

National Biodiversity Assessment 2018

The status of
South Africa's ecosystems
and biodiversity

SYNTHESIS REPORT

Prepared by the
South African National Biodiversity Institute

Front cover images, left to right:

Coastal landscape including Maphelane and Lake St Lucia in the iSimangaliso Wetland Park. South Africa's estuarine, freshwater and coastal ecosystems face numerous pressures and are highly threatened. © iSimangaliso Wetland Park.

The Critically Endangered Waterberg Copper (*Erikssonia edgei*). Butterflies are the only terrestrial invertebrate group to have been assessed to date. Their Red List Index shows a sharp decline with 13 species becoming more threatened between 2013 and 2018. © Reinier F. Terblanche, Lepidopterists' Society of Africa.

Women washing clothes in the uThukela River near Bergville. Rivers, wetlands and their catchment areas are crucial ecological infrastructure for water security, but the benefits from some of these ecosystems are currently compromised by their poor ecological condition. © Ariadne van Zandbergen/The Africa Image Library.

Iconic Quiver Tree (*Aloidendron dichotomum*) landscape in Namaqualand. The Succulent Karoo biome is an arid winter-rainfall biome with the highest diversity of succulent plants in the world. © Andrew Purnell.

Back cover images, left to right:

Net fishing in Strandfontein, False Bay. Estuarine and marine ecosystems provide South Africans with food and livelihoods by providing a basis for fishing – whether commercial, subsistence or recreational. © Kerry Sink.

West Coast Rock Lobster (*Jasus lalandii*). Commercial catch of this species has declined by 89% since the 1950s; the stock can be considered collapsed and in crisis. © Geoff Spiby.

King Penguin (*Aptenodytes patagonicus halli*) on Marion Island. Marine ecosystem types in South Africa's sub-Antarctic territory (Prince Edward and Marion Islands and associated waters) have been classified and mapped, allowing for the inclusion of our sub-Antarctic territory in the NBA for the first time. © Stephni van der Merwe.

Red Babiana (*Babiana villosa*). This flower is endemic to the Fynbos biome and is considered Near Threatened as it has lost 80% of its habitat to agriculture. South Africa's flora is unique, with 67% of our 20 401 taxa endemic and 14% of all plants threatened. © Ismail Ebrahim.

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Prepared by the South African National Biodiversity Institute
under its mandate to assess and monitor the state of South Africa's biodiversity



Pretoria
2019

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The South African National Biodiversity Institute is an entity of

This report uses the names of the government departments confirmed in June 2019. However, at the time of printing revised logos were not available. Please refer to www.gov.za to see all the changes in government departments and ministries.



environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

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Editorial conventions

Species

Both scientific and common names are provided when referring to species. The English common name is used unless a non-English common name is predominantly used in South Africa. It is recognised that more than one English common name may exist, and that common names in other South African official languages also exist. The common name of species is capitalised, as per the guidance provided by the International Union for the Conservation of Nature (IUCN) Red List of Species.

Acronyms

A full list of acronyms and their definitions is provided at the end of the report. The use of acronyms has been restricted to those that are in common usage or used frequently throughout the document.

Terminology

A glossary of terms is provided at the end of the report. Readers are also encouraged to refer to the Lexicon of Biodiversity Planning in South Africa (SANBI 2016), which provides standard definitions of key concepts and frequently used terms.

Currency

South African Rand is denoted as R.

References

All references for the text are provided in a single list at the end of the report, sorted according to the section in which they were used.

Acknowledgements

The National Biodiversity Assessment (NBA) is led by the South African National Biodiversity Institute (SANBI) as part of their mandate to assess and monitor the state of South Africa's biodiversity. SANBI cannot do this task alone, and draws substantially on contributions from a wide range of partners over the course of the NBA. This is important not only for completing the work, but also for the collective ownership of the NBA by the biodiversity science community. The assessment would not have been possible without the substantial in-kind contributions of time and data, and sometimes actual monetary contributions in terms of travel to workshops, from numerous individuals and institutions. NBA 2018 was completed through over 135 000 person hours of work contributed by over 470 individuals from approximately 90 institutions during the period April 2015 to September 2019, and these individuals and their institutions are profusely thanked for their time and effort.

The **Council for Scientific and Industrial Research (CSIR)** played a crucial role in the NBA by leading the inland aquatic and estuarine components, and

the **Nelson Mandela University** has given substantial contributions to the marine and estuarine components and led the coastal component. These institutions in particular are thanked for their substantial contributions.

Various governance structures were put in place in 2015 to guide the approach taken in the NBA 2018, and ensure that a wide range of experts in each specific biodiversity field were included in the process. The lead authors would like to specifically thank: the members of the **NBA 2018 Core Reference Group** (consisting primarily of the lead authors and some independent experts) for their technical leadership; the expert members of the various **ecosystem classification committees** and **species working groups** for their technical inputs; the members of the **SANBI Cross Functional Steering Committee** (consisting of SANBI senior management officials) for their oversight and guidance; the members of the **Strategic Advisory Committee** (consisting of senior officials from various government departments, non-governmental organisations and research institutes) for their advice on uptake, impact and communicating the NBA findings.

Foreword

South Africa is a special country, with diverse cultures, remarkable geological wealth and exceptional biodiversity, much of which is unique to our nation. With this rich endowment comes the responsibility and challenge of ensuring our species and ecosystems are conserved and used sustainably to the benefit of all South Africans and future generations. This biodiversity wealth gives our people tangible benefits like food, clean water, medicine and materials; it supports agricultural and fisheries production, and helps protect us from natural hazards like floods and droughts; and it provides the basis of a vibrant tourism industry while offering natural spaces for recreational and cultural activities.

Biodiversity is central to South Africa's national objectives of addressing poverty, inequality and unemployment, and supports increased economic growth and improved service delivery for all its citizens. Examining biodiversity in the context of social and economic change shows us that investing in ecological infrastructure is as important as investing in built infrastructure, and safeguarding the delivery of services from ecosystems can support service delivery from all spheres of government.

I am proud to present South Africa's National Biodiversity Assessment 2018, a product of high scientific calibre that summarises the state of our biodiversity by drawing on a broad foundation of information compiled by over a hundred authors. This body of knowledge should be used as a basis for policy, planning and decision making regarding the wise use and conservation of our country's biodiversity assets and the management and restoration of ecological infrastructure. The NBA is a tool not only for the environment sector, but for all sectors of government that share the responsibility for the sustainable development of our landscapes and seascapes.

Ms Barbara Creecy, MP
Minister of Environment, Forestry and Fisheries



Preface

The South African National Biodiversity Institute (SANBI) is proud to release the National Biodiversity Assessment (NBA) 2018. The NBA is the primary tool for monitoring and reporting on the state of biodiversity in South Africa, and is prepared as part of the SANBI mandate under the National Environmental Management: Biodiversity Act (Act 10 of 2004).

The NBA allows us to take stock of what biodiversity we have and what condition it is in, which then informs South Africa's strategic objectives and activities for managing and conserving biodiversity, as well as policies and strategies in sectors that rely on our natural resources. It helps us prioritise the often limited resources allocated for managing and conserving our biodiversity, and feeds into land-use planning and decision making at various scales. In addition, the NBA assists us with both our national and international reporting commitments. The NBA is not prescriptive in its priority actions going forward, as it presents a body of knowledge and evidence that can be adopted by government and civil society to inform outputs such as sector-specific summaries and action plans, research strategies, natural capital accounting and scenario planning.

The NBA focusses primarily on assessing biodiversity at the ecosystem and species level, and the two headline indicators of threat status and protection level are applied to both ecosystems and species in the four realms (terrestrial, inland aquatic, estuarine and marine) and in two cross-realm areas (the coast and South Africa's sub-Antarctic territory). These established headline indicators provide a way of comparing results meaningfully across the realms, and a standardised framework that links with policy and legislation in South Africa to facilitate an effective interface between science and policy. Underlying the headline indicators is a wealth of geographically detailed information that can be applied at the provincial and local level.

The NBA 2018 builds on the National Spatial Biodiversity Assessment 2004 and the NBA 2011. This provides us with a comprehensive picture of South Africa's biodiversity threat status and protection level across time. Each NBA builds on decades of research and innovation by South African scientists, and makes that science available in a suitable form to users both inside and outside of the biodiversity sector.

Collaboration between multiple institutions and individuals is an essential part of the NBA process. Without the voluntary contributions from experts and institutions outside SANBI, the NBA would not be possible. Special mention is due to experts from the Council for Scientific and Industrial Research who led the inland aquatic and estuarine components, and experts from the Nelson Mandela University who led the work on the coast. Over 90 institutions have been involved in the NBA 2018, and more than 470 individuals have contributed an estimated 135 000 person hours, or 75 person years, of work. The collaborative process ensures that the best available science underpins the NBA, promotes collective ownership of the NBA products by the biodiversity community in South Africa, and helps ensure a common vision for action following the assessment.

The products of the NBA include this technical synthesis report, seven technical reports, various supplementary technical documents, maps and datasets, and several popular outputs, all of which are freely accessible to the public through the NBA website. Please join me in congratulating the many contributors to the NBA on this monumental body of work.

Ms Beryl Ferguson
Board Chair: South African National Biodiversity Institute



Key messages

Preamble

South Africa has exceptional biodiversity, characterised by a wide variety of ecosystem types, high species richness and high levels of endemism. South Africa’s biodiversity provides an array of benefits¹ to the economy, society and human wellbeing. These

¹ There is substantial work ongoing both in South Africa and internationally on the benefits/contributions/services that people gain from biodiversity and terminology in use is continually evolving. Phrases such as ‘ecosystem services’, ‘ecosystem goods’, ‘ecological infrastructure’, ‘benefits of biodiversity’ and ‘nature’s contributions to people’ are in common use. The terms ‘benefits’, ‘services’ and ‘ecological infrastructure’ are used throughout the NBA 2018 products and defined in the glossary of the synthesis report. Please refer to the NBA 2018 supplementary document ‘Compendium of Benefits of Biodiversity’ for more information.

benefits that nature provides are dependent on intact ecosystems, healthy species populations and genetic diversity.

The NBA is the primary tool for monitoring and reporting on the state of biodiversity in South Africa and informs policies, strategic objectives and activities for managing and conserving biodiversity more effectively. The NBA is especially important for informing the National Biodiversity Strategy and Action Plan (NBSAP), the National Biodiversity Framework (NBF) and the National Protected Area Expansion Strategy (NPAES), and also informs other national strategies and frameworks across a range of sectors, such as

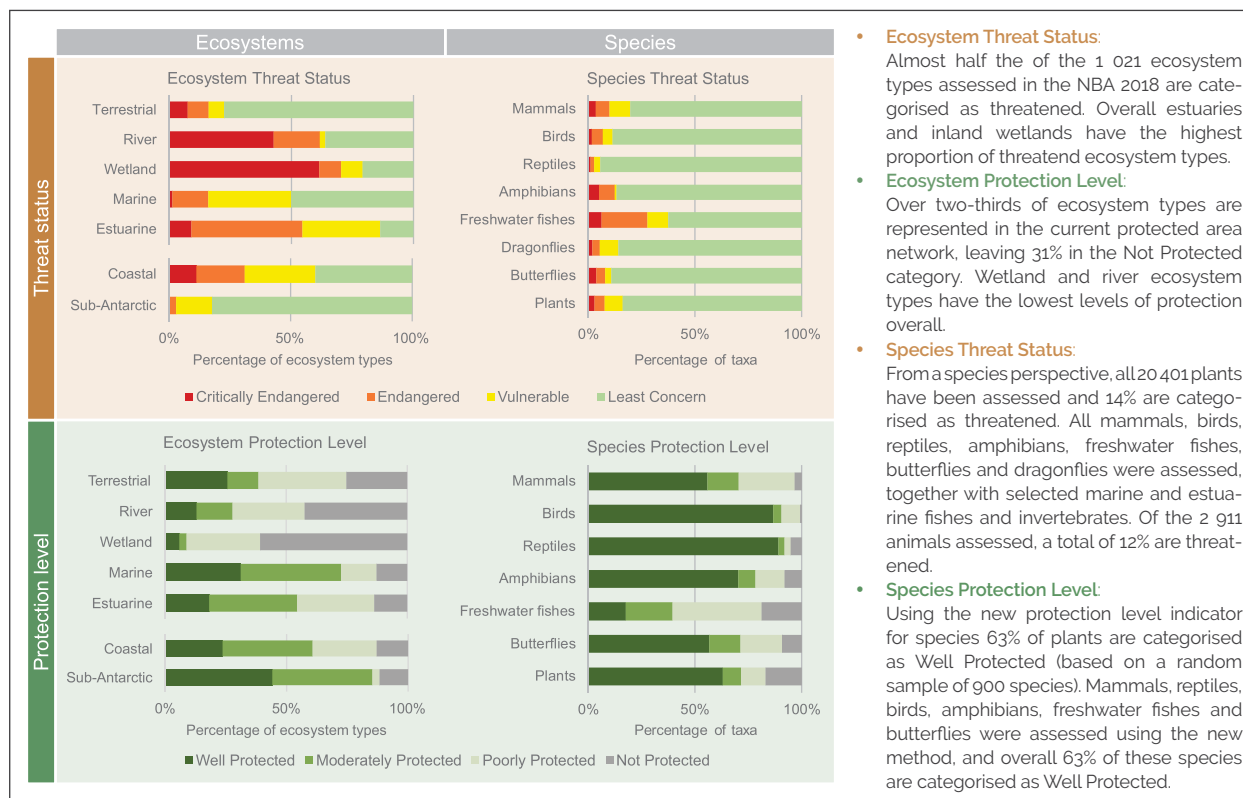


Figure 1. The NBA has four headline indicators, providing information on the threat status and protection level of ecosystems and species. The threat status indicators use the established IUCN Red List of Species and Red List of Ecosystems assessment frameworks. The risk of extinction (species) or collapse (ecosystems) is evaluated across all realms and for taxonomic groups for which sufficient data exists. The protection level indicators reflect how well our species and ecosystem types are represented in the protected area network.

the National Spatial Development Framework, the National Water and Sanitation Master Plan and the National Biodiversity Economy Strategy.

The key messages presented in this section distil some of the most important findings of the NBA 2018, each with the rationale for why the finding is important and a call to action. The key messages can inform sector-specific strategies and action plans, cross-sectoral planning, research strategies, scenario planning and spatial prioritisation exercises that may be developed subsequently to the NBA. Many of these will be trans-disciplinary and should be co-produced between all relevant stakeholders so that uptake and implementation is enhanced.

The NBA 2018 key messages are grouped into three clusters: a) South Africa’s biodiversity provides benefits to people; b) South Africa’s biodiversity is under pressure, but solutions are at hand; and c) the NBA stimulates work to address knowledge gaps.

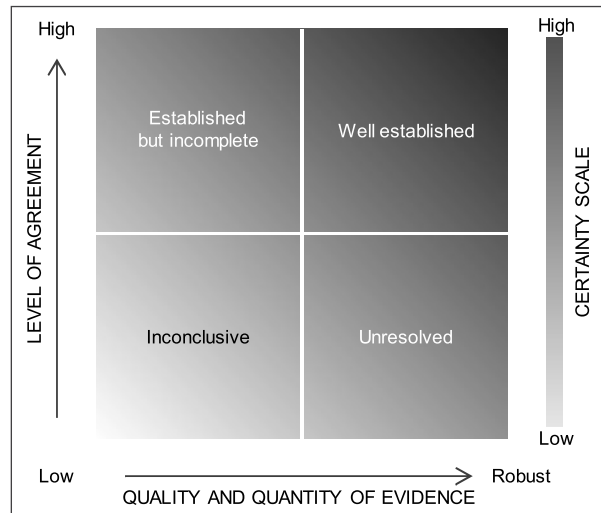


Figure 2. Each message is accompanied by a qualitative statement of the degree of confidence in the finding. The NBA 2018 used the model adopted by IPBES that plots findings on two axes: quality and quantity of evidence on the x-axis and level of agreement on the y-axis.

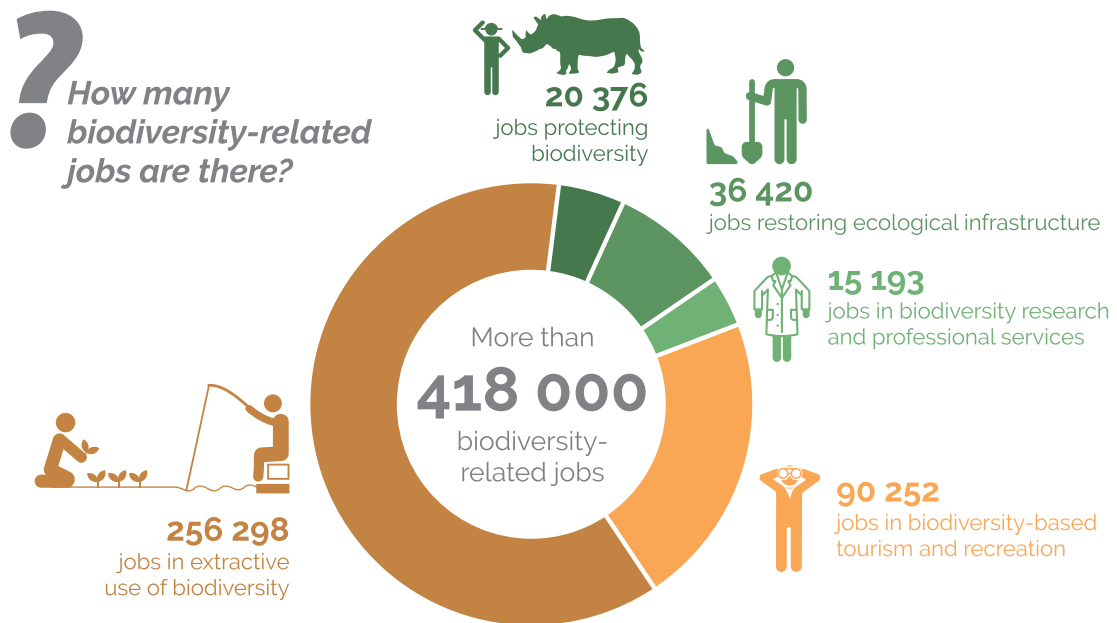
Key messages	
A South Africa's biodiversity PROVIDES BENEFITS TO PEOPLE	A1. Biodiversity PROVIDES JOBS
	A2. HEALTHY ECOSYSTEMS are essential for water security
	A3. WATER FLOWING INTO THE SEA provides multiple benefits to people
	A4. SMALL HIGH-VALUE ECOSYSTEM TYPES take up just 5% of South Africa’s territory, but provide multiple benefits to people
	A5. BENEFITS FROM FISHING are at risk, including food and job security
	A6. CLIMATE CHANGE is impacting on people and ecosystems; in spite of this, HEALTHY ECOSYSTEMS can help us adapt to climate change
B South Africa's biodiversity is under pressure, but SOLUTIONS ARE AT HAND	B1. ESTUARIES AND WETLANDS are the most threatened and least protected ecosystems in South Africa
	B2. COASTAL BIODIVERSITY ASSETS , including beaches, are at risk
	B3. PROTECTED AREAS : investment success in the ocean and on land
	B4. PROTECTED AREAS : providing effective protection for many species
	B5. FRESHWATER FISHES are the most threatened species group in South Africa
	B6. TRENDS IN THREAT STATUS show rapid declines in some of South Africa’s species, especially freshwater species and butterflies
	B7. Areas where pressures are concentrated should be PRIORITIES FOR SPATIAL PLANNING
	B8. BIOLOGICAL INVASIONS threaten biodiversity and human wellbeing
	B9. COOPERATIVE GOVERNANCE is essential for healthy landscapes and seascapes
C The NBA stimulates work to ADDRESS KNOWLEDGE GAPS	C1. South Africa’s new SEAMLESS MAP OF ECOSYSTEM TYPES paves the way for improved assessment, planning and monitoring
	C2. NEW INDICATORS developed during the NBA 2018 advance South Africa’s ability to report on the status of biodiversity
	C3. EVALUATION OF GENETIC DIVERSITY brings new value to the NBA
	C4. Investment in strategic and collaborative BIODIVERSITY MONITORING PROGRAMMES is crucial to inform management and decision making and for biodiversity assessments

A South Africa's biodiversity provides benefits to people

A1. Biodiversity provides jobs

South Africa's biodiversity provides substantial employment in a range of sectors (*established but incomplete*). Continued investment in managing and conserving biodiversity is essential so that jobs that depend on biodiversity can continue to increase.

Jobs directly related to biodiversity total more than 418 000, and this is likely an underestimate. This level of employment is comparable to that of the mining sector. For every job dedicated to conserving biodiversity (e.g. in protected areas or conservation authorities), there are at least five other jobs that depend directly on biodiversity use. These jobs are in sectors such as fisheries, wildlife ranching, biodiversity-based tourism, traditional medicine and indigenous tea production.



For each job dedicated to protecting biodiversity... **1 : 5** ...there are 5 jobs that depend directly on using biodiversity.

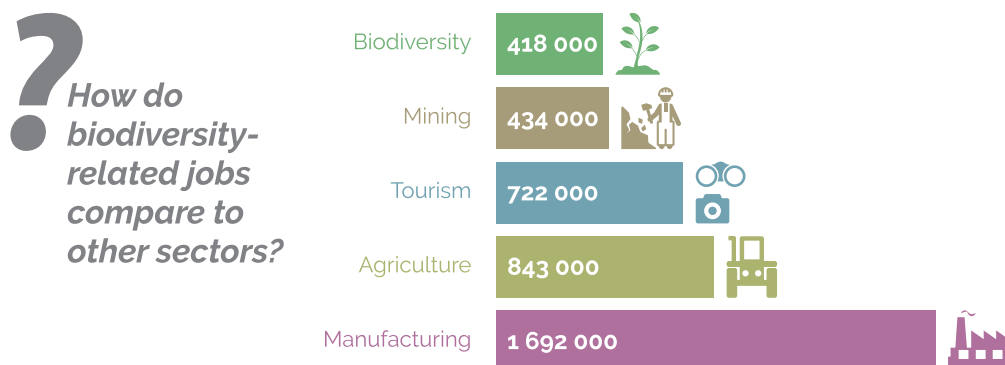


Figure 3. Biodiversity provides a substantial number of labour-intensive jobs. Managing and conserving biodiversity is essential so that job numbers can continue to grow.

Many biodiversity-related jobs are outside the urban centres and are labour intensive, contributing to rural development, poverty alleviation, inclusive growth and labour absorption.

In a context where employment in traditional sectors such as manufacturing and agriculture is declining, biodiversity-related employment is based on a renewable resource that, if appropriately managed, can provide the foundation for long-term economic activity and sustainable growth.

Biodiversity-based tourism is regarded as a particularly important growth area. In 2015, this sector accounted for more than 88 000 direct jobs and generated a direct spend of over R30 billion in the South African economy. National tourism and economic growth strategies should incorporate biodiversity-based tourism as an area for targeted investment.

For more information, see Part 3 and the NBA 2018 technical reports.

A2. Healthy ecosystems are essential for water security

Rivers, wetlands and their catchment areas are crucial ecological infrastructure for water security, often complementing built infrastructure, but the benefits from some of these ecosystems are currently compromised by their poor ecological condition (*well established*). Water security can be improved through integrated management of natural resources in Strategic Water Source Areas as well as other key catchments, including protection and restoration in some cases.

Water security is essential for human wellbeing and socio-economic development. Aquatic ecosystems provide the quantity and quality of water that people require to live and prosper, and also play a crucial role in buffering us through drought periods and long-term climate variation. Over-abstraction of water, for example for irrigation, urban and industrial use, as well as pollution of water, place these services at risk.

Strategic Water Source Areas (SWSAs) are areas in the landscape that supply a disproportionate quantity of water in relation to their size and/or have high groundwater recharge. These nationally important areas provide freshwater for downstream urban

centres that support half of South Africa's population and nearly two-thirds of its economy. SWSAs for surface water cover 10% of South Africa's extent and account for 50% of the mean annual runoff. SWSAs for groundwater extend over 9% of the land surface of South Africa and account for up to 42% of base flow to rivers. Currently, only 13% of the extent of the SWSAs falls within protected areas.

The ecological infrastructure of rivers, inland wetlands and their catchment areas complement built infrastructure (such as dams) for the sustainable delivery of water to people. Catchment-level water resource planning and management are crucial to



The Drakensberg mountain range includes several Strategic Water Source Areas, where high-altitude grasslands play a critical role in supplying water to the dams downstream. (Injisuthi River with Monks Cowl in background). © Simon van Noort.



The Kouga Dam contributes to water supply for Nelson Mandela Bay (Port Elizabeth) and supplies the Gamtoos irrigation scheme in the Eastern Cape. The health of the catchment above the dam impacts directly on the quality and quantity of water delivered to the dam and in turn to people downstream. © Geoff Spilby.



Poor ecological condition in rivers and wetlands makes expensive water treatment necessary before human use. This water flowing from the Hartebeestpoort Dam in the North West Province is green owing to eutrophication – a dense growth of algae caused by excessive nutrients in the water from pollution. © Eric Nathan / Alamy Stock Photo.

ensure that the diversity, functionality and connectivity of this ecological infrastructure are managed and maintained. Protection and rehabilitation (particularly the management of invasive plants) should be prioritised in the SWSAs.

For more information, see Part 3.2 and NBA 2018 technical report for the inland aquatic realm.

A3. Water flowing into the sea provides multiple benefits to people

Freshwater flowing from rivers through estuaries into the sea is *not* wasted, and is essential for coastal and marine food production, livelihoods, tourism and future climate change resilience (*established but incomplete*). Through appropriate management, South Africa can maintain the vital freshwater flows that reach the coast.

Freshwater flowing from rivers is essential for maintaining the many benefits that people receive from coastal and marine biodiversity. Estuaries truly demonstrate



© Darren Hanner

this interconnectivity between land and sea; however, over 30% of them are impacted by freshwater flow reduction, especially the large permanently open estuaries (e.g. Orange and Groot Berg). Even in the remote Prince Edward Islands, the importance of freshwater flow into the sea is demonstrated by recent evidence that decreased rainfall and associated reduced runoff is contributing to changes in productivity in marine ecosystems.

Healthy functioning rivers deliver freshwater, nutrients and sediments² to estuaries and the ocean, and sand to beaches and dunes. A reduction in freshwater flow from land to sea thus compromises coastal water quality, estuarine connectivity, fish nursery functions (with knock-on effects for marine fisheries) and movement of sand and other sediments. Without sufficient flow, water quality declines, salinity regimes are compromised and sediment accumulates in estuary mouths – often increasing the risk of coastal flooding. Species that move between marine and inland freshwater environments during their life cycle (e.g. eels, *Anguilla* spp.) are especially at risk when estuarine connectivity and functioning are altered, as are many commercially important fish (such as Dusky Kob [*Argyrosomus japonicus*]) that use estuaries as nurseries.

² Sediments refer to sand, silt, mud or other solid matter that moves from the land into rivers and is then transported downstream by rivers.



© Kerry Sink

Sediment-rich water flowing from rivers into the sea provides many benefits, such as nutrients for fish and sand for beaches. If the volume of freshwater reaching the sea is reduced, for example by dams and irrigation schemes upstream, negative impacts can include erosion of beaches and decline in productivity of fisheries. Prawns, for example, are a favourite South African seafood that depend on freshwater flow into the marine environment.

Fisheries associated with muddy ecosystem types (e.g. prawns, sole and several other fish species) are supported by mud delivery and the maintenance of land–sea connections required for the completion of their life cycles. Freshwater flow and associated sediment inputs maintain key tourism assets such as sandy beaches and reduce the risks of long-term erosion of beaches and dunes – thereby decreasing coastal vulnerability to natural hazards like sea storms currently and in future with increasing climate change impacts.

Further freshwater flow reductions through water abstraction, for example for irrigation and urban use, should be carefully considered and avoided wherever possible, opting instead for more efficient use of already available water resources. The issue should be addressed as part of the Department of Water and Sanitation's multi-stakeholder water classification process and should be included in national water resource strategies and plans and in catchment management strategies. In addition, coastal and estuary management plans need to capture the details of freshwater allocation, fish resource use, water quality management and land-use planning activities that impact on coastal and marine productivity.

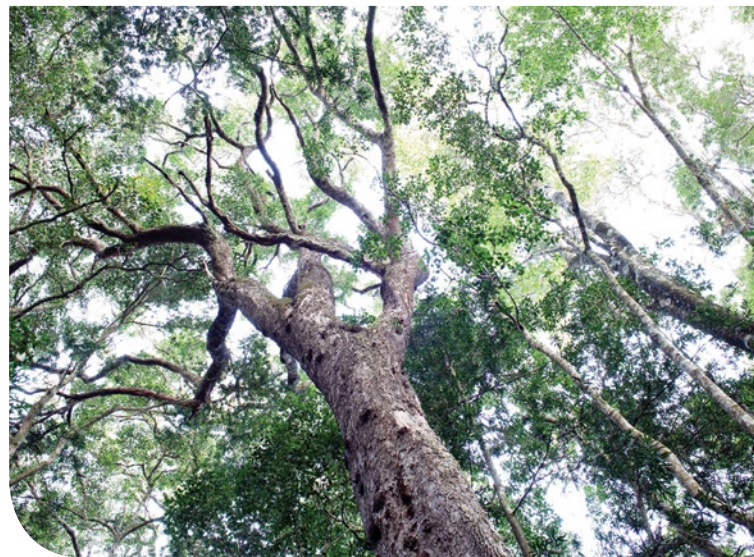
For more information, see Part 3.3.3, 3.4.3 & 3.5.3.

A4. Small high-value ecosystem types take up just 5% of South Africa's territory, but provide disproportionate benefits to people

Certain small ecosystem types function as crucial ecological infrastructure and, despite their small footprint, provide multiple benefits to society (*established but incomplete*). Managing, protecting and restoring these small, high-value ecosystems give a large return on investment.

Indigenous forests, inland wetlands, lakes, estuaries, mangroves, dunes, beaches, rocky shores, kelp forests, reefs, seamounts, pinnacles and islands together take up less than 5% of South Africa's territory, but are responsible for a disproportionately large number of benefits such as water purification, nutrient cycling, carbon storage, storm protection, recreation and harvesting of food directly from nature.

These small, high-value ecosystems should be prioritised for planning, management, and protection and



Indigenous forests make up less than 1% of South Africa's land area, and often occur in small patches, such as the Hoekwil forest in the Wilderness area, Western Cape. © Donovan Kirkwood.

restoration efforts, as such efforts will provide a high return on investment, both for biodiversity conservation and for benefits to society. These ecosystem types are often also particularly vulnerable to climate change, and are therefore valuable for monitoring and detecting climate change impacts as well as learning more about how ecosystems adapt to climate change.

In South Africa, mangrove habitats are found in only a few estuaries on the east coast. This is a White Mangrove (*Avicennia marina*) creek in the Nxaxo Estuary, Eastern Cape. © Janine Adams.





Coastal sand dunes can offer excellent buffering from storms if left undeveloped, like these dunes in De Hoop Nature Reserve, Western Cape. © Donovan Kirkwood.



Kelp forests cover a small portion of the marine realm, but play a role in climate regulation and buffering coastal communities from storms and tsunamis; their rich resources also provide food, essential minerals and fertiliser. © Geoff Spiby.

- **Indigenous forests** provide carbon sinks and harvesting areas for wild foods and fibres.
- **Inland wetlands** absorb flood waters, helping to reduce the impact of floods, and clean pollutants from freshwater, providing effective water purification infrastructure.
- **Lakes** are reservoirs that provide important habitats for endemic species and are important spiritual and cultural sites in South Africa.
- **Estuaries** are nursery grounds for important commercial fish stocks and are some of the most popular holiday and recreation destinations in South Africa.
- **Mangroves** provide coastal protection from storms and key nursery habitat for fish, and also store carbon and stabilise sediments.
- **Dunes** protect settlements and built infrastructure from coastal storms, sea-level rise and tsunamis.
- **Beaches** filter up to 10 000 litres of water per 1 m strip of beach per day, keeping the surf clean for the enjoyment and health of both humans and fishes.
- **Rocky shores** provide food (e.g. mussels) and fishing bait, and are important armour for wave surges.
- **Kelp forests** are one of the most productive ecosystems on Earth, providing food and fertiliser. They also shelter the shore from wave action.
- **Reefs** provide shelter and spawning grounds for a variety of marine species, and are well-loved dive sites.
- **Seamounts and pinnacles** are oases in the open ocean that are highly nutrient-rich and support a myriad of marine life.
- **Islands and their highly productive surrounding waters** support abundant biodiversity and important fisheries.

For more information, see Part 3 and the NBA 2018 technical reports.

A5. Benefits from fishing are at risk, including food and job security

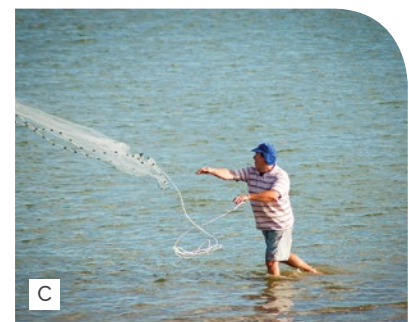
Estuarine and marine ecosystems provide South Africans with food and livelihoods by providing a basis for fishing – whether commercial, subsistence or recreational. Yet many fish stocks are overexploited and many fish species are threatened (*well established*). While a range of plans are in place to ensure that fisheries are sustainable, better practices to rebuild stocks of priority species are needed, as well as reliable data and sufficient capacity for undertaking regular stock assessments.

