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Chapter_Biodiversity and Ecosystem Functioning

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Biodiversity and Ecosystem Functioning

CONTENTS

Chapter	Description	Page

List of Figures

List of Tables

1 Biodiversity and Ecosystem Functioning

1.1 Introduction

The Convention on Biological Diversity (CBD) defines **biodiversity** as "the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (SCBD, 1992). South Africa is one of the most biologically diverse countries in the world due to its species diversity, level of endemism and diversity of ecosystems (DEA, 2014).

The 2nd South Africa Environment Outlook (SAEO) Report provided a national snapshot of how South Africa is performing in terms of responses to changing environmental conditions (DEA, 2012). The biodiversity section of the 2nd SAEO Report relied mostly on information contained in the National Biodiversity Assessment (NBA) of 2011 (Driver *et al*., 2012). The NBA assesses the state of South Africa's biodiversity across terrestrial, freshwater, estuarine and marine environments, emphasising spatial information for both ecosystems and species (Driver *et al*., 2012). It is a fundamental tool used in environmental decision-making and land-use planning, to strengthen strategic development planning for South Africa. It also identifies priorities for management and restoration of ecosystems (DEA, 2015a), and is updated every 5-7 years. Information presented in Driver *et al*. (2012) therefore remains current and relevant until the updated NBA is published in 2018.

From a South African perspective, biodiversity loss and impacts on ecosystem health have intensified since the publication of the 1st SAEO Report (DEA, 2012; 2015a) and most likely since the 2nd SAEO Report and the 2011 NBA. Changes in the state of biodiversity and trends since the 2011 NBA and verification of this assumption, however, cannot be completed until the latest NBA is published in 2018. The focus for this chapter will therefore be on the drivers and indicators of biodiversity change and will discuss persisting issues and highlight emerging issues.

The 3rd SAEO Report follows the Drivers-Pressures-State-Impact-Response (DPSIR) model. This describes a framework with a chain of fundamental links starting with "**driving forces**" (economic sectors and human needs/activities) causing "**pressures**" (loss of natural land, over exploitation, pollution), which alter ecosystem "**states**" (habitat loss, ecosystem degradation), and result in "**impacts**" (loss of species and habitat, loss of genetic diversity), and eventually leading to political "**responses**" (prioritisation, target setting, indicators) (Kristensen, 2004).

1.2 Drivers and pressures on biodiversity

The two major issues surrounding biodiversity and ecosystem health are biodiversity loss (species and genetic diversity) and ecosystem degradation. It is widely accepted that the drivers of biodiversity loss and decline in ecosystem health are macro-type activities involving people and the needs of a growing human population and increasing per capita consumption (Chapin *et al*., 2000; DEA, 2012, 2014; McRae *et al*. 2014; SCBD, 2014; WWF, 2014; FSC, 2015). With the county's population growing by 3,883,097 people between 2011 and 2016 (Stats SA, 2016), the need for land for settlements, agriculture, and industry, in addition to the need for clean drinking water and other natural resources, are major drivers for key pressures on biodiversity. These drivers influence the quality of ecosystems, affect their functionality and alter the rate at which ecosystems deliver goods and services (Chapin *et al*., 2000; SANBI, 2014).

Key pressures include irreversible loss of natural habitat, ecosystem and land degradation, over-abstraction and harvesting (over-exploitation of biodiversity resources and ecosystem services), pollution, invasive alien species and climate change. These issues are generally known to erode natural capital, compromise ecosystem stability and threaten economic productivity (DEA, 2012). The consequences are not only ecological but often also economic (Turpie *et al.*, 2008; Dawson *et al.*, 2011; Pfab, 2011; Nel and Driver, 2012; Sink *et al.*, 2012; van Wilgen *et al.*, 2012). These are issues that will remain relevant due to their link to anthropogenic needs and many of these are inter-related. Other key pressures on our ecosystems include poor land management practices, overgrazing, abstraction of water and changes in flow, destruction of river banks, decrease in freshwater reaching estuaries and the coast, overfishing, shipping, bait collection, and inappropriate land use and development. Many of these result in similar impacts on biodiversity, usually causing loss or displacement of species, alteration of community structure, and loss of gene flow.

1.2.1 Loss of natural habitat and habitat fragmentation

Loss of habitat occurs when land is transformed by anthropogenic activities such as agriculture, cultivation, afforestation, mining, urban development and industry, residential development, coastal tourism development and dam construction. Habitat is also lost through land degradation and considering South Africa comprises 91% dryland, the country is prone to land degradation and drought (DEA, 2017). Loss of habitat means a direct loss or displacement of biodiversity and for species the issue is not simply the loss of patches of natural vegetation but also the resulting fragmentation of the remaining natural vegetation (GDARD, 2017; WCDEADP, 2013; NWDREAD, 2014; DEA, 2015a; LEDET, 2015). This is problematic for species that require larger habitat areas and species that need to move through the landscape. Fragmentation also prevents landscape-scale ecological processes, such as fire, from functioning effectively and leads to loss of genetic diversity (Fahrig, 2003). Loss of habitat also impacts negatively on the functioning of catchments, and thus on the condition of rivers, wetlands and estuaries (Nel *et al*., 2011).

Desertification is the process by which fertile land becomes desert, typically as a result of drought, deforestation, or inappropriate agriculture (Geist, 2005). It is a type of land degradation in which land becomes increasingly arid, typically losing its bodies of water as well as vegetation and wildlife (Geist and Lambin, 2004). Desertification is considered a major threat to biodiversity worldwide and in South Africa (DEA, 2012b).

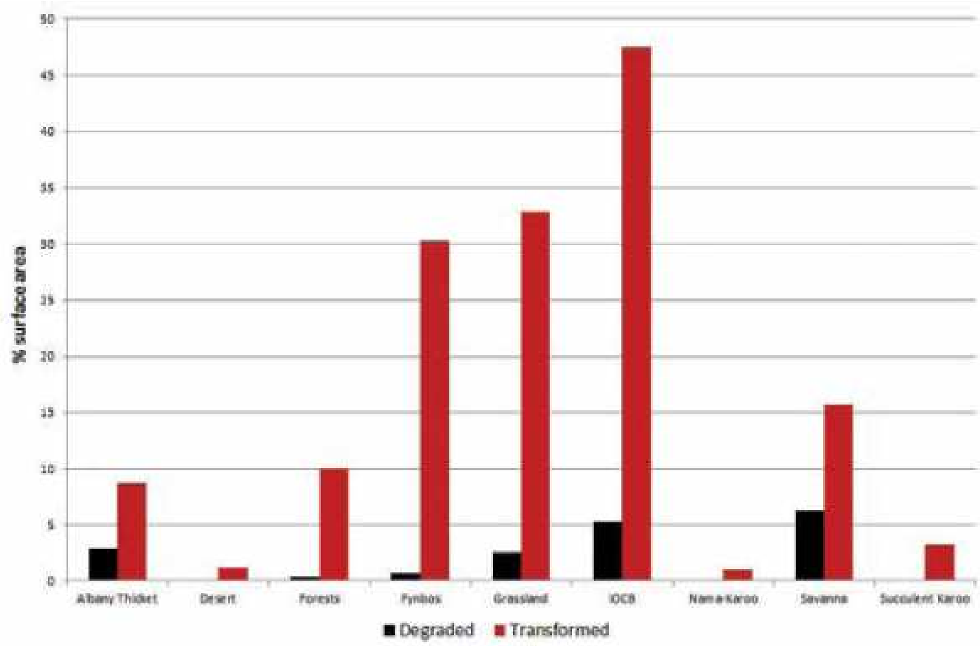

Figure 1: The proportion of each biome that has been degraded or transformed (expressed as a % area) (Mucina and Rutherford 2006; DEA, 2015)

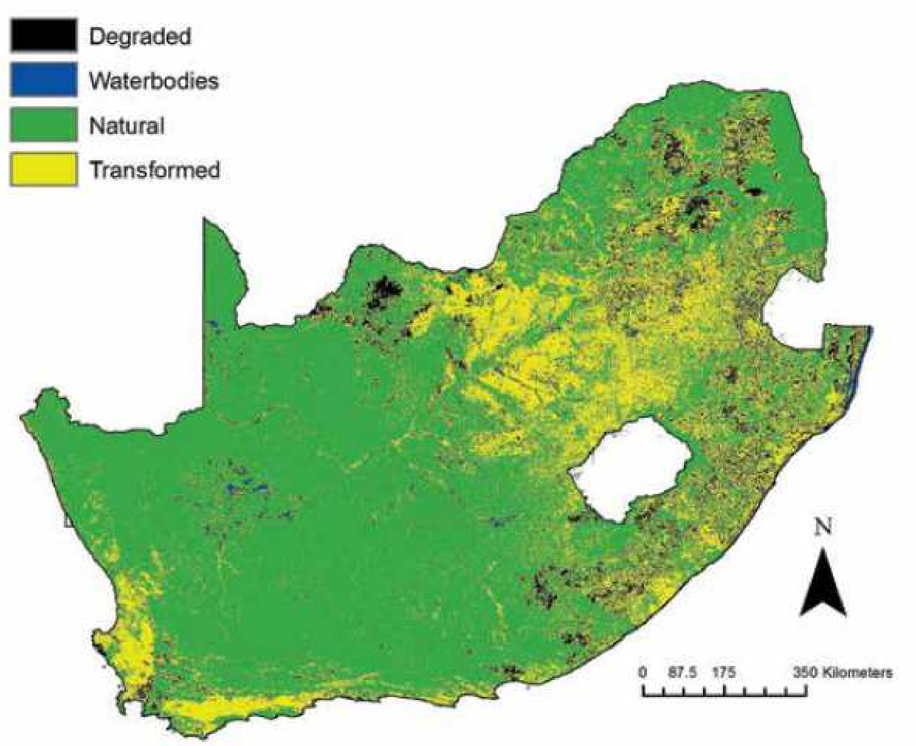

Figure 2: Map of the transformed versus natural areas of South Africa (DEA, 2015

Linked to habitat fragmentation are barriers to movement for biodiversity. These come in the form of fences around private properties and between natural areas such as game farms and around protected areas, in addition to linear structures such as roads, railway lines and powerlines etc.

Linear features do not only create barriers to movement, but also pose a risk to fauna through direct strikes and collisions, as well as degradation of habitat surrounding the human activities (van der Ree *et al*., 2015).

