnitude and the momentum of the drivers, however, will require a far greater commitment of resources and enforcement of legislation to turn this tide.

The involvement of an active civil society in South Africa in many environmental issues has helped significantly to improve the awareness of the state of the country's biodiversity. As highlighted in the Millennium Assessment, "less biodiversity would exist today had not communities, NGOs, governments, and, to a growing extent, business and industry taken actions to conserve biodiversity, mitigate its loss, and support its sustainable use". In terms of the involvement of business and industry in biodiversity conservation, South Africa is among the leaders in the field of 'mainstreaming'[96].

South Africa offers a wealth of further opportunities for biodiversity conservation and sustainable use. With large areas of natural habitat still remaining in many parts of the country (a situation that is not common in many other countries), conservation and biodiversity-friendly land uses (such as game ranching) have the chance to develop and flourish. Our tourism industry (the fastest-growing sector, and second only to manufacturing in its contribution to gross domestic product) provides an excellent incentive for better biodiversity management and for exploring the economic benefits that can result.

All the existing highly commendable policies, plans, and strategies, however, need to be fully entrenched and implemented on the ground to achieve the stated objectives of not only conserving biodiversity but also of achieving sound ecosystem health and functioning to underpin socio-economic development.

NOTES

a. 'Biological diversity' or 'biodiversity' means the variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part. It also includes diversity within species, between species, and of ecosystems.

b. Terrestrial ecosystem status figures were calculated from the National Land Cover 2000 map provided by the CSIR.

c. Biodiversity targets are also referred to as 'conservation targets'. They are quantifiable targets that indicate how much of each biodiversity feature should be conserved so as to maintain functioning landscapes and seascapes. These targets should be based on best available science rather than on arbitrarily defined thresholds. This chapter uses the biodiversity targets for representation as determined in the National Spatial Biodiversity Assessment, ranging from 16–36% of the ecosystem that should be conserved.

d. Both the Orange River Mouth and Blesbokspruit Ramsar sites have been included in the Montreux Record. The Montreux Record is the principal tool of the Ramsar Convention for highlighting those sites where an adverse change in ecological character has occurred, is occurring, or is likely to occur, and which are therefore in need of priority conservation attention.

e. A contractual park is defined as a park established through a contractual agreement between historically disadvantaged peoples (landowners) with land claims within proclaimed protected areas and the government institution responsible for the biodiversity management within such areas, whereby agreed benefits are accrued by such peoples, enabling their socio-economic development.

f. Details about CITES are available at http://www.cites.org

g. Information about the Working for Water programme is available at http://www.dwaf.gov.za/wfw

h. Information about the Working on Fire programme is available at http://www.workingonfire.org

i. Information about the Mondi Wetlands Project is available at http://www.wetland.org.za

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*The clearest way into the universe
is through a forest wilderness.*

John Muir

*We do not inherit this land
from our ancestors;
we borrow it from our children.*

Haida Indian saying

*Man is a complex being;
he makes the deserts bloom
and lakes die.*

Gil Stern