The benefits provided by fishing, which include providing food for people and fodder for intensive animal farming, as well as thousands of jobs, are at risk from poaching, overfishing, unselective fishing practices (e.g. gill netting, trawling), habitat degradation (e.g. mining) and declining conditions of fish nursery areas (e.g. in estuaries). South Africa's shallower waters, reefs and estuaries suffer from cumulative pressures on certain fish species. Fisheries stock status is not assessed for 90% of the more than 770 harvested marine taxa, and of those 10% that have been assessed, more than a third are overexploited or collapsed.

Inshore marine resources such as South African Abalone (*Haliotis midae*) and West Coast Rock Lobster (*Jasus lalandii*) are in crisis with escalating poaching preventing the recovery of populations. In addition, several estuarine-dependent linefish species are threatened by overfishing (especially gill netting), reduced freshwater flow and declining water quality, including, Dusky Kob (*Argyrosomus japonicus*), White Steenbras (*Lithognathus lithognathus*) and Spotted Grunter (*Pomadasys commersonnii*), which are all at less than a quarter of pristine reproductive adult biomass (i.e. breeding potential).

To maintain livelihoods of legitimate fishers, stronger interventions to rebuild and protect stocks need to be developed, based on scientific recommendations. This requires further data for stock assessments, as well as building and maintaining fisheries science expertise. Reducing damaging fishing practices, increasing compliance, improving spatial fisheries management (e.g. to protect spawning and nursery areas) and maintaining genetic diversity within fish populations are essential. Recovery of fish stocks is only possible if poaching can be addressed through effective integrated law enforcement and steps to address underlying social challenges.

For more information, see Part 3.3, 3.4 and the NBA 2018 technical reports for the marine and estuarine realms.



South Africa has a large variety of fishing cultures, such as (A) Rock Lobster harvesting on the west coast, © Jaco Barendse; (B) Trek-net fishers in Strandfontein, False Bay, © Peter Chadwick; (C) Cast netting for small bait fish in Gourits Estuary, southern Cape, © Oswald Kurten; (D) Beach seine netting in Durban for in-shore shoaling species, © Kerry Sink; (E) Woven fish traps in Kosi Estuary, KwaZulu-Natal, © iSimangaliso Wetland Park; and (F) Red Bait harvesting on the rocks, © Kerry Sink.



Hard infrastructure built inappropriately close to the shore puts the built environment at greater risk from the extreme weather events associated with climate change. Keeping natural dunes and beaches intact can buffer these risks. © Rodger Shagam/AfriPics.

A6. Climate change is impacting on people and ecosystems; in spite of this, healthy ecosystems can help us adapt to climate change

The impacts of climate change are evident across all realms and within most species groups. Biodiversity provides resilience against the worst effects of climate change (*established but incomplete*). Restoring ecosystems and maintaining them in a good ecological condition means they are better able to support natural adaptation and mitigation processes, offering increased protection to human communities and reducing the economic burden of future climate disasters.

Evidence of impacts of climate change on biodiversity has rapidly accumulated and now spans all realms and most species groups. Impacts include changes in ecosystem structure and function as well as direct threats to a wide range of species. Shifting migration times (e.g. Palaearctic migrant birds), declines in range sizes (e.g. Protea Canary [*Crithagra leucoptera*])

and large-scale plant die-offs (e.g. Clanwilliam Cedar [*Widdringtonia cedarbergensis*]) are being observed. Climate change also amplifies other pressures, including competition with invasive species, disease, as well as habitat loss and habitat degradation. For freshwater flow, for example, changing temperatures, increased intensity of extreme events and unpredictable rainfall exacerbate pressures like over-abstraction of water and pollution.

These impacts have been driven by marked shifts in South Africa's climate. Mean monthly, seasonal and annual temperature increases of more than 1°C have been observed over much of the country in the past 50 years, accompanied by the intensification of extreme events including dry spells, heavy rainfall events, coastal storm surges, strong winds and wildfires. In the last four decades southern Africa recorded nearly 500 climatic disasters impacting 140 million people. Increases of 2–4°C are predicted for southern Africa by 2050, and confidence is therefore high that climate change will have dramatically escalating impacts on South Africa over the coming decades.

Ecosystems in good ecological condition are better able to cope with climate change impacts and in turn help people to adapt. Healthy ecological infrastructure like inland wetlands, estuaries and coastal



The iconic Clanwilliam Cedar (*Widdringtonia cedarbergensis*) is Critically Endangered and faces increasing pressures as temperatures rise, the environment dries out and fires become more frequent. © Geoff Spiby.

dunes are better able to protect built infrastructure and people from impacts of extreme weather events.

Maintaining intact ecosystems and species populations, and ensuring connectivity across landscapes and seascapes, are vital for preserving adaptive capacity of nature to climate change across all realms,

which in turn will enhance human adaptive capacity and resilience.

For more information, see Part 2 and Part 3.1.3, 3.2.3, 3.3.3, 3.4.3 and the NBA 2018 technical reports.

B South Africa's biodiversity is under pressure, but solutions are at hand

B1. Estuaries and wetlands are the most threatened and least protected ecosystems in South Africa

Estuarine and inland wetland ecosystems face many pressures and are highly threatened (*established but incomplete*). The restoration and protection of estuaries and inland wetlands will secure essential benefits and deliver large return on investment.

Estuarine and inland wetlands are under higher levels of threat than ecosystems in other realms, as shown in the graphs below. In addition, because these ecosystem types are relatively small, they are considered to be at greater risk of collapse than large, widespread types. Approximately 99% of estuarine area and 88% of wetland area is threatened. Across the realms, estuaries and inland wetlands are also the least protected ecosystem types, with less than 2% of their extent in the Well Protected category. Improvements in mapping wetlands since the NBA 2011 means that there is greater confidence in this finding

than previously, suggesting that interventions to date (such as allocations of freshwater flows and rehabilitation) have not been effective enough.

Estuaries and inland wetlands are essential ecological infrastructure for water security, food security, tourism and recreation, as well as natural disaster risk reduction. They are also important havens for many endemic species that are threatened. Restoring and protecting these ecosystems will secure the key benefits from these ecosystems and deliver a large return on investment.

Given the considerable and often growing pressures, restoration efforts need to increase, building on the successful restoration programmes such as undertaken by Working for Wetlands and flagship rivers programmes. Estuaries along the Cape west coast and in KwaZulu-Natal are the most threatened, and should be prioritised for conservation interventions, including protected area expansion, increased compliance and fisheries management, and restoration of base flows and water quality. The inland wetlands of the interior Highveld and Cape Fold Mountains should be prioritised for interventions such as catchment management plans and biodiversity stewardship programmes, which can reduce pressures on freshwater species and wetlands. Implementation of the national monitoring programmes for

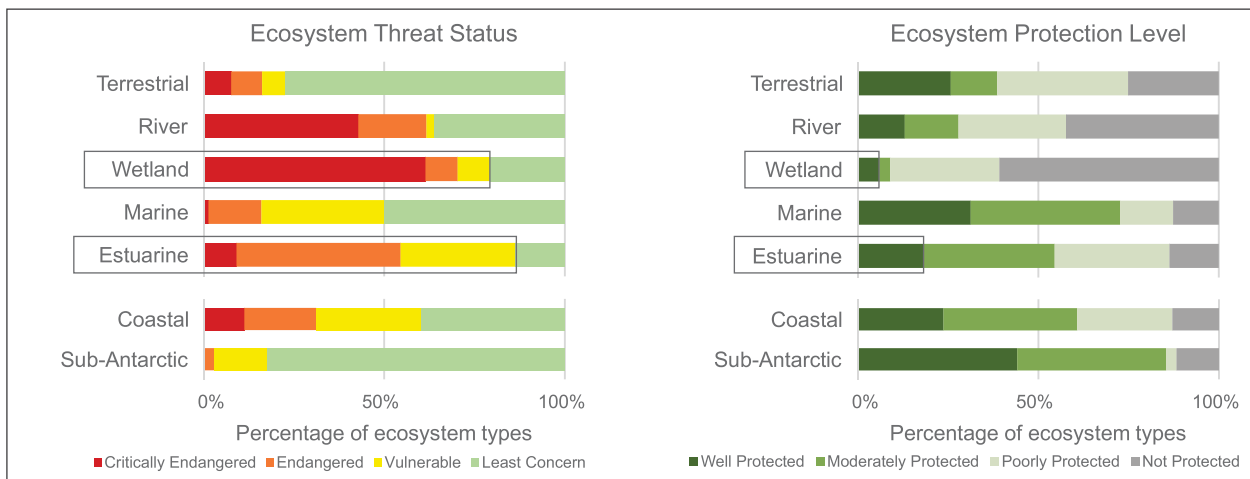


Figure 4. The graph on the left, ecosystem threat status across all realms, shows that estuaries and inland wetland ecosystem types are more threatened than ecosystem types in the other realms. The graph on the right, ecosystem protection level, shows that they also have low levels of protection.

inland wetlands and estuaries are critical for management and future assessments.

For more information, see Part 2.

B2. Coastal biodiversity assets, including beaches, are at risk

Sixty per cent of coastal ecosystem types are threatened – a result of the many pressures concentrated on the coast (*well established*). Judicious coastal development that avoids sensitive areas can minimise further damage, maintain ecological infrastructure and reduce climate risks.

Coastal development at the land–sea interface is one of the biggest drivers of habitat loss, and brings with it many associated pressures and risks. If infrastructure is located inappropriately, development can undermine the resilience of coastal ecosystems and increase the risk of infrastructure failure in the face of natural hazards and climate change – placing human lives in danger, and increasing extinction risk for endemic



Beaches lose sand for a variety of reasons, including insufficient sediment flow from rivers to the coast, inappropriate coastal development that changes natural sand shifting patterns, and sand mining. © Amanda Driver.

species. This is compounded by reduced delivery of sand to the coast by rivers and estuaries, because of, for example, reduced freshwater flow, sand mining and historical stabilisation of dunes. The combined result is that some beaches are being degraded and even lost in some places.



Inappropriate coastal development undermines the resilience of coastal ecosystems and increases the risk of infrastructure failing in the face of natural hazards. © Linda Harris.



This aerial view of the Struisbaai village and harbour shows well-planned coastal development behind setback lines, but also how the building of artificial structures like the breakwater wall can affect natural sand movements. © Peter Chadwick.

Investment in beaches as key ecological infrastructure supports one of South Africa's most popular activities, beach visiting. Investment in ecological infrastructure along the coast also enhances resilience of settlements and built infrastructure to sea-level rise and extreme weather events, and protects unique species that provide services like improving coastal water quality (e.g. prawns) and recreational opportunities (e.g. bird watching, line fishing).

Judicious coastal development should take the following into consideration: development should be located behind setback lines, ribbon development should be avoided, sufficient freshwater flow and sediment delivery to the coast should be ensured, degraded dunes should be restored, and soft engineering solutions should be implemented in preference over hard structures as far as possible.

For more information, see Part 3.5.

B3. Protected areas: investment success in the ocean and on land

Protected areas have expanded in the ocean and on land, and are a source of pride for South Africans (*well established*). Continued expansion will help to ensure biodiversity conservation, ecological sustainability and even more social and economic benefits from biodiversity.

In 2018, 20 new Marine Protected Areas (MPAs) were accepted for declaration, covering 5% of the country's mainland marine territory and advancing the marine realm above other realms in terms of the percentage of ecosystem types having at least some protection (87%). Substantial advances were also made around the Prince Edward Islands in 2013, with a large MPA that covers 36% of South Africa's marine territory in the sub-Antarctic. The protected area estate of South Africa's terrestrial mainland increased by 11% between 2010 and 2018, and now covers nearly 9% (> 108 000 km²) of the country's land area. The land-based protected area network is increasingly representative of the full range of ecosystem types, with three-quarters of terrestrial ecosystem types now having some form of representation.

Previous NBAs contributed to these important outcomes by highlighting ecosystem types in all realms that were under-protected (Not Protected, Poorly Protected or Moderately Protected). These ecosystem types were then prioritised in the National Protected Area Expansion Strategy (in 2008 and 2016) to ensure that they were the focus of the expansion efforts.

Biodiversity stewardship has accounted for two-thirds of the protected area expansion on land since 2011 and continues to be the most cost-effective mechanism for land-based protected area expansion. Biodiversity stewardship involves contracts between conservation authorities and landowners, and helps to leverage private investment in public goals.

Protected areas are important not only for protecting ecosystems and species, but also for social and

economic development, especially in rural areas. Protected areas are vital for ecological sustainability and climate change adaptation. They serve as nodes in our ecological infrastructure network, protecting the ecosystems that deliver important ecosystem services to people.

Efforts should be made to support and expand biodiversity stewardship programmes, and at the same time efforts to expand state-owned protected areas should continue. Protected area expansion should continue to focus on under-protected ecosystem types, ensuring that the protected area network becomes increasingly representative of all South Africa's ecosystem types over time. To this end, national and international indicators that track protected area expansion (and include the requirement for representation of all ecosystem types) have been developed. Protected areas also need to be well managed to realise their full potential to contribute to ecological, social and economic goals. To achieve this, focussed monitoring of management actions is essential.



The 20 new Marine Protected Areas approved for declaration in 2018 will ensure that 5% of the ocean around South Africa is protected, with benefits for ecosystems, people and the economy. © Peter Chadwick.

For more information, see Part 2.2.



Biodiversity stewardship, in which private or communal land owners enter into agreements with conservation authorities to protect and manage their land for biodiversity conservation, has accounted for two-thirds of protected area expansion on land since 2011. © CapeNature.

B4. Protected areas: providing effective protection for many species

South Africa's protected areas are generally providing good protection for species, as shown by new protection level indicators for species (*established but incomplete*). The results provide important feedback for protected area expansion strategies and for protected area management.

South Africa's birds and reptiles are the best protected of the seven species groups assessed in this NBA, with over 85% of these species considered Well Protected. Continued investment in protected areas is paying off for species, as the proportion of threatened species represented in protected areas has increased for most groups over the past 30 years.

Plants and freshwater fishes have the highest proportion of species that are Not Protected, and worryingly, most of these species are both endemic and threatened. When considering threatened species alone, a high proportion are under-protected: more than 85% of threatened birds, plants, freshwater fishes, amphibians, mammals and butterflies are under-protected.

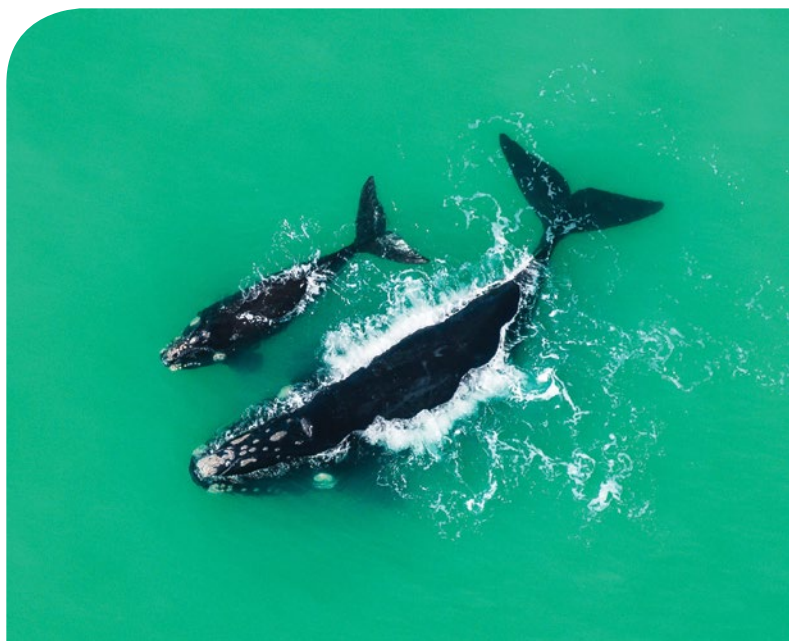
Persistence of species depends not only on whether they are present inside a protected area, but also on whether the protected area actually helps to reduce

Stoebe rosea is a highly range-restricted endemic plant species. Its entire range is within the Table Mountain National Park in Cape Town, where it receives effective protection. © Nick Helme.



The Table Mountain Ghost Frog (*Heleophryne rosei*) occurs mostly within the Table Mountain National Park, but is nevertheless assessed as under-protected. This is because it is threatened by poor water quality and water abstraction from the few streams in which it occurs and these pressures need to be mitigated by inter-institutional cooperation. © Joshua Weeber.

Protection levels have yet to be assessed for marine species. Permanent protection of the Walker Bay MPA is needed to effectively protect the breeding grounds of Southern Right Whales (*Eubalaena australis*), a key ecotourism asset for South Africa. © Peter Chadwick.



the pressures faced by that particular species. The new protection level indicator accounts for this using an adjustment factor developed by species expert groups with knowledge of both the individual species and the pressures impacting on species within protected areas. Reducing key pressures within some protected areas could improve the status of 21% of freshwater fishes, 6% of plants, 7% of butterflies, 9% of amphibians and 4% of mammal taxa.

Under-protected species identified by the indicator (especially those that are both endemic and threatened) should be prioritised for inclusion in protected area expansion efforts. The detailed information underlying this indicator, including expert assessments of how well protected areas cater for specific species, can contribute to improved protected area management and planning.

For more information, see Part 2.6.



The small Fiery Redfin (*Pseudobarbus phlegethon*) is Endangered, with only a few remaining populations. However, its range has been extended following the successful rehabilitation of the Rondegat River through eradication of an invasive alien fish species (Smallmouth Bass – *Micropterus dolomieu*) by CapeNature. © Riaan van der Walt.

B5. Freshwater fishes are the most threatened species group in South Africa

Freshwater fishes are the most threatened of all species groups that have been fully assessed in South Africa, and half of South Africa's freshwater fish species are found nowhere else in the world (*established but incomplete*). Effective management and conservation strategies to halt the decline and promote recovery of threatened fish species are needed, focussed on the rivers and catchments where these fish occur.

South Africa has 118 freshwater fish species, of which half are endemic. One-third of South Africa's native freshwater fish species are threatened. Two-thirds of the endemic taxa are threatened and most of these are concentrated in the mountainous Cape Fold ecoregion. Several localised extinctions of populations of freshwater fishes, particularly those in the genera *Pseudobarbus*, *Sedercypris* (redfins), *Cheilobarbus*, *Sandelia* and *Galaxias* have been recorded. Predation by invasive alien fishes and habitat degradation were identified as the key pressures on native freshwater fishes in the country. These high levels of threat are a reflection of the generally poor ecological condition of South Africa's rivers, as two-thirds of the total length of rivers is degraded. Ongoing decline for many species is due to the persistence of these pressures.

A number of successful interventions (e.g. eradication of invasive species) have been made by conservation agencies to prevent extinctions of highly threatened freshwater fishes, and these should be continued and expanded. While protected areas are effective conservation measures for many species, they are less effective for freshwater fishes as the pressures typically originate in the wider catchment area, outside the protected area boundary. As a result, integrated catchment-level protections and interventions are required if the pressures are to be curbed. Partnerships between various government departments and conservation agencies should be strengthened and monitoring of important fish areas needs to be undertaken regularly. It is essential that adequate freshwater flows be allocated to the rivers in which

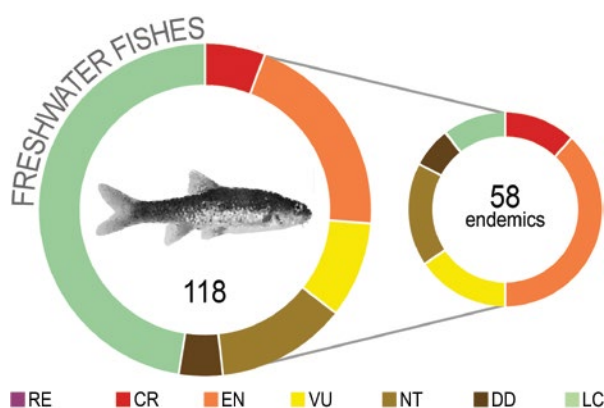


Figure 5. Nearly half of South Africa's 118 freshwater fish species are endemic, and two-thirds of these endemic species are threatened (shown by the red, orange and yellow sections of the graph) – mostly by habitat degradation and predatory invasive alien fishes.

these threatened fish are found, and that base flows be protected during droughts (which are becoming increasingly severe due to climate change). The maintenance or restoration of water quality is also a key consideration in reducing pressures on threatened freshwater fish species.

For more information, see Part 2.5 & 3.2.

B6. Trends in threat status show rapid declines in some of South Africa's species, especially freshwater species and butterflies

Changes in species threat status over time were tracked for eight taxonomic groups using the IUCN Red List Index (RLI). Increased extinction risk is evident for most groups, but freshwater species and butterflies, in particular, show a steep decline (*established but incomplete*). For the RLI to be more comprehensive, repeat assessments are required for species in the marine and estuarine realms, and invertebrates in general.

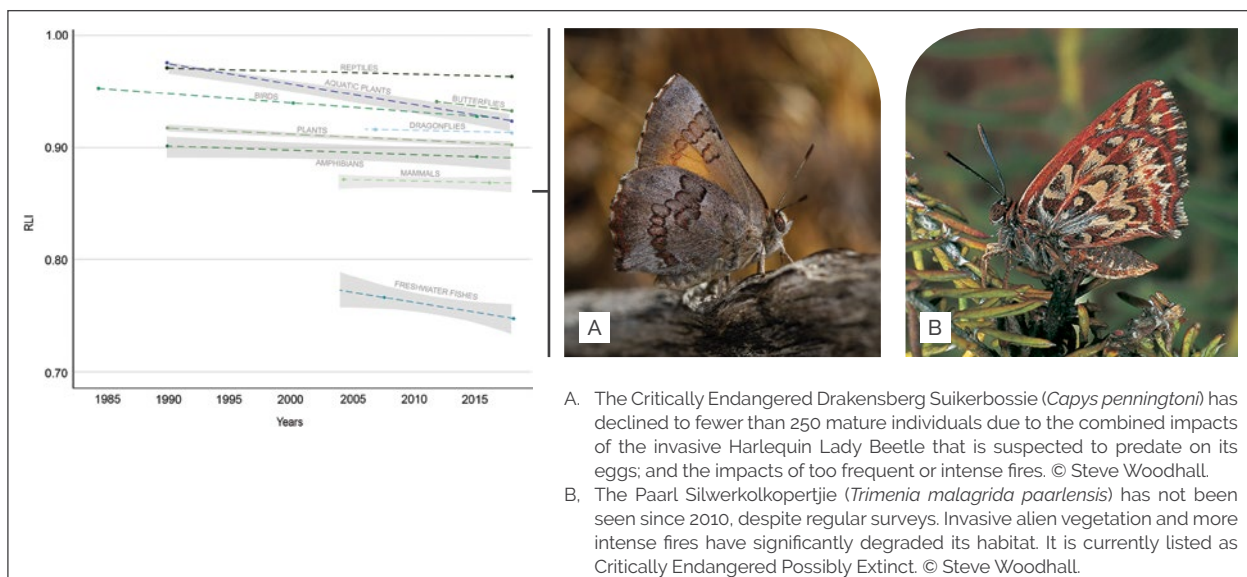
The first application of the **Red List Index** for South African species, utilising national Red List assessments,

allows us to track trends in extinction risk for certain taxonomic groups that have undergone comprehensive and repeat assessments. For the NBA 2018, the Red List Index includes plants, reptiles, birds, mammals, amphibians, freshwater fishes, dragonflies and butterflies. The results indicate that species confined to inland aquatic ecosystems are declining more rapidly than those occurring in terrestrial ecosystems. In particular, freshwater fishes and freshwater plants show the steepest decline. Butterflies also show a steep decline that is of concern, suggesting there is a need to assess and monitor other groups of invertebrates as many are thought to be in decline.

The Red List Index is a powerful tool for identifying taxonomic groups that are in rapid decline and are in need of conservation interventions. It also potentially indicates where conservation actions have resulted in improvements in the threat status of taxonomic groups over time. To expand South Africa's national Red List Index, comprehensive taxonomic group assessments for marine and estuarine taxa, as well as for more terrestrial and freshwater invertebrate species, should be conducted. To do this, key gaps in the taxonomic knowledge base need to be filled, more data on species distribution and life histories need to be gathered, and population trends need to be monitored on a regular basis. Monitoring of species populations is a huge task, which can be assisted by online citizen science platforms that allow people across the country to contribute to the effort.

For more information, see Part 2.5.

Figure 6. The Red List Index tracks the overall status of species groups that have been assessed more than once. It shows that freshwater plants and fishes have steep declines – reflecting the poor status of South Africa's rivers and wetlands. Butterflies also show a decline that is of concern, suggesting there is a need to assess and monitor other groups of invertebrates, many of which are thought to be in decline.



B7. Areas where pressures are concentrated should be priorities for spatial planning

The spatial distribution of pressures on biodiversity across the landscape and seascape is uneven. Pressure hotspots, where many different pressures converge, require strategic spatial planning and focussed management (*established but incomplete*).

Human activities are often concentrated in areas rich in natural resources, of high productivity and high accessibility. Pressures are particularly marked in and around estuaries, inland wetlands, river valleys and riparian areas, lowland areas such as coastal plains, the seashore, bays and the inner shelf and shelf edge

in the ocean. In addition to these natural features, pressures are also focussed on regions with high agricultural potential, around human settlements and in regions with high mining potential. Ecosystems and species in these pressure hotspots are therefore particularly at risk of extinction or collapse due to the accumulation of pressures.

Maps of Critical Biodiversity Areas and Ecological Support Areas (known as CBA maps) combine biodiversity information with information about pressures to provide a strategic spatial plan for ecological sustainability of the landscape or seascape, taking into account the need for ecological connectivity and avoiding conflict with other land uses or sea uses wherever possible. CBA maps are crucial for informed planning and decision making, especially in pressure hotspots, where it is often possible to combine a range of economic activities *and* maintain healthy ecosystems as long as intensive land or sea uses are carefully placed. Land-based CBA maps cover all provinces,

Figure 7. Ecosystem condition across land and sea; the brown shades indicate poor condition regions.





Invasive trees such as pines and eucalypts reduce the flow of freshwater into rivers, wetlands and dams. The lightly infested bank on the left of this picture contrasts with the heavily infested opposite bank. Removing invasive trees is an important part of cost-effective catchment management, and is especially critical in Strategic Water Source Areas. © Andrew Purnell.

and are already used extensively in land-use planning (e.g. in Spatial Development Frameworks) and environmental authorisations (e.g. in Environmental Impact Assessments). CBA maps for coastal and marine areas are relatively new, and provide a key informant for Marine Spatial Planning and integrated coastal planning.

For more information, see Part 2.4.

B8. Biological invasions threaten biodiversity and human wellbeing

Over 100 alien species have a severe impact on South Africa's biodiversity and, in some cases, on human wellbeing (*well established*). Although some successes in the management of biological invasions have been achieved, the adoption of a national strategy for managing biological invasions, improved project-level planning for prevention and management, and enhanced spatially explicit data will greatly increase effectiveness of current efforts.

Over 2 000 alien species have become established in South Africa and at least a third of these have

Various species of *Opuntia* cacti are invasive in South Africa, and are among the most abundant invasive plant species in the arid areas of the country, reducing the grazing capacity of rangelands. Cochineal insects (*Dactylopius opuntiae*) have been established as biological control agents on some species of cacti, with good success in restoring rangelands and conservation areas in several parts of the country. © SANBI.

become invasive. Of these, 107 species (mostly plants), are having a severe impact on both biodiversity and human wellbeing. Biological invasions are major pressures on biodiversity assets and ecological infrastructure in all realms, impacting on water and food security. Invasive trees and shrubs reduce surface water resources by 3–5%, and threaten up to 30% of the water supply of cities like Cape Town and Port Elizabeth. Invasive alien plants also reduce the capacity of natural rangelands to support livestock production, thereby threatening rural livelihoods and food production. All the major taxonomic groups have species that are directly threatened by invasive species, with plants, freshwater fishes and amphibians particularly affected. Invasive mice on Marion Island have had a wide range of impacts; degrading vegetation, depleting invertebrate populations and plant seed stock, and preying on petrel and albatross chicks and eggs.

South Africa is a global leader in developing a comprehensive regulatory framework to specifically deal with invasive species. Some successes in the management of biological invasions are already documented; for



example, of the 60 invasive plant species targeted for biological control (i.e. control using another species that is the natural enemy of an invasive species) thus far in South Africa, 15 species are now under complete biological control and another 19 species under a substantial degree of biological control. In addition, three species have been completely eradicated from the country to date (Freckled Edible Snail [*Otala punctata*] and Kharpa Beetle [*Trogoderma granarium*] from the mainland, and the Domestic Cat [*Felis catus*] from Marion Island), and effective protocols are being implemented to prevent the legal introduction of high-risk alien species.

The first national report on invasive species, *The status of biological invasions and their management in South Africa*, has created an excellent foundation on which to build a comprehensive monitoring and reporting programme, which can guide research and implementation efforts. Adopting a national strategy for managing biological invasions is the next step to ensure that the work of all role-players is integrated and that all projects are working towards national objectives. Enhanced spatially explicit data on the extent and severity of invasions would greatly improve planning for interventions and reporting on the status of invasions. Recommendations for improving implementation include that a combination of control measures should be implemented to improve their effectiveness, and that improved project-level planning will assist with the efficiency and cost-effectiveness of control measures.

For more information, see Part 2.3.

Bg. Cooperative governance is essential for healthy landscapes and seascapes

Biodiversity patterns and ecological processes are connected in complex ways that cross realms as well as human-constructed boundaries. At the same time, human activities in a range of different sectors that have separate policies and legislation and are separately managed, can impact on the same biodiversity or ecological infrastructure (*established but incomplete*). To deal with this interconnectedness, cooperative governance and cross-sectoral planning and decision making are essential.

The management of biodiversity assets and ecological infrastructure that underpin benefits and services to people should not take place in silos. Just as all biodiversity in South Africa is connected, management interventions, research, monitoring and data management efforts should also be connected. The National Development Plan 2030 states: 'South Africa belongs to all its people and the future of our country is our collective future. Making it work is our collective responsibility'. Biodiversity is central to South Africa's national objectives of inclusive economic growth, job creation, improved service delivery and wellbeing for all its citizens.

A clear priority action is to ensure that all sectors better integrate this collective responsibility into their policies and practices. Collaboration is needed between government departments with different mandates, between national, provincial and local spheres of government, and between government, research institutions, NGOs and the private sector.

South Africa's policy and legislative framework includes several tools to facilitate cross-sectoral planning and decision making. An example is the Spatial Planning and Land Use Management Act, which requires that multi-sector Spatial Development Frameworks are developed at local, provincial and national level. Marine Spatial Planning legislation requires a similar multi-sectoral approach to balance environmental, fisheries, transport, mining and other needs in the marine realm. Implementation of these frameworks can be challenging, but relationship building,

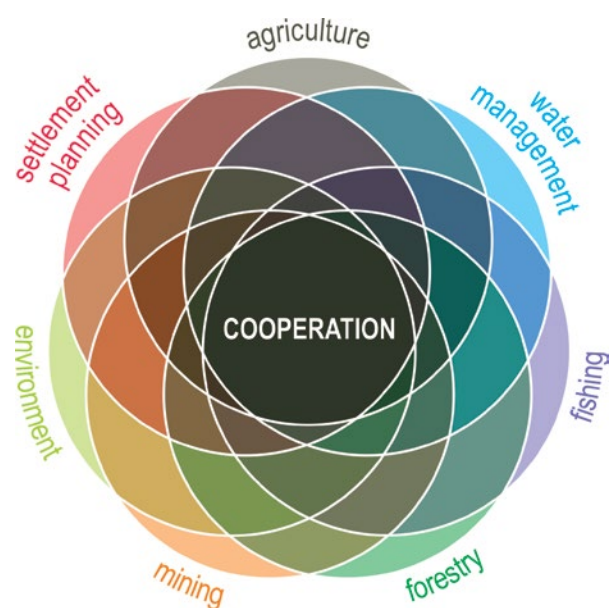


Figure 8. Planning for people, planning for the economy and planning for sustainable environmental resources cannot take place in isolation, but require cooperation across sectors that frequently work in silos.

partnerships and sharing of information can advance these efforts. In some cases, institutional arrangements are in place to support this. An example is the Interdepartmental Committee on Inland Water Ecosystems, convened by the Department of Water and Sanitation, which brings together all organs of state that share the mandate for managing and conserving rivers and inland wetlands. Ideally cooperative governance should go beyond just government actors to involve civil society. At the sub-national level, excellent examples of cooperative governance can be found in some catchments, for example the Umzimvubu Catchment Partnership Programme in the Eastern Cape and the uMngeni Ecological Infrastructure Partnership

in KwaZulu-Natal, where stakeholders have come together to address natural resource challenges in a way that supports social and economic development.