1.2.2 Invasive alien species

Biological invasions are a major component of human-induced global change, and affect all ecosystems including terrestrial- (land), freshwater- (rivers and wetlands), estuaries-, and marine- and coastal ecosystems (WCDEADP, 2013; NWDREAD, 2014; DEA, 2015a; LEDET, 2015; GDARD, 2017; van Wilgen *et al*., 2017). Invasive alien species can have significant negative impacts on biodiversity and on the ecosystem services on which all of humanity is dependent (van Wilgen *et al*., 2017). An estimated R6.5 billion worth of ecosystem services is lost each year as a result of invasive alien plants (SANBI, 2012). Invasive alien plants generally consume more water than native species, which poses a major problem to many of the country's ecosystems, agriculture, and local economies (DEA, 2011). Figure 3 provides an indication of the total percentage of cover invasive alien plants as mapped by the National Invasive Alien Plant Survey (Kotzé *et al*., 2010).

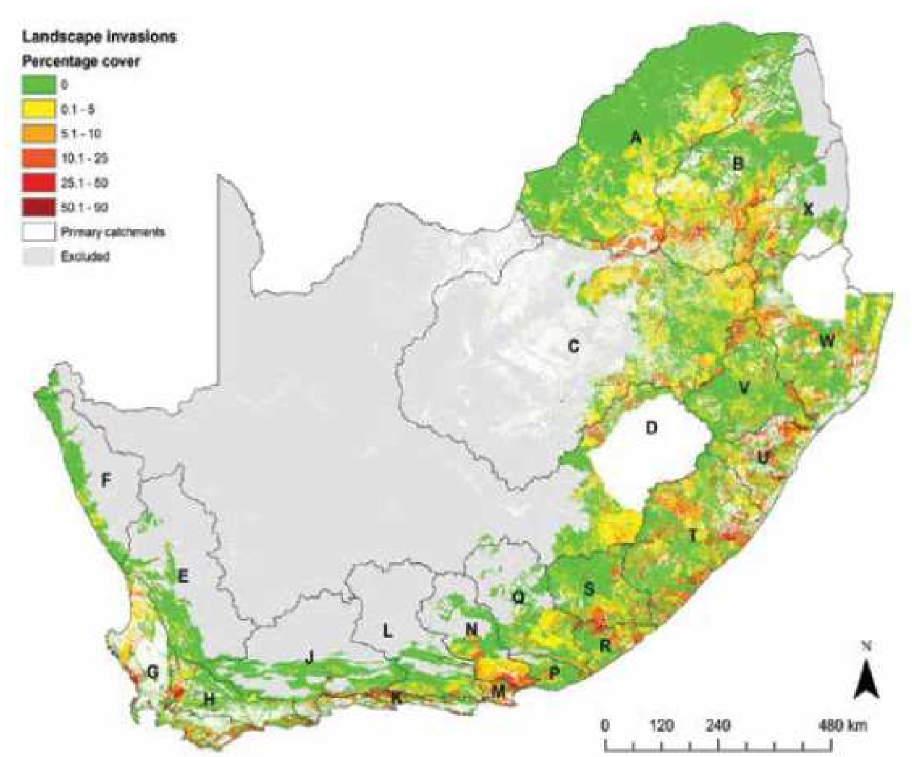

Figure 3: The estimated total percentage cover of invasive alien plant species for each primary catchment as mapped by the National Invasive Alien Plant Survey (Kotzé *et al*. 2010)

Invasive alien fish such as species introduced for recreational fishing and aquaculture (i.e. bass and trout), can wipe out indigenous fish species and other life (DEA, 2012). Invasive species also affect the marine environment where many marine species have been introduced by ship fouling, ballast water and aquaculture (Picker and Griffiths, 2011; Robinson, 2015). Refer to section [to add] of the Oceans and Coasts Chapter for additional information.

1.2.3 Climate change and related pressures

Climate change is a long-term change in the earth's climate, especially due to an increase in the average atmospheric temperature. Projections have indicated that both temperature and evapotranspiration are likely to increase into the 21st century (DEA, 2013). The magnitude, timing, and distribution of storms that produce flood events, and the frequency and intensity of drought events are expected to change with the changing climate (Fauchereau *et al*., 2003; Engelbrecht and Landman, 2010; Tadross *et al*., 2011). This process is being accelerated by increasing levels of greenhouse gases in the atmosphere due to increased emissions due to human economic activity, driven by demand for energy, goods and services, and to the conversion of natural ecosystems to intensive land use (GDARD, 2017; DEA, 2012, 2013; WCDEADP, 2013; NWDREAD, 2014; LEDET, 2015).

The projected changes in climate have been predicted to have a variety of impacts on South African Biomes (Midgley *et al*., 2002; Driver *et al*., 2012; DEA, 2013) and include rising temperatures, temperature extremes, decrease/increase in rainfall, more intense rainfall, extreme storms, rising CO_2, changes in fire regimes, and sea level rise (DEA, 2015b). The Vulnerability Assessment (DEA, 2012c) showed that climate change projections will lead to significant changes across the biomes through the alteration of existing habitats, seasonal rainfall, species distribution, and ecosystems. The Long-Term Adaptation Scenarios (LTAS) Flagship Research Programme Biodiversity Report (DEA, 2013) identified the following biomes as being the most vulnerable to land-use and climate change:

- Grassland and Indian Ocean Coastal Belt – Highest priority for action;
- Fynbos and Forest – High priority for action; and
- Nama Karoo and Succulent Karoo – Medium priority for action.

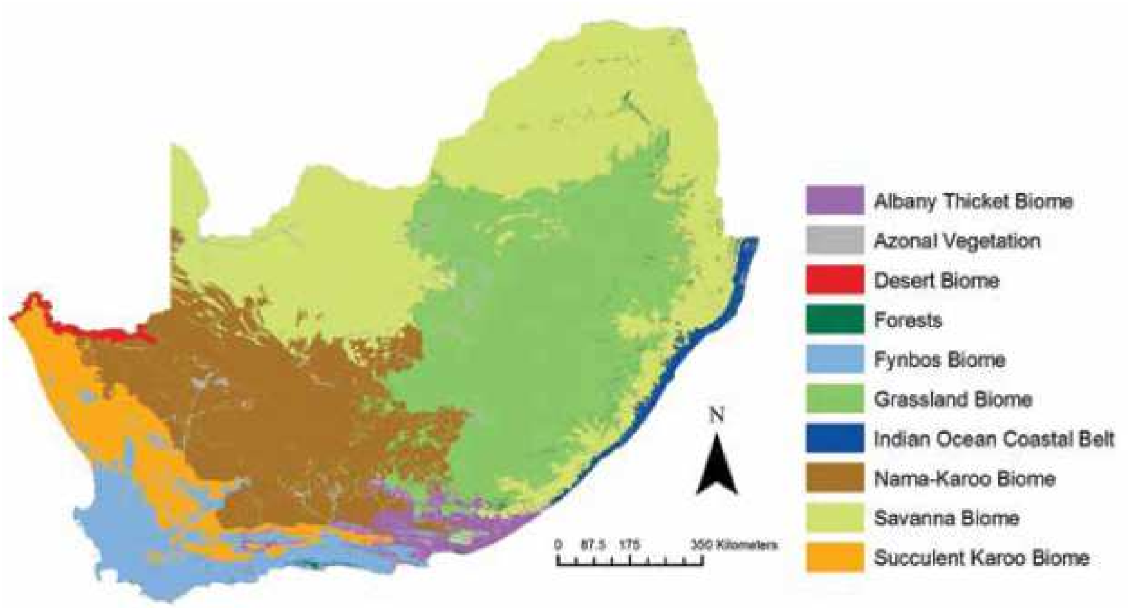

Figure 4: The biomes of South Africa (Mucina and Rutherford, 2006)

According to the Third National Communication under the United Nations Framework Convention on Climate Change (UNFCCC) (in DEA, 2017), South Africa has warmed significantly from 1931 to 2015. The observed rate of warming has been 2°C per century, in the order of twice the global rate of temperature increase. Between 1921 and 2015, there has been a statistically significant increase in rainfall occurring over the southern interior regions, extending from the western interior of the Eastern Cape and eastern interior of the Western Cape northwards into the central interior region of the Northern Cape (DEA, 2017). Extreme rainfall events have increased over these areas, with increases being statistically significant and extending northwards into North West, the Free State and Gauteng. Over Limpopo there has been a statistically significant decreases in annual rainfall (DEA, 2017).

Climate change projections for South Africa up to 2050 and beyond under unmitigated emission scenarios include warming trends, but most approaches project the possibility of both drying and wetting trends in almost all parts of the country (DEA, 2013). Projections from 2025 and beyond can be described using four broad climate scenarios at the national scale, with different degrees of change and likelihood that capture the results of global mitigation action and the passing of time (DEA, 2013):

1. Warmer and wetter, with greater frequency of extreme rainfall events.
2. Warmer and drier, with an increase in the frequency of drought events and somewhat greater frequency of extreme rainfall events.
3. Hotter and wetter, with substantially greater frequency of extreme rainfall events.
4. Hotter and drier, with a substantial increase in the frequency of drought events and greater frequency of extreme rainfall events.

The effect of strong international mitigation responses would be to reduce the likelihood of scenarios 3 (hotter/wetter) and 4 (hotter/drier), and increase the likelihood of scenarios 1 (warmer/wetter) and 2 (warmer/drier) during the course of this century (DEA, 2013). Refer to section [to add] of the Climate Change Chapter for additional information.

Species have certain habitat requirements that relate to factors such as temperature, pH, altitude and rainfall (DEA, 2012a). These factors are affected directly by a changing climate and this in turn will affect the way species respond. For example, studies show that the geographic ranges of South African endemic species may contract due to climatic changes (Midgley and Thuiller, 2010). Consequently, this may affect the quality and quantity of habitats and ecosystems. According to the South African Risk and Vulnerability Atlas (DST, 2010), the populations of 30% of South African species may be reduced by 2050, exposing them to significantly higher levels of extinction risk. Long-term changes in climate and extreme weather events will affect agriculture, biodiversity and ecosystem services, water, oceans and marine environments, health, livelihoods, employment, access to resources and infrastructure (DEA, 2012).