Cross-sectoral planning and cooperative governance are always complex, and approaches are not always transferable from one place to another. Nevertheless, there are successes in South Africa from which lessons can be drawn, and built on, for better management of landscapes and seascapes to enhance benefits for society.

For more information, see Part 4.3.

C The NBA stimulates work to address knowledge gaps

C1. South Africa's new seamless map of ecosystem types paves the way for improved assessment, planning and monitoring

Substantial progress made in classifying and mapping ecosystem types seamlessly across all realms has unlocked comprehensive and systematic assessment and planning for all of South Africa's territory, providing improved information to inform policy and decision making.

Building on experience in mapping and classifying ecosystems gained across all realms over recent decades, a new, comprehensive and integrated map of ecosystem types has been developed as part of the

NBA 2018 and paves the way for improved assessment and planning. The map seamlessly aligns the terrestrial, marine and estuarine realms through a detailed delineation of seashore ecosystem types at the interface of these three realms. Together with the rivers and inland wetland ecosystem types, the integrated map includes a total of 1 021 distinct ecosystem types covering South Africa and its sub-Antarctic territory. These ecosystem types are mapped at a fine enough geographical scale to be used not only in national planning and decision making, but also at the provincial and local level.

This dedicated collaborative effort from a wide range of national experts in historically separate realms has provided the basis for an ecological identification, classification and assessment of the entire country – an important step for achieving sound management of biodiversity assets and ecological infrastructure. The seamless integration also allows for a spatially detailed assessment of coastal ecosystem types for the first time.

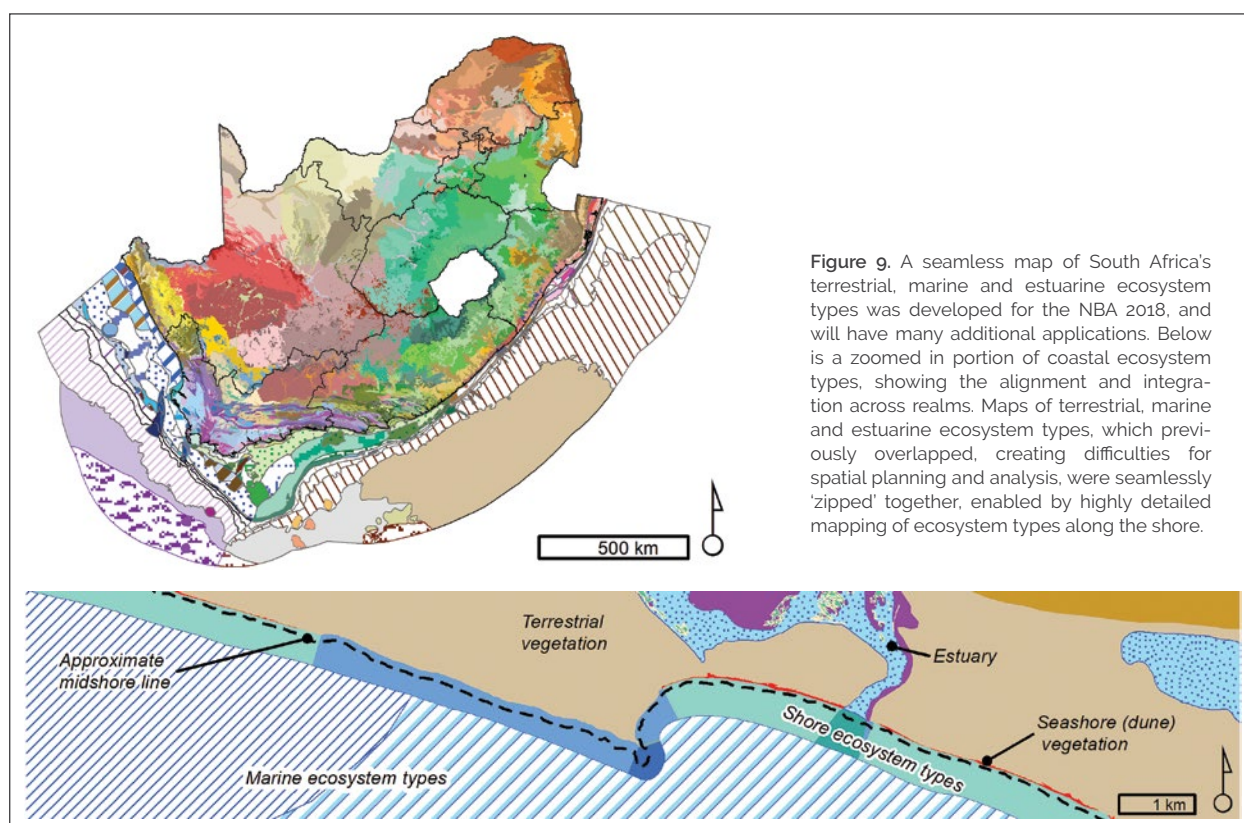


Figure 9. A seamless map of South Africa's terrestrial, marine and estuarine ecosystem types was developed for the NBA 2018, and will have many additional applications. Below is a zoomed in portion of coastal ecosystem types, showing the alignment and integration across realms. Maps of terrestrial, marine and estuarine ecosystem types, which previously overlapped, creating difficulties for spatial planning and analysis, were seamlessly 'zipped' together, enabled by highly detailed mapping of ecosystem types along the shore.

Going forward, the map provides a crucial dataset required for the strategic and proactive planning of future growth and development in South Africa that enhances benefits from biodiversity. It will also facilitate the mapping of ecological infrastructure, form the foundation for ecosystem accounts and will pave the way for improved, cross-sectoral research, planning, management and regulation.

For more information, see Part 2.1.

C2. New indicators developed during the NBA 2018 advance South Africa's ability to report on the status of biodiversity

The collaborative process of undertaking the NBA builds on innovations and advances in the biodiversity sector to produce new techniques and advances in knowledge. In the NBA 2018, several new indicators have been developed to provide a more comprehensive picture of the state of ecosystems and species.

Key advances made in the process of developing the NBA 2018 include the development of several new indicators that add value to the NBA and allow for more comprehensive reporting on the status of the country's biodiversity. The indicators are key elements of the emerging National Biodiversity Monitoring Framework and support South Africa's international reporting requirements linked to the United Nations' Convention on Biological Diversity (CBD) and Convention to Combat Desertification (UNCCD), as well as for the Sustainable Development Goals (SDGs). New indicators in the NBA 2018 include:

- The **species protection level indicator**, which gauges how well protected areas represent and conserve species. A world first, this indicator complements the existing NBA indicator for ecosystem protection level, bringing the set of headline indicators in the NBA to four.
- The first application of the **Red List Index** for South African species, utilising national Red List assessments, allows us to track trends in extinction risk for certain taxonomic groups that have undergone repeat assessments.

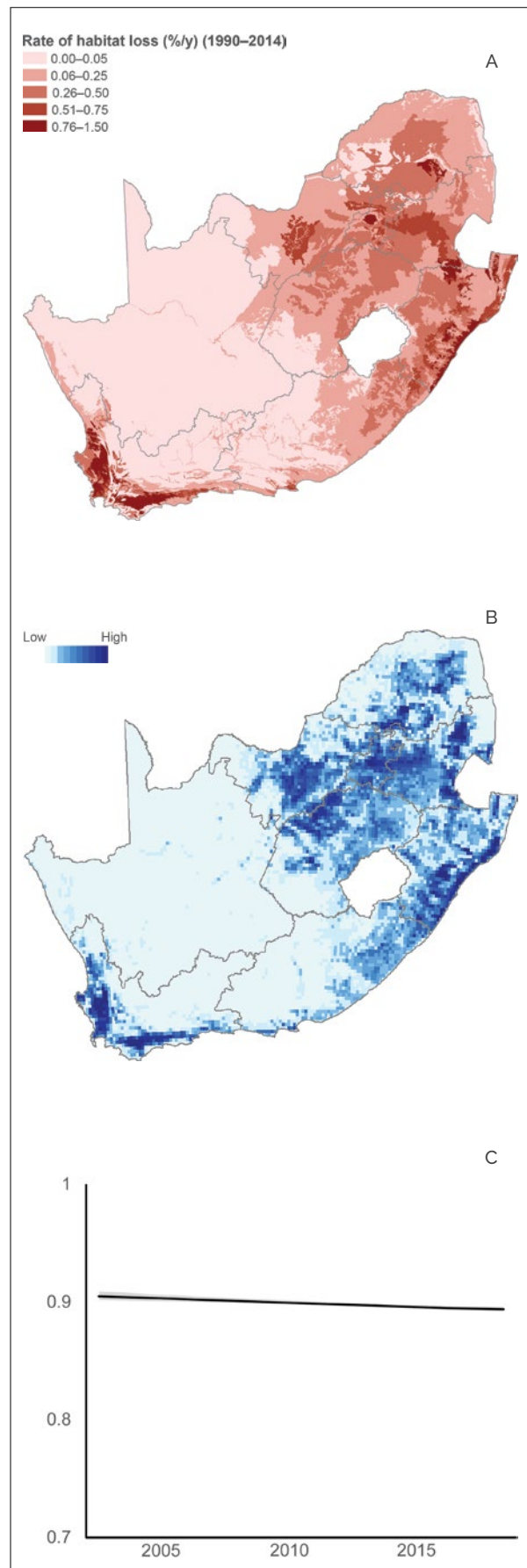


Figure 10. New indicators in the NBA: A, Rates of habitat loss; B, Genetic diversity in the terrestrial realm; C, Species Red List Index.

- **Indicators of rates of terrestrial habitat loss**, possible for the first time due to land cover data from several time points, strengthen assessment of ecosystem threat status and can be used in biodiversity prioritisation efforts.
- Potential **indicators to track and monitor the status of genetic diversity** were tested in the NBA 2018 and can assist to identify areas essential for the maintenance of genetic diversity across the landscape.

For more information, see Part 2.5, 2.6, 3.1.3, 3.1.8 and the NBA 2018 technical report on genetic diversity.

C3. Evaluation of genetic diversity brings new value to the NBA

Genetic diversity enables species to evolve and adapt within an ever-changing environment. The development of potential genetic diversity indicators for national-level assessments and monitoring has added value to the NBA and South Africa's international reporting commitments.

Species with high genetic diversity – and the evolutionary resilience that comes with it – are more likely to overcome rapid environmental change than species with low genetic diversity. Risks to genetic diversity include genetic erosion, which can occur through

habitat fragmentation, reduced population sizes and connectivity, hybridisation and inbreeding, unsustainable use, and through the live translocations of individuals. This can compromise the genetic integrity of natural populations. For example, fragmentation of Western Leopard Toad (*Sclerophrys pantherina*) habitat in the City of Cape Town isolates populations, leaving them vulnerable to inbreeding and loss of diversity; in the marine and estuarine realms, the Dusky Kob (*Argyrosomus japonicus*) have been reduced by overfishing and loss of freshwater flow and nursery habitat, which has led to genetic bottlenecks – consequently, genetic diversity should be safeguarded to minimise genetic erosion.

New indicators to track and monitor the status of genetic diversity are being developed in South Africa and internationally. These can assist in the identification of areas essential to the maintenance of genetic diversity over the landscape or seascape for target species. For example, the northeastern parts of South Africa exhibit high phylogenetic diversity for reptiles and have high rates of habitat loss, potentially leading to genetic erosion. To fully assess the risks to the genetic component of biodiversity, additional temporal genetic datasets across various taxonomic groups are required, and a national genetic monitoring framework should be developed. The framework should prioritise species for monitoring, and recommend what genetic markers to use, how often populations should be monitored and which metrics to consider. It should also be designed to strategically track key pressures on genetic diversity and monitor key areas and species for biodiversity planning.

Safeguarding and maintaining genetic diversity is an explicit target in the CBD, and the incorporation of

The Western Leopard Toad (*Sclerophrys pantherina*) is one of South Africa's Endangered species of amphibians. Its habitat is very fragmented, which leads to isolated populations and a loss of genetic diversity. © John Measey.



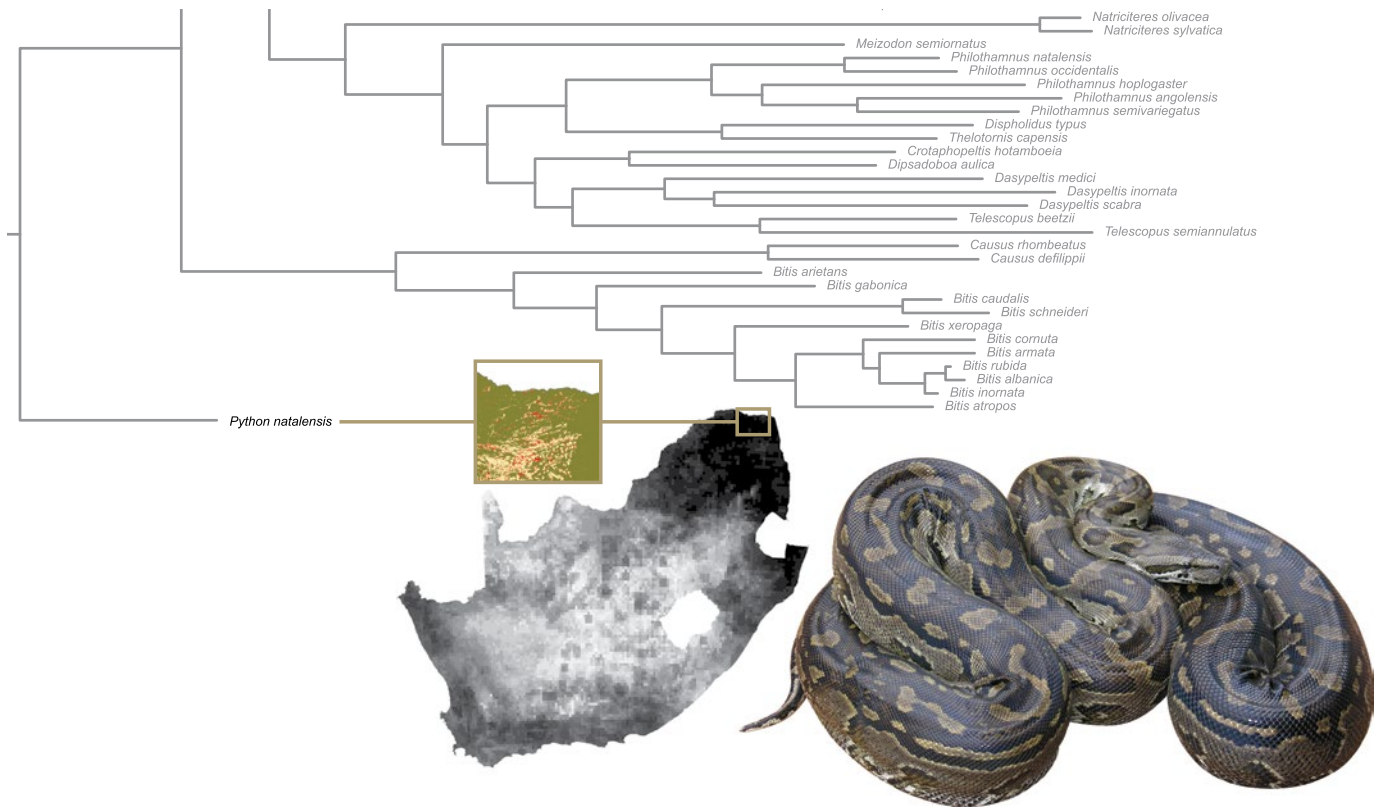


Figure 11. Phylogenetic diversity (PD) is a useful measure of the total species level genetic diversity (i.e. phylogenetic richness) in a geographic area. For example, PD in the northern part of South Africa is high (dark shading on map) because several species from different clades in the phylogeny occur in that geographic region, such as *Python natalensis*. When the PD map is overlaid with land cover (inset), it is possible to identify geographic regions that have high phylogenetic richness, and that are also impacted by land cover change. These areas might be sensitive to a loss of overall phylogenetic richness (e.g. 'genetic erosion'), because local populations of species will be lost where land cover is no longer suitable for that species. Python image: © Graham Alexander.

genetic indicators in this NBA is a first step to address South Africa's present and future commitments to the CBD.

For more information, see NBA 2018 technical report on genetic diversity.

C4. Investment in strategic and collaborative biodiversity monitoring programmes is crucial to inform management and decision making and for biodiversity assessments

Investment in existing and future strategic and cooperative biodiversity monitoring programmes is essential to strengthen our ability to detect and report on trends, plan accordingly and manage effectively.



Ordinary citizens can make big contributions to monitoring biodiversity, for example by gathering data using web-based tools. Here young citizen scientists learn to use the BirdLasser application on their phones to capture bird sightings and locations. © SANBI.

While South Africa has some robust biodiversity monitoring programmes, many involving citizen scientists (e.g. South African Bird Atlas Project), the NBA 2018 has highlighted gaps that should be filled and priorities for building on existing monitoring efforts. It is important that gaps in monitoring of species populations, ecological condition and community composition are filled (e.g. implementation of the new National



Children can take part in important water quality monitoring through the miniSASS programme, and find interesting freshwater species too! © Jeremy Shelton.

Wetland Monitoring Programme). Existing monitoring programmes (e.g. National Aquatic Ecosystem Health Monitoring Programme, which is focussed on rivers) need to be maintained and supported. These efforts should be linked with international efforts to identify Essential Biodiversity Variables (a set of variables, which collectively capture biodiversity change at multiple spatial scales and within time intervals that are of scientific and management interest), and should take advantage of new methods and innovative technologies. Monitoring pressures on biodiversity, such as invasive species distribution and abundance, impacts of harvesting, mining operations, water pollution and hydrological regime changes, is also crucial for biodiversity risk assessments and informed planning. Threats to biodiversity and human livelihoods like climate change cannot be realistically understood unless there is continuous, long-term, regular monitoring of relevant data like temperature and rainfall.

There has been a decline in resources allocated to monitoring programmes, and some of South Africa's key monitoring datasets are very old and others are not secure (e.g. some estuarine biodiversity datasets are over 30 years old, and water quality monitoring is in danger of ceasing completely).



Polhillia ignota, a species previously thought to be extinct that was rediscovered by the Custodians of Rare and Endangered Wildflowers (CREW) programme in 2017; demonstrating the value of continuous and dedicated species monitoring programmes for biodiversity science. © SANBI.

Strategic selection of the most crucial monitoring programmes should take place under the auspices of the emerging National Biodiversity Monitoring Framework and interdepartmental coordination of monitoring and reporting should be encouraged.

For more information, see Part 4.4.

Recommendations and key actions

South Africa has a well-developed suite of policy and legislation for the management, conservation and sustainable use of biodiversity, including two overarching national tools: the National Biodiversity Strategy and Action Plan (NBSAP) and the National Biodiversity Framework (NBF). These documents, developed through thorough stakeholder consultation, set out South Africa's strategic objectives for managing and conserving biodiversity and are the primary reference points for related priority actions. The NBA both informs the development of the NBSAP and NBF, and supports their implementation. Together the NBSAP, NBF and NBA provide three key, inter-related anchors for the work of the biodiversity sector in South Africa.

South Africa's biodiversity is not evenly distributed across the country from a geographic point of view and when this is combined with limited resources for action, it means that it is essential to prioritise spatially. An important feature of South Africa's biodiversity-related response to the pressures on biodiversity has been spatial planning to identify priority areas in the landscape and seascape for intervention. This is particularly important for the implementation of Strategic Objectives 1 (Management of biodiversity assets), 2 (Investment in ecological infrastructure) and 3 (Biodiversity considerations are mainstreamed) of the NBSAP and NBF, which otherwise run the risk of being spread too thin geographically to be effective. The production of spatial planning tools at the

national and sub-national level, such as CBA maps, relies heavily on the spatial data layers and datasets that are compiled and collated for the NBA. Efforts to strengthen foundational data for the NBA also support the development of high quality spatial biodiversity plans.

The NBSAP 2015 and NBF 2018 highlight a wide range of interventions that are priorities for managing and conserving biodiversity, many of which are confirmed and reinforced by the findings of the NBA 2018. Key priorities for improving the effectiveness of interventions emerging from this NBA include the need to improve compliance with existing laws, strengthen cross-sectoral planning, strengthen adaptive management, and build and maintain capacity.

Although the NBA and the data sources available to it have evolved and grown substantially since its first iteration in 2004, a number of avenues for improvement remain. The final section of the NBA 2018 looks back on the research priorities identified in the previous NBA (2011), describes the main limitations of the NBA 2018 and outlines potential solutions. This is followed by a summary of essential research, monitoring and data management needs to improve future NBAs.

For more information, see Part 4.

Part One

About South Africa's Biodiversity and the NBA

The NBA is a collaborative effort to synthesise and present the best available science on South Africa's biodiversity. It aims to inform policy, planning and decision making in a range of sectors for the conservation and sustainable use of biodiversity.

The NBA is a platform for reporting on the current state of biodiversity within South Africa. It describes the key pressures on biodiversity and, where possible, identifies important trends. It covers the terrestrial, inland aquatic³, estuarine and marine realms, as well as the coast and South Africa's sub-Antarctic territory

as cross-realm zones. The NBA is used to illustrate the benefits that biodiversity and intact ecosystems provide to the economy, society and human well-being. Finally, the systematic approach of the NBA allows us to identify important national knowledge gaps and research priorities linked to biodiversity.

³ Inland aquatic realm refers to rivers and inland wetlands. The term 'freshwater realm' is regularly used in the biodiversity sector, but since numerous inland saline wetland ecosystems occur in South Africa, the term 'inland aquatic' is preferred. The term 'inland wetland' is used to distinguish these ecosystems from estuarine or marine wetlands, which are considered part of the estuarine and marine realms respectively.

Biodiversity is defined 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 across ecosystems' (CBD). Biodiversity incorporates diversity at the genetic, species and ecosystem level, which together form the foundation of ecosystem services and are integrally linked to human wellbeing.



Figure 12. Biodiversity is organised at three fundamental levels: ecosystems, species and genes.

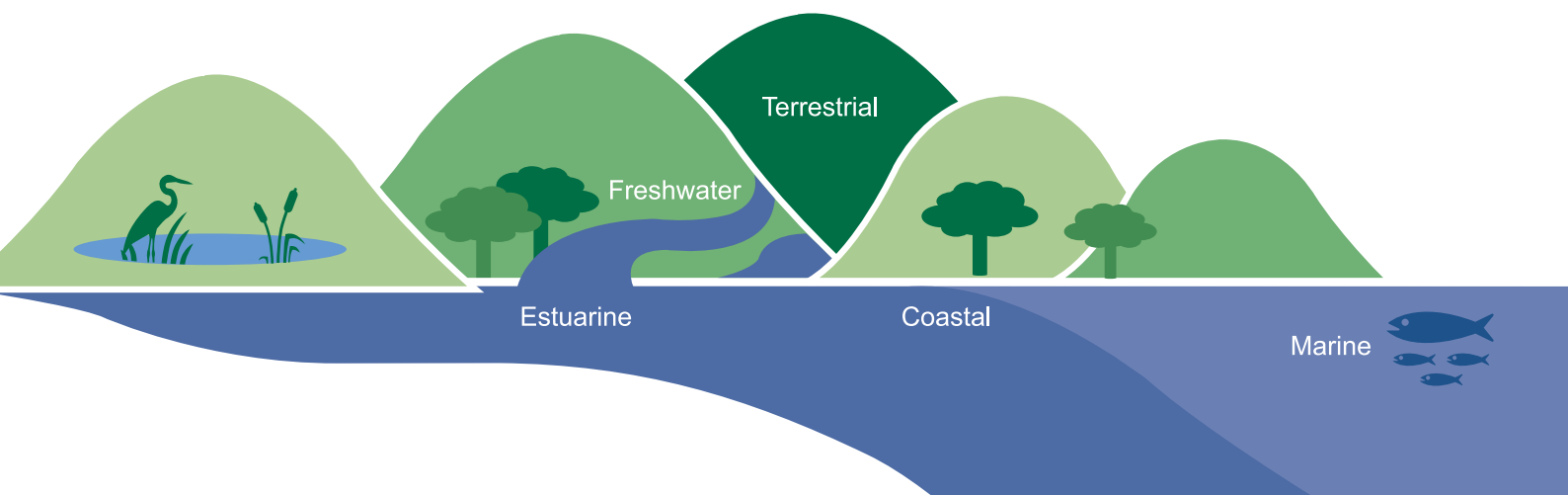


Figure 13. The NBA covers all four realms: terrestrial, inland aquatic (freshwater), estuarine and marine.

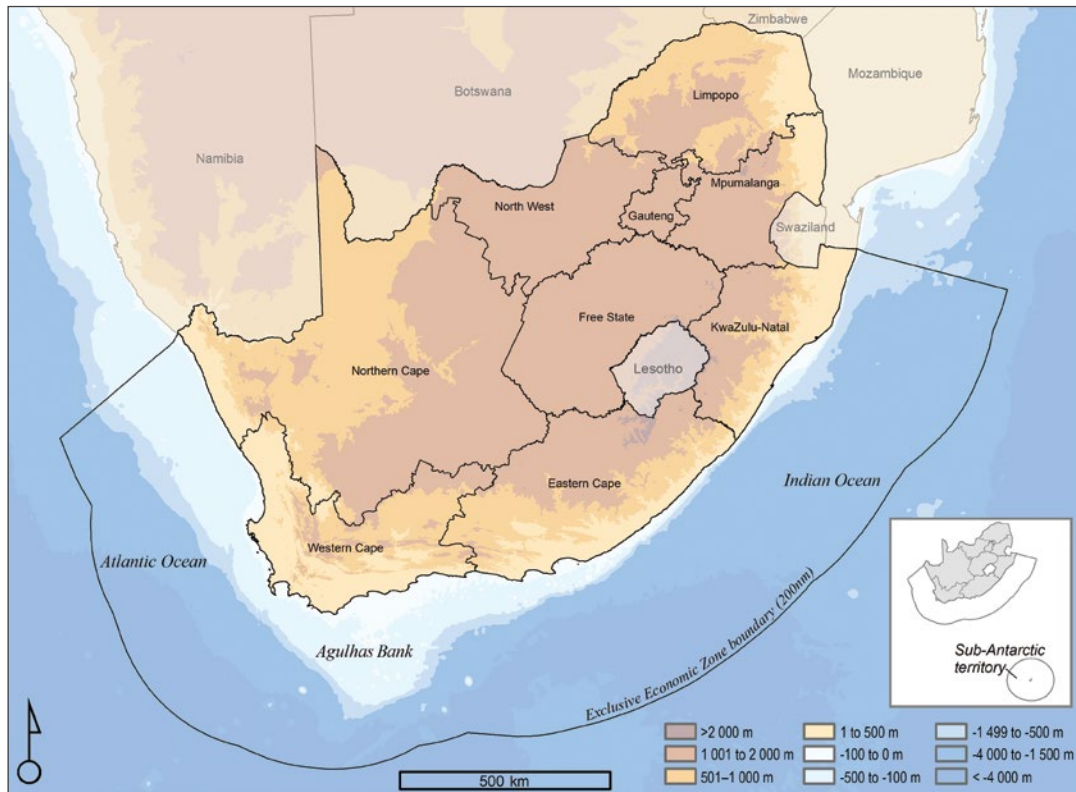


Figure 14. The geography of South Africa showing the elevation range of the mainland and bathymetric (depth) profile of the territorial waters and Exclusive Economic Zone. South Africa's sub-Antarctic territory, namely Prince Edward and Marion Islands, 1 700 km from the mainland, is shown in the inset.

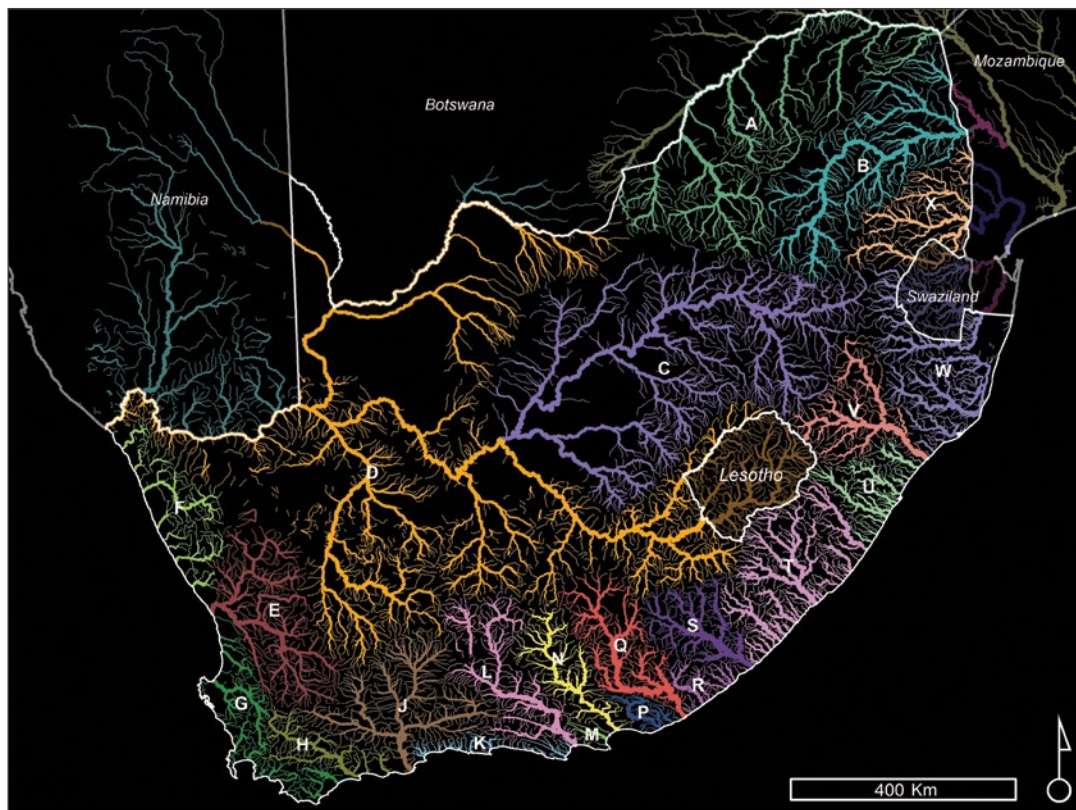


Figure 15. Primary catchments of South Africa showing the major river networks. The largest catchment in the country is linked to the Orange River (D), which together with the Vaal (C), Limpopo (A) and Olifants (B) rivers, dominate the interior. Map inspired by the work of Sukhmani Mantel, Rhodes University.

1.1 South Africa's biodiversity profile

South Africa has exceptional biodiversity, characterised by high species richness, high levels of species endemism and a wide variety of ecosystems. South Africa's diversity and richness are not limited to biodiversity. Within its borders are also diverse cultures and languages, and exceptional geological and climatic diversity.

Identified as one of the world's 17 megadiverse nations, South Africa ranks as one of the top ten nations globally for plant species richness and third for marine species endemism. With a landmass of 1.2 million km² and surrounding seas of 1.1 million km², South Africa⁴ is among the smaller of the world's megadiverse countries – which together contain more than two-thirds of the world's biodiversity. South Africa also holds three of the world's 35 biodiversity hotspots (a measure of biological diversity combined with vulnerability to threats): the Cape Floristic Region, Succulent Karoo biome, and the Maputaland–Pondoland–Albany centre of endemism.

Current statistics have the number of South African animal species estimated at 67 000, while 20 401 plant species have been described. Approximately 7% of the world's vascular plants; 5% of mammals; 7%

of birds; 4% of reptiles; 2% of amphibians; and 1% of freshwater fishes are found in South Africa. There is limited information on invertebrate groups, but South Africa has almost a quarter of global cephalopods (octopus, squid and cuttlefish). Some terrestrial invertebrate groups have high richness relative to the global fauna. For example, 13% of the world's sunspiders (Solifugae), ticks (Ixodidae) and silverfish/fishmoth (Zygentoma), and nearly 5% of butterflies occur in South Africa (Table 1).

Around half of the reptiles, amphibians, butterflies and freshwater fishes found in South Africa are endemic. Plants have even higher levels of endemism, with two-thirds of species considered endemic to South Africa – mostly linked to the unique Cape Floristic Region. High marine species endemism has consistently been reported for the Agulhas ecoregion on the south coast, which lies entirely within South Africa's territory and is geographically isolated from the globe's other Warm Temperate regions. Approximately 40% of South Africa's estimated 10 000 marine animal species are endemic, the vast majority of which are invertebrates.

South Africa's wide range of bioclimatic, oceanographic, geological and topographical settings have resulted not only in high species diversity and endemism, but also high ecosystem diversity and endemism across all realms. There is a wide variety

⁴ South Africa's sub-Antarctic territories of Prince Edward Island, Marion Island and their surrounding seas cover an additional 0.5 million km².

Table 1. Summary of species richness and endemism for selected South African taxonomic groups, including global estimates

Taxonomic group	Species	Endemics	Endemics as % of total SA species	Global estimates of number of species	Species in SA as % of global total
Amphibians	125	62	50%	7 934	1.6%
Birds	732	38	5%	11 122	6.6%
Butterflies	799	418	52%	17 500	4.5%
Dragonflies	162	28	17%	5 680	2.9%
Fishes (freshwater)	118	58	49%	14 953	0.8%
Fishes (marine)	~ 2 000	261	13%	~20 000	10.0%
Mammals	336	57	17%	6 399	5.3%
Octopus, squids	195	unknown	unknown	800	24.3%
Plants (vascular)	20 401	13 763	67%	304 419	6.7%
Reptiles	404	200	50%	10 793	3.7%
Seaweeds	878	~178	~20%	~11 000	~8%
Spiders	2 239	1 300	58%	40 700	5.5%

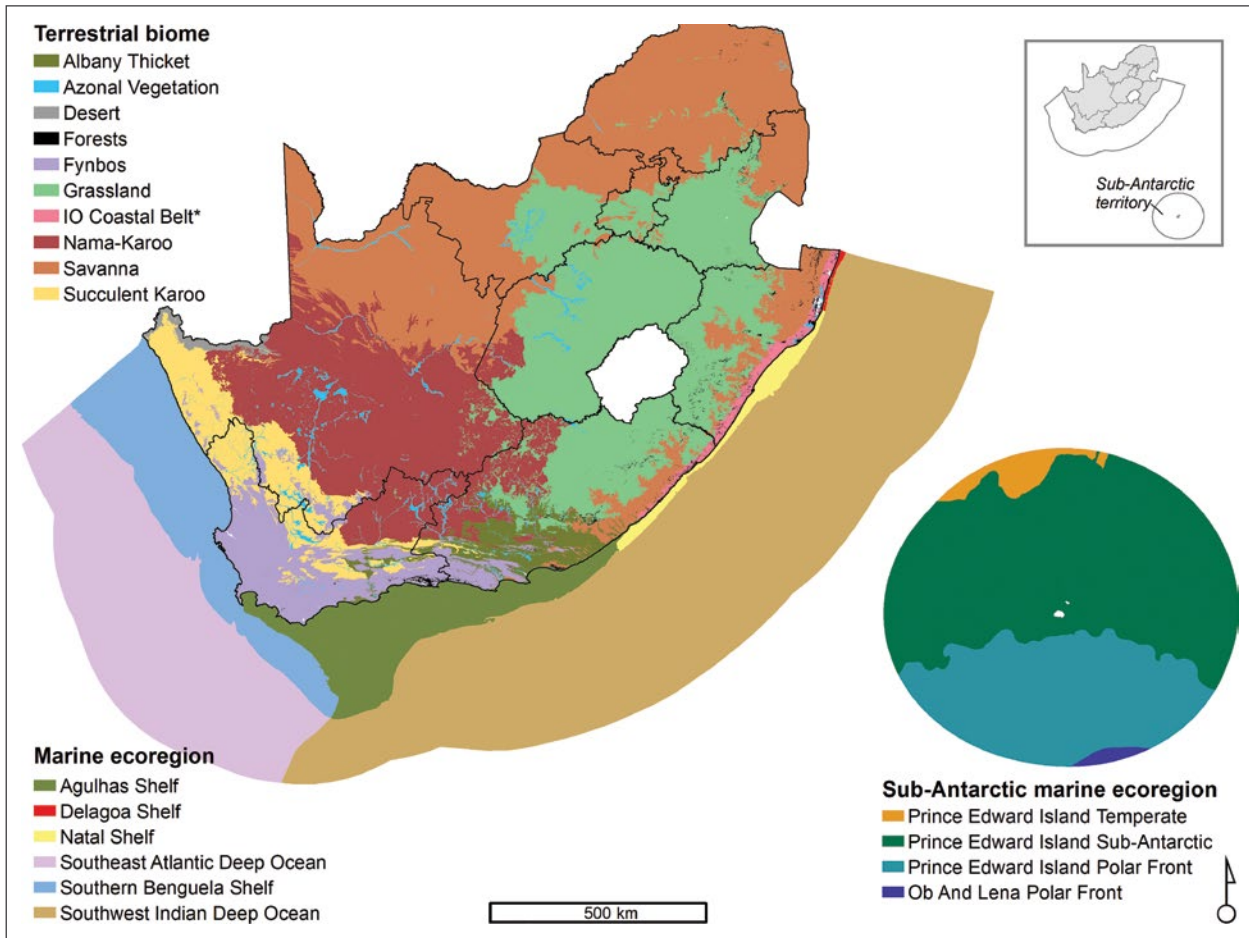


Figure 16. Terrestrial biomes and marine ecoregions of South Africa and the marine ecoregions surrounding the Prince Edward Islands group (South Africa's sub-Antarctic territory), 1 700 km southeast of the mainland. The vegetation of the sub-Antarctic islands is classified as either Sub-Antarctic Tundra or Polar Desert biome. *IO Coastal Belt refers to Indian Ocean Coastal Belt.

of terrestrial biomes and marine ecoregions in South Africa, its surrounding seas and sub-Antarctic territory; ranging from the unique Fynbos biome to the extensive savannas and grasslands of the eastern interior, and from the Subtropical Indian Ocean through the Warm Temperate Agulhas Shelf to the cold upwelling influenced shelf of the Southern Benguela (Figure 16). Situated 1 700 km south of the country, the Prince Edward Islands and their surrounding seas add a cold, sub-Antarctic set of ecoregions and biomes to South Africa's territory (Figure 16).

South Africa's **terrestrial** realm can be categorised into nine biomes and 458 ecosystem types, approximately 80% of which are endemic. The moist, winter-rainfall region in the southwest of the country is home to the unique Fynbos biome. Adjacent to this lies the Succulent Karoo biome, an arid winter-rainfall biome with the highest diversity of succulent plants in the world. The Nama-Karoo biome covers the arid, summer-rainfall, western interior. The Savanna biome (the largest biome in southern Africa) dominates the northern and eastern summer-rainfall regions of South

Africa. The Grassland biome occurs mostly on the cooler, high-lying central plateau and has high levels of endemism. The Albany Thicket biome occurs in the eastern and southern Cape and contains a unique combination of plant forms with an Eocene origin and unique evolutionary history. The Forest biome (with Warm Temperate and Subtropical types) is the smallest biome and is characterised by patches distributed across the winter and summer rainfall areas of the country. The Indian Ocean Coastal Belt biome represents the southernmost extent of the wet tropical seaboard of East Africa. The Desert biome occupies a small portion of the extreme northwest of the country, forming the southernmost extent of the Namib Desert.

South Africa's **marine** realm includes the Atlantic, Indian and Southern oceans with the contrasting cold Benguela upwelling systems and the warm, fast-flowing Agulhas current. This diverse oceanographic setting, combined with complex geology and topography, drives exceptional marine biodiversity and a wide array of ecoregions and ecosystem types. Three shelf ecoregions are recognised; the Cool Temperate



© Angus Burns



© Melanie Cornelius

South Africa's terrestrial biomes have incredible diversity – ranging from the arid Succulent Karoo and Desert in the west through high-lying Grassland and wetter Savanna, to the tropical Indian Ocean Coastal Belt. The unique Fynbos biome hosts the national flower, the King Protea (*Protea cynaroides*).

Southern Benguela, the Warm Temperate Agulhas and the Subtropical Natal–Delagoa. The deep ocean beyond the shelf edge includes two further ecoregions in the form of the Southeast Atlantic and the South-west Indian. The Southern Benguela includes two sub-regions, the Namaqua and Cape regions, which separate at Donkin Bay (north of St Helena Bay) on the west coast. In addition, the Natal–Delagoa ecoregion includes the Delagoa, KwaZulu-Natal Bight and KwaZulu-Natal–Pondoland regions, which have distinct biodiversity patterns. These ecoregions and sub-regions include 150 marine ecosystem types that include several functional ecosystem groups: Sandy

Shores, Rocky and Mixed Shores, Islands, Bays, Kelp Forests, Soft Shallow Shelf, Shallow Reef and Rocky Shelf, Deep Soft Shelf, Deep Rocky Shelf, Slope, Plateau and Abyss.

South Africa is among the most water-scarce countries per capita in the world, and has a high temporal and spatial variability of rainfall. This results in highly variable runoff and river flow regimes, and a relative scarcity, but surprisingly rich variety, of inland wetlands. The diversity of **river and inland wetland** ecosystem types (together comprising the inland aquatic realm) is underpinned by the strongly contrasting bioclimatic



© Geoff Spiby



© Steve Benjamin

South Africa is ranked third in the world for marine species found nowhere else on Earth. The marine realm includes ecosystems like delicate corals and kelp forests through to deep ocean canyons and seamounts. Fish such as the Red Roman (*Chrysoblephus laticeps*), a species of seabream, are found only on South Africa's near-shore reefs.



© Cally Henderson

zones – the arid western interior (summer rainfall), the mesic eastern grassy biomes (summer rainfall), the arid western coastal regions (winter rainfall) and the mesic winter-rainfall southwestern Cape. The latest mapping data indicates that inland wetlands cover 2.2% of South Africa's surface area, though this is likely to be an underestimate. These wetlands are classified into 135 distinct ecosystem types on the basis of vegetation bioregions and hydrogeomorphic units. The diversity of river ecosystem types is driven by ecoregions, bioclimatic variation and geomorphological factors, resulting in 222 distinct types.

South Africa has 290 **estuaries** and 42 micro-estuaries, which have been classified into 22 estuarine ecosystem types and three micro-system types. This represents a high diversity of estuary types stemming from diverse climatic, oceanographic and geological drivers. The comparatively small, wave-dominated



© iSimangaliso Wetland Park



© Jeanne Tarrant

Despite being a water-scarce country, South Africa's freshwater realm is rich with diversity. From the second highest waterfall in the world (uThukela, pictured) to eight unique freshwater lakes and highly threatened inland wetlands, these freshwater systems host many unique and threatened species such as this Pickersgill's Reed Frog (*Hyperolius pickersgilli*), Endangered.



© David Harasti

South Africa has 290 estuaries and 42 micro-estuaries dotted around the coast, the largest being the St Lucia Estuary in the iSimangaliso Wetland Park. The iconic Knysna Seahorse (*Hippocampus capensis*) is now restricted to only three estuaries and is listed as Endangered.



© Oswald Kurten



© Peter Chadwick

South Africa's coast ranges from cliffs and rocky shores through to pristine beaches and dune systems, and this diversity results in high levels of species endemism – especially in invertebrates and dune plants.

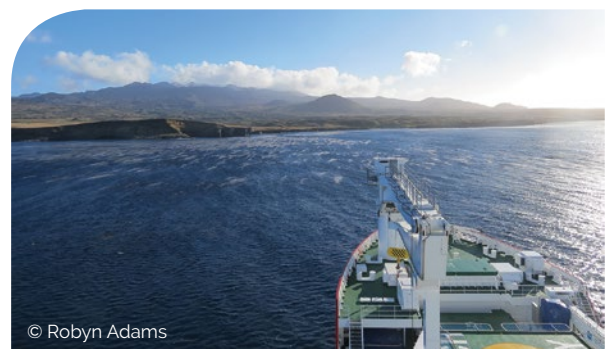
South African estuaries generally have restricted inlets, with more than 75% closing for varying periods when a sandbar forms across the mouth. Four bioregions apply to South African estuaries: the Cool Temperate (Orange to Ratel), the Warm Temperate (Heuningnes to Mendwana), the Subtropical (Mbashe to St Lucia) and the Tropical (uMgobezeleni to Kosi).

For the NBA 2018, an ecologically determined **coast** (cross-realm) was defined and used, which spans the terrestrial, estuarine and marine realms. The South African coast is microtidal (<2 m range) and mostly high energy, with generally exposed to very exposed conditions from the Subtropical northeast coast to Cold Temperate west coast. It comprises a wide range of coastal vegetation types (from forests

to arid shrublands), dunes, cliffs, beaches, rocky and mixed shores, estuaries, mangroves, kelp, reefs, bays, and river-influenced shelf regions that extend as far offshore as the shelf edge in some places. With this heterogeneity comes exceptionally high coastal biodiversity and high levels of endemism, especially among dune plants, beach fauna and other invertebrate taxa. There are 186 ecosystem types that are considered coastal: 22 estuarine, 79 terrestrial and 85 marine, all of which are fundamentally influenced by both the land and sea.

South Africa's **sub-Antarctic territory** (cross-realm) consists of Prince Edward Island, Marion Island and surrounding seas (collectively known as the Prince Edward Islands, PEIs), and is situated 1 700 km southeast of the mainland. These tiny islands and surrounding seas have a very different biodiversity profile from that of the mainland and its oceans. The islands are volcanic in origin and experience a cold temperate or polar climate with a strong oceanic influence; with five terrestrial ecosystem types described. There are 29 marine ecosystem types covering the shore, the territorial waters and Exclusive Economic Zone, and these range from temperate ecoregions in the north to polar ecoregions in the south. As part of the Southern Ocean, our sub-Antarctic marine ecosystems contribute to a globally important carbon sink and play an integral role in climate regulation.

South Africa's islands and their surrounding seas are a natural laboratory, with numerous scientists visiting the Marion Island base (pictured here from the *SA Agulhas II*) to study the sub-Antarctic. Several threatened bird species breed on the islands, including the Wandering Albatross (*Diomedea exulans*), listed as Vulnerable.



© Robyn Adams



© Otto Whitehead

1.2 The importance of biodiversity

South Africa's biodiversity provides a wide array of benefits to the economy, society and human wellbeing. These benefits that nature can provide are dependent on intact ecosystems, healthy species populations and genetic diversity. Human activities present a range of direct and indirect pressures on biodiversity that need to be carefully considered with the need to maintain and protect biodiversity, and the benefits that are derived from biodiversity.



© Angus Burns



© Jonathan Colville

Biodiversity supports food security. Natural rangelands cover much of South Africa's land area and support meat production. Nearly invisible insect pollinators are essential for the production of the fruits and vegetables needed for good nutrition.

Biodiversity-related jobs number approximately 418 000 and the biodiversity-based tourism industry is worth over R30 billion per year. Intact ecosystems and high species diversity are essential for agricultural production – providing healthy populations of crop pollinators and natural predators of agricultural pests. Healthy rangelands support both livestock and wild-life ranching (the latter worth R14 billion per year). Intact catchments, wetlands and riparian systems help clean water supplies, attenuate floods and store water for times of drought – in so doing, they protect people from floods and droughts and help with adaptation to a changing climate. Harvesting of edible plants, edible insects, fish, medicinal plants and building or weaving materials from the wild is widely practised in South Africa and is an important part of the rural economy. Our natural ecosystems, plants and animals have also influenced cultural and spiritual development, and are woven into languages, place names, religion and folklore. This web of associations with biodiversity forms part of South Africans' national identity and heritage.

Nelson Mandela said, *'Our people are bound up with the future of the land. Our national renewal depends upon the way we treat our land, our water, our sources of energy, and the air we breathe. ...Let us restore our country in a way that satisfies our descendants as well as ourselves.'* This recognition of peoples' reliance on the natural environment and biodiversity was later further enshrined in the South African Constitution, which states that everyone has the right to an environment that is not harmful to their health or wellbeing; and to have that environment protected for the benefit of present and future generations through reasonable measures.

While biodiversity is a national asset and a powerful contributor to inclusive growth and job creation, its protection is at times cast as a hurdle to socio-economic development. This is unfortunate considering the extent to which biodiversity and use of biodiversity can contribute to the objectives in the National Development Plan 2030. The primary goals of reducing poverty and inequality in South Africa

Ecological infrastructure refers to naturally functioning ecosystems that generate or deliver valuable services to people.



© Peter Chadwick



© CapeNature



© Angus Burns

Galjoen (*Dichistius capensis*) is South Africa's national fish and may be caught by recreational fishers with a special permit. Many South Africans harvest and use biodiversity directly from the wild. There are over 1 300 edible plant species found in South Africa, and over 650 medicinal plant species are traded regularly. Many South Africans still fetch their water directly from rivers and wetlands.



Interacting with nature brings measurable emotional, mental and physical benefits, and plays a key role in our overall enjoyment of life. Our natural ecosystems, plants and animals influence our cultural and spiritual development, and are woven into languages, place names, religions and folklore. This web of associations with biodiversity forms an important part of South Africans' national identity and heritage.

through stimulating the economy, improving employment figures, building an inclusive rural economy and providing affordable health care; all rely to some extent on biodiversity, healthy ecosystems, resilient ecological infrastructure and environmental sustainability.

Every decision taken, whether by governments or individuals, affects the future of biodiversity. By investing in the restoration, protection and management of our biodiversity assets and ecological infrastructure, we enhance social and economic development and contribute to human wellbeing.

1.3 Purpose and structure of the NBA

The NBA is the primary tool for monitoring and reporting on the state of biodiversity in South Africa. It is prepared as part of the South African National Biodiversity Institute's (SANBI) mandate⁵ to monitor and report regularly on the status of South Africa's biodiversity, and is a collaborative effort from many institutions and individuals. The NBA focusses primarily on assessing biodiversity at the ecosystem and species level, with efforts being made to include genetic level assessments. Two headline indicators that are applied to both ecosystems and species are used in the NBA: threat status and protection level. The products of the NBA include seven technical reports, a technical synthesis report and several popular outputs.

The primary **purpose** of the NBA is to provide a high-level summary of the state of South Africa's biodiversity at regular points in time, with a strong focus on spatial information. Each NBA builds on decades of research and innovation by South African scientists, and makes that science available in a useful form to users both

inside and outside of the biodiversity sector. As a body of work the NBA is not prescriptive; it presents important information that can be adopted by government and civil society in various decision making processes to support socio-economic imperatives, human well-being, and the best management and conservation of South Africa's biodiversity.

Like the previous assessments in 2004 and 2011, this third iteration of the NBA will feed into a range of processes within the environmental sector and beyond (Figure 17). Key applications include:

- Informing policies and strategies in the biodiversity sector (e.g. National Biodiversity Framework, National Protected Area Expansion Strategy), and other key sectors responsible for natural resources utilisation and/or protection, such as the water, agriculture, fisheries and mining sectors (e.g. Mining and Biodiversity Guidelines).
- Providing information to help prioritise the often limited resources for managing and conserving biodiversity; including datasets that feed into site and regional level planning and assessment (e.g. Strategic Environmental Assessments and Environmental Impact Assessments) and provincial and

⁵ SANBI's mandate is outlined in the National Environmental Management: Biodiversity Act (10 of 2004), hereafter referred to as the 'Biodiversity Act'.



Figure 17. International reporting processes and channels into which the NBA is a key informant, including international conventions signed by the South African Government and voluntary processes.

municipal Bioregional Plans and Marine Spatial Plans (i.e. systematic biodiversity planning).

- Creating a key reference and educational work for use by scientists, students, consultants, decision makers and funders.
- Serving as an effective national level platform for encouraging and facilitating collaboration, information sharing and, importantly, capacity building in the biodiversity sector in South Africa.
- Providing information for a range of national and international level monitoring, reporting and assessment processes such as state of environment reporting and reporting on commitments to international conventions (e.g. linked to the United Nations Convention on Biological Diversity [CBD], the Sustainable Development Goals [SDGs] and the Intergovernmental science–policy Platform on Biodiversity and Ecosystem Services [IPBES]).

Navigating the NBA products

The NBA has a varied audience each with different needs, hence the NBA is presented in various forms. The NBA website is the primary portal through which you can access all information and products (<http://nba.sanbi.org.za/>). The NBA website also provides factsheets and presentations summarising the NBA for non-technical audiences, using graphics and accessible language.

The NBA 2018 has **seven technical reports**: one for each realm (terrestrial, inland aquatic, estuarine and marine); two cross-realm technical reports (the coast and South Africa's sub-Antarctic territory); and a technical report on genetic diversity. The technical reports are comprehensive volumes covering all input data used for the assessments, detailed explanations of methods and approach, full results and discussion, key messages for decision makers, limitations and knowledge gaps, and priorities for the future. These reports are for a scientific and technical audience, and are fully referenced and peer reviewed. The technical reports refer to various supplementary technical documents, maps and datasets; all of which are available through the NBA website with accompanying metadata.

The **synthesis report** (this volume) focuses on the main findings and key messages from each technical report. As the technical reports give full details of the methods and input data used for the NBA, the

synthesis report only briefly discusses the building blocks and approach used on a broad level. The synthesis report is divided into four parts:

- Part One introduces the NBA, its contextual framework and relevance in the biodiversity sector, and provides a biodiversity profile for South Africa.
- Part Two contains the integrated national findings across all realms.
- Part Three presents the main findings for each realm (terrestrial, inland aquatic, estuarine and marine), for the coast, and the sub-Antarctic territory.
- Part Four addresses some of the interventions from the biodiversity sector that are aimed at addressing key pressures on biodiversity and outlines priority actions for enhancing these interventions. It reflects on the limitations of the current assessment and identifies research and monitoring required to strengthen future assessments.

The NBA process

The breadth and scope of the NBA make collaboration between multiple institutions and individuals an essential part of the process. SANBI plays the lead role and facilitates contributions by a large pool of experts. The collaboration ensures that the best available science underpins the NBA, promotes collective ownership of the NBA products by the biodiversity community

The NBA 2018 required approximately 135 000 person hours, contributed by more than 470 individuals, from approximately 90 institutions. The CSIR led the inland aquatic and estuarine components, and the Nelson Mandela University led the coastal component.



NELSON MANDELA
UNIVERSITY

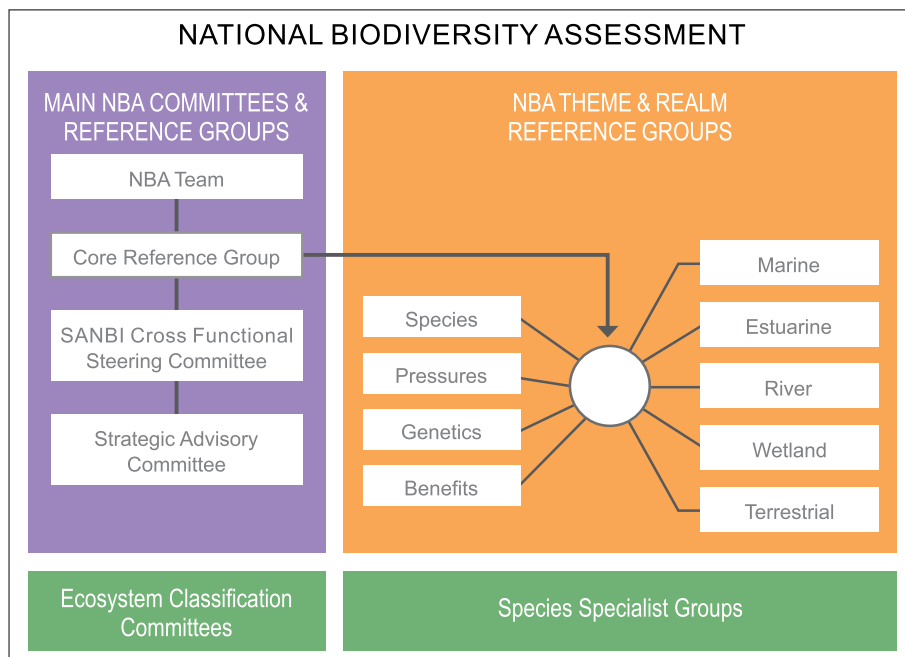


Figure 18. Committees and reference groups established for the NBA 2018. The purple panel includes the oversight structures for the NBA management team, the orange panel includes the reference committees for the technical elements, and the green panel indicates foundational ecosystem and species assessment work that underpins the NBA.

in South Africa, and helps ensure a common vision for action following the assessment. The vast majority of contributions to the NBA are voluntary, and the few formally funded contributions involve significant co-financing. Without these voluntary contributions from experts and institutions outside of SANBI, the NBA would not be possible. While the reliance on experts to contribute voluntarily does present significant risks to the process, paid alternatives bring their own challenges and budget constraints.

Various internal and external governance structures were put in place in 2015 to guide the NBA 2018, ensure the project received adequate oversight, and provide structures for the consultation of a wide range of experts in each specific biodiversity field (Figure 18). The reference groups included researchers, experts and officials with technical roles, while the steering and advisory committees included senior officials. The NBA 2018 process focussed particularly on increasing cross-realm collaboration, which led to better alignment between realms for input data, assessment approaches and explanation of areas for improvement.

Units of assessment and headline indicators

The NBA focusses primarily on assessing biodiversity at the ecosystem and species level, with efforts being made to include genetic level assessments. The

units of assessment for the ecosystem-level analyses are ecosystem types, which have been identified and delineated for each realm as part of a National Ecosystem Classification System. Species-level assessments occasionally include subspecies or varieties; for taxonomic groups where this is the case it is necessary to use the word 'taxa' as this term includes species, subspecies and varieties.

Two headline indicators, applied to both ecosystems and species, are used in the NBA:

1. **Threat status** is based on the current IUCN risk assessment frameworks for species and ecosystems. The IUCN Red List of Species is well established globally and South Africa has used the IUCN species assessment system as part of the NBA reporting since 2004. The IUCN Red List of Ecosystems (RLE) is relatively new from a global perspective (v1.0 released in 2016) – but a similar ecosystem assessment framework has been in use in South Africa since 2004. In this NBA, ecosystem risk assessment broadly follows the new IUCN RLE method.
2. **Protection level** was developed in South Africa for national reporting in 2004 and, at the time, addressed only the extent to which ecosystems (not species) were protected. The indicator has received renewed scientific attention, and species protection level (for selected taxa) is reported in the NBA 2018 for the first time.

The established headline indicators in the NBA provide a way of comparing results meaningfully

across the different realms, and also provide a standardised framework that links with policy and legislation in South Africa; thus facilitating the interface between science and policy. There is growing recognition within government and other institutions of the need to respond to these headline indicators in planning and decision making. The indicators of the NBA should form the basis for indices that track change over time. One such index, developed by the IUCN, is the Red List Index for species that tracks changes in extinction risk across entire species groups between Red List assessments. It is used to track progress against the Aichi Targets and SDGs. A similar Red List Index for ecosystems is being developed. As these indicators mature in terms of input data and computation, our ability to undertake trend analysis will improve.

In addition to the headline indicators, indicators that track the condition of ecosystems and the various pressures that act on biodiversity are emerging. Recent work in South Africa describes indicators for biological invasions, and international literature is expanding for indicators that track ecosystem extent and health. Indicators for assessing genetic diversity at a national scale are also being explored. Additional data will need to be collected to meaningfully compute some of these new indicators. Future assessments may also include Key Biodiversity Areas (KBAs) and Ecologically or Biologically Significant Marine Areas (EBSAs), which will allow for improved alignment with emerging global biodiversity indicators linked to the SDGs and future iterations of CBD targets in the post-2020 agenda for biodiversity.

1.4 New in the NBA 2018

The NBA 2018 is the third such assessment for South Africa – following the National Spatial Biodiversity Assessment 2004 and the National Biodiversity Assessment 2011. Each NBA builds on years of research and innovation by South African scientists. The NBA 2018's goals of improving ecosystem classification and mapping, introducing a species protection level indicator and potential genetic diversity indicators, and including South Africa's sub-Antarctic territory for the first time were all met. In addition, this NBA trialled the new IUCN Red List of Ecosystem criteria and was able to track trends in species status and habitat loss for the first time.

Ecosystems

New maps of marine, estuarine and inland wetland ecosystem types: Substantial collaborative efforts produced completely revised classification systems and maps for marine, estuarine and inland wetland ecosystem types. With these improved maps comes greater confidence in the ecosystem assessments.

Seamless integration of ecosystem types across realm boundaries: The maps of ecosystem types for each realm have been carefully integrated into a seamless layer for the first time; a task made possible by the new and highly detailed delineation of coastal ecosystem types. This integration across the land–sea interface, and between estuaries, inland wetlands and vegetation paves the way for cross-realm assessments and plans.

First map of marine ecosystem types for the sub-Antarctic territory: Marine ecosystems surrounding the PEIs have been classified and mapped, allowing for the inclusion of South Africa's sub-Antarctic territory in the NBA for the first time.

Adoption of the IUCN Red List of Ecosystems assessment framework for terrestrial, marine and estuarine realms: A new approach to ecosystem assessment has been followed for terrestrial, marine and estuarine ecosystem types using the recently released IUCN RLE framework and guidelines. The adoption of a global standard (as for the species Red List assessments) strengthens international reporting and defensibility of assessments.

Species

New Red List assessments of species across all realms: The following taxonomic groups have been included in the species assessment of the NBA for the first time: sharks, corals, linefish (including all seabream species; members of the Sparidae), selected estuarine invertebrates and endemic fish, and dragonflies; greatly strengthening the utility of this indicator.

First Red List Index to track species threat status over time: Repeated Red List assessments of selected taxa have allowed for the computation of the IUCN Red List Index for the first time for reptiles, amphibians, mammals, birds, freshwater fishes, plants, dragonflies and butterflies.

Development of new indicator for species protection level: An innovative new indicator of species protection level, developed as part of the NBA, has been applied to selected terrestrial and inland aquatic taxa (including reptiles, amphibians, mammals, birds, freshwater fishes, plants and butterflies).

Other

First investigation of indicators of genetic diversity: New indicators to track and monitor the status of genetic diversity are being developed and can assist in identifying areas essential to the maintenance of genetic diversity over the landscape for target species.

A new Compendium of Benefits of Biodiversity: The NBA includes a comprehensive compendium of material on the benefits of biodiversity, providing crucial context and support for the technical assessment of the state of biodiversity.

A new indicator of the rate of habitat loss: Land cover change data (1990–2014) has made it possible to compute the rate of habitat loss for each terrestrial ecosystem type, leading to improved ecosystem assessments.

New trend analysis for protection level: Protected level time-series analyses have been made possible by development of the South African Protected Areas Database that tracks new declarations.

Part Two

Integrated Findings

This section brings together the findings from components of the NBA 2018 and presents them in an integrated fashion. The headline indicators are compared across realms and taxonomic groups, key pressures that affect all realms are highlighted, and genetic diversity – that applies to all realms and taxonomic groups – is addressed. Part 3 includes more detailed findings for each realm, the coast and the sub-Antarctic territory.

2.1 Maps of ecosystem types for all realms

As ecosystem types are the main unit of assessment for ecosystems, a key recommendation of the NBA 2011 was to improve the classification and mapping of ecosystems across all realms as part of the National Ecosystem Classification System. Realm-specific committees were set up or re-established to plan and guide ecosystem classification and mapping improvements for the NBA 2018.

The National Vegetation Committee released a new version of the map of terrestrial ecosystem types (VEGMAP), including a major update of the Albany Thicket biome classification scheme and map, improved delineation of the forest features in Limpopo and the Eastern Cape, and numerous other minor improvements.

The marine map and classification system were completely revised using a wide range of new data and a broad expert stakeholder engagement process led by the Marine Ecosystem Classification Committee and five task teams to support improvements in the coast, inclusion of bays and kelp forests, mapping of river-influenced ecosystems offshore, and improved reef, canyon and sediment mapping (Figure 20). For the first time the marine ecosystem types surrounding the PEI group were classified and mapped (Figure 4, p. 12).

The estuarine map saw extensive refinements in delineation of the Estuarine Functional Zone (EFZ) and estuarine habitats, and the classification system was completely revised.

Working with vegetation, marine and estuarine experts, the coastal team refined the delineation and updated

the classification scheme for seashore ecosystem types, allowing for the seamless integration of the marine, estuarine and terrestrial maps of ecosystem types

Box 1. Realm extent

The comparative total extent of each realm (km²) with the number of ecosystem types contributing in brackets. The coast is shown separately as it consists of terrestrial, marine and estuarine ecosystem types. The marine and terrestrial ecosystem types are shown together for the sub-Antarctic territory. Rivers are not shown as extent is measured as river length (total length 147 180 km, number of types 222).

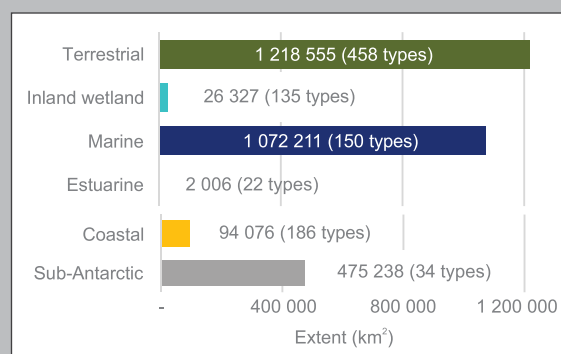


Figure 19. The extent of the terrestrial, inland wetland, marine and estuarine realms, the coast, and the Sub-Antarctic territory. The number of ecosystem types is shown in brackets.