A theme within climate change is the issue of rising atmospheric carbon dioxide (CO_2) levels attributable to anthropogenic activities following industrialisation. Because plants use CO_2 during photosynthesis to produce sugars and to grow, changing levels of atmospheric CO_2 affect the way plants grow and store carbon (Ward, 2005). Elevated CO_2 levels have been linked to bush encroachment, which is a process where there is an increase in the woody layer or an increase in tree abundance within savanna and grassland ecosystems (Sankaran *et al*., 2005; Ward, 2005; Morgan *et al*., 2007; Lewis *et al*., 2009; Wigley *et al*., 2010; Bond and Midgley, 2012; Skowno *et al*., 2017). The growth rate of juvenile plants can be influenced by CO_2, thereby affecting tree recruitment and the conversion of open savannahs to woodlands (Bond and Midgley, 2012). Bush encroachment has negative impacts on agricultural productivity, rangelands, grazing lands and biodiversity, where the ecology of grassland and savanna ecosystems is altered. The magnitude of the impacts depends on how quickly species can adapt to the changes (Reznick and Ghalambor, 2001; Parmesan and Yohe, 2003; Kleynhans *et al*., 2016). Some may thrive as tree abundance increases and others may not be able to survive as their habitat and niche changes.

In southern Africa, studies have shown an increase in woody plant cover over the last 50 years to a century, mainly in savanna grasslands (Ward *et al*., 2014; Wigley *et al*., 2010; Skowno *et al*., 2017), but also a decrease in woody cover under certain scenarios (Eckhardt *et al*., 2000; Asner and Levick, 2012; Skowno *et al*., 2017). Skowno *et al*. (2017) provides the first spatially continuous national-scale estimate of woodland expansion in South Africa over the last two decades (Figure 5). They estimate that from 1990 to 2013, woodlands have replaced grasslands over ~57,000km^2 and conversely grasslands have replaced woodlands over ~30,000km^2, a net increase in the extent of woodland of ~27,000km^2 and an annual increase of 0.22%.

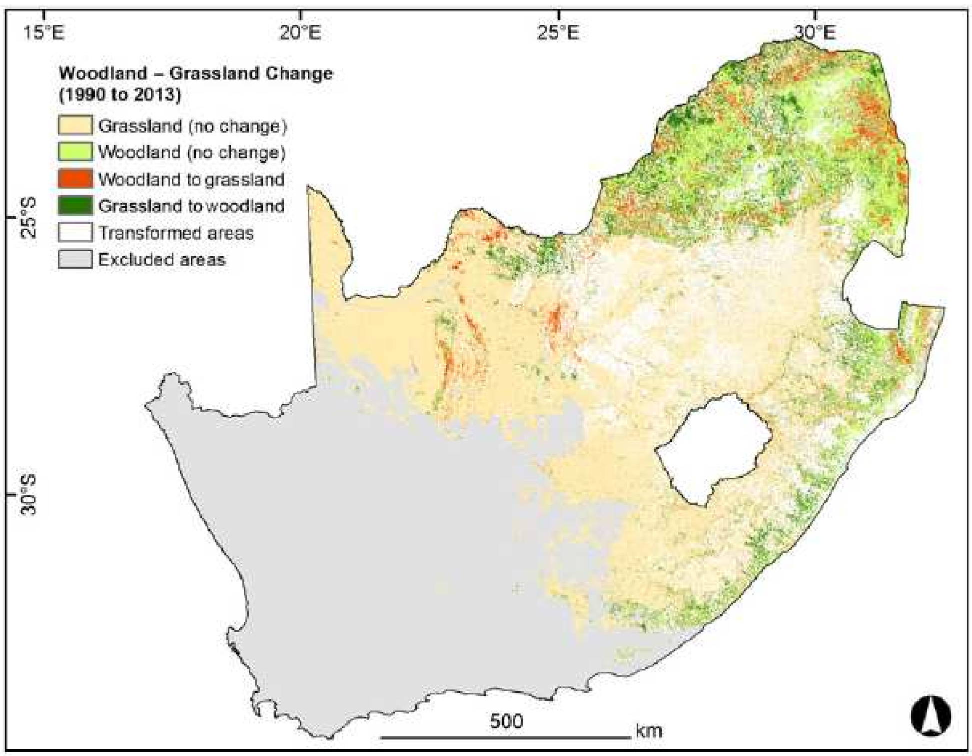

Figure 5: Estimated change in woodland and grassland extent between 1990 and 2013 in the grassy biomes of South Africa (Skowno *et al*., 2017)

Increased atmospheric CO_2 can lead to ocean acidification, which is the gradual reduction in pH of the ocean caused by the absorption of CO_2 by seawater from the atmosphere (Sabine *et al*., 2004). As CO_2 is absorbed and pH reduces, carbonate ion concentration and the saturation states of biologically important calcium carbonate minerals decreases (Langdon and Atkinson, 2005; Orr *et al*., 2005; Kleypas *et al*., 2006; Fabry *et al*., 2008; NOAA, 2017). These minerals are the building blocks for the skeletons and shells of many marine organisms, and a decrease will have a negative impact on biodiversity, as organisms will not be able to produce or maintain their shells (Kleypas *et al*., 2006; Fabry *et al*., 2008). Levels of CO_2 also influences the physiology and metabolism of marine organisms through acid-based imbalance and reduced oxygen transport capacity (Langenbuch and Pörtner, 2004; Fabry *et al*., 2008). Refer to section [to add] of the Oceans and Coasts Chapter for more information.

1.2.4 Over-exploitation

South Africa has high biodiversity, therefore many plants and animals are subject to exploitation (WCDEADP, 2013; NWDREAD, 2014; DEA, 2015a; LEDET, 2015; GDARD, 2017). For example, a total of 192 plant taxa are known to be threatened by direct use or harvested at levels that are not sustainable (Pfab, 2011). Over-use and over-exploitation threatens biodiversity in all ecosystems including terrestrial (land), freshwater (rivers and wetlands), estuaries, and marine and coastal. Drivers of over-use, exploitation and killing include harvesting for medicinal purposes (traditional and scientific), horticultural purposes, pet trade, collectors, hunting, and intentional killing (e.g. poisoning, poaching) (DEA, 2012).

Over abstraction and flow-modification to freshwater systems is a cause of concern not only for aquatic diversity but also estuarine and marine systems, with the changes in freshwater flows and volumes reaching these ecosystems. Terrestrial biodiversity can also be affected indirectly where displacement of habitat or species can occur as a result of changes in the availability of freshwater resources.

In South Africa, there are a few large-scale industrial fisheries that employ about 27 000 people (Stats SA, 2017). Large-scale industrial fisheries target high-quantity harvesting of offshore resources, which are usually extracted to the upper limit or over-exploited. Increasing the allowable catch of most resources is not sustainable, therefore, to retain a viable fishery it is paramount that the resource is managed sustainably and protected (Stats SA, 2017).

1.2.5 Wildlife economy and bioprospecting

South Africa is the third most biologically diverse country in the world and therefore has one of the largest natural capital assets and many of our resources have very good commercial potential (DEA, 2016). The Wildlife Economy in South Africa is focussed on the sustainable use of indigenous biological resources, including biodiversity-derived products for trade and bioprospecting, the hunting industry, agriculture and agro-processing of indigenous crops and vegetables and livestock breeds and indigenous marine resources and fisheries (DEA, 2016). Additional products with commercial potential for industrial or pharmaceutical application are micro-organisms, marine organisms, gums and resins and venoms (DEA, 2016). Other biodiversity-based products include bee-keeping products (honey, wax, propollis and royal jelly), mopane worms and ostrich egg shells and feathers.

The wildlife sector has been growing consistently faster than the general economy, contributing R3 billion to the Gross Domestic Product (GDP) in 2014 (DEA, 2016) and this should be considered a red flag for the need to assess the impacts of this on biodiversity in South Africa. The wildlife sector comprises three sub-sectors, wildlife ranching, recreational wildlife activities and wildlife products

(DEA, 2016). Wildlife ranching may have a positive influence on biodiversity although land management practices would need to be sound to ensure the land can support the biodiversity. Recreational activities such game viewing would also have a positive influence while activities such as hunting and wildlife products can have a negative influence if not regulated and done in a sustainable manner.

The bioprospecting industry includes the harvesting of resources, processing and trade, and final domestic product. This industry could have severe negative effects on biodiversity if not regulated and conducted in a sustainable manner. Mass cultivation will contribute to loss of habitat with the land needed for cultivation, and wild individual populations are at risk if wild harvesting is not done sustainably.

As a response, a National Biodiversity Economy Strategy (NBES) is therefore required to guide the sustainable growth of the wildlife and bioprospecting industries and to provide a basis for addressing constraints to growth, ensuring sustainability, identifying clear stakeholder's responsibilities and monitoring progress of the Enabling Actions. The vision of NBES is to optimise the total economic benefits of the wildlife and bioprospecting industries through its sustainable use, in line with the vision of the Department of Environmental Affairs (DEA) (DEA, 2016). The purpose of NBES is to provide a 14 year national coordination, leadership and guidance to the development and growth of the biodiversity economy (DEA, 2016). [Perhaps move to Responses section]

1.2.6 Coastal and marine tourism

Coastal and Marine Tourism (CMT) focuses on recreational activities along the coastal zone and/or the marine environment (DEA, 2016). With the 3rd longest coastline in Africa, CMT has untapped potential to contribute to South Africa's development and transformation (DEA, 2012). CMT activities include marine wildlife tourism (e.g. boat-based whale watching, shark cage diving, seals, dolphins, turtles, birds etc.), recreational fishing, spear fishing, scuba diving/snorkelling, water sports, yachting, ocean experience (e.g. cruise tourism, marinas, island tourism, under water archaeology, etc.), coastal wildlife tourism (e.g. land-based whale watching, coastal avi-tourism, marine turtles tours, etc.), sand/beach sport, coastal heritage and events, sight-seeing, educational and scientific excursions, spiritual experiences and pure recreational (DEA, 2012). Unless there is a direct benefit to biodiversity such as the proclamation of Marine Protected Areas (MPAs), such activities can have a negative influence on biodiversity if not regulated and sustainable.

An important aspect of CMT is the placement of shark nets and drum lines along the KwaZulu-Natal coastline. Shark nets place pressure on marine biodiversity through the by-catch of non-targeted species such as dolphins, sea turtles, batoids (rays) and teleosts (ray-finned fishes) (Dudley and Cliff, 1993; Brazier *et al*., 2012). The exclusion of large shark species also results in a proliferation of small shark species in the absence of predation, which affects the overall food-chain of inshore habitats (Dudley and Cliff, 1993; Brazier *et al*., 2012). The true impact on biodiversity needs to be quantified and measured against their need and function within CMT. While this is regarded as a persisting issue, as the shark nets and drum lines have been in existence for some time, it has previously not been reported on as a pressure for marine biodiversity. The search for alternative technologies for deterring sharks from entering human swimming zones at popular tourist beaches should be prioritised as the current system has a major impact on the local populations of marine life. Refer to section [to add] of the Oceans and Coasts Chapter for more information. [Possible example/case study – Humpback Dolphins in Richards Bay]

1.2.7 Pollution

Many anthropogenic activities produce unwanted by-products or waste, which need to be disposed of or stored out of sight. Waste or unwanted by-products often end up polluting natural systems if not discarded in the correct manner. There are also many accidental pollution events, such as oil spills or plastic pellet (or nurdle) spills, which can have catastrophic effects on biodiversity. Pollution has a negative effect on biodiversity if natural systems are contaminated. An example of severe negative effects of pollution on biodiversity is the problem of plastic pollution and the impact it has on marine biodiversity. Plastic floating in water is often mistaken by marine mammals, fish, turtles and pelagic birds, for food. This may cause death of the animal through asphyxiation or malnutrition and eventually starvation, as it fills the stomachs with non-nutritive mass. Refer to sections [to add] of the Waste Management, Air Quality, and the Oceans and Coast Chapters respectively for more information on topics surrounding pollution.