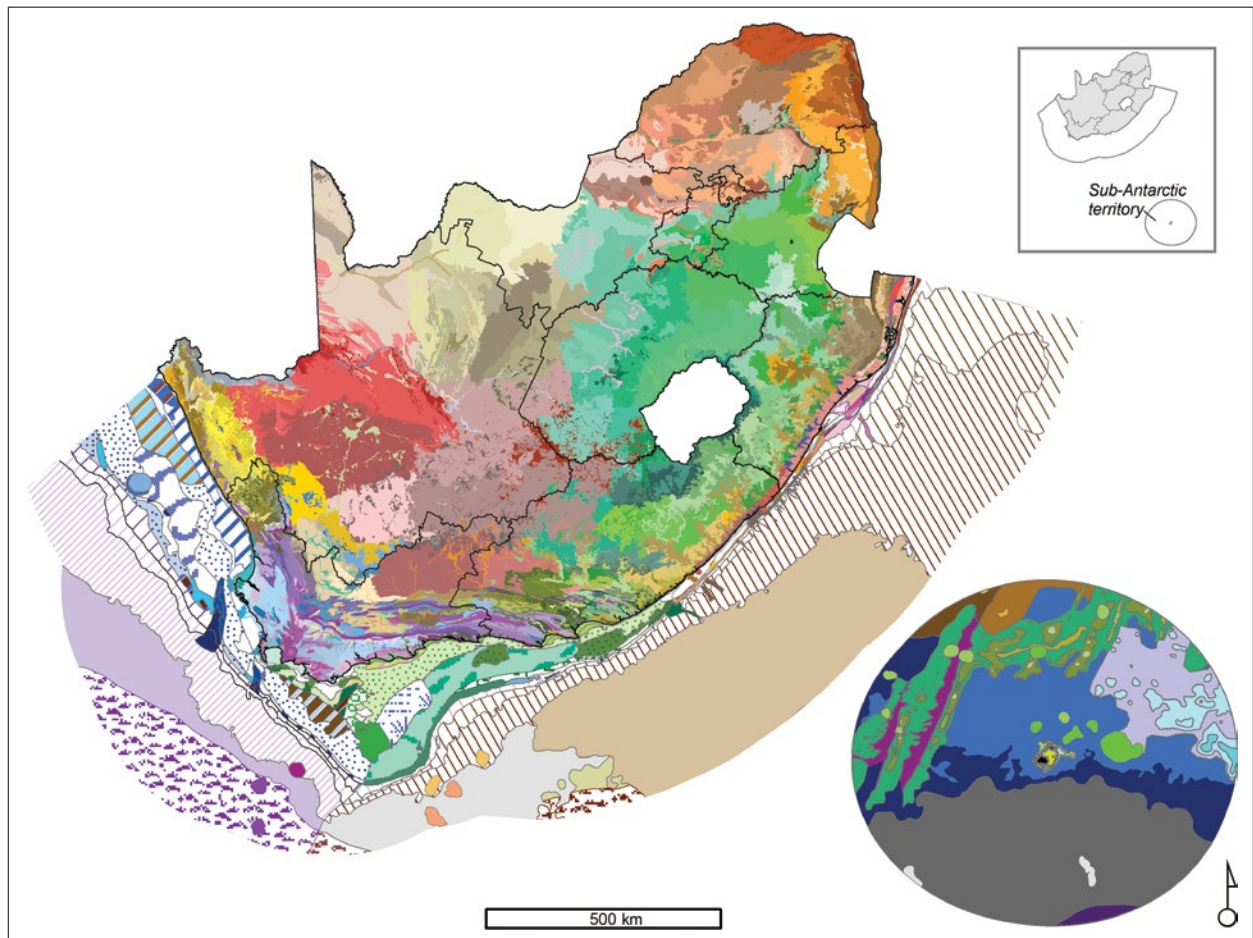


Figure 20. Seamless map of South Africa's terrestrial, marine and estuarine ecosystem types. Rivers, inland wetlands and vegetation types of the Prince Edward and Marion Islands are not shown due to the fine scale of the features. The maps and data can be found at <http://nba.sanbi.org.za/>.

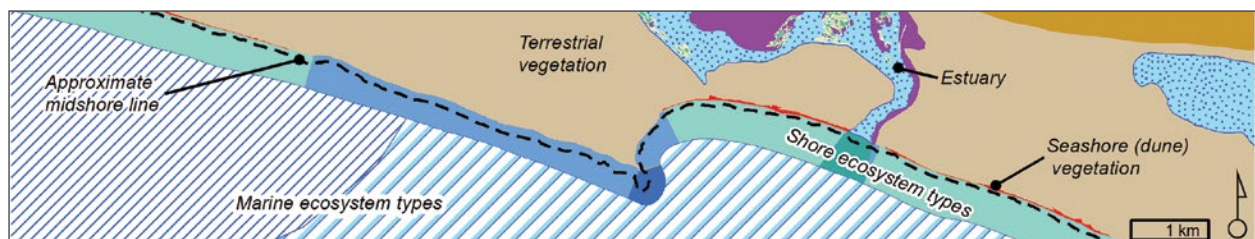


Figure 21. Zoomed-in portion of coastal ecosystem types, showing the high degree of integration. Ecosystem type maps for the terrestrial, marine and estuarine realms were integrated seamlessly through highly detailed mapping of shore ecosystem types.

(Figure 21). This is a major collaborative achievement that not only forms the foundation of the NBA, but also forms the basis for truly cross-realm spatial planning in coastal areas.

The Wetland Ecosystem Classification Committee oversaw major efforts from a wide range of collaborators to improve delineation of inland wetland features using the existing national classification system. This

mammoth task of accurately delineating thousands of small wetland features, using constantly evolving techniques, will continue for many years.

The river ecosystem classification and delineation is stable and remains largely the same as that used in the NBA 2011, although refinements to align with estuaries, the South African boundaries and data deficient systems have been incorporated.

2.2 Protected areas

A protected area is an area of land or sea that is formally protected by law and managed mainly for biodiversity conservation, while having many other benefits (Box 2). Understanding the extent and location of protected areas is a crucial component of the protection level indicators for both species and ecosystems.

The South African Protected Areas Database (SAPAD), maintained by Department of Environment, Forestry and Fisheries (DEFF) and released quarterly, formed the core of the protected area dataset used in this NBA. The database required various restructuring steps for use in the protection level analysis. Overlaps were resolved and inconsistencies between conservation agency data and SAPAD were investigated and resolved. The strength of this dataset is that it includes

designation dates and allows for time-series protection analysis; while a limitation of the dataset is that many of the privately owned nature reserves declared prior to publication of the Biodiversity Act have yet to be validated.

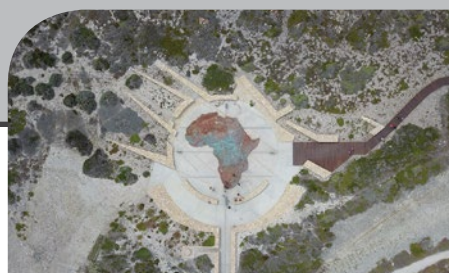
The terrestrial protected area estate has grown steadily over the last 30 years, with stewardship replacing state purchase as the principal expansion mechanism. More than 8% of South Africa's landmass now falls within a protected area (as defined by the Protected Areas Act) (Figure 22A & Figure 23B). The terrestrial protected area network is increasingly representative of the full range of ecosystem types, and overall ecosystem protection levels are improving. Three-quarters of the terrestrial types, half of inland aquatic types and all but three estuarine ecosystem types

Box 2. The benefits of protected areas

Protected areas are portions of the land or seascape that are formally protected by law with the primary purpose of biodiversity conservation – i.e. protecting ecosystem types, species and genetic diversity. Protected areas are a source of pride for South Africans as national icons that support biodiversity and as significant tourist destinations that benefit the economy. They serve as a refuge for species to live in and reproduce, which is crucially important for threatened or rare species and species that are harvested such as fishes and medicinal plants. As vast areas of ecological infrastructure, they provide services such as carbon sequestration, cleaning water and mitigating against natural disasters such as floods and drought. Protected areas are vital to the local economy, as they are important employers, and the land on their borders often becomes very valuable and a hive of economic activity due to tourist routes to and from the parks. Some protected areas allow certain types of use (e.g. grazing, fishing, harvesting useful plants) if managed appropriately. Ultimately, protected areas are havens for people to experience nature in its true form, allowing for many spiritual, cultural, educational and recreational benefits. This web of associations with biodiversity is an important part of South Africans' national identity and heritage.



South Africa's protected areas are some of our most important tourist attractions and bring substantial international revenue to the country. The iconic Map of Africa Monument, celebrating Agulhas being the southern-most tip of Africa, was unveiled in Agulhas National Park in March 2019. The monument is hand-sculpted out of concrete and is a 3D relief map of Africa that visitors are encouraged to walk on to explore the continent. Protected areas are valuable outdoor classrooms as well as tourist attractions. © Eugene Mitchell, Agulhas National Park.



have some degree of representation in the protected area network. The gap between the solid and dotted lines in Figure 23A indicates that many ecosystems remain under-represented.

The MPA network has expanded considerably as a result of the Operation Phakisa Oceans Economy MPA Initiative and ongoing efforts in the sector. The careful planning processes followed have resulted in a highly efficient MPA network with high ecosystem representation, with 87% of marine ecosystem types represented in a MPA network covering just over 5%

of the ocean area (Figure 22A & Figure 23B). Despite this spatial efficiency, the new MPA network still falls short of the Aichi biodiversity target (10%). South Africa's sub-Antarctic territory (PEI and surrounding Exclusive Economic Zone – EEZ) are well covered by protected areas. Marion Island and PEI were proclaimed as a Special Nature Reserve in 1995, and in 2013 a large MPA was proclaimed covering 35% of the ocean area surrounding the islands (Figure 22B & Figure 23C). Considered together, almost 90% of the terrestrial and marine ecosystem types in and around PEI are represented in the protected area network.

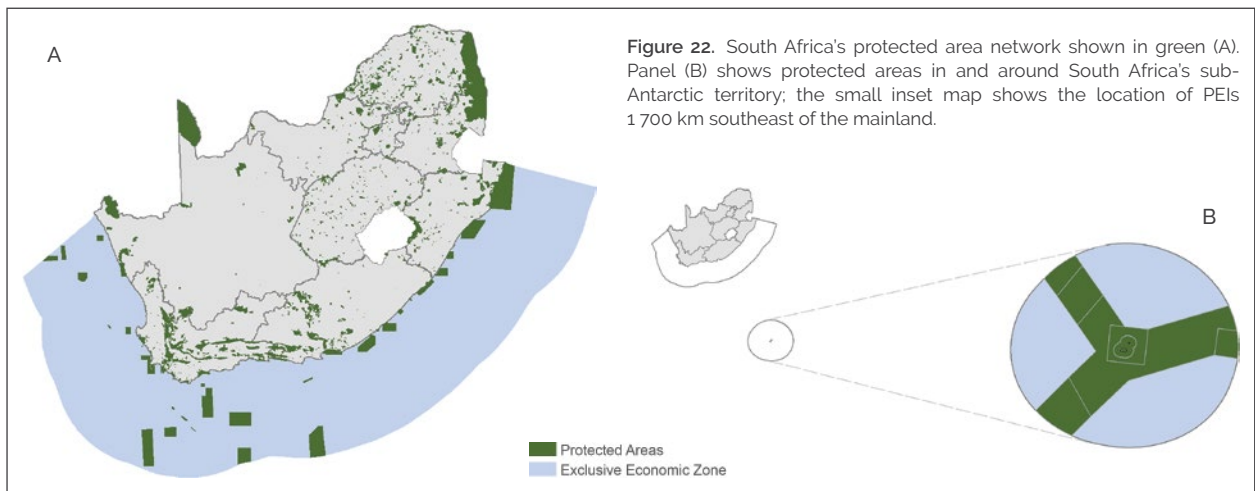


Figure 22. South Africa's protected area network shown in green (A). Panel (B) shows protected areas in and around South Africa's sub-Antarctic territory; the small inset map shows the location of PEIs 1700 km southeast of the mainland.

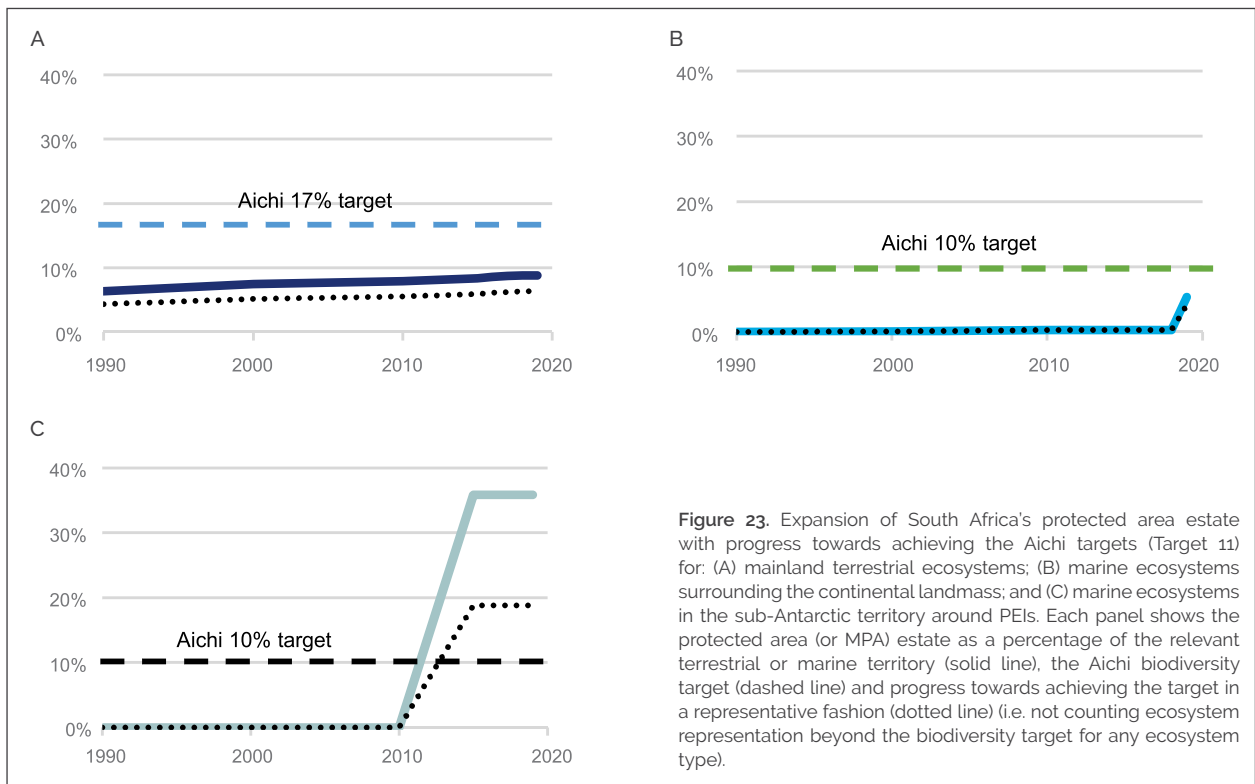


Figure 23. Expansion of South Africa's protected area estate with progress towards achieving the Aichi targets (Target 11) for: (A) mainland terrestrial ecosystems; (B) marine ecosystems surrounding the continental landmass; and (C) marine ecosystems in the sub-Antarctic territory around PEIs. Each panel shows the protected area (or MPA) estate as a percentage of the relevant terrestrial or marine territory (solid line), the Aichi biodiversity target (dashed line) and progress towards achieving the target in a representative fashion (dotted line) (i.e. not counting ecosystem representation beyond the biodiversity target for any ecosystem type).

2.3 Pressures across realms

The International Union for the Conservation of Nature (IUCN) proposes a threats classification scheme with a hierarchical structure for various pressures on biodiversity. The NBA 2018 adopted this approach with some minor language adaptations and the resulting pressure plots are used throughout the NBA 2018 reports. The species plots were based on a meta-analysis of species Red List assessments (which document pressures on each species) and the cross-realm plot was informed by the species meta-analysis and expert inputs.

Changes in hydrological regime and **poor water quality** are the major pressures on biodiversity in inland aquatic, estuarine, many coastal and selected terrestrial ecosystems (Figure 24). The over-abstraction of water and building of dams (primarily for crops, human settlements and mining) result in direct negative impacts on species and ecosystems, and indirect impacts through the disruption of important

ecological processes such as sediment supply. Pollution of inland aquatic ecosystems from a combination of acid mine drainage, mining, industrial and urban waste water, as well as agricultural return flows, negatively impact water quality. When combined with flow regime changes, pollution represents a major additional pressure on inland aquatic, estuarine and coastal biodiversity.

In contrast, the primary pressure in the terrestrial realm is **habitat loss** as a result of land clearing for croplands, plantation forestry, human settlements and

The **hydrological regime** (also referred to as **flow regime**) includes all aspects relating to the flow of water, including: magnitude, frequency, duration, predictability and flashiness.

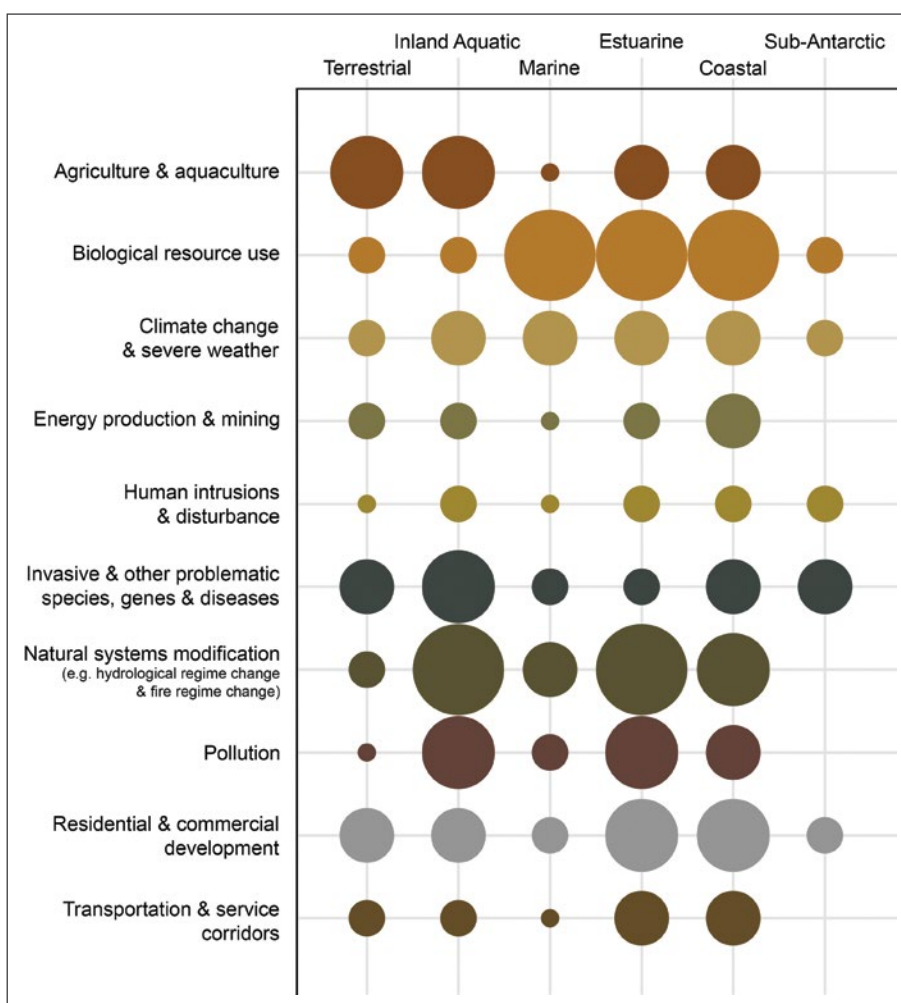


Figure 24. The key pressures on biodiversity in each realm, based on a meta-analysis of the threatened species database and expert opinion. The size of the bubbles indicates the relative importance of each pressure class.



Eutrophication of the lower reaches of the Orange River. Excessive nutrients in the water resulting from pollution cause algal blooms that turn the water green. The Orange River is a hardworking river, draining nearly 60% of the surface area of South Africa. Extensive reaches of the river are considered to be in a poor ecological condition. © Lindie Smith-Adao.

mining (Figure 24). Agriculture, which includes cultivation for crops and plantation forestry, significantly impacts on all the terrestrial and freshwater species groups assessed to date (Figure 25).

Overutilisation of rangelands, which results in loss of shrub and herbaceous cover and leads to increased erosion, is a direct pressure to terrestrial species and ecosystems and an indirect pressure on inland aquatic ecosystems. In the estuarine and marine realms, and in coastal areas, the **unsustainable use of biological**

The unsustainable harvesting of biological resources like fish is a key pressure in the coast, estuaries and the marine realm. Highly-utilised terrestrial species include medicinal plants and species like cycads and reptiles, which are traded, as they have high value. © Peter Chadwick.



Habitat loss from the clearing of land for croplands, forestry and residential/commercial development is the primary pressure on the terrestrial realm and the coast. © Oswald Kurten.



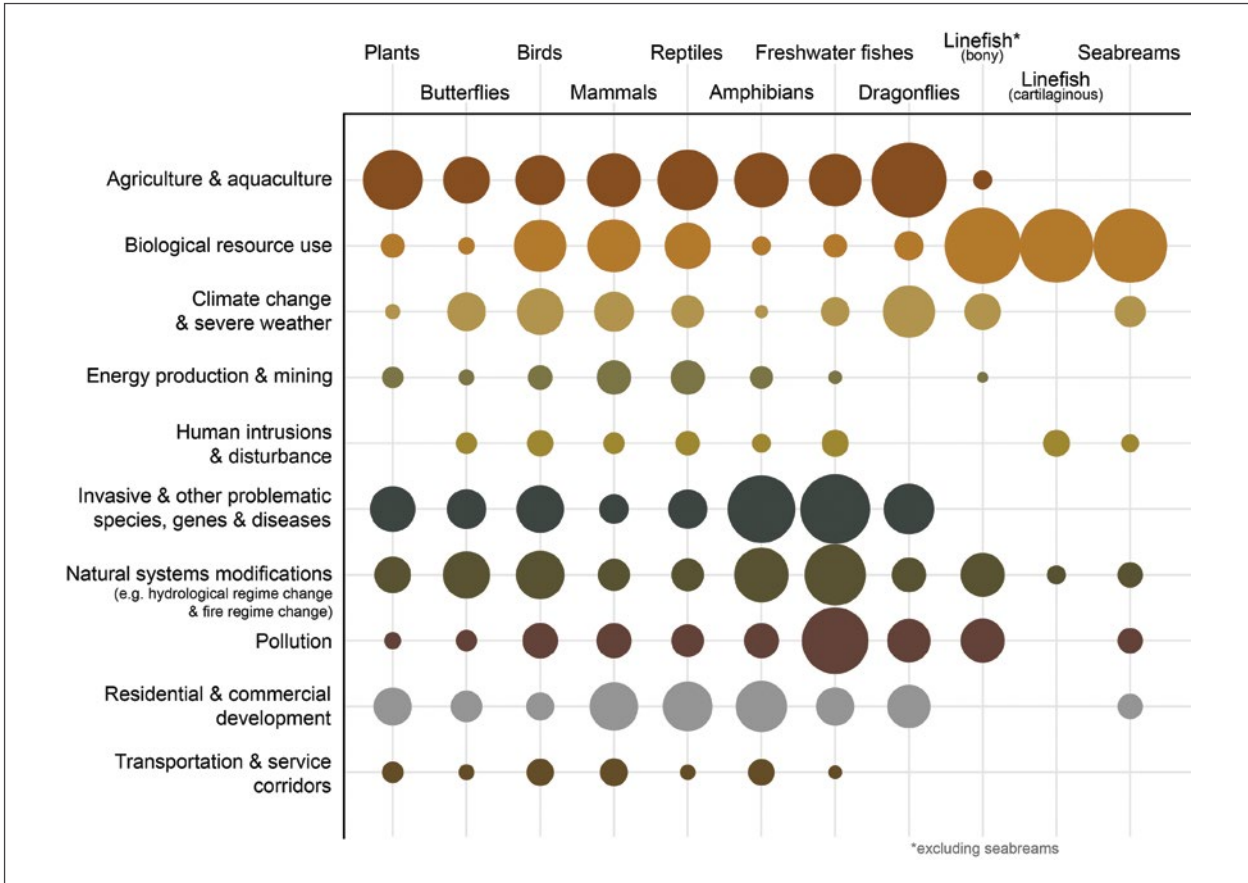


Figure 25. The key pressures for Taxa of Conservation Concern (ToCC) based on a meta-analysis of the South African Species Red List Database. The size of the bubble corresponds to the percentage of ToCC in the taxonomic group that is subject to each pressure. The pressures categories follow the IUCN threat classification system.

resources (in this case overfishing of key species) is a significant pressure on biodiversity (Figure 24).

Changes to fire regimes linked to management imperatives, climate (drought events and high winds) and an increase in fuel loads from invasive plants are important natural system modifications in the terrestrial realm that have a detrimental impact on biodiversity. Species that have evolved special adaptations to survive fire, such as certain lycaenid butterflies and Fynbos plants, struggle to cope with fires that have increased intensity and occur more frequently than in the past.

Biological invasions impact all realms, with predatory alien fishes substantially impacting indigenous fish species in rivers (Figure 25). A wide range of woody invasive plant species impact riverine areas, wetlands and mountain catchments in particular and cause severe declines to South Africa’s indigenous plants and amphibians (Figure 25 & Box 3).

Mining typically does not have the same footprint as other pressures in terms of area, but is an intense form of pressure on biodiversity, with long-term

direct and indirect impacts on species and ecosystems. South Africa’s mineral wealth is comparable to its outstanding biodiversity; to make the most of these resources, careful spatial planning, monitoring

Mining, although very localised, is intense – and sometimes has indirect impacts like pollution downstream.
© Lara Atkinson.





Invasive species are a growing problem in the marine realm. A total of 96 introduced marine species have been reported, of which 55 are invasive. This Japanese Skeleton Shrimp (*Caprella mutica*) is a new invasive species linked to yachting. © Charles Griffiths.

Box 3. Biological invasions

Biological invasions represent a major threat to biodiversity. Many species have been transported by humans (either accidentally or intentionally) to areas where they are not naturally present, and on reaching such areas, some species have become invasive and have spread across natural ecosystems, threatening indigenous biodiversity and reducing the ability of ecosystems to deliver vital services. These biological invasions often have direct negative impacts on the wellbeing of many people, and in particular threaten rural livelihoods.

SANBI, in collaboration with the DST–NRF Centre of Excellence for Invasion Biology at Stellenbosch University, recently published South Africa's first national report on the status of invasive species. The report is the first such country-level assessment anywhere in the world that focuses specifically on biological invasions. The report is structured around four aspects: pathways of introduction and dispersal; the number, distribution and impact of individual species; species richness and abundance of alien species in defined areas; and their impact in those areas and the effectiveness of interventions – how effective the regulations and control measures are in reducing the problem.

The report finds that the rate of introduction of species is increasing, in line with increases in travel and trade, and currently stands at seven new species per year. Of the 2 034 alien species known to have established populations outside of cultivation or captivity, over a third (775) have become invasive. Of these, 107 have caused severe negative impacts on the environment, affecting 80 000 km², and on human wellbeing. For example, woody plant invasions in Western Cape mountain catchment areas directly threaten Fynbos biodiversity and disrupt hydrological process that underpin water delivery to agricultural and urban users.

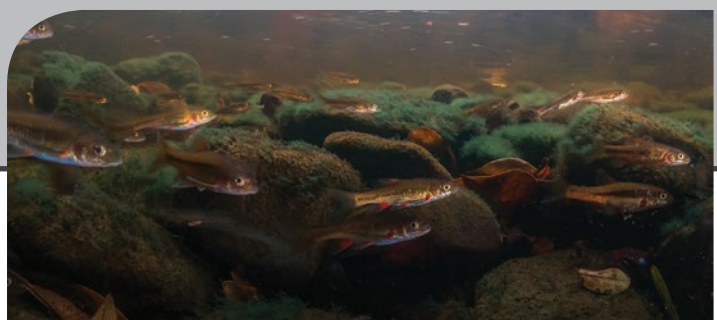


The expansion of woody invasive plants is having a substantial impact on South Africa's biodiversity. Competition from invasive species is the leading pressure that has resulted in plant species becoming more threatened since the last assessment. Nearly 80% of amphibian taxa of conservation concern are impacted by invasive alien plants modifying their habitats. Shown here is the expansion of pines into the unique Fynbos habitat and breeding area for the Critically Endangered Rough Moss Frog (*Arthroleptella rugosa*) on the Caledon Swartberg Mountains. © Andrew Turner.

The negative impacts of invasive species on biodiversity are felt in all realms, but are considered to be most severe in the terrestrial and inland aquatic realms, evidenced by the fact that invasive species emerged as the leading pressure to indigenous amphibians and freshwater fishes in the comprehensive species assessments undertaken for the NBA 2018 (Figure 25). In addition, invasive species were the primary driver of species being listed in higher categories of threat during this assessment period for plants, butterflies, freshwater fishes and amphibians.

Our understanding of the current extent and severity of invasions, the impacts of the invasions on biodiversity, and how to predict and prevent further invasions is not adequate. Focussed monitoring of invasive species introduction pathways, distribution and abundance is urgently required to better predict, understand and manage biological invasions.

A total of 81% of South Africa's freshwater fishes of conservation concern are threatened by non-native invasive fishes. Shown here is the Gamtoos River Redfin (*Pseudobarbus swartzii*), which has lost much of its range due to predation by Black Bass species (*Microp-terus* spp.) and the African Sharptooth Catfish (*Clarias gariepinus*). © Jeremy Shelton.



Box 4. Climate change

Negative impacts of climate change on biodiversity and ecosystem function have now been observed in all realms (Figure 24 & Figure 25). Unmitigated, climate change is likely to cause significant changes in South Africa's ecosystem structure and functioning by as early as mid-century, and to result in significant losses in biodiversity in the latter half of this century. In addition to acting as a direct driver of species loss and habitat degradation, climate change multiplies other pressures on biodiversity, both exacerbating the effects of other pressures and altering the frequency, intensity and timing of events. The various pressures described above can also leave species and ecosystems more susceptible to climate change and extreme events.

Climate change is already triggering large-scale spatial, temporal and compositional shifts in biodiversity. Species' population-level changes are being translated into community-level reorganisations, and even regime shifts (e.g. bush encroachment), which can impair ecological function. Over the last few decades these changes have been noted in South African ecosystems from estuaries, coral communities, open savannas to montane streams, exerting pressure either directly or indirectly on all species within these habitats. Climate change is a key threat to sub-Antarctic ecosystems; mean annual air and sea temperatures have increased at twice the mean global rate at our Prince Edward Islands.

Climate risk assessments are becoming better supported by species and ecosystem data, spatial climate data and improved impacts models in the terrestrial realm. High resolution impact models in the marine, freshwater and estuarine realms are either less developed or have not been as widely applied. Lack of sufficient data on observed biological responses to climate change and interacting pressures reduces the potential to test modelled projections, and thus determine key thresholds with confidence.

Since understanding the nature and mechanisms of climate change impacts are essential for developing plans to mitigate them, South Africa needs a deliberate, coherent strategy for detecting and tracking climate change impacts on biodiversity. Preserving intact ecosystems and species populations, maintaining connectivity and ameliorating compounding anthropogenic stressors are vital for preserving adaptive capacity across all realms and in both our mainland and sub-Antarctic territories. Intact biodiversity supports ecosystem functioning and can increase resilience to climate change impacts in both natural and managed systems, with significant benefits for people under all likely climate scenarios this century.



The Cape Rockjumper (*Chaetops frenatus*) is listed as Near Threatened, and its range is shrinking from climate change. © Logan Kahle.



Coral bleaching is a visible impact of climate change, as the corals whiten as water temperature rises. Monitoring coral bleaching is important to detect, understand, predict and cope with climate change impacts. © Kerry Sink.

Taxa of Conservation Concern (ToCC) are species and subspecies that are important for South Africa's conservation decision making processes. They include all taxa that are assessed according the IUCN Red List criteria as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Data Deficient (DD) or Near Threatened (NT). Detailed information on the pressures impacting these taxa has been captured during the Red List assessment processes. Throughout the NBA, reference to the impact of a particular pressure on a taxonomic group is determined from the proportion of ToCC impacted by that pressure.

and management of mining operations are essential to avoid and mitigate the worst of the impacts.

Climate change is a documented threat across all realms, and also amplifies other pressures such as competition with invasive species, disease, habitat loss and habitat degradation (Box 4). Though impacts

of climate change on biodiversity are best understood in the terrestrial realm, coastal and estuarine ecosystems are particularly at risk from extreme weather events, especially where human settlements limit the natural resilience of these ecosystems by encroaching into dune systems and the Estuarine Functional Zone.

2.4 Ecological condition across realms

Ecological condition is estimated using a range of different approaches across the realms, but essentially depends on the ability to spatially represent the various pressures exerted on biodiversity. Ecological condition in the terrestrial realm relies primarily on land cover change data; cumulative pressure mapping is used in the marine realm; and a multi-criteria ecological

condition framework is used in the estuarine and inland aquatic realms. The different systems were aligned as far as possible in the NBA to allow for cross-realm comparisons and unified terminology (Table 2).