1.2.8 Eutrophication

Over the past 40 years, eutrophication has become an increasing threat to the freshwater resources in South Africa (van Ginkel, 2011). Eutrophication is the process of nutrient enrichment and the associated excessive plant growth in water bodies. While natural nutrient enrichment occurs, anthropogenic activities have accelerated the process through increased nutrient loads from agriculture, industry, and urban discharge and runoff (van Ginkel, 2011). Similarly atmospheric emissions of ammonia and nitrogen oxides lead to increased loads of ammonia and nitrogen oxides in precipitation. The presence of high concentrations of nutrients in the water supports the rapid growth of algae and macrophytes (van Ginkel, 2011). Large fluctuations in dissolved oxygen is a result of algal blooms and oxygen depletion occurs when the algae/plant life die and decompose. This creates hypoxic conditions and usually results in fish kills (Gong and Xie, 2011). Another important consequence of eutrophication is blooms of cyanobacteria, carrying the threat of cyanotoxin contamination (van Ginkel, 2011). Excessive macrophyte biomass blocks waterways, impedes access to dams and rivers, clogs drainage systems and contributes to flooding and the destruction of canals (van Ginkel, 2011). [Possible example/case study – Hartebeestpoort Dam].

1.2.9 Pesticides

Pesticides have a major effect on biological diversity, alongside habitat loss and climate change (Geiger *et al*., 2010). They can have toxic effects on directly exposed organisms in the short-term, and long-term effects can result from changes to the food chain (Geiger *et al*., 2010). The impacts that pesticides have on wildlife is a major cause for concern in regards to the deterioration of biodiversity worldwide and in South Africa. It has been documented that certain pesticides, when introduced to soil or aquatic environments, cause a decline in species diversity in aquatic organisms, predatory insects and soil inhabiting fauna (Fountain *et al*., 2007; Reinecke and Reinecke, 2007; Añasco *et al*., 2010; Evans *et al*., 2010). Also of concern is the cumulative effect of the many different pesticides existing at below-limit levels, or multiple pesticide residues. Cumulatively these relatively small levels may reach a level of toxicity that is not measurable.

1.2.10 Hydraulic fracturing (fracking)

In South Africa, shale gas holds significant potential in energy value but there are high levels of uncertainty and controversy surrounding the proposals, and as such it is expected that shale gas will not become a significant energy source at least within the next ten years (DEA, 2012). Fracking has a range of negative impacts on biodiversity and could become an important driver of biodiversity loss in South Africa. Studies show that fracking can be harmful to many plant and animal species, and may decrease biodiversity (Kiviat, 2013; Vandecastelle *et al*., 2015). In South Africa, the Karoo Basin faces the greatest risk. This area includes highly sensitive and unique ecosystem types, supports many range-restricted species and is relatively rich in biodiversity (Holness *et al*., 2016). Of the different identified impacts, noise, pollution, direct and indirect habitat loss, and the direct impacts of fracking-associated transport such as habitat fragmentation, have been highlighted as the likely key drivers of ecological impact in the Karoo (Holness *et al*., 2016; Todd *et al*., 2016).

Holness *et al*. (2016), in the Strategic Environmental Assessment (SEA) for fracking in South Africa, spatially analysed, and categorised areas of the Karoo Basin (frackable area) and took ecological importance and sensitivity into account, i.e. Ecological and Biodiversity Importance and Sensitivity (EBIS). Sites with high "Importance" are those that are most needed for meeting biodiversity targets (in other words are most irreplaceable), and sites with high "Sensitivity" are those containing features that are highly vulnerable to disturbance or where recovery is slow. The map of EBIS (
Figure 6) shows that EBIS-1 and EBIS-2 (see Table 1 for definitions) comprises an estimated 50% of the study area, while EBIS-3 comprises around 44% and EBIS-4 only 1% of the study area. Loss or degradation of habitat in areas classified as EBIS-1 and EBIS-2 must be avoided, and they should be secured through appropriate legal mechanisms (Holness *et al*., 2016).

Table 1: Extent of areas of EBIS within the study area (hectares and percentage) (Holness *et al*., 2016)

Zone	Extent (Hectares)	Extent (%)
Protected areas: No-go	828 191	5
EBIS-1: Irreplaceable areas that contain extremely sensitive features, such as key habitat for rare, endemic or threatened species, or features that perform critical ecological functions	2 253 544	13
EBIS-2: Optimal areas that contain highly sensitive features and/or features that are important for achieving targets for representing biodiversity and/or maintaining ecological processes. These areas represent the optimal configuration for securing the species, ecosystems and ecological processes of the Karoo	6 348 763	37
EBIS-3: Other natural or semi-natural areas that do not contain currently known sensitive or important features, and are not required for meeting targets for representing biodiversity or maintaining ecological processes	7 593 740	44
EBIS-4: Areas in which there is no remaining natural habitat, e.g. urban areas, larger scale highly degraded areas, large arable intensively farmed lands	156 900	1
Total	**17 181 138**	**100**

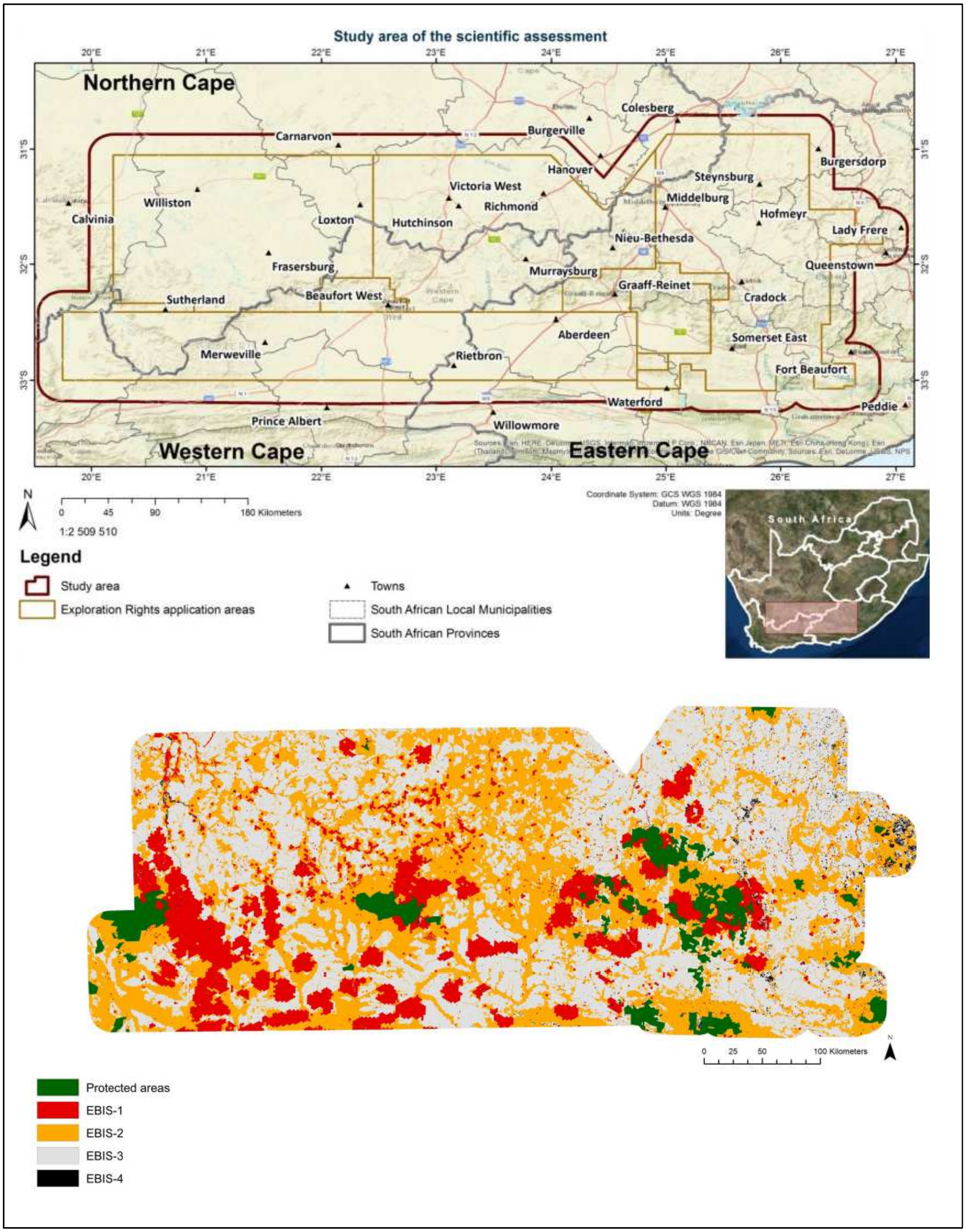

Figure 6: Map of Ecological and Biodiversity Importance and Sensitivity in the study area (Holness *et al*., 2016)

1.2.11 Micro-pollutants

Micro-pollutants are emerging as a new challenge to conservation over the past few decades, with the occurrence of micro-pollutants in the aquatic environment becoming a worldwide issue of increasing environmental concern (Luo *et al*., 2014; Wanda *et al*., 2017). Micro-pollutants, also termed as emerging contaminants, consist of a vast (and expanding) variety of anthropogenic as well as natural substances including pharmaceuticals, personal care products, steroid hormones, industrial chemicals, pesticides and many other emerging compounds (Luo *et al*., 2014; Wanda *et al*., 2017). The occurrence of micro-pollutants in the aquatic environment have been frequently associated with a number of negative effects, including short-term and long-term toxicity, endocrine disrupting effects and antibiotic resistance of micro-organisms (Fent *et al*., 2006; Pruden *et al*., 2006).

1.2.12 Desalination

The need for potable water in drought stricken or water stressed countries has seen a rise in the testing of desalination technologies. The effects of desalination on biodiversity in South Africa are not yet fully understood (Einav *et al*., 2002; Hiscock *et al*., 2004; Danoun, 2007; Cooley *et al*., 2013). The main impacts on biodiversity caused by the desalination process include intake of large volumes of sea water, which destroys microbial organisms, plankton, fish eggs, and fish larvae that constitute the base layer of the marine food chain. Also the concentrated salty sludge leftover after desalination, often with heavy metals added to the chemical load of the brines through corrosion, which are discharged to the marine environment (Höpner and Lattemann, 2002; Cooley *et al*., 2013).

1.3 State and impacts

The 2011 NBA (Driver *et al*., 2012), which assessed the state of South Africa’s biodiversity across terrestrial, freshwater, estuarine and marine environments, emphasising spatial information for both ecosystems and species, remains current and relevant until the updated NBA is published in 2018.

1.3.1 Status of species

As reported in the 2011 NBA, South Africa is one of the most biologically diverse countries in the world and is therefore known as a mega-diverse country. Home to over 95 000 known species, South Africa contributes a significant proportion to world’s plant species (6%), reptile species (5%), bird species (8%) and mammal species (6%), with new species discovered and described regularly (Driver *et al*., 2012).

Red List assessment results show that one in five terrestrial mammal species is threatened; one in five freshwater fish species is threatened; one in seven frog species is threatened; one in seven bird species is threatened; one in eight plant species is threatened; one in twelve reptile species is threatened; and one in twelve butterfly species is threatened (Table 2; Driver *et al*., 2012). The proportion of threatened species is highest for freshwater fish and terrestrial mammals while the plants show the highest numbers of threatened species (over 2 500). There are still gaps in knowledge with respect to the conservation status of certain species, particularly marine species and invertebrates. [To include explanation and graphic of Red List categories]

Table 2: Summary of species status in South Africa , for those groups that were comprehensively assessed at the time (Driver *et al*., 2012)

Taxonomic group	# described taxa	# threatened	% threatened	# extinct	# endemic to SA	% endemic to SA	% of Earth's taxa
Plants	20 692	2 505	12	40	13 203	64	6
Terrestrial Mammals	307	60	20	3	57	19	6
Birds	851	133	16	2	38	4.5	8
Amphibians	118	17	14	0	51	43	2
Reptiles	421	36	9	2	196	447	5
Freshwater Fish	114	24	21	0	58	51	1
Butterflies	793	59	7	3	415	52	?

Species of special concern are those species that are of particular ecological, economic or cultural significance. As reported in Driver *et al*. (2012), in the South African context, these include (but are not limited to):

- Rhinoceros species because of unprecedented levels of poaching;
- Cycads, the most threatened plant group in South Africa and globally;
- Medicinal plants, such as *Pelargonium sidoides* and *Aloe ferox*, upon which many people rely for primary health care and income. South Africa's wealth of medicinal plant species are mostly not threatened, with some important exceptions especially amongst heavily traded species (Raimondo *et al*., 2009; Williams *et al*., 2013);
- Freshwater fish, one of the country's most threatened animal groups;
- Harvested marine species, which provide nutritious food and support a large industry. Many of these species are in a poor state, raising concerns about the ongoing ability of this resource to provide ecosystem services; and
- Species that provide the basis for non-consumptive ecotourism or CMT. For example, tourism based on non-consumptive use of marine species is rapidly expanding in value, and is currently on par with major fishery sectors in three coastal provinces. Key resources are whales, sharks, seabirds and turtles.

1.3.2 Status of ecosystems

The ability to map and classify ecosystems into different ecosystem types is essential in order to assess threat status and protection levels and track trends over time. South Africa has a National Ecosystem Classification System, including vegetation types, river ecosystem types, wetland ecosystem types, estuary ecosystem types, and marine and coastal habitat types, which provides an essential scientific basis for ecosystem-level monitoring, assessment and planning (DEA, 2014). Significant advances in mapping and classifying ecosystems, as well as refinement of the thresholds used in the assessment of ecosystem threat status, makes reporting on trends in ecosystem threat status possible.

The ecosystem threat status in the NBA 2011 highlighted that wetland ecosystems are the most threatened ecosystems in South Africa and the ecosystem protection level highlights that wetland and offshore ecosystems have the highest proportion of ecosystem types that are not protected.

1.3.3 Protected areas

Protected areas are a way of conserving species and their habitats, and they offer refuge to threatened species that would otherwise be at greater risk of targeted exploitation (WWF, 2014). Biodiversity targets have been set for national ecosystem types and this means that protected area targets for ecosystem types can be set (SANBI, 2013). The protected area target for each ecosystem type (for a particular timeframe) forms a portion of the biodiversity target for that ecosystem type.

The 2008 National Protected Area Expansion Strategy (NPAES) set 20-year protected area targets at just more than half of the biodiversity target for each ecosystem type (DEA, 2010). This means that national protected area targets are built from the bottom up, based on ecosystem-level targets, and that protected area targets will be met only by expanding protection of ecosystems that are currently under-protected (Driver *et al*., 2012).

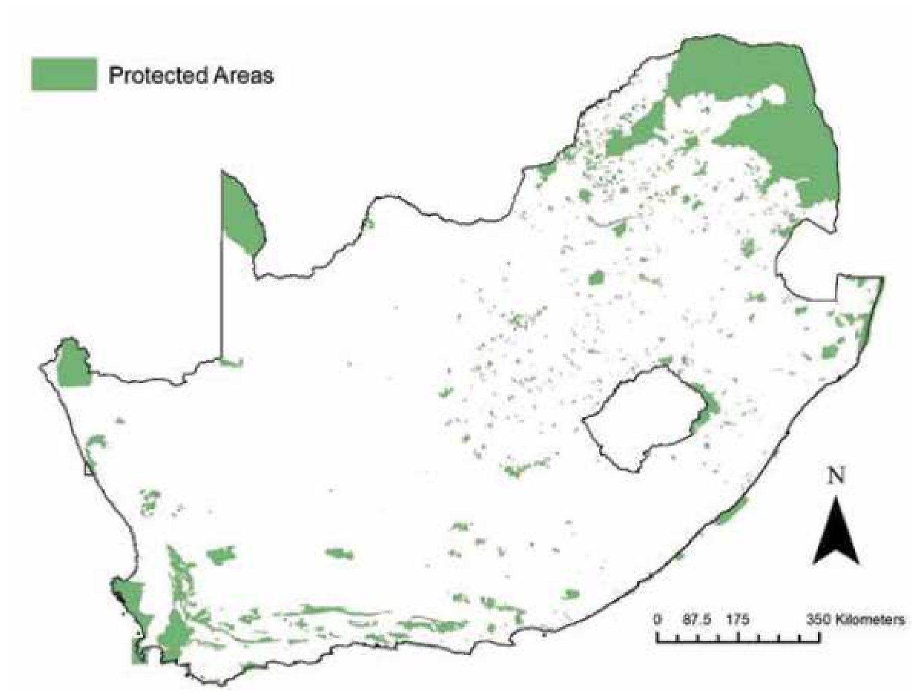

Figure 7: Map of the Conservation Areas and Protected Areas (DEA Protected Areas Database)

The 2016 NPAES is due to be published. It builds on the 2008 NPAES and brings in new concepts such as building of priorities from the bottom up based on ecosystem level targets. As targets can only be met in intact habitat, it has included integrated and almost fully comprehensive ecosystems and condition maps. These include maps of ecosystem type, ecological condition, protected areas and biodiversity targets (Holness *et al*., 2016). The first ever integrated map of ecosystem condition, taking into account all the indicators of biodiversity, was produced for South Africa and used information contained in the following datasets:

Terrestrial Ecosystems: The revised 2012 National vegetation map based on Mucina & Rutherford (2006).

- There are 450 ecosystem types.

Wetlands: Natural wetlands included in the 2015 revised national wetland map (4a).

- Wetlands were included at the group level which has 136 distinct ecosystem types.

Coastal and marine types: The integrated coastal and benthic habitat maps prepared for the National Biodiversity Assessment 2011.

Estuaries: Estuaries types were mapped based on the outlines in the national estuary map 2012 and the classification in Whitfield (1992).

- There are 46 estuary ecosystem types in 3 biozones.

Rivers: River ecosystems were based on the NFEPA classification and dataset.

Current **Protected Areas** (as at 2014)

National Land Cover (NLC 2013/2014) for inland areas

Using this information, NPAES 2016 can evaluate existing protection levels and decide on priority areas for expansion. Table 3 shows the results of ecosystem threat status and ecosystem protection level in each environment as assessed by the NBA (Driver *et al*., 2012).

Table 3: Ecosystem threat status and ecosystem protection level in each environment in SA (Driver *et al*., 2012; DEA, 2012)

Ecosystem	Threat status	Protection level
Terrestrial	40% of ecosystem types threatened	22% of ecosystem types well protected, 35% not protected
Riverine	57% of ecosystem types threatened	14% of ecosystem types well protected, 50% not protected
Wetland	65% of ecosystem types threatened	11% of ecosystem types well protected, 71% not protected
Estuarine	43% of ecosystem types threatened	33% of ecosystem types well protected, 59% not protected
Coastal and inshore	58% of ecosystem types threatened	9% of ecosystem types well protected, 16% not protected
Offshore	41% of ecosystem types threatened	4% of ecosystem types well protected, 69% not protected

1.4 Indicators of biodiversity loss

Within the DPSIR framework, indicators are used as representatives for the state of the environment. An indicator is defined by the Biodiversity Indicators Partnership (BIP) as “a measure based on verifiable data that conveys information about more than just itself” meaning that indicators are purpose dependent, i.e. the interpretation or meaning given to the data depends on the purpose or issue of concern (BIP, 2017). Indicators are an essential aspect of monitoring and reporting progress towards the achievement of national targets, such as those set in National Biodiversity Strategy and Action Plans (NBSAPs) or sustainable development strategies, and are also important in facilitating adaptive management (BIP, 2017).

Biodiversity indicators are statistical measures of biodiversity that help us understand the condition of biodiversity and the factors that affect it (ZSL, 2015). Indicators must be well selected and supported by available information so that they can provide a clear statement on where the environment is improving and deteriorating, and the nature and the urgency of the response required (DEA, 2012).