The marine and terrestrial realms are similar in terms of their relatively high percentage of natural/near-natural

Table 2. The ecological condition categories used in the NBA, showing the original Department of Water and Sanitation framework (Present Ecological State [PES] categories using the letters A to F) applied to rivers, inland wetlands and estuaries and the IUCN Red List of Ecosystems approach of percentage degradation of ecosystems or percentage disruption of biotic processes

Department of Water and Sanitation (DWS) ecological condition	A	B	C	D	E	F
	Natural	Largely natural	Moderately modified	Largely modified	Highly degraded	Extremely degraded
IUCN RLE ecosystem degradation categories	Natural or near-natural (<50% degr.)		Moderately degraded (50–70% degr.)	Severely degraded (70–90% degr.)		Very severely degraded (>90% degr.)
NBA ecological condition categories	Natural	Near-natural	Moderately modified	Heavily modified	Severely modified	Critically modified

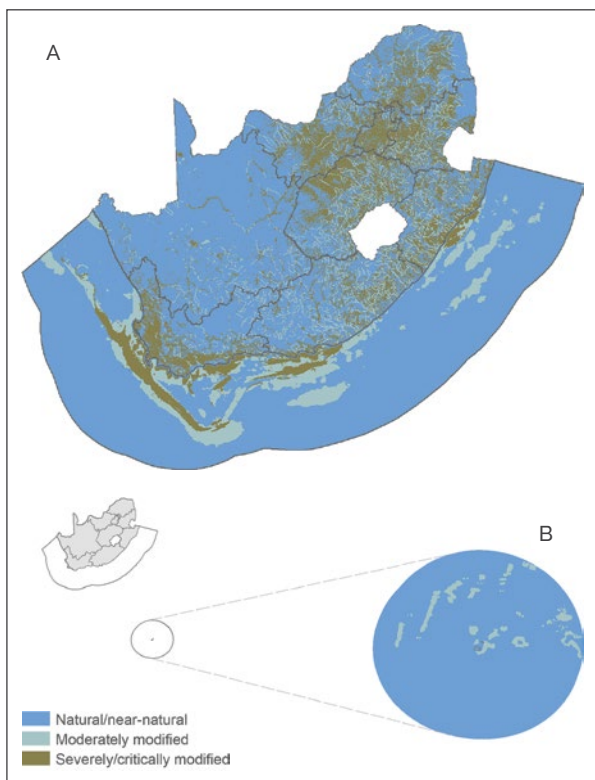


Figure 26. Ecological condition map of South Africa (A). Panel (B) shows the ecological condition around South Africa's sub-Antarctic territories.

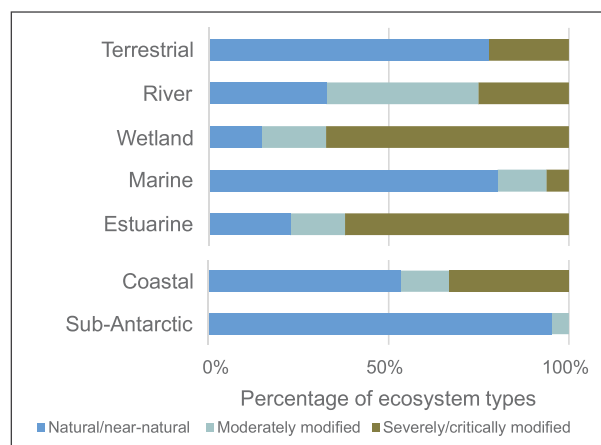


Figure 27. Relative extent of simplified ecological condition classes.

ecosystem extent ($\pm 80\%$). In these extensive realms (Box 1), ecosystem modification tends to be focussed in pressure hotspots, usually linked to regional characteristics such as high productivity, accessibility and valuable natural resources (Figure 26); while large areas remain relatively unmodified or intact. For example, the Cape lowlands have extensive winter field crops while the mountainous areas of the Cape see far less intensive agriculture; all bay ecosystem types, the shelf edge and the KwaZulu-Natal Bight are subject to multiple pressures while many deep sea ecosystems

beyond the shelf have yet to see extensive modification. In stark contrast, inland wetlands, rivers and estuaries are predominantly heavily modified or worse, and are in poor condition. These realms are geographically constrained and pressures tend to concentrate. Only 11% of estuarine area, 15% of inland wetland area and 33% of river length are considered to be in natural/near-natural condition (Figure 27). Coastal biodiversity is also under particularly high pressure and only half of the ecologically determined coastal zone remains in a natural/near-natural condition.

2.5 Threat status across realms

Ecosystem threat status

The IUCN Red List of Ecosystems framework uses the concept of ecosystem collapse as the end point for ecosystem decline. Each ecosystem is categorised according to its risk of collapse, based on quantitative thresholds for rate and extent of decline. Ecosystem threat status is an indicator of the degree to which ecosystems are still intact or alternatively losing vital aspects of their structure, function or composition. Ecosystem types are categorised as Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Least Concern (LC), based on quantitative criteria and thresholds linked to ecosystem extent and condition.

Inland wetland, river and estuarine ecosystems have very high levels of threat. In these realms, both the majority of the ecosystem types and the majority of ecosystem extent are threatened. Rivers and inland wetlands have the highest proportion of types in the Critically Endangered category; 42% and 61% respectively. Estuaries have the highest overall proportion of threatened ecosystem types (86%), followed by inland wetlands (79%) and rivers (64%) (Figure 28).

Ecosystem types and species are referred to as **'threatened'** when they have been categorised as Critically Endangered, Endangered or Vulnerable.

This reflects the generally poor ecological condition of inland aquatic and estuarine ecosystems, which are subject to a wide array of compounding pressures, of which the increasing disruptions to the hydrological regime and deteriorating water quality are most concerning. In contrast, a relatively large proportion of marine and terrestrial ecosystem types are listed as Least Concern (i.e. not threatened) (Figure 28). This is due to: i) relatively low pressures on some ecosystem types (e.g. remote mountainous or abyssal ecosystem types); and ii) the potential underestimation of pressures on particular ecosystem types (e.g. marine pelagic fishing and grazing pressures in the rangelands). The ecosystem threat status assessments will be updated regularly as new information and methods on risks of ecosystem collapse are applied in future assessments.

Considering extent, threatened ecosystems have a relatively small footprint in the terrestrial and marine realms (Figure 28B). This can be partly explained by the fact that in the IUCN RLE framework, ecosystem types of limited extent are generally considered to be at higher risk of collapse than large widespread types. In the marine realm, the larger remote offshore ecosystem types are generally less threatened than the smaller inshore ecosystem types; in the terrestrial realm the large ecosystem types of the Nama-Karoo are less threatened than the many small types in the Fynbos biome (Figure 29A). The Eastern Cape estuaries (specifically those along the Wild Coast) are less threatened than those on the Cape west coast and northern KwaZulu-Natal (Figure 29F),

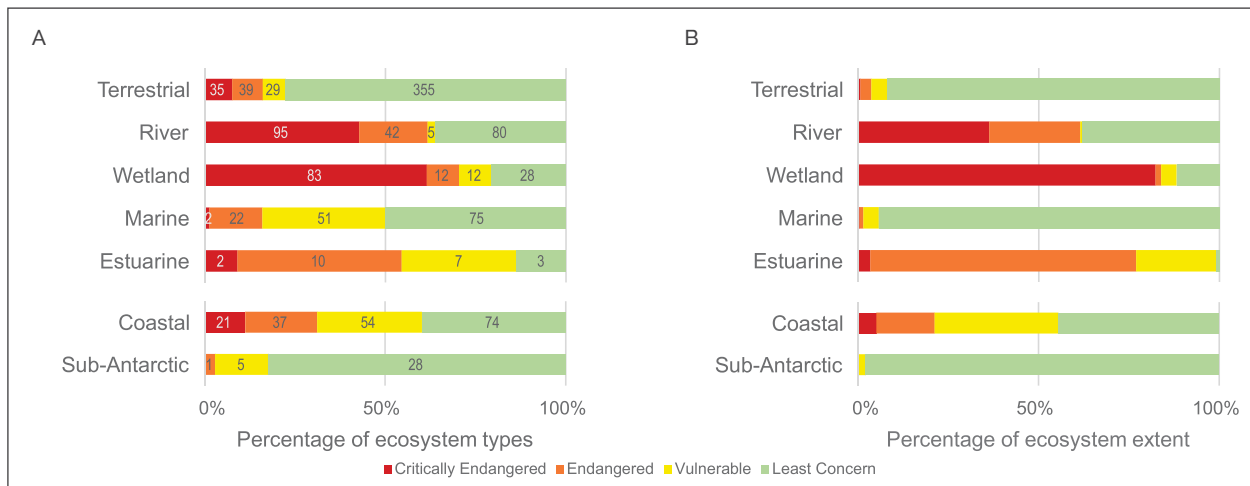


Figure 28. (A) Percentage of ecosystem types in each threat status category in each realm, and (B) the percentage extent of ecosystems in each threat status category in each realm (note for rivers, length is used as the unit of extent, for all other realms area is used).

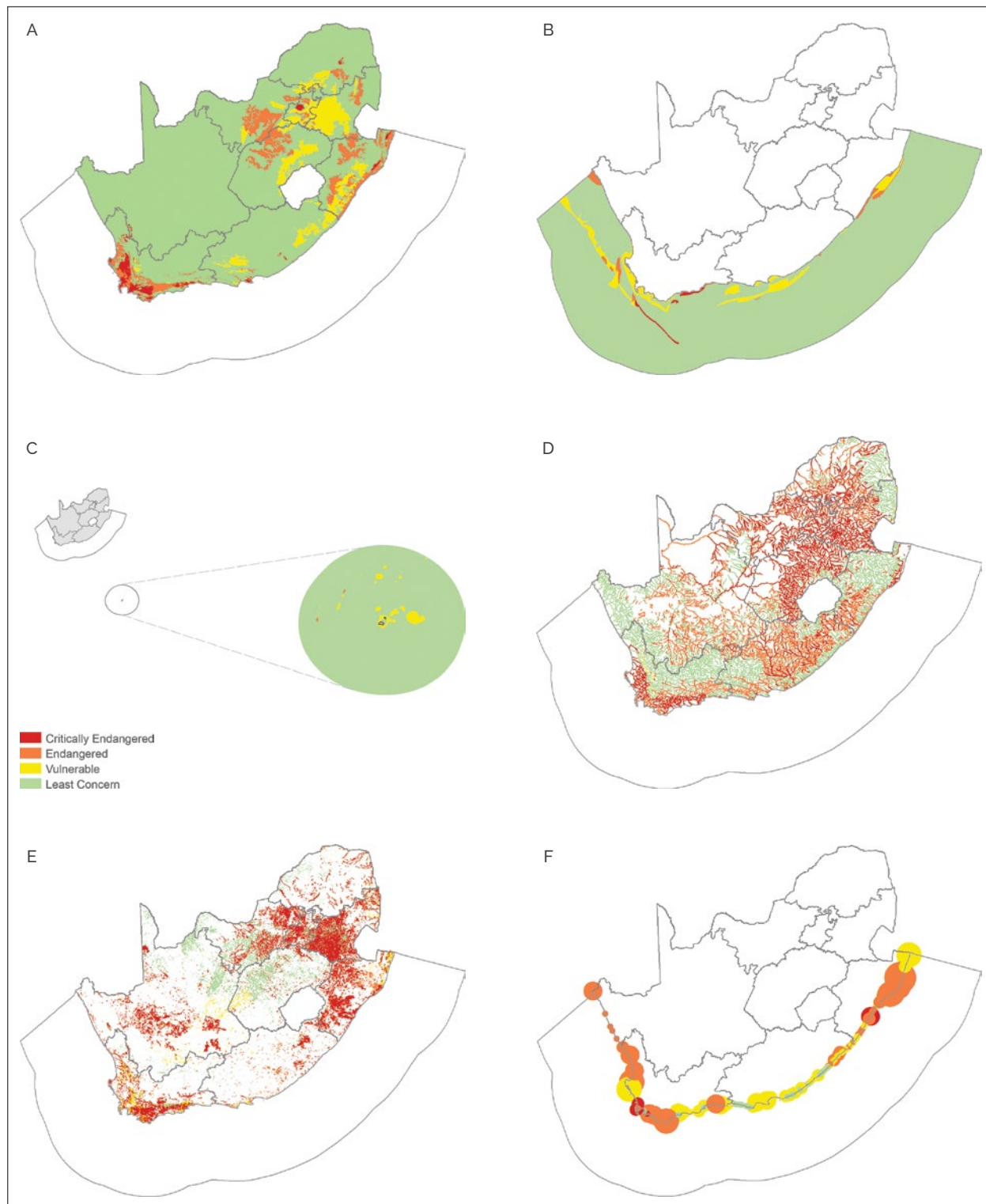


Figure 29. Spatial distribution of threatened ecosystems for each realm: (A) terrestrial, (B) marine, (C) sub-Antarctic territory including the PEIs and surrounding seas, (D) river, (E) inland wetland, (F) estuarine (since the actual estuaries are not visible at the map scale used, circles, scaled to the extent of each estuary, are used).

reflecting the condition of their catchments. The rivers of northern KwaZulu-Natal, the Lowveld and the Succulent Karoo areas are generally less threatened than other regions of the country (Figure 29D). The inland wetlands of the interior Highveld, along the escarpment and the southwestern Cape are the

most threatened (Figure 29E). In the marine realm, the Southern Benguela ecoregion has more threatened ecosystems than the Agulhas ecoregion, and most of the threatened ecosystem types in the Natal-Delagoa ecoregion are found in the KwaZulu-Natal Bight (Figure 29B).

Species threat status

South Africa has assessed the threat status of 23 312 indigenous taxa from 11 taxonomic groups using the IUCN Red List of Species categories and criteria. This is an objective system that can be consistently applied across a range of taxonomic groups. The quantitative criteria are based on scientific studies of populations of a range of different species and the biological conditions under which they are highly likely to go extinct. The quantitative nature of the system demands that assessments are justified by supporting data. While no modifications were made to the IUCN categories and criteria, we did augment the system by adding a category for rarity – defined here as including range-restricted endemic species that have a global extent of occurrence of less than 500 km² occurring where there are no anthropogenic pressures. Such species qualify as Least Concern under the IUCN system, but are priorities for inclusion in national conservation interventions.

A **taxon** (plural **taxa**) is any unit used in the science of biological classification (taxonomy). Some species have been split into subspecies and/or varieties, and were assessed at these levels. Consequently, if a taxonomic group includes subspecies or varieties, the summary statistics use the term 'taxa'. If a group contains only species, then the term 'species' is used in the summary statistics.

Of the assessed taxa, 0.2% are extinct (48 taxa) and a further 3 157 taxa are threatened with extinction (14%). South Africa has high levels of species endemism: 67% of plants, 53% of reptiles, 52% of butterflies, 50% of amphibians, 49% of freshwater fishes and 35% of seabreams. For all of these groups, levels of threat to endemic taxa are higher than for all indigenous taxa (Table 3). Twenty per cent of endemic taxa are threatened with extinction (2 911 taxa) and 0.3% have gone extinct (44 taxa).

The proportion of taxa that are threatened is remarkably similar across all realms (Figure 30). Estuaries have the highest proportion of threatened taxa (27%), which corresponds with the results of the ecosystem assessment. Nineteen per cent of taxa assessed for the marine realm are threatened. For both the marine and estuarine realm, there has been a focus on conducting assessments of economically important and charismatic species as opposed to conducting comprehensive assessments for full taxonomic groups. This is likely to have resulted in an overestimate of the proportion of threatened taxa. Species assessments in the marine realm are also limited by gaps in taxonomic knowledge, and the lack of information on species distribution, life histories and long-term population trends has resulted in high levels of data deficiency. For the inland aquatic and terrestrial realms full taxonomic groups have been assessed and there is higher confidence in the results. Approximately 17% of freshwater and 13% of terrestrial taxa assessed to date are threatened. The terrestrial realm has the highest numbers of species that have gone extinct (46 taxa).

Table 3. Status of all indigenous taxa assessed. NT is Near Threatened, DD is Data Deficient, FW is freshwater

Taxon	Birds	Mammals	Reptiles	Amphibians	Butterflies	Plants	FW fishes	Dragonflies	Seabreams	Linefish (bony)	Linefish (cartilaginous)	Corals
Extinct	0	5	2	0	3	36	0	2	0	0	0	0
Threatened	84	57	24	16	78	2 804	42	20	9	12	2	9
NT, DD, Rare	49	56	25	17	62	3 366	21	13	9	36	13	34
Least Concern	599	218	346	92	656	14 195	55	127	24	31	11	52
Total	732	336	397	125	799	20 401	118	162	42	79	26	95
Endemics	38	57	209	62	418	13 763	58	28	15	2	2	0
% Extinct	0%	1%	1%	0%	0.4%	0.2%	0%	1%	0%	0%	0%	0%
% Threatened all taxa	11%	17%	6%	13%	10%	14%	36%	13%	21%	13%	7%	9%
% Endemics	5%	17%	53%	50%	52%	67%	49%	17%	35%	3%	7%	0%
% Endemics threatened	24%	39%	7%	26%	18%	20%	66%	36%	33%	0%	0%	na

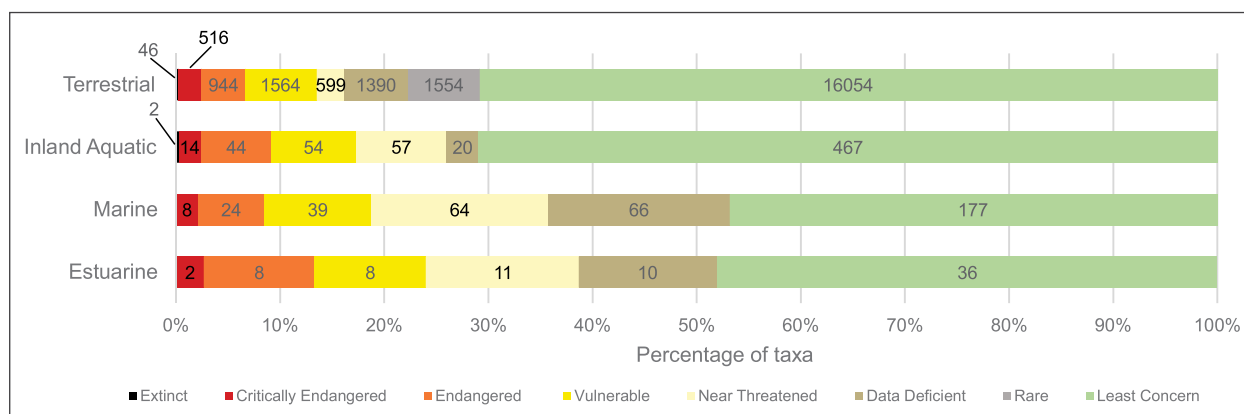


Figure 30. Species threat status across the realms with the bars representing percentage of species in each category and the labels show the number of taxa in each category.

Freshwater fishes are the most threatened taxonomic group, with 66% of endemic taxa threatened (Figure 31); a reflection of the poor ecological condition of South Africa's rivers. The pressures on freshwater fishes have resulted in several localised extinctions of populations, particularly those in the genera *Pseudobarbus*, *Cheilobarbus*, *Sedercypris*, *Sandelia* and *Galaxias*. However, active management interventions by conservation agencies, targeted at Critically Endangered species, have prevented any species extinctions taking place.

While the many fish species that are reliant on estuaries have not yet been comprehensively assessed, the species selected for inclusion are highly threatened. There is a particular concern regarding species endemic to estuaries, as all are listed as threatened due to a combination of pressures linked to water abstraction and flow regulation, pollution, overfishing (especially gillnetting), and predation by invasive species (Figure 31). Marine reptiles similarly have high proportions of threatened taxa. However, this group consists mostly of marine turtles that are extremely wide ranging, so many of the threats causing population declines are taking place outside of South Africa's waters. More than a third (37%) of South Africa's seabirds are threatened, higher than the threat levels for birds associated with other realms (Figure 31). The threat status of seabirds is primarily driven by fishing, including reduced seabird prey and historical incidental mortality, and invasive species.

In the terrestrial realm almost half of endemic mammals are threatened (Figure 31). While there are signs of progress with ten mammal taxa improving in status between 2004 and 2016, there is, unfortunately, still an overall decrease in the status of mammals with 13 taxa becoming more threatened during the same period. Of all groups assessed to date, plants have the absolute highest number of threatened taxa with

2 804 taxa (14%) threatened with extinction, the vast majority of which are endemics (2 722 taxa).

The trend in species status over time was measured using the globally recognised indicator the Red List Index (RLI). The RLI is calculated for specific groups of species based on genuine changes in Red List categories over time and indicates trends in the status for each group of species. The RLI value ranges from 0 to 1. The lower the value the faster the group of species is heading towards extinction – i.e. if the value is 1, all species are Least Concern and if the value is 0, all species are extinct. Accurately determining trends over the different time periods requires that assessments are back cast and that all information available at the later time period is taken into account for previous assessment periods. This ensures that taxonomic changes and new information do not unduly affect the index. The index was derived from information from all the comprehensively assessed taxonomic groups in South Africa (i.e. groups for which all member taxa were included in the assessment) that have been assessed more than once: plants, reptiles, birds, mammals, amphibians, freshwater fishes, dragonflies and butterflies.

The results indicate that species confined to rivers and inland wetlands are declining more rapidly than those that occur in terrestrial ecosystems. In particular, freshwater fishes and aquatic plants show the steepest decline in RLI (Figure 32). Conversely, some vertebrate groups do not show a strong decline in RLI. When considered across all realms, birds and reptiles are the least threatened of South Africa's vertebrate taxa. While mammals show relatively high levels of overall threat (Table 3), population declines for many species took place in the more distant past (18th and 19th century) and the RLI has remained relatively stable over the last 15 years (Figure 32). Butterflies show a steep RLI decline that is concerning, suggesting

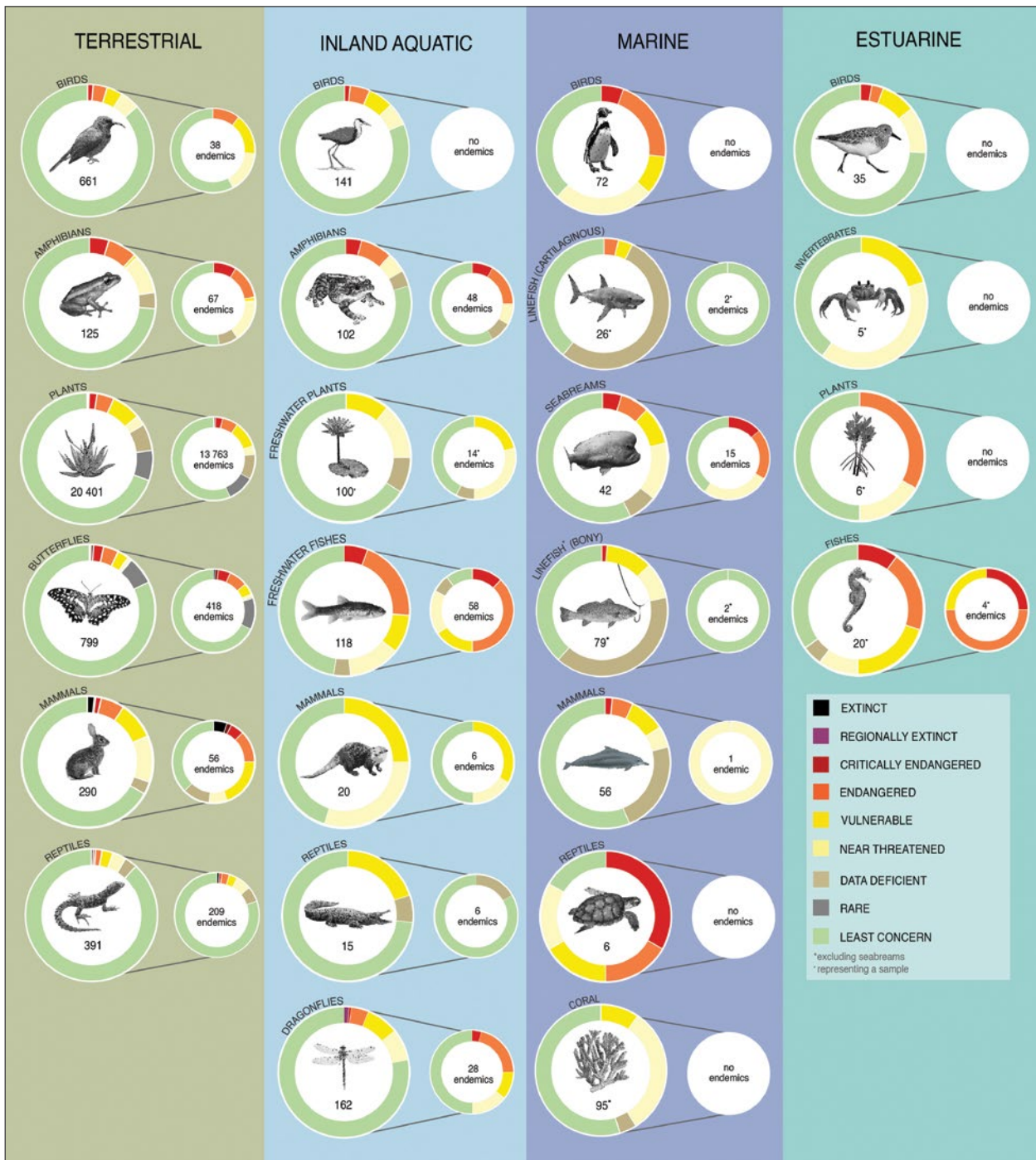


Figure 31. Threat status of South Africa's taxonomic groups, categories follow the IUCN 3.1 Red List categories and criteria with an additional national category of Rare added for range-restricted, localised endemics that are not declining. The proportion of species in each category is shown in the larger circle, and the proportion of endemic species per category is shown in the smaller circle. The total number of taxa per group is indicated in the interior of the circle.

there is a need to assess and monitor other groups of invertebrates, particularly given that many groups of invertebrates are thought to be in decline. The trend for butterflies could be a warning sign that invertebrate communities in general are heavily impacted.

Internationally, the Global IUCN Red List has been used to produce an aggregated RLI, based on multiple time-point assessments for birds, mammals,

amphibians, corals and cycads. The aggregated Global RLI is limited in scope, as only the few comprehensively assessed groups are included. The Global RLI was disaggregated for each country by weighting the contribution of each taxon based on the fraction of each taxon's distribution occurring within the country (Figure 33B). As a comparison, a national aggregated RLI was calculated for South Africa's plants, reptiles, birds, mammals, amphibians, freshwater fishes,

dragonflies and butterflies (Figure 33A). This national aggregated index (for 2018) was higher (0.899) than the estimate for South Africa based on the Global RLI (0.776). This discrepancy is, at least in part, due to the global estimate including only five taxonomic groups compared to the eight used in the national index. The RLI generated from the more comprehensive set of

national assessments should be considered a better estimate of the trends for South Africa's species.

To improve South Africa's national RLI, repeat assessments are required for taxonomic groups confined to the marine and estuarine realms, as there is currently a bias towards the terrestrial and inland aquatic realms.

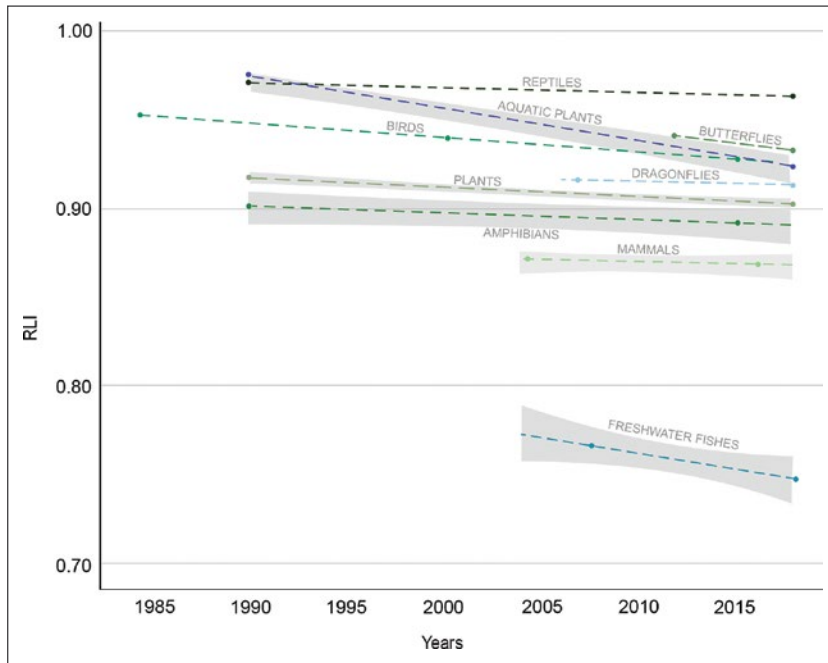


Figure 32. The Red List Index shows the trends in proportion of the taxon group at risk of extinction. The grey shading indicates uncertainty, which is strongly influenced by number of Data Deficient taxa within a taxonomic group (birds and dragonflies have no DD taxa). The slope of the line indicates the rate at which taxa within each group are becoming more threatened over time.

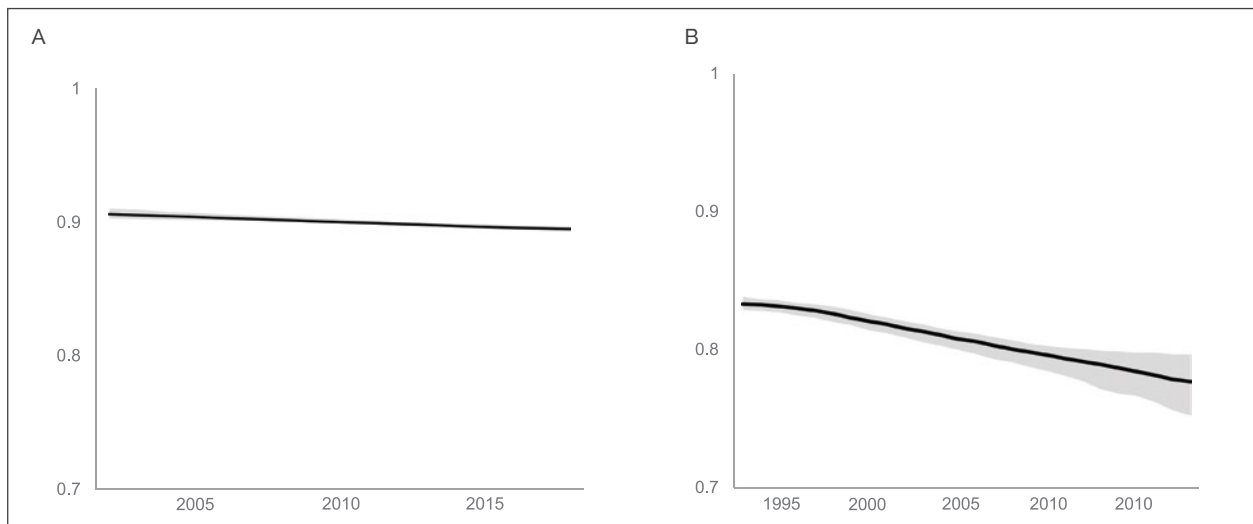


Figure 33. (A) South Africa's aggregated National Red List Index based on the eight taxonomic groups assessed; (B) global Red List Index disaggregated for South Africa (BirdLife International, IUCN and UNEP WCMC, 2018). The grey shading indicates uncertainty, which is strongly influenced by the number of Data Deficient taxa within a taxonomic group.

2.6 Protection level across realms

Ecosystem protection level

Ecosystem protection level is an indicator that tracks how well represented an ecosystem type is in the protected area network. It has been used as a headline indicator in national reporting in South Africa since 2005. It is computed by intersecting maps of ecosystem types and ecological condition with the map of protected areas. Ecosystem types are then categorised based on the proportion of the biodiversity target for each ecosystem type that is included in one or more protected areas. For terrestrial ecosystems, biodiversity targets were set for each ecosystem type using established species–area accumulation curves (ranging between 16 and 34%). For the other realms, species accumulation curves have not yet been estimated and a protection target of 20% was applied to each ecosystem type used. The categories for protection level are Well Protected (WP) where the extent protected exceeds the biodiversity target; Moderately Protected (MP) where the extent protected is between 50 and 99% of the target; Poorly Protected (PP) where the extent protected is between 5 and 49% of the target; and Not Protected (NP) where the extent protected is less than 5% of the target.

Inland wetlands have the lowest overall level of ecosystem protection of any realm, with over 60% of ecosystem types categorised as Not Protected and fewer than 10% of ecosystem types in the Well Protected and Moderately Protected categories

Under-protected ecosystem types and species are those categorised as Not Protected, Poorly Protected and Moderately Protected in the protection level assessment.

(Figure 34A & B). This is largely a result of their poor ecological condition. Rivers have comparable levels of protection to the terrestrial realm with more than half the ecosystem types having some form of protection (Figure 34). A high proportion of estuarine ecosystem types have some form of protection, but very few are considered Well Protected. Protecting estuaries is challenging given the range of pressures that can impact on them directly and on their catchment areas. Marine protection has improved dramatically in 2018/2019 with the declaration of 20 new MPAs – this translates into higher levels of protection within the marine realm when compared to the terrestrial realm. The marine realm has a small number of large ecosystem types that are under-protected (Figure 35) – this results in a difference between Figure 34A (% of types) and Figure 34B (% of extent).