From a national perspective, the two chief indicators showing the **ecosystem threat status** and **ecosystem protection level** (as per NEMPAA) as presented in the NBA (Driver *et al*., 2012), are the best reference as to the status of the country's ecosystems. Species and population trends, extinction risk, community composition, extent, intactness and condition of habitat, threat status and protection level of vegetation types, extent of protected areas, change in species distribution, distribution and abundance of invasive alien species, extent and condition of centres of endemism all play a role in these indicators. For example, the percentages of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, and the percentage of marine and coastal ecosystem types that are well-represented in protected areas, are indicators for the response to biodiversity loss through destruction of habitat, fragmentation, climate change and over-exploitation. Ecosystem threat status and ecosystem protection level are assessed in a consistent way across all environments, enabling comparison between terrestrial, river, wetland, estuarine, coastal and marine ecosystems, as summarised in the following figure.

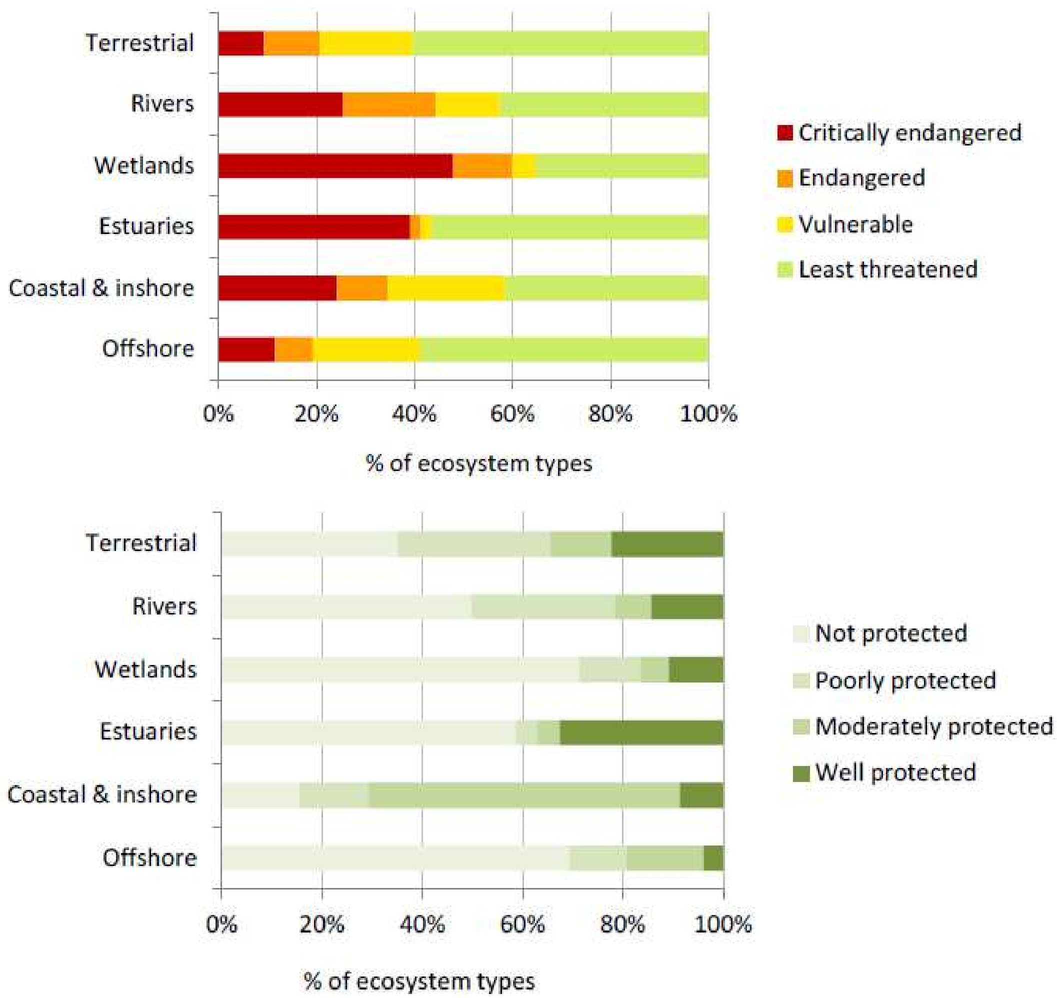

Figure 8: Summary of ecosystem threat status (top) and ecosystem protection level (bottom) across terrestrial and aquatic environments (Driver *et al*., 2012)

Indicators enable us to recognise changes in states of biodiversity in response to particular drivers and pressures, which then help us to identify appropriate responses to the pressures and states to ensure that the benefits of biodiversity are enhanced. For example, in South Africa the percentage of terrestrial, freshwater, marine and coastal ecosystems that were well protected, increased by 1% between 2010 and 2016 (
Figure 9; Stats SA, 2017). Table 4 summarises indicators for pressures, states and responses of biodiversity loss in South Africa further.

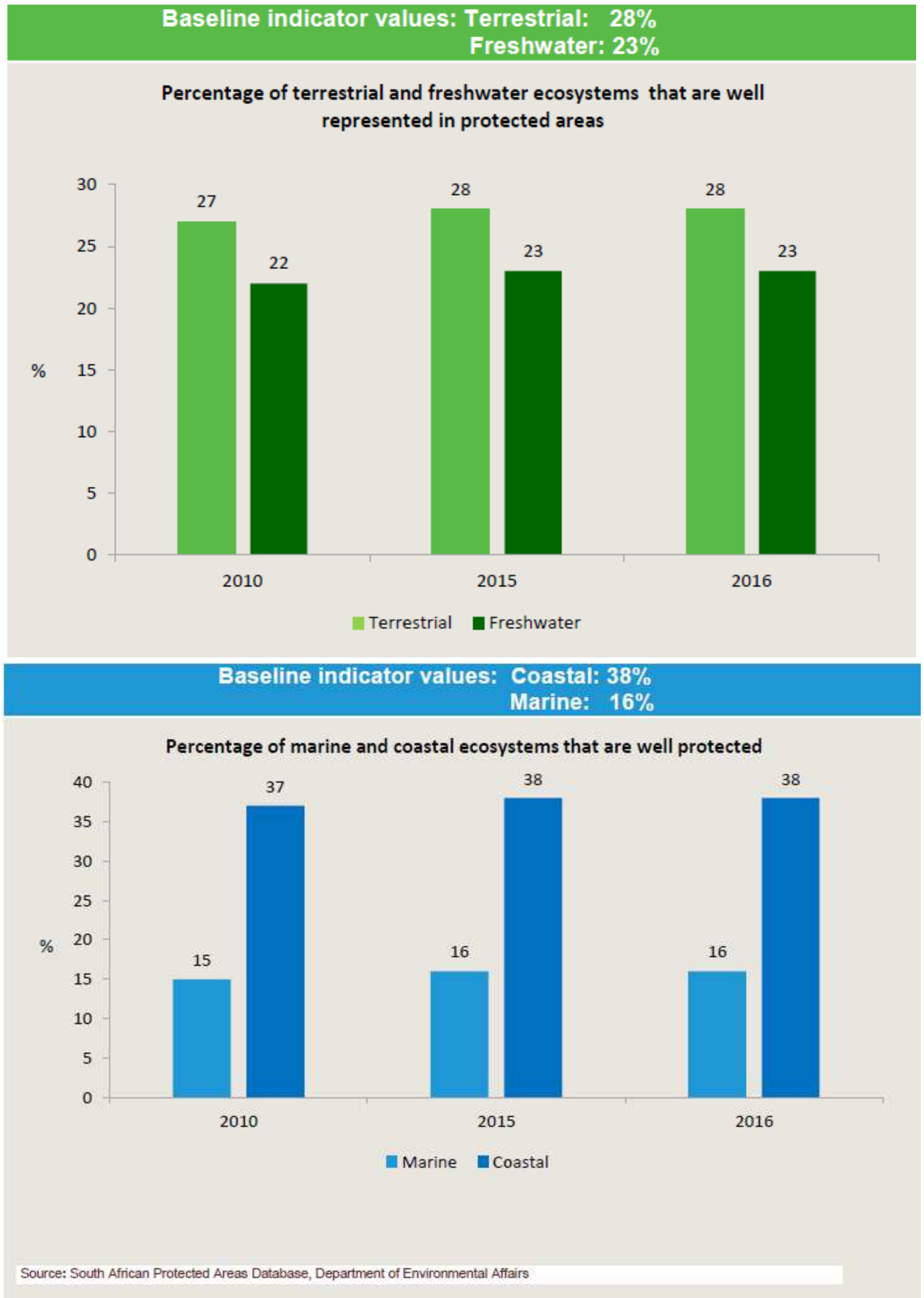

Figure 9: Percentage of ecosystems that are well protected or well represented in protected areas in South Africa (Stats SA, 2017)

Table 4: Summary of issues and associated indicators for biodiversity

Theme (Issues)	Indicator	Description	Relevance				Status	
			NBA	CBD/Aichi	SDG	SOE	Source (Latest)	Data Availability
Pressures on Biodiversity								
Habitat loss and fragmentation due to anthropogenic landuse needs (Agriculture, Cultivation, Afforestation, Urban development, Dam construction, Mining, Fracking, Coastal developments)	Extent of Impacted Land Cover / Intactness of Terrestrial Habitat	Land cover data – amount of natural habitat remaining compared to transformed lands	✓	Target 5: Habitat loss	15.1 15.2 15.5	✓	DEA (2015)	
Land degradation (Overgrazing, Desertification, Poor land management practices)	Land Cover Change / Extent of Terrestrial Degraded Land Cover	Portion of degraded land cover based on repeatable methodology using DEA land cover data	✓	Target 5: Habitat loss	15.3	✓	DEA (2015)	
Invasive alien species	Distribution and density of invasive alien species	Indicator of cumulative alien species presence and density at sites	✓	Target 9: Invasive species	15.8	✓	?	
Climate change and related pressures (Sea level rise, Elevated CO_2, Bush encroachment)	Extent of Terrestrial Degraded Land Cover	Portion of degraded land cover based on repeatable methodology using DEA land cover data	✓	Target 5: Habitat loss	13.2	✓	DEA (2015)	
	Extent of Remaining Natural Habitat	Portion of natural land cover based on repeatable methodology using DEA land cover data					DEA (2015)	
	Marine and Coastal Ecosystem Condition	Condition of marine and coastal ecosystems					?	
Pressures on biodiversity related to anthropogenic use (Direct exploitation, Overexploitation, Bioprospecting, Wildlife economy)	Target Population Statistics	Individual population statistics for each target species		Target 5: Habitat loss Target 12: Extinction risk	14.6 15.7		?	

Theme (Issues)	Indicator	Description	Relevance				Status	
			NBA	CBD/Aichi	SDG	SOE	Source (Latest)	Data Availability
Pressures on Freshwater Ecosystems (Over-abstraction, Flow modification, Waste discharge, Sedimentation, Poor catchment management, Eutrophication, Pollution, Micro-pollutants)	Freshwater Ecosystem Condition	Condition of freshwater features	✓		15.1	✓	?	👎
Pressures on Marine and Coastal Ecosystems (Overfishing / trawling, Shipping, Pollution, Micro-plastics, Desalination, Coast and Marine Tourism, Reduction in flow of fresh water to estuaries, Cumulative impacts from upstream on estuaries, Ocean acidification)	Marine and Coastal Ecosystem Condition	Condition of marine and coastal ecosystems	✓		14.2 14.3 14.4 14.6	✓	?	👎
State of Biodiversity								
Terrestrial Ecosystems	Threat Status of Terrestrial Ecosystems	Individual Red List values for terrestrial ecosystems	✓	Target 12: Extinction risk	15.1 15.5	✓	SANBI (NBA, 2011)	👍
Freshwater Ecosystems	Threat Status of Freshwater Ecosystems	Individual Red List values for freshwater ecosystems	✓	Target 12: Extinction risk	6.1	✓	SANBI (NBA, 2011)	👍
Marine and Coastal Ecosystems	Threat Status of Marine and Coastal Ecosystems	Individual Red List values for marine and coastal ecosystems	✓	Target 12: Extinction risk	14.1	✓	SANBI (NBA, 2011)	👍
Species	Threat Status of Species	Red List values for individual species as per Red Listing process	✓	Target 12: Extinction risk	15.5 15.7 15.8	✓	SANBI / EWT / BirdLife	👍
Response to Biodiversity Loss								
Habitat loss and fragmentation	Terrestrial Ecosystem Protection Levels	Individual protection level values for terrestrial ecosystems	✓	Target 11: PA network	15.1	✓	DEA and SANBI (NPAES, 2016)	👍
Climate Change	Protection Levels for Ecosystems	Individual protection level values for ecosystems	✓	Target 11: PA network	13.2	✓	DEA and SANBI (NPAES, 2016)	👍

Theme (Issues)	Indicator	Description	Relevance				Status	
			NBA	CBD/Aichi	SDG	SOE	Source (Latest)	Data Availability
Freshwater Ecosystems	Freshwater Ecosystem Protection Levels	Individual protection level values for freshwater ecosystems	✓	Target 11: PA network	15.1 6.1	✓	DEA and SANBI (NPAES, 2016)	👍
Marine and Coastal Ecosystems	Marine and Coastal Ecosystem Protection Levels	Individual protection level values for marine and coastal ecosystems	✓	Target 11: PA network	14.1 14.5	✓	DEA and SANBI (NPAES, 2016)	👍
Species	Species Protection Levels	Protection levels for individual species	✓	Target 12: Extinction risk	15.1	✓	DEA and SANBI (NPAES, 2016)	👍

1.5 Responding to biodiversity loss

The Convention on Biological Diversity (CBD) is a global agreement established in 1992 that addresses global biodiversity. It was inspired by the world community's growing commitment to sustainable development and was established with three main objectives, the conservation of biodiversity; the sustainable use of its components; and fair and equitable sharing of benefits arising out of the utilisation of genetic resources (SCBD, 1992). At the 10^{th} Conference of the Parties (COP) held in Aichi, Japan in 2010, a decision was made to formulate a Strategic Plan for Biodiversity, including the Aichi Biodiversity Targets, for the 2011-2020 period. This plan provides an overarching framework on biodiversity for all parties involved in biodiversity management and policy development. The vision for the Strategic Plan for Biodiversity 2011-2020 is that by 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people.

South Africa's Fifth National Report to the CBD was prepared in 2014 in accordance with Article 26 of the Convention and decision X/10 of the COP. The structure of the report is based on the Guidelines for the Fifth National Report published by the Convention. The report was prepared by the South African National Biodiversity Institute (SANBI) at the request of the DEA, with contributions from the DEA and relevant stakeholders through a workshop, written submissions, and inputs on a draft of the report.

The part of the report that provides a brief overview of the current status of South Africa's biodiversity, including ecosystems and species, and the role of biodiversity in human wellbeing, economic and social upliftment, draws considerably on the 2011 **NBA** (Driver *et al*., 2012), which used two core indicators, **ecosystem threat status** and **ecosystem protection level**, to assess the state of terrestrial, freshwater, estuarine, coastal and marine ecosystems and associated species.

National indicators of the state of biodiversity have been linked to the United Nation's global **Sustainable Development Goals (SDGs)** and how the objectives of the National Development Plan (NDP), align to these goals. On 25 September 2015, countries adopted a set of goals to end poverty, protect the planet, and ensure prosperity for all as part of a new sustainable development agenda (United Nations, 2015). Each goal has specific targets to be achieved over the next 15 years. For biodiversity, Goal 15 is most relevant, while Goals 13 and 14 are also important.

Goal 13: Take urgent action to combat climate change and its impacts

Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

The **National Biodiversity Strategy and Action Plan (NBSAP)** is a requirement of contracting parties to the CBD and sets out a strategy and plan to fulfil the objectives of the Convention. With the adoption of the CBD's Strategic Plan for Biodiversity for 2011-2020, parties agreed to revise and align their NBSAPs to the Strategic Plan and the Aichi Targets. The South African NBSAP was revised for the period 2015-2025 (DEA, 2015) with the vision to "Conserve, manage and sustainably use biodiversity to ensure equitable benefits to the people of South Africa, now and in the future". This vision describes the long-term goal for the state of biodiversity in the country, while six strategic objectives reflect the most pressing issues that the NBSAP seeks to address in support of the vision (DEA, 2015):

1) Management of biodiversity assets and their contribution to the economy, rural development, job creation and social wellbeing is enhanced;
2) Investments in ecological infrastructure enhance resilience and ensure benefits to society;
3) Biodiversity considerations are mainstreamed into policies, strategies and practices of a range of sectors;
4) People are mobilised to adopt practices that sustain the long-term benefits of biodiversity;
5) Conservation and management of biodiversity is improved through the development of an equitable and suitably skilled workforce; and
6) Effective knowledge foundations, including indigenous knowledge and citizen science, support the management, conservation and sustainable use of biodiversity.

In the NBSAP (DEA, 2015), each strategic objective has been broken down into a comprehensive set of outcomes, and each outcome is then addressed through a number of activities. Indicators and targets have been identified at the outcome level, which have been drawn from existing national or organisational strategic plans in South Africa. This has ensured that the NBSAP is firmly integrated and aligned with the strategic priorities and plans of major role players in South Africa and therefore represents a common vision and plan for biodiversity management.

1.5.1 Policy and legislation

South Africa has a strong policy and legislative framework for the conservation, management and sustainable use of biodiversity (DEA, 2014). Following are the key legal elements:

- The Constitution of South Africa (Act 108 of 1996);
- White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (1997);
- National Environmental Management Act (Act 107 of 1998);
- National Environmental Management: Biodiversity Act (Act 10 of 2004);
- National Environmental Management: Protected Areas Act (Act 57 of 2003);
- Marine Living Resources Act (Act 18 of 1998);
- National Forest Act (Act 84 of 1998);
- National Biodiversity Strategy and Action Plan (2015);
- National Biodiversity Framework (2008);
- National Protected Area Expansion Strategy (2016);
- Provincial biodiversity legislation – this differs from province to province; and

- Provincial biodiversity strategies, and provincial protected area expansion strategies, which have been developed by some provinces.

Other important policies and legislation include:

- Regulations for the Convention on International Trade in Endangered Species (CITES);
- National Moratorium on Trade of Individual Rhinoceros Horns;
- Threatened or Protected Species (TOPS) Regulations;
- Prohibition of Trade in Certain *Encephalartos* (Cycad) Species;
- List of Threatened Terrestrial Ecosystems;
- Regulations for Alien and Invasive Species;
- Biodiversity Management Plans for Species;
- Norms and Standards for Biodiversity Management Plans for Ecosystems;
- Bioprospecting, Access and Benefit Sharing Regulatory Framework: Guidelines for Providers, Users and Regulators; and
- National Coastal Management Programme.

1.5.2 Increased protection for biodiversity

South Africa has made significant improvements into the protection of biodiversity in the last five years and includes the following responses:

- National Protected Area Expansion Strategy (NPAES) 2016;
- Biodiversity stewardship programmes;
- Land Reform Biodiversity Stewardship Initiative (LRBSI);
- Marine Protected Areas (MPAs);
- Ramsar sites;
- Biosphere Reserves;
- World Heritage Sites;
- National Botanical Gardens;
- People and Parks Programme; and
- Management Effectiveness Tracking Tool (METT-SA).

1.5.3 Reduced loss of biodiversity

As discussed, loss of natural habitat is one of the biggest pressures on South Africa's biodiversity. Although there are many ways of reducing biodiversity loss and degradation of natural habitat, key actions in South Africa include the following (DEA, 2014):

- Streamlining environmental decision-making process and planning;
- Providing the foundation for land-use decision support;
- Listing of threatened ecosystems;
- Publishing bioregional plans;
- Taking early action to eradicate invasive species and exploring methods and potential for eradication; and

- Tracking land degradation and setting targets for neutrality.

Strategic plans that are used as tools to fulfil these action include the following:

- Use of provincial Spatial Biodiversity Plans (SBPs) to inform land-use planning and decision-making;
- Biodiversity Sector Plans and bioregional plans (map of Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs);
- Incorporating biodiversity into Environmental Impact Assessments (EIAs);
- Biodiversity offsets policy framework;
- Biodiversity Management Plans (BMPs);
- Grasslands Programme, which focusses on mainstreaming biodiversity in key production sectors, including mining, forestry and urban development, to reduce their footprint and prevent further loss of biodiversity priority areas in the grassland biome;
- Mining and Biodiversity Guideline: Mainstreaming Biodiversity into the Mining Sector" (DEA *et al*., 2013); and
- The Land Degradation Neutrality (LDN) response strategy and Target Setting Programme (TSP). The LDN response strategy revolves around avoiding degradation; reducing degradation and restoring degraded lands. South Africa has enacted several laws and policies aimed at preventing land degradation. South Africa ratified the United Nations Convention to Combat Desertification (UNCCD) in September 1997. Parties to the Convention are required to produce National Action Programmes (NAP) to combat land degradation. South Africa produced its first NAP in 2004 and is in the process of finalising the revised and updated NAP. The LDN TSP will further complement the implementation of the new NAP. Preliminary LDN targets for South Africa are as follows (DEA and LDN, 2017):

LDN at the national scale

- LDN is achieved by 2030 as compared to 2015 (no net loss).
- LDN is achieved by 2030 as compared to 2015 and an additional 5% of the national territory has improved (net gain).