The spatial patterns of protection level track the protected area network, with the terrestrial ecosystem types around large national parks (e.g. Kruger National Park in the northeast of the country) being best protected (Figure 35). Under-protected regions on the mainland include the grasslands of the Free State, Steytlerville Karoo region in the western parts

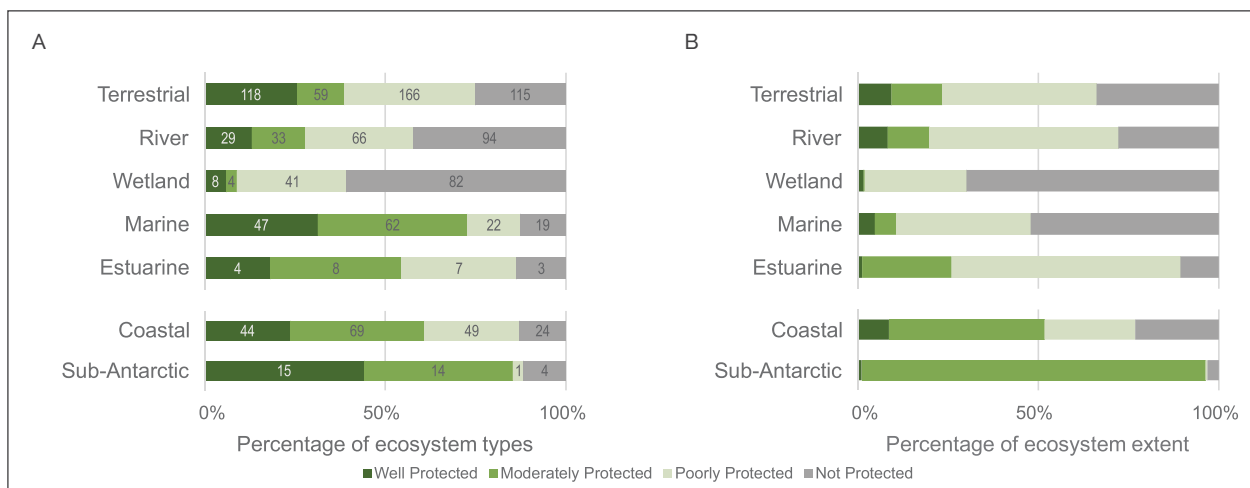


Figure 34. (A) The percentage of ecosystem types in each protection level category in each realm; (B) the percentage extent in each category in each realm (for rivers length is used as the unit of extent, for all other realms area is used).

of the Eastern Cape, the northern grassland areas of the Eastern Cape and the Northern Cape interior including Bushmanland and the northern Namaqualand coast. Other gaps in the protected area network are evident in the offshore eastern portion of the marine realm, the south Eastern Cape coast and the Northern Cape coast (Figure 35).

Species protection level

A new indicator to determine how well the protected area network is conserving species has been developed for this NBA. This indicator has been used to assess terrestrial and freshwater species within seven

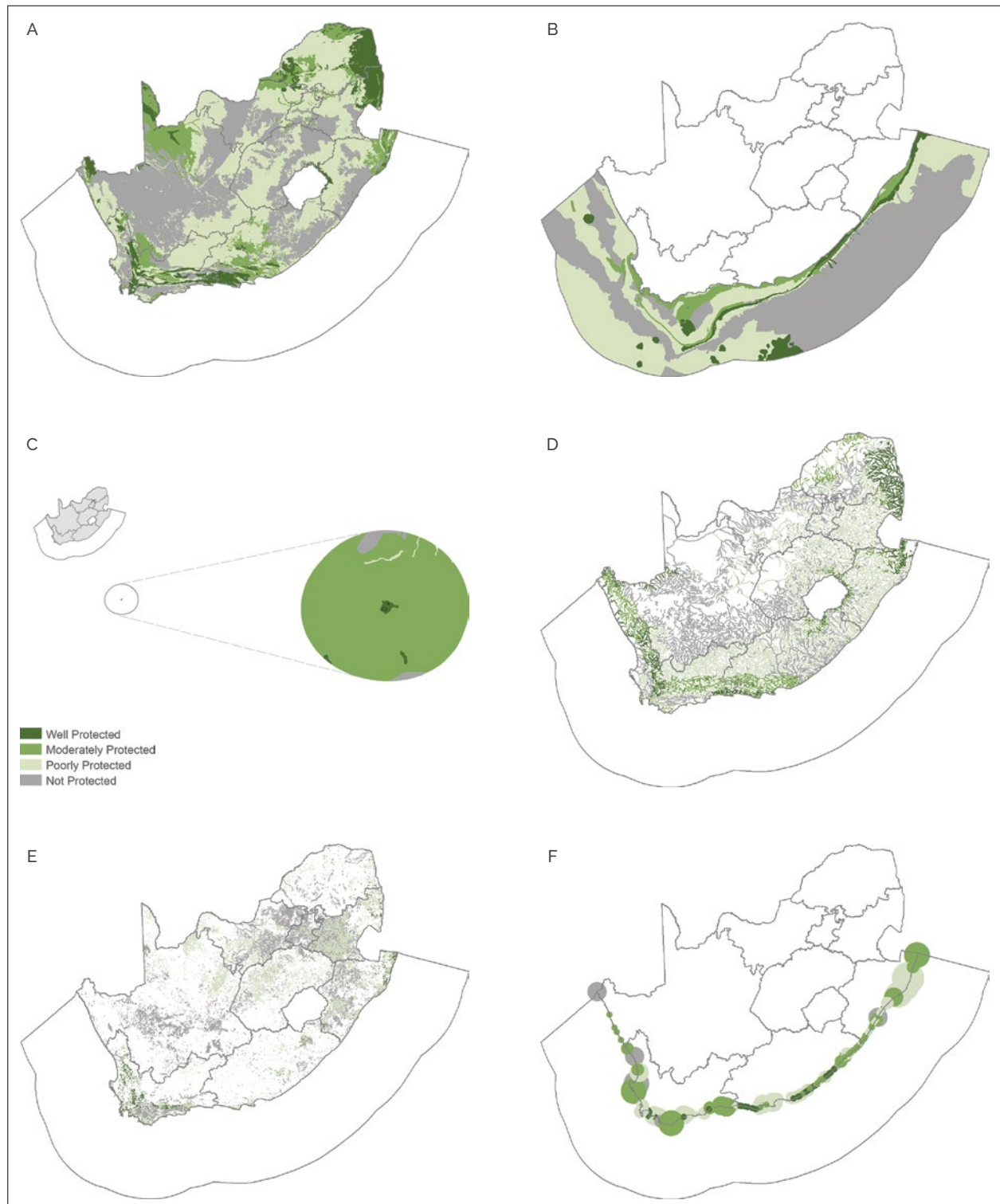
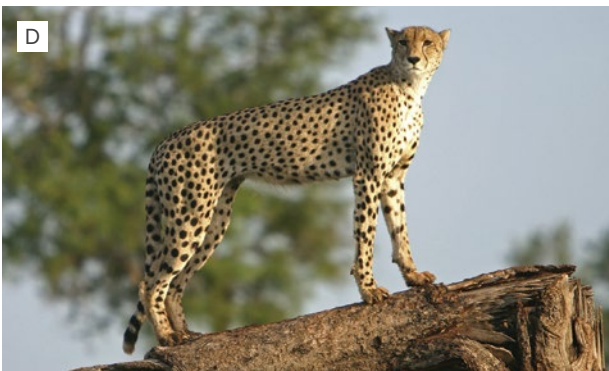


Figure 35. Spatial distribution of ecosystem protection level for each realm: (A) terrestrial, (B) marine, (C) sub-Antarctic territory including the PEIs and surrounding seas, (D) river, (E) inland wetland, (F) estuarine (represented as circles for graphic purposes).

A new protection level index for species has highlighted that many of South Africa's threatened species remain under-protected. For example:

- (A) *Bradypodion caffer*, an Endangered species of chameleon, currently occurs only outside of protected areas and is therefore Not Protected. Future protected area expansion needs to include this and many other threatened but under-protected species. © Krystal Tolley.
- (B) The Tawny Eagle (*Aquila rapax*), Endangered, is assessed as Poorly Protected. Large birds of prey that occur at low densities are difficult to protect effectively, as they require huge ranges of natural habitat. Regional conservation of these birds is required to effectively manage populations. © Martin Taylor.
- (C) *Manulea robusta*, Vulnerable, is assessed as Poorly Protected. All known populations of this rare species occur within protected areas in the Richtersveld. Unfortunately protection effectiveness is compromised by livestock overgrazing that occurs inside of these protected areas. © Lize von Staden.
- (D) The Cheetah (*Acinonyx jubatus*), Vulnerable, is assessed as Poorly Protected as it occurs at such low densities that to effectively manage the conservation target for this species would require 36% of South Africa's area to be conserved. Species like the Cheetah that occur naturally at such low densities will always remain under-protected and these species require active meta-population management. © Johan Wessels.
- (E) *Eriksionia edgei*, Critically Endangered, is only known from the Waterberg area, and is Not Protected. A total of 9% of South Africa's butterfly species have no protection. © Jeremy Dobson.
- (F) *Pseudobarbus skeltoni*, Endangered, is Poorly Protected despite all remaining populations occurring within formally protected areas (Hottentots Holland Nature Reserve and the Limietberg Nature Reserve). The protection offered by these reserves is ineffective against invasion and impacts from non-native fish species. Freshwater fishes have the highest proportion of under-protected species with 82% of species under-protected. © Jeremy Shelton.



taxonomic groups (Figure 36). The species protection level indicator measures progress towards protecting a population persistence target for each species. As species persistence is dependent on the degree to which protected areas can mitigate threats that cause population decline, a protected area effectiveness factor was included in the calculation of species protection level. The categories for protection level are: Well Protected where the species persistence target is met or exceeded by the protected area network; Moderately Protected where between 50 and 99% of the species persistence target is met; Poorly Protected where between 5 and 49% of the species persistence target is met; and Not Protected where less than 5% of the species persistence target is met. Protection level was calculated for freshwater fishes and terrestrial birds, mammals, reptiles, amphibians and butterflies. Plants were assessed using a representative sample of 900 taxa. Peripheral taxa, which have less than 5% of their distribution range occurring in South Africa, were excluded from the analysis.

With the exception of freshwater fishes, South Africa's protected area network protects species relatively well, with most groups having over 50% of species qualifying as Well Protected. The protection level of birds and reptiles is particularly good with both groups having over 85% of their taxa qualifying as Well Protected (Figure 36A). Overall protection levels of endemic species are lower than for all species (Figure 36B). Plants and freshwater fishes have the highest proportion of species that are Not Protected, 17% and 19% respectively. For plants, 88% of Not Protected species are endemic and one-third are threatened, while for freshwater fishes 94% of Not Protected species are endemic and all (100%) are threatened with extinction. Of further concern is that 70 butterfly taxa (9.4%) are Not Protected; 95% of these are

endemic and half (51%) are threatened with extinction. When just considering threatened taxa, there are high proportions that are under-protected: 98% of threatened birds, 98% of threatened plants, 95% of threatened freshwater fishes, 94% of threatened amphibians, 89% of threatened mammals, 89% of threatened butterflies and 37% of threatened reptiles are under-protected. Under-protected species, especially those that are both endemic and threatened, need to be prioritised for inclusion in protected area expansion efforts going forward.

The effectiveness of protected areas in mitigating threats to species was estimated. While 27% of freshwater fish taxa are well represented within protected areas (Figure 36), many species are not being effectively protected due to the presence of invasive alien fish species within protected areas and limited management interventions in place to control invasive species. Pollution and water abstraction upstream of protected areas further compromises protection effectiveness. Consequently, only 17% of South African freshwater fish taxa qualify as Well Protected once the impact of these pressures are taken into account. Plants, butterflies and amphibians are also significantly impacted by threats occurring within protected area boundaries. This is mostly due to alien plant invasions and disrupted fire regimes for protected areas occurring in the Fynbos biome – a centre of endemism for all three groups. As a result, 6% of plant species, 7% of butterflies and 9% of amphibian species drop down a category of protection. Eleven mammal taxa (4%) drop a category of protection due to protected areas not effectively mitigating against poaching and bushmeat hunting. A mechanism to share data on priority threatened species, where protected areas are failing to mitigate threats impacting on these species, is currently being developed for use by protected area managers.

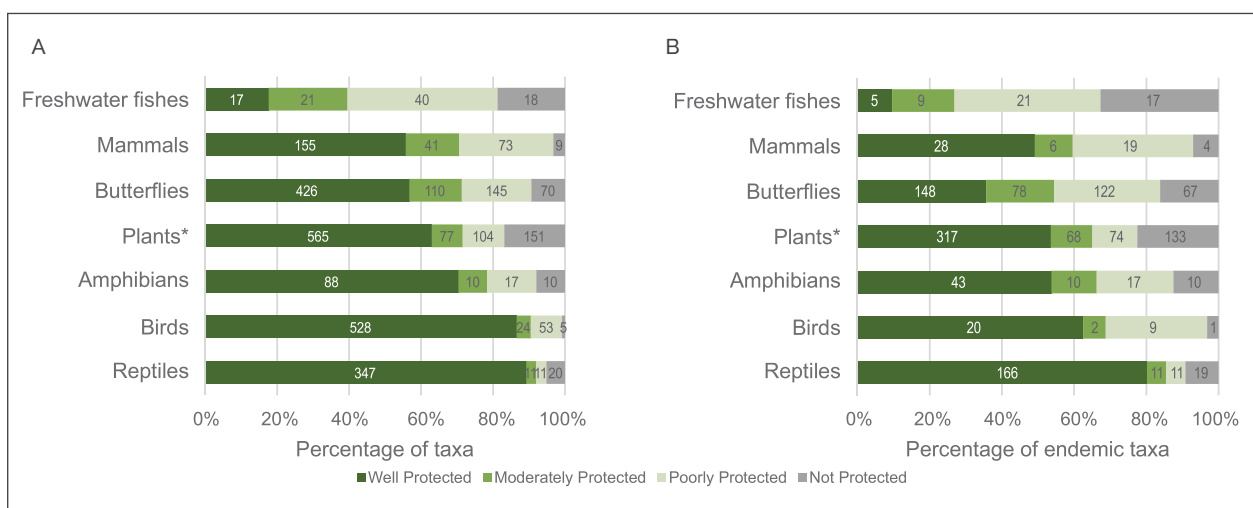


Figure 36. Protection level assessment results for (A) all indigenous freshwater and terrestrial associated taxa; and (B) endemic freshwater and terrestrial associated taxa. *For plants protection level was calculated for a statistically representative random sample of 900 taxa.

2.7 Genetic diversity

Although trends in genetic diversity cannot be compared across realms due to the lack of temporal genetic diversity datasets and indicators, there is a consistent call for the establishment of long-term genetic monitoring datasets for priority taxa. Within all realms, genetic data do exist, but they predominantly represent a snapshot (single point estimate) of a species' genetic diversity, and typically only for a limited distribution of the species' range. Moreover, these point estimates are assessed for a relatively small proportion of species. Currently, temporal genetic monitoring studies have been initiated for two threatened amphibians. There is a need for long-term commitment from government, national facilities and scientific councils to ensure these and future long-term studies persist. Furthermore, a national genetic monitoring framework needs to be established to ensure consistency across monitoring studies and realms.

At the landscape level, there is the potential to apply genetic change indicators to assess and monitor changes to phylogenetic richness over time, and these indicators could be applied across all realms. However, to date there is a single case study using reptiles from the terrestrial realm. The study shows there are several landscape level phylogenetic richness hotspots, and that some of these hotspots correspond with areas that are under pressure from conversion of natural habitat for agriculture and human settlements (Figure 37). It is possible that hotspots of phylogenetic richness are present in each realm, and there is a need to understand if other realm hotspots are also

Genetic diversity can be defined as the amount of variation observed in the DNA of individuals, populations or species. It is thought to be linked to adaptive potential and resilience in a species. However, genetic diversity should be interpreted with caution as low genetic diversity does not always indicate that a species will be adversely affected.

Phylogenetic diversity (PD) is a spatial measure of the total genetic diversity in an area, for a taxonomic group. PD is estimated using a phylogenetic tree.

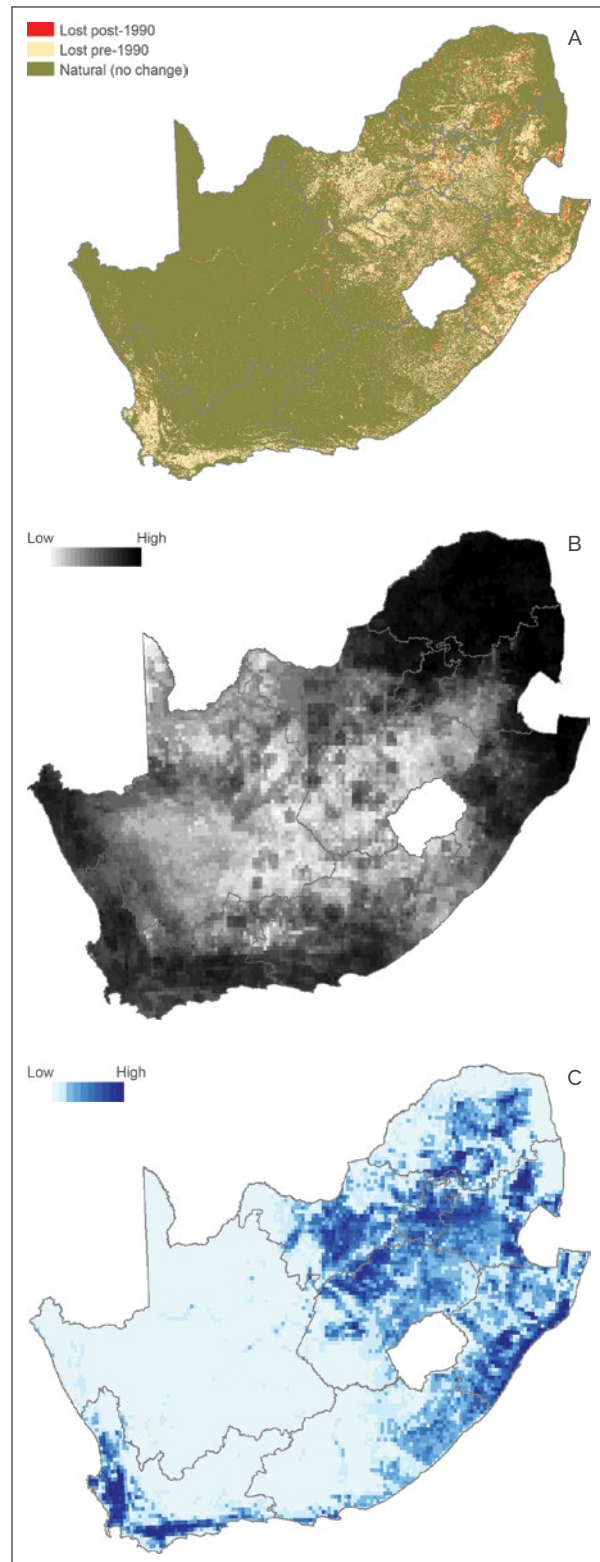


Figure 37. Land cover change in South Africa (A) contrasted with areas of high phylogenetic richness (as measured by phylogenetic diversity) for reptiles (B), with the integrated metric to track areas sensitive to genetic erosion (C).

under pressure. Furthermore, the indicators could be applied across multiple taxonomic groups to examine if there are common patterns relating to high richness that is under pressure. Future analyses will need to be coordinated across the realms and for multiple taxonomic groups.

Phylogenetic richness is an umbrella term that includes all metrics that combine phylogenetic and spatial information at the interspecific or higher (generic or familial) level.

Crop wild relatives are wild species of plants that are closely related to commercial crops around the world. The checklist of food and fodder crop wild relatives for South Africa lists 1 593 species, subspecies and varieties, of which 258 are of high priority for conservation due to their close genetic relationship with major crops and the fact that they are endemic. These crop wild relatives are a vital component of agricultural biodiversity and are a resource of genetic material that can be used in plant breeding to enhance crop production. Several areas in South Africa are identified as areas of crop wild relative richness. The implementation of the National Strategic Action Plan for the Conservation and Sustainable Use of Crop Wild Relatives in South Africa, which identifies priority actions for both in situ and ex situ conservation, should be a priority.

South Africa has an important wild relative of rye, *Secale strictum* subsp. *africanum*, known only from the Roggeveld escarpment. This species has become so threatened by livestock overgrazing and competition from invasive grasses that it now remains on only one farm and is listed as Critically Endangered. © Helga van der Merwe.



Part Three

Detailed Findings

3.1 Terrestrial realm

ECOSYSTEMS

22%

of 458 ecosystem types
Threatened

26%

of 458 ecosystem types
Well Protected

25%

of 458 ecosystem types
Not Protected

SPECIES

13%

of 22 667 taxa assessed
Threatened

69%

of 3 050 taxa assessed
Well Protected

9%

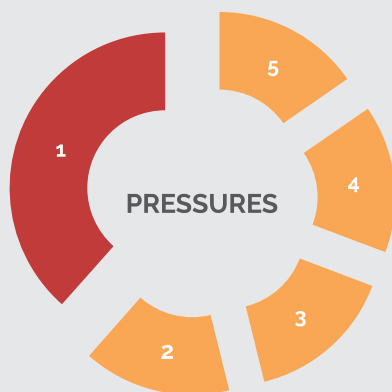
of 3 050 taxa assessed
Not Protected

3.1.1 Summary

South Africa's terrestrial realm is recognised globally for its biodiversity and high levels of endemism. The unique and diverse fauna and flora, together with the wide range of ecosystems, underpins South Africa's vibrant and growing tourism and wildlife industries, culturally and economically important traditional medicine practices, extensive livestock farming industry, and the functioning of water catchment areas. Together these industries and functions provide hundreds of thousands of jobs and contribute to food and water security.

Terrestrial ecosystems and species face pressures from a range of human activities, including loss and degradation of natural habitat, biological invasions, pollution and waste, unsustainable natural resource use and climate change. These pressures interact in complex ways that undermine biodiversity and ecological infrastructure, which are important foundations of the country's social and economic systems. The key drivers of habitat loss are land clearing for croplands, human settlements, plantation forestry, mining and infrastructure development. These activities have led to the loss of 21% of South Africa's natural terrestrial ecosystem extent. Other key pressures include invasive species (plants in particular), overutilisation of rangelands, disrupted fire regimes and climate change. These have not yet been mapped and quantified at an adequate scale to gauge and track their impacts on biodiversity nationally, and this situation needs to be addressed urgently.

Almost a quarter of South Africa's terrestrial ecosystem types are threatened. This is a clear indicator of mounting pressures on biodiversity and ecosystems. These pressures should be closely monitored and the data required to do this (principally ecological condition data) should be acquired as a matter of priority. The Indian Ocean Coastal



- 1 Habitat loss
- 2 Overutilisation of rangelands
- 3 Altered fire regimes
- 4 Biological invasions
- 5 Climate change

Section based on:

Skowno, A.L., et al. (eds). 2019. *South African National Biodiversity Assessment 2018 Technical Report Volume 1: Terrestrial Realm*. South African National Biodiversity Institute, Pretoria. <http://hdl.handle.net/20.500.12143/6370>.



South Africa's terrestrial realm has nine biomes and 458 ecosystem types, 80% of which are endemic. A quarter of all terrestrial ecosystem types are listed as threatened. The diversity is astounding and ranges from the winter-rainfall Fynbos in the southwestern Cape (A), through the arid Desert (B) and semi-arid Succulent Karoo (C) and Nama-Karoo shrublands, to the extensive Savanna and Grassland (D) biomes in the north and east. The Forest biome (E) is small and occurs in scattered patches throughout the more mesic regions of the country. The Albany Thicket biome is unique to South Africa and lies in the southeast of the country. The Indian Ocean Coastal belt extends northwards into Mozambique along the east coast of Africa.



Belt, Fynbos and Grassland biomes have the highest proportion of threatened ecosystem types including 27 Critically Endangered and 29 Endangered types between them. Since most land that has not been cleared is considered natural/near-natural, the assessment generally underestimates ecosystem modification and some ecosystem types may be in significantly worse condition (and at higher risk of collapse) than the available data suggest. Improved invasive alien plant and land degradation mapping is required to address this shortcoming. The innovative steps taken to incorporate threatened ecosystem types into systematic biodiversity plans and land-use decision making processes should be continued.

Of the 22 667 terrestrial taxa assessed, 3 024 (13%) are threatened. Mammals have 17% of taxa threatened with extinction; plants have 14%, amphibians 13%, butterflies 10%, birds 9% and reptiles 5%. South Africa has very high levels of endemism (64%) and one in five of these endemics are threatened with extinction. The trend in species status over time has been measured for the first time using the Red List Index (RLI). Groups for which sufficient time-series data existed included all terrestrial vertebrates, a sample of 900 plants and one invertebrate group, butterflies. Similar levels of decline were observed for all taxa. The decline observed for butterflies highlights the need to assess and monitor additional invertebrate groups. Despite there being an overall increase in risk of extinction for all six taxonomic groups assessed, ten mammal taxa have genuinely improved in threat status since 2004.

The terrestrial protected area estate of South Africa increased by 11% between 2010 and 2018 – now covering almost 9% of the mainland. The placement of these new protected areas has resulted in overall improvement in ecosystem protection levels for all biomes. A quarter of the terrestrial ecosystem types are Well Protected and a quarter are Not Protected. Biodiversity stewardship programmes underpinned the majority of this increase and continue to be the most cost effective mechanism for protected area expansion. Efforts should be made to support and expand biodiversity stewardship programmes and address those ecosystem types that are Not Protected.

Protection levels for species were assessed for the first time – using an indicator developed specifically for the NBA – and show that birds and reptiles are relatively well protected by South Africa’s protected areas network, while butterflies, mammals, plants and amphibians are under-protected (i.e. Not Protected, Poorly Protected or Moderately Protected). Over 85% of bird and reptile taxa qualify

as Well Protected, while 72% of amphibians, 63% of plants, 57% of butterflies and 56% of mammals are Well Protected. Plants have the highest proportion of under-protected taxa with 17% in the category Not Protected. Even for relatively Well Protected groups, like reptiles, the most threatened species often remain unrepresented in protected areas. Threatened or endemic taxa should therefore also be considered, along with under-represented taxa, to be targeted in protected area expansion efforts.

3.1.2 Input data and method for the terrestrial realm

Ecosystem assessments

One of the key input datasets for the terrestrial ecosystem assessment was the 2018 update of *The Vegetation of South Africa, Lesotho and Swaziland*. This digital map delineates and describes 458 national vegetation types nested within nine biomes: Fynbos, Succulent Karoo, Desert, Nama-Karoo, Grassland, Savanna, Albany Thicket, Indian Ocean Coastal Belt and Forest. The vegetation map reflects the historical extent of the vegetation prior to major anthropogenic land conversion (ca. 1750). The other key input dataset for the assessment is a map of ecosystem extent and condition. For the terrestrial realm the ecological condition dataset is based on a national scale, remote sensing based land cover change dataset with two time points (1990 and 2014), combined with a range of regional land cover products, and ecological condition datasets partially covering the Western Cape and the Albany Thicket biome. While this dataset represents a significant improvement on any previous products, significant limitations remain: i) the 2014 dataset is already outdated, and ii) the lack of ecosystem degradation data for the majority of the country limits our ability to gauge the subtler forms of ecosystem modification such as invasion by alien plants and overgrazing.

A simple indicator of terrestrial habitat loss or ecosystem extent was developed for the NBA 2018. The land cover change data were used to calculate the rate of loss of natural habitat to anthropogenic activities between 1990 and 2014 (expressed as percentage of the 1990 remaining extent lost per year).

A comprehensive assessment of all terrestrial ecosystem threat status was performed focussing on IUCN RLE Criteria A&B (criteria linked to spatial configuration and remaining extent of ecosystems).

The assessment used the national scale ecosystem extent and condition dataset (based on the land cover change dataset) with two time points (1990 and 2014), and high resolution habitat loss data from various metropolitan areas and from KwaZulu-Natal, Western Cape and Mpumalanga provinces. Efforts are underway to develop a comprehensive national land degradation dataset, aimed at various ecosystem-level assessments, but this is not yet available. Various regional land degradation or ecosystem modification datasets are available and these were used to supplement the assessments for selected ecosystem types: Albany Thicket biome, Little Karoo and parts of the Western Cape. Evidence for ongoing decline and threatening processes in ecosystems of limited extent (Criteria B1a[iii] & B2a[iii]) was inferred based on the number of threatened plant taxa present in the ecosystem listed due to pressure from invasive species, fire or overgrazing.

Species assessments

For species assessments to feed into national level indicators such as the IUCN Red List Index, it is important that full taxonomic groups are assessed. Six terrestrial taxon groups were included in the NBA 2018, for which there is a relatively stable taxonomy, sufficient distribution data and knowledge of life history, ecology and threats. These include all terrestrial vertebrates (mammals, birds, reptiles and amphibians), all South African plants, and one speciose group of invertebrates (butterflies). Work is underway to increase the number of invertebrate groups that are assessed, with a current assessment underway for arachnids (specifically spiders and scorpions). Over the next five years, invertebrates important for pollination processes (such as bees and specific families of flies) will be included.

3.1.3 Key drivers and pressures in the terrestrial realm

Terrestrial ecosystems and species face pressures from a range of human activities, including loss and degradation of natural habitat, invasive alien species, pollution and waste, natural resource use and climate change. These pressures interact in complex ways that scientists are only beginning to understand. The loss of natural habitat is the single biggest cause of loss of biodiversity and ecosystem functioning in the terrestrial environment. Outright loss of natural habitat takes place mainly as a result of conversion of natural vegetation for cultivation of croplands, mining, plantation forestry, human settlements and other infrastructure development. Patterns and trends linked to land-use and land cover change are closely linked to changes in terrestrial biodiversity and ecosystem extent. Habitat loss is also usually associated with habitat fragmentation, which further impacts ecological functioning and viability of species, particularly in the context of climate change and biological invasions.

Habitat loss

Based on the national land cover, 81% of South Africa (985 559 km²) was in a natural state in 1990 (Table 4). By 2014 natural areas were estimated to have declined to 79% (961 010 km²). Habitat loss, as a result of historical (1750–1990) and recent (1990–2014) clearing of natural⁶ habitat for field crops, horticultural crops and planted pastures, is the largest pressure on terrestrial ecosystems and biodiversity in South Africa and has affected 16% of the land area.

Animal-pollinated crops (from peppers and tomatoes to other fruits and nuts) provide vital nutrients in human diets, and are responsible for 90% of vitamin C and the majority of vitamin A and related carotenoids. Insect pollinators are critical for most fruit and vegetable crops in South Africa. Ensuring that a diversity of pollinating species live near crops, and strategically using South Africa's indigenous honeybee species at key times as managed pollinators, leads to a greater chance of pollinators being active when the crop is flowering and better crop yields. Pollinators and their habitats and food resources should be protected to support human food security.



Hives of the Cape Honeybee (*Apis mellifera capensis*) in a fruit tree orchard. © SANBI.



A



B

Habitat loss as a result of clearing natural vegetation for field crops, horticultural crops and pastures is the largest pressure on terrestrial biodiversity. Pictured are (A) vegetable crops growing near Patensie in the Eastern Cape, © Geoff Spiby; and (B) wheatlands in the Swartland region of the southwestern Cape, © Oswald Kurten.

Clearing of natural habitat for new croplands between 1990 and 2014 affected 1.4% of the country. The relatively mesic eastern portions of South Africa and the Fynbos and Renosterveld of the Cape lowlands were the most impacted by this clearing (Figure 38). Built-up areas (including rural and urban settlements, industrial and commercial areas and large infrastructure) also contribute to natural habitat loss and currently cover over 2.5% of the country. The rate of habitat loss linked to new built-up areas is increasing, especially in Gauteng and along the KwaZulu-Natal coast and adjacent interior. Plantation forestry (including non-native pine, eucalyptus and acacia species) is an important

driver of habitat loss, in mesic grassland regions in particular, and cover just under 2% of South Africa; although new plantations are being established the rate of habitat loss to this activity may be decreasing. The impact of mining as a direct driver of habitat loss is relatively low (0.3% of South Africa); however, the highly uneven distribution of mining areas means that the impacts are focussed on particular ecosystems, and the impacts are often persistent.

⁶ In the terrestrial section the term 'natural' includes 'near-natural' areas in which at least plant species composition, structure and function are largely intact.