LDN at the sub-national scale (if applicable/done)

- LDN is achieved in the grassland biome by 2030 as compared to 2015 (no net loss)
- LDN is achieved in the thicket biome by 2030 as compared to 2015 (no net loss)

Specific targets to avoid, minimize and reverse land degradation

- Improve productivity and SOC stocks in 6 000 000 hectares of cropland by 2030
- Rehabilitate and sustainably manage 3 253 736 hectares of "forest"[2] by 2030
- Rehabilitate and sustainably manage 358 100 ha of fynbos by 2030
- Rehabilitate and sustainably manage 1 499 400 ha of grassland by 2030
- Rehabilitate and sustainably manage 1 149 600 ha of Succulent Karoo by 2030
- Rehabilitate 61 900 ha of wetlands by 2030,
- Clear 1 063 897 ha of alien invasive species by 2030
- Clear 633 702 ha of bush encroached land by 2030, and
- Rehabilitate 350 000 ha of artificial areas by 2030.

1.5.4 Restoration of biodiversity

The following are examples of programmes that ensure that active restoration or rehabilitation is carried out where required (DEA, 2014):

- Natural resource management programmes such as Working for Water, Working for Wetlands, Working on Fire, Working for Land, Working for Forests and Working for Energy and Eco-Furniture Factories;
- Restoring the health of St Lucia, South Africa's flagship estuary;
- Launch of uMngeni Ecological Infrastructure Partnership; and
- Updated linefish profiles show some recovery in linefish status.

1.5.5 Increased focus on inland water ecosystems in the work of the biodiversity sector

The National Freshwater Ecosystem Priority Areas (NFEPA) successfully aimed to identify a national network of freshwater ecosystem priority areas, including rivers, wetlands and estuaries, using systematic biodiversity planning techniques; and to develop an institutional basis for implementing the freshwater ecosystem priority areas through engaging with key stakeholders (Nel *et al*., 2011). Major achievements of the project include the following:

- Publication of the Atlas of Freshwater Ecosystem Priority Areas (FEPAs) in South Africa (Nel et al., 2011), accompanied by an Implementation Manual (Driver *et al*., 2011) and a set of GIS files that are publically available;
- Use of maps of FEPAs to inform decision-making that impacts on freshwater ecosystems, including the classification of water resources in terms of the National Water Act into one of three management classes (minimally used, moderately used or heavily used);
- Development of a National Estuary Biodiversity Plan, which identifies 120 national priority estuaries (out of approximately 300 estuaries), 58 of which require full protection and 62 of which require only partial protection (Turpie *et al*., 2012);
- Publication of National Estuary Management Protocol (DEA, 2013), which guides the development of Estuary Management Plans in terms of the Integrated Coastal Management Act (ICMA);
- Establishment of the Interdepartmental Committee on Inland Water Ecosystems in 2011, which is convened by the Department of Water and Sanitation (DWS) and meets twice a year to bring together all organs of state relevant to the management of freshwater ecosystems, including DEA, DWS, SANBI and SANParks;
- Establishment of a Freshwater Ecosystem Network, convened by SANBI, to serve as a coordination, learning and capacity building mechanism for provincial conservation authorities, DWS, DEA, SANBI, SANParks and relevant Non-Government Organisations (NGOs). The first workshop of the network was held in September 2013; and
- Successes in incorporating ecological infrastructure for water security in the National Water Resource Strategy and the Water Pricing Strategy.

1.5.6 Progress on access and benefit sharing relating to genetic resources

Through the Bioprospecting, Access and Benefit Sharing (BABS) Programme, South Africa is one of the few countries to put in place national legislation that gives effect to Articles 15 and 8(j) of the Convention, which recognise the importance of regulated access to genetic resources as well as their associated traditional knowledge. This is done by requiring the users of these resources to obtain prior informed consent and negotiate mutually agreed terms to share the benefits derived from commercial or non-commercial exploitation of such resources in a fair and equitable manner with the provider countries including indigenous and local communities (DEA, 2014).

1.5.7 Communicating the benefits of biodiversity

The following actions and outcomes support the CBD's cross-cutting work on communication, education and awareness (DEA, 2014):

- Making the case for Biodiversity Project (DEA and SANBI, 2011);
- LIFE: The State of South Africa's Biodiversity 2012 (SANBI, 2013);
- Biodiversity for Development (Cadman *et al*., 2010); and
- International Day for Biodiversity.

1.5.8 Advances in the science foundation and strengthening the science-policy interface

Many of the achievements discussed above have been underpinned by science, information management, and human capital development (DEA, 2014):

- National Biodiversity Assessment (NBA) 2011;
- National Ecosystem Classification System;
- Spatial biodiversity planning;
- Ecologically and Biologically Significant Areas (EBSAs) in the marine environment;
- Red Lists of Species;
- National Biodiversity Research Strategy;
- National Biodiversity Monitoring Framework; and
- Citizen science.

1.5.9 Biodiversity information management and information sharing

South Africa has made significant progress in biodiversity information management (DEA, 2014):

- Biodiversity Advisor web portal and Biodiversity GIS (BGIS) website;
- Land-use decision support tool;
- Biodiversity information management policies;
- Participation in the Global Biodiversity Information Facility (GBIF);
- Training and capacity building related to biodiversity information management and use; and
- Biodiversity Information Management Forum (BIMF).

1.5.10 Human capital development

The following actions and outcomes support the CBD's cross-cutting work on communication, education and awareness (DEA, 2014):

- Development of a Biodiversity Human Capital Development Strategy (BHCDS); and
- Groen Sebenza skills development programme.

1.6 Conclusion

The major persisting drivers of biodiversity change on a national and global scale are habitat loss, ecosystem degradation, invasive alien species, climate change and over-exploitation. Certain other important drivers are relevant to the South African situation, many of which are existing issues that are not new threats to biodiversity and should be considered looking forward. These include wildlife economy, CMT, bio-prospecting, eutrophication, desertification, and pesticides, hydraulic fracturing (fracking) and desalination.

The two chief indicators, ecosystem threat status and ecosystem protection level, are the best reference as to the status of the country's ecosystems. Indicators enable us to recognise changes in states of biodiversity in response to particular drivers and pressures, which then help us to identify appropriate responses to the pressures and states to ensure that the benefits of biodiversity are enhanced.

South Africa has a strong policy and legislative framework for the conservation, management and sustainable use of biodiversity. In response to pressures and impacts on biodiversity, South Africa has many policies, publications and programmes that aim to implement the CBD targets.

Figure 10 provides a summary of the DPSIR model applied to the case of biodiversity in South Africa.

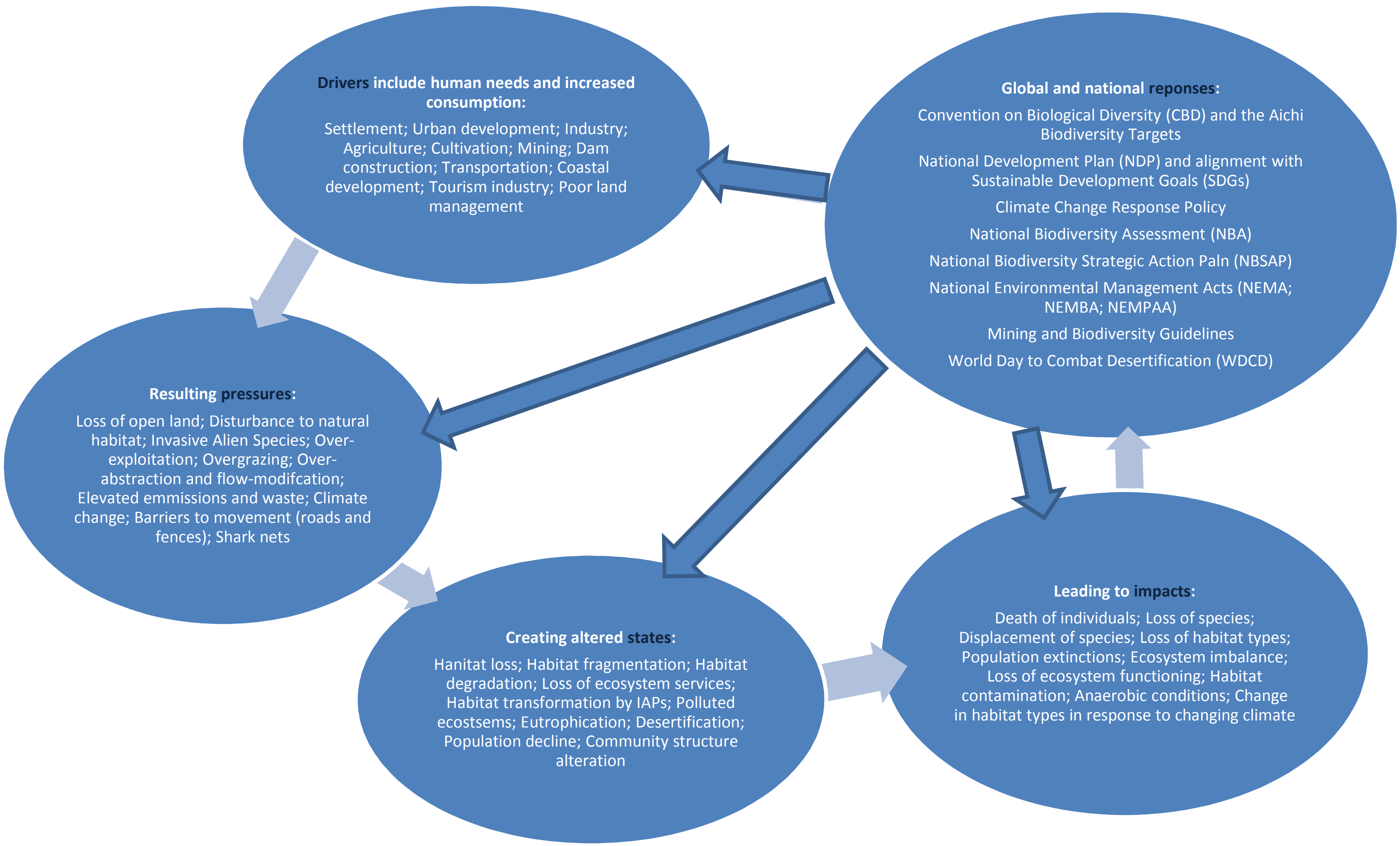

Figure 10: DPSIR framework for biodiversity loss and ecosystem degradation

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