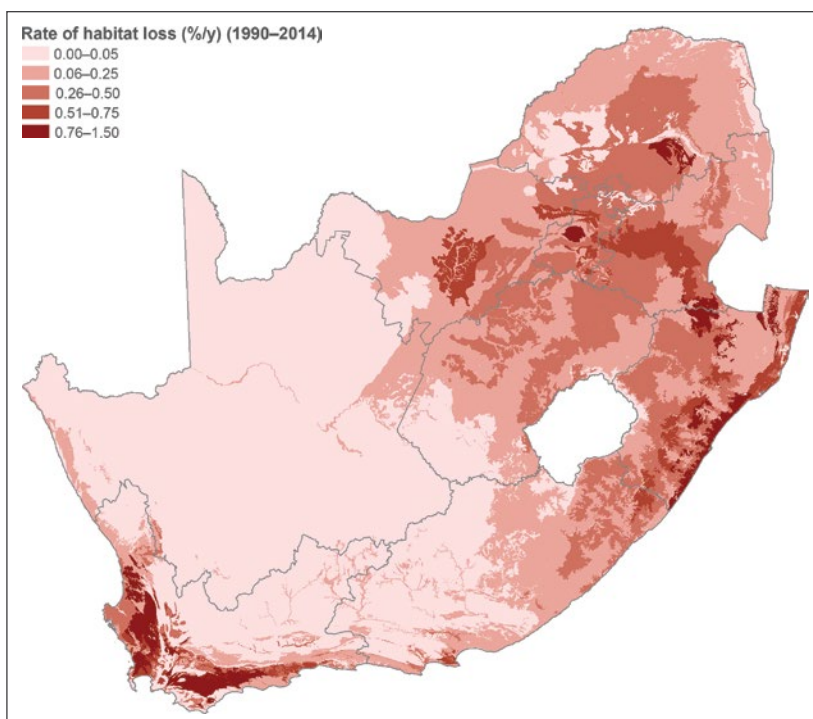


Figure 38. Rate of recent habitat loss indicator 1990–2014 calculated per terrestrial ecosystem type. The Cape lowlands, Mpumalanga Highveld grasslands and KwaZulu-Natal coast and adjacent interior have the highest rates of habitat loss between 1990 and 2014, with expanding croplands and human settlements being the key drivers. The terrestrial ecosystem types are provided by the 2018 version of the National Vegetation Map.

Table 4. The key drivers of habitat loss for mainland South Africa prior to 1990 and between 1990 and 2014, based on the land cover change dataset. This table does not show transitions between all classes, it summarises all transitions between natural areas and anthropogenic land cover / land-use classes

Land cover / land-use class	Historical loss of habitat km ² (prior to 1990)		Recent loss of habitat km ² (1990–2014)	
Artificial waterbody	5 629	(0.5%)	305	(0.0%)
Built-up	27 337	(2.2%)	3 284	(0.3%)
Cropland	177 639	(14.6%)	16 591	(1.4%)
Mine	2 834	(0.2%)	739	(0.1%)
Plantation	19 135	(1.6%)	2 982	(0.2%)
Total habitat loss	232 574	(19.1%)	23 901	(2.0%)
Remaining natural habitat	986 886	(80.9%)	962 297	(78.9%)

Land degradation

In addition to land clearing related habitat loss, large portions of South Africa's rangelands have seen extensive modifications from centuries of livestock farming, and mountain catchment areas have been modified through invasion by alien woody plant species. The ecological condition in these modified areas ranges from near-natural to critically modified depending on the degree to which ecosystem structure, function and composition have been altered. Unfortunately, there is currently limited spatial data with which to assess these impacts at the scale of ecosystem types, though national assessments of land degradation in South African rangelands in particular have shown that overgrazing and bush encroachment are widespread. Recent work also suggests that, while there may be a trend towards improvement in primary productivity in some arid rangelands, bush encroachment is increasingly widespread and severe. An alternative way to gather information on pressures on biodiversity is through the meta-analysis of

threatened species assessment datasets. Figure 39 shows a detailed pressure profile for the terrestrial realm for the six taxonomic groups assessed. From these data, it is clear that natural system modifications – in this case overgrazing of rangelands and the disruption of natural fire regimes – are having a major impact on biodiversity.

Biological invasions

Biological invasions, especially invasive alien plants, are also a major pressure on the biodiversity and ecosystem functioning of the terrestrial realm. All the major taxonomic groups have species that are directly threatened by invasive species (Figure 39, p. 77). Of the 1 865 terrestrial alien species recorded (or assumed to be present) outside of cultivation or captivity in South Africa, 692 are known to be invasive, 116 are known to be naturalised but not invasive, and 558 are present, but not naturalised. For the remainder (499 species), there is insufficient

Rangelands for the livestock and game farming sectors occupy 70% of South Africa's land surface and provide approximately 250 000 jobs (2013). The wildlife ranching sector (with activities ranging from hunting to tourism) is worth ± R14 billion (2015) per year. Degradation of these rangelands lowers the carrying capacity for both livestock and wildlife, with associated decrease in other ecosystem services like water quality, erosion control and carbon sequestration, as well as the sustainability of jobs in these sectors. Both wildlife ranching and livestock farming are vitally important land uses for both socio-economic development and biodiversity conservation, but can have negative impacts if conducted too intensively.



Invasion debt is the potential increase in the biological invasion problem in the future given current levels of introduction, establishment, spread of species and the potential increase in impacts.

information to assign them to an introduction status category. While the majority of invasive species have relatively restricted distributions there are some (plants and birds in particular) that are widespread. A recent, expert-based assessment suggested that 19 terrestrial species were having a severe impact, and 73 were having a major impact. Of these 92 species, most (76) are plants, eight are mammals, five are invertebrates, two are amphibians, and there is one bird species. These species have a range of impacts on biodiversity, displacing indigenous species, disturbing habitats and disrupting ecosystem functioning. Australian acacias, for example, can form closed canopy stands that exclude indigenous species, change fire regimes and impact surface water runoff, negatively impacting both biodiversity and water catchment function. Herbaceous and succulent species such as Triffid Weed (*Chromolaena odorata*) can severely reduce rangeland productivity and thus the livelihoods of rural people; while invasive shrubs such as Silky Hakea (*Hakea sericea*), can displace most other species and increase fire intensity – leading to soil damage and excessive erosion. Examples of severe impacts in other high-level taxa include the Garden Snail (*Cornu aspersum*) that causes damage to commercial and ornamental crops; and the Argentine Ant (*Linepithema humile*), which

disrupts ant–plant mutualisms responsible for the seed dispersal of indigenous plants, and thus pose serious threats to indigenous vegetation survival. Overall, alien plants are the most diverse, widespread and damaging group of invaders in South Africa. Furthermore, it is clear that South Africa has a major alien plant invasion debt. Well over 100 new taxa have been recorded as naturalised or escaped from cultivation over the past decade and the recorded range of almost all plants have increased significantly. This is a significant cause for concern, as it clearly indicates that problems associated with alien species are set to increase.

Climate change

Anthropogenic climate change has been shown to impact on most ecological processes with disruptions evident from the genetic level to the landscape level. Abiotic pressures affecting the terrestrial realm include increases in dry spell duration, mean and maximum temperatures, wind, wildfires, sea level; and increases in the frequency and intensity of storm surges, extreme rainfall events and very hot days. Annual rainfall has both increased and decreased in different regions and overall changes in rainfall seasonality have been noted.

Evidence of early impacts of climate change on species is rapidly accumulating, with 70 amphibian species contracting their geographic ranges, at least partly due to climate change impacts on freshwater systems. Large scale die-offs of desert plant communities have been documented, along with shifting migration times and range contractions for bird



A perfect storm of drought and overexploitation: four decades of monitoring arid regions in Africa by the BIOTA/SASSCAL observation system have linked the persistent drought in the Richtersveld to unprecedented biodiversity losses. Combined with impacts from increased stock farming, the drought has left large areas of the plains in the northern Richtersveld bare of living plants. With over 250 plant species endemic to the Richtersveld and Gariiep Centre, the impact of this drought is devastating to plant diversity in South Africa and to local communities. The photos show the decline in the *Brownanthus pseudoschlichtianus* community on the Koeroegabvlakte between 2004 (A) and 2018 (B). © Norbert Jürgens.



A changing climate and rising CO₂ are leading to bush encroachment – the densification and spread of woody plant species that adversely affects species dependent on open grasslands. © Andrew Skowno.

species. Fynbos community composition has also been shown to have altered due to climate change. Over the past century one of the most pervasive structural changes observed has been an increase in the density and spread of woody species. This global trend, known as bush encroachment or woody thickening, is widespread in southern African grasslands, open savannas and mixed grass/shrub ecosystems. Research has shown that a changing climate and rising CO₂ are probable background drivers of extensive and broad-scale switches towards greater woody plant cover, but that other important drivers (fire and grazing/browsing) influence the rate of this change. These widespread ecological shifts have triggered plant and animal community reorganisations, net declines in biodiversity and changes in land-use activities. These alarming shifts drive the urgent need for climate change mitigation and management of interacting change drivers. Since progressive climatic, CO₂ and resulting biodiversity changes are now inevitable, a review of conservation objectives and desired outcomes is essential, along with planning and implementation of targeted conservation interventions. These need to be supported by a wider

array of long-term monitoring efforts, including of the effectiveness of the new conservation approaches required.

Biological resource use

Biological resource use directly targets specific wildlife species and includes the hunting and trapping of animals as well as the harvesting of plants. In South Africa, animals and plants are commonly used as traditional medicine for both the healing of ailments and for cultural purposes. Over 2 000 indigenous plant species have documented traditional medicinal uses. Some 656 medicinal plant species are common in trade and many are unsustainably harvested, with 184 species declining due to excessive use and 56 listed as threatened. Approximately 147 vertebrate species, representing about 9% of the total number of vertebrate species in South Africa, are traded for traditional purposes. Vultures are particularly threatened by cultural use and it has been estimated that 29% of local vulture deaths are due to harvesting for traditional purposes. Harvesting for traditional medicine has increased pressure on endemic species of

The harvesting of edible plants, edible insects and medicinal plants and animals from the wild is widely practised in South Africa and is particularly important as part of the rural economy. There are $\pm 1\,300$ edible plant species in South Africa; >20 edible insects have been documented in Limpopo (a national review has not been conducted); and $>2\,000$ indigenous plant species and 147 vertebrate species have documented traditional medicine uses. Medicinal plants and animals are essential to the work of some 200 000 Traditional Health Practitioners and provide a further $\pm 93\,000$ income generating activities in the informal sector for harvesters and traders. It is estimated that the informal African Traditional Medicine industry is valued at about R18 billion per year. There is growing concern about the sustainability of the medicinal trade. An increasing number of species in high demand have experienced local extirpations in the past ten years and are now being imported from neighbouring countries (e.g. *Siphonochilus aethiopicus*, *Warburgia salutaris*, *Alepidea* spp.), while many species once used only locally are now sold commercially in markets outside of their natural distribution range. Sixty per cent of 300 traditional medicine practitioners surveyed in Limpopo during 2017 reported an inability to access desired material due to overharvesting. The management of medicinal resources needs an integrated management response involving traditional healers and traders, government (DEFF, DSI, provincial conservation agencies and SANParks), NGOs and industry.



© John Donaldson

The past decade has seen a rise of international wildlife trafficking syndicates that supply species subject to global trade bans to overseas markets. Poaching of both Black Rhinoceros (*Diceros bicornis*) and Southern White Rhinoceros (*Ceratotherium simum simum*) for their horns increased since 2010, and there has been large-scale investment by the South African government and private sector in anti-poaching measures. Poaching attempts in the Kruger National Park (where 52% of Southern White Rhinoceros occur) have nevertheless continued to rise and the park has lost almost half its rhinoceros population due to the combined impacts of poaching and the recent drought. It is evident that the underlying causes of poaching (i.e. high demand for horn at high prices, coupled with poverty and unemployment in rural communities) have yet to be fully addressed. South Africa's cycads (*Encephalartos* spp.) are also under severe pressure from poaching, and it is suspected that large adult plants are being smuggled overseas. The extensive reach of social media platforms has given rise to unprecedented levels of international demand for wild harvested South African succulent plant species, while also facilitating all aspects of this trade. Research by South Africa's CITES Scientific Authority to quantify this trade and identify species most at risk will be used to inform regulatory and enforcement efforts to protect these species.



This screengrab from a social media page shows how there is large scale trade in South Africa's wild collected succulent plants.



Rhino poaching has increased since 2010. © Martin Harvey / AfriPics.

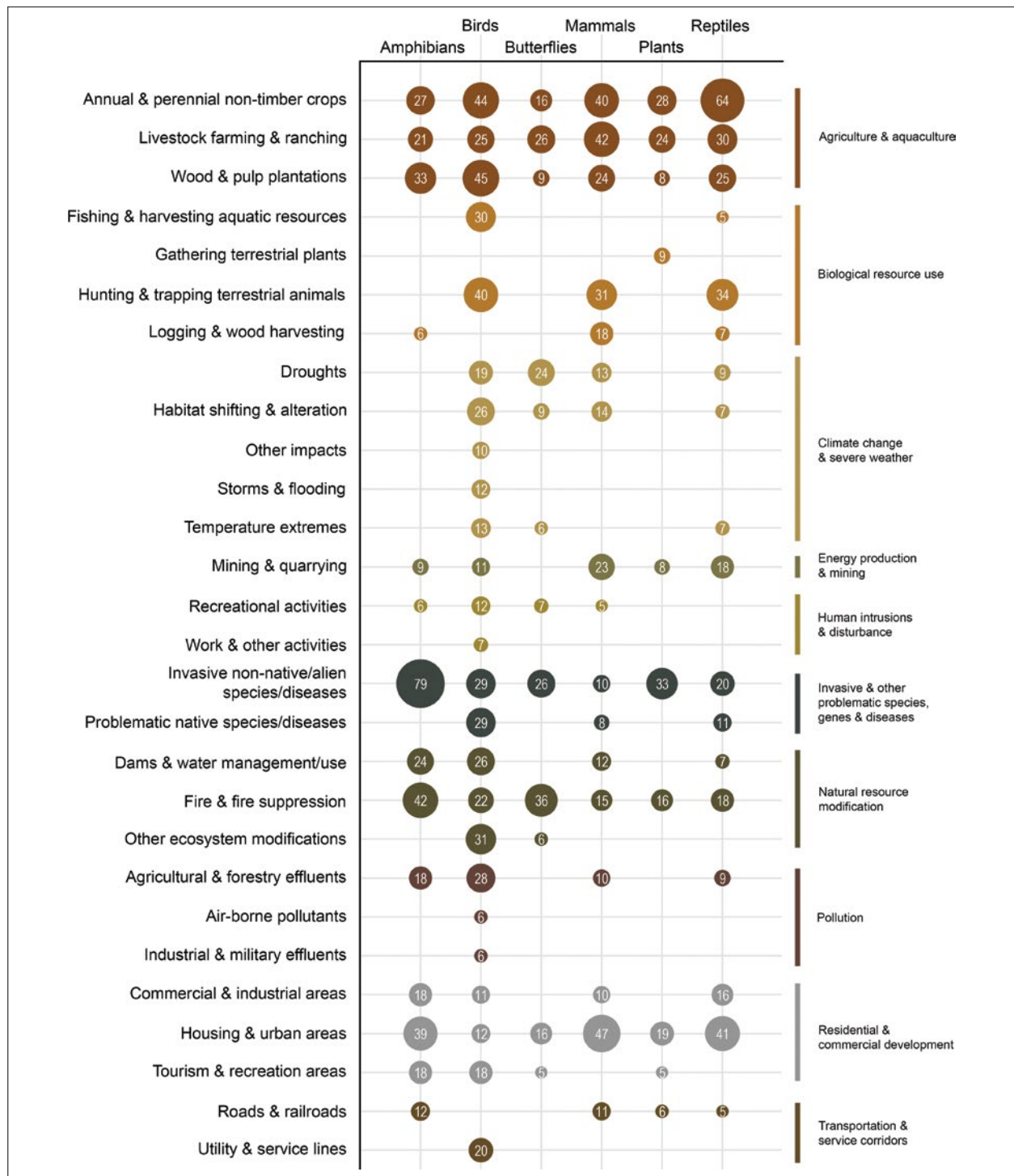


Figure 39. The key pressures for Taxa of Conservation Concern (ToCC) in the terrestrial realm based on a meta-analysis of the South African Species Red List Database. The size of the bubble and label number is the percentage of ToCC in the taxonomic group that is subject to each pressure. The pressure categories follow the IUCN threat classification system.

reptiles, such as the Sungazer Lizard (*Smaug giganteus*). Expansion of human settlements, especially in areas bordering protected areas, has resulted in increased hunting intensity for bushmeat and/or traditional medicine and cultural regalia, with species including Leopard (*Panthera pardus*), Temminck’s Ground Pangolin (*Smutsia temminckii*) and Oribi (*Ourebia ourebi*).

Other pressures

Waste generated by mining, agriculture, manufacturing and urban settlements causes water pollution, soil pollution and air pollution, which impact on ecosystems, species and ecological processes – often substantial distances away from the original pollution source.

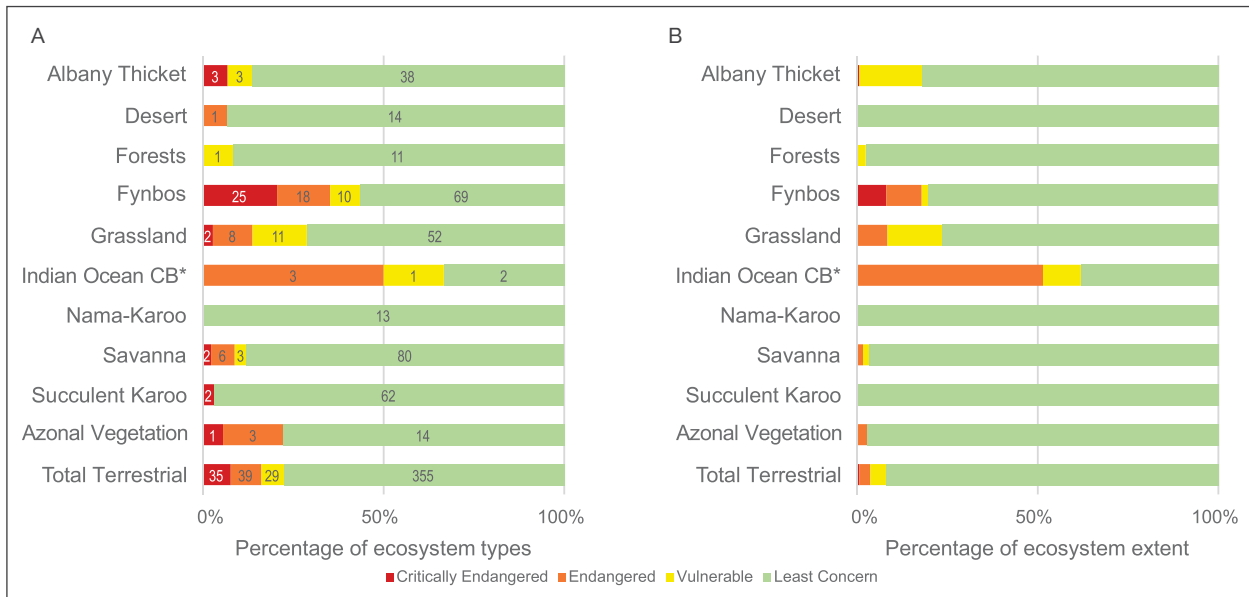


Figure 40. (A) The percentage of terrestrial ecosystem types in each IUCN RLE category (per biome) with the number of ecosystem types per category shown along the bars. (B) The percentage natural remaining habitat within each threat category (per biome), indicating the geographical extent of the listed ecosystems. *CB, Coastal Belt.

3.1.4 Ecosystem threat status in the terrestrial realm

The first implementation of the IUCN Red List of Ecosystems for South Africa resulted in 103 of the 458 terrestrial ecosystem types (22%) being categorised as threatened: 35 Critically Endangered, 39 Endangered and 29 Vulnerable ecosystem types (Figure 40A). Of the approximately 961 010 km² of natural habitat remaining in South Africa (ca. 2014), 8% is categorised as threatened (Figure 40B). The Fynbos biome has the highest number of threatened ecosystem types (53), followed by Grassland (21) and Savanna

(11) and these make up 20%, 24% and 3% of the natural remaining habitat of the biome respectively (Figure 40). Of the six ecosystem types making up the Indian Ocean Coastal Belt biome, four are threatened and 38% of the natural remaining habitat in the biome is threatened. The arid regions of the country (in the Northern Cape in particular) have far fewer threatened ecosystems (by type and by extent) than mesic regions of the southwestern Cape, east coast and eastern interior (Figure 41). The Succulent Karoo has two threatened ecosystems (amounting to 0.2% of the natural habitat) and the Nama-Karoo has no threatened ecosystems. This is partly due to limited field crop potential and low human settlement footprint in many arid regions (i.e. translating into low

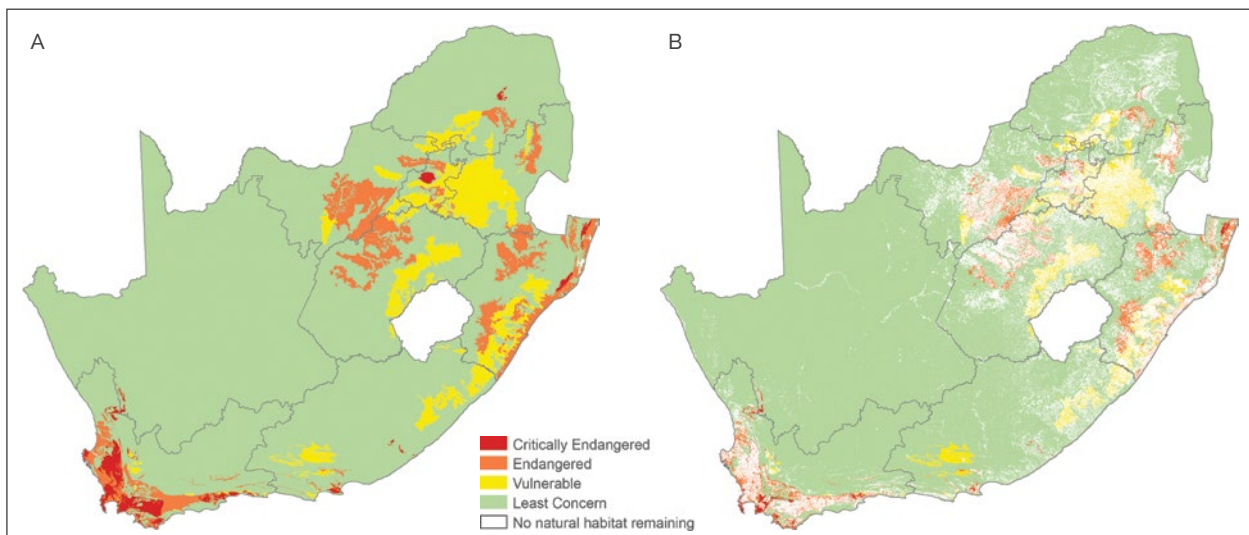


Figure 41. The distribution of threatened terrestrial ecosystem types in their historical extent (A); and in their 2014 extent (B).

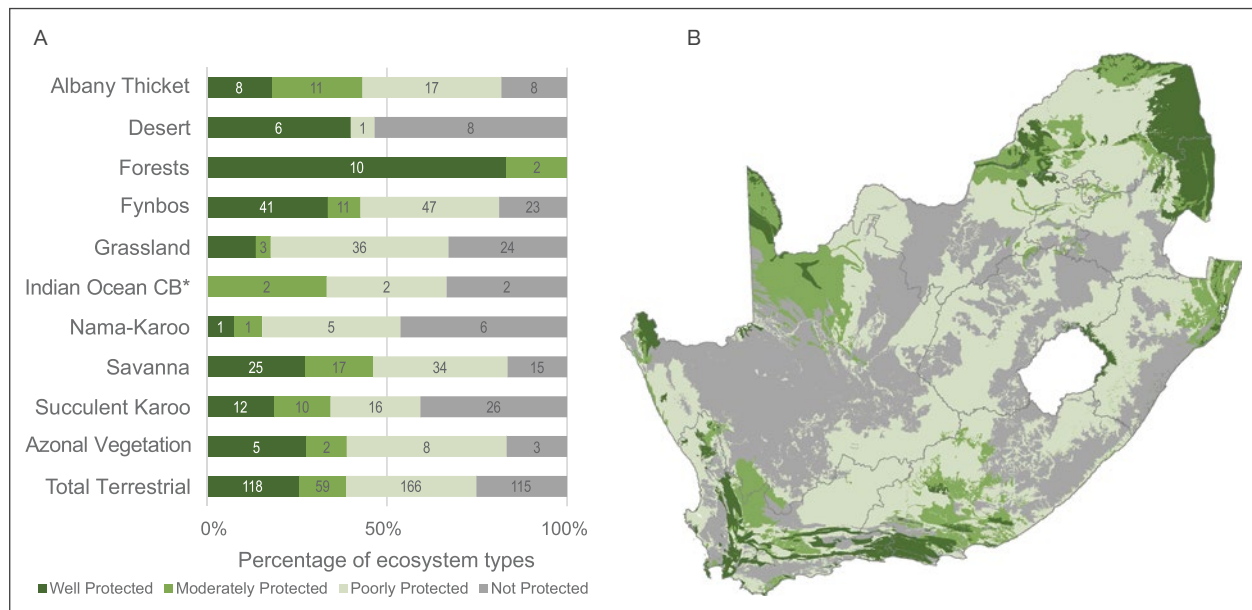


Figure 42. Protection level for terrestrial biomes of South Africa; proportion of ecosystem types in each category (A) and a map of ecosystem protection level (showing the historical extent of the ecosystem type) (B). *CB, Coastal Belt.

rates of habitat loss). However, it is also likely that the use of incomplete land degradation data for the assessment has resulted in the underestimation of the risk of ecosystem collapse in biomes with extensive rangelands (including the arid regions). It is likely that a number of ecosystem types assessed as Least Concern are in fact threatened. It is crucial that suitable land degradation or ecological condition data are available for future updates of the RLE. A further consideration is the 'new' set of pressures emerging across the country, such as large-scale solar and wind energy installations and shale gas exploration (and potentially extraction), which, when better mapped and understood, could contribute to the listing of additional ecosystem types.

3.1.5 Ecosystem protection level in the terrestrial realm

Overall, the proportion of South Africa's total land area included in the protected area network has increased from 8% in 2010 to 9% in 2018, and, importantly, much of this protected area expansion has happened in under-protected ecosystem types. The levels of protection that this 9% of land area provides for terrestrial ecosystem types are shown in Figure 42. Just over a quarter of terrestrial ecosystem types are currently Well Protected (leaving just under 75% under-protected) (Figure 42). A historical analysis of

protection levels showed that there has been a steady increase in the number of Well Protected ecosystem types from 22% (1990) to 24% (2010) to 26% in 2018 (see technical report).

By biome, the Indian Ocean Coastal Belt, Nama-Karoo, Grassland and Albany Thicket have the highest proportion of under-protected ecosystem types (Figure 42). Forest and Desert have the highest proportion of Well Protected ecosystem types. However, Fynbos, Savanna and Grassland have by far the highest actual number of under-protected ecosystems types due to their higher number of ecosystem types.

Even within biomes there can be further significant differences between ecosystem types (Figure 42). For example, while mountain Fynbos ecosystem types tend to be Well Protected, lowland ecosystem types within the Fynbos biome are Poorly Protected. Similarly, Lowveld Savanna types are Well Protected by the Kruger National Park and arid Savanna types by the Kgalagadi Transfrontier Conservation Area, but the central bushveld Savanna types (largely in central Limpopo) are still Poorly Protected.

Threatened and under-protected ecosystem types

There are 95 threatened (CR, EN or VU) terrestrial ecosystem types that are under-protected (Table 5 & Figure 43). This group of ecosystems have both a high risk of collapse and are under-represented in the current protected areas network, and form a

Table 5. Terrestrial ecosystem threat status and ecosystem protection level

	Not Protected	Poorly Protected	Moderately Protected	Well Protected	Total
Critically Endangered	15	12	5	3	35
Endangered	14	18	5	2	39
Vulnerable	13	11	2	3	29
Least Concern	73	125	47	110	355
Total	115	166	59	118	458

key input into conservation planning processes and protected areas expansion strategies.

3.1.6 Species threat status in the terrestrial realm

South Africa has a total of 3 024 threatened terrestrial indigenous taxa, 13% of the 22 667 indigenous terrestrial taxa assessed to date (Figure 44). There is a trend towards increased risk of extinction in all six taxonomic groups assessed. South Africa has very high levels of endemism (64% of the species assessed are found nowhere else) and 19% of these endemics are threatened with extinction. The trend in species status over time, measured by the Red List Index (RLI), shows that vertebrate groups and plants are declining in threat status at a similar rate, but butterflies show a sharper RLI decline (Figure 45).

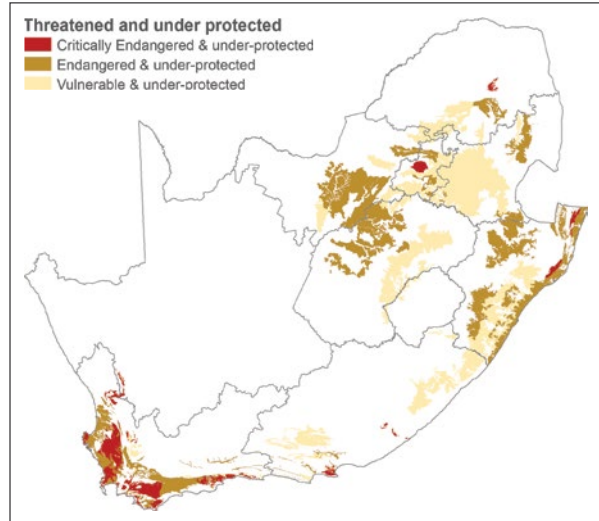


Figure 43. Threatened and under-protected ecosystem types.

Mammals are the most threatened taxonomic group, with 17% of indigenous taxa threatened (Figure 44). However, much of the decline was historical and compared to other taxonomic groups they have declined the least in the last 15 years (Figure 45). Concerted efforts to conserve threatened mammal species by South African conservation agencies have resulted in ten species becoming less threatened (Box 5). Overall, the status of South African mammals is still declining, with 13 taxa having moved to a higher category of threat between 2004 and 2016. The main pressures causing mammals to increase in threat status are direct persecution through poaching and hunting for bushmeat, crop cultivation, plantation forestry (affecting 46% of taxa), and housing development (affecting 31% of taxa). Agriculture in the form of crop cultivation and livestock farming is the pressure that impacts on the highest proportion of Taxa of Conservation Concern (Figure 39, p. 77). The Savanna biome has the highest concentration of threatened mammal taxa (Figure 46).

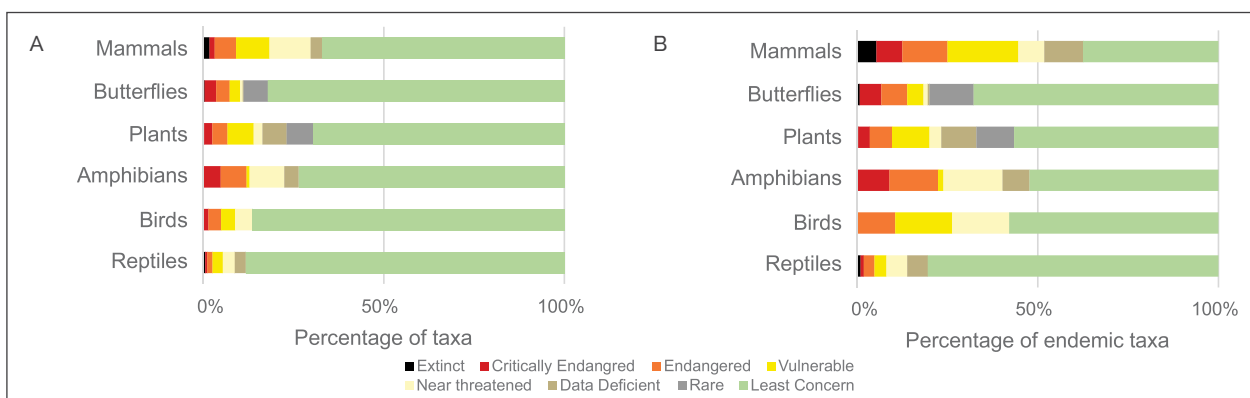


Figure 44. The proportion of indigenous taxa (A); and endemic indigenous taxa (B) in each of IUCN categories for the terrestrial realm.



© Cape Nature



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© Elsa Bussiére

Box 5. Improvement in the threat status of certain mammals

While wildlife abundance continues to decline across most of Africa, South Africa remains a stronghold for mammal conservation, boasting genuine success stories that often result from cooperation between the public and private sectors. Both the Cape Mountain Zebra (*Equus zebra zebra*) and Lion (*Panthera leo*) are no longer listed as threatened due to strong population growth in both protected areas and private conservation areas. For the Cape Mountain Zebra, the population has been increasing steadily from 1985 to 2014, despite being reduced to fewer than 80 individuals in the 1950s. Similarly, the Lion has been stable or increasing over the past 20–30 years. In Kruger National Park, the population has increased over the past decade, and the population within smaller protected areas and private conservation areas has increased from ten to ± 500 . Cheetahs, which were extirpated from over 90% of their former distribution range in South Africa, are slowly starting to increase in numbers through careful metapopulation management. Honey Badgers (*Mellivora capensis*) have improved in status as a result of reduced persecution linked to farmers being incentivised via ‘badger friendly’ honey labelling programmes to rather protect hives from damage than to persecute badgers.

The effectiveness of South African protected areas (both terrestrial and marine) in mitigating threats has been demonstrated by the improvement of status of Tsessebe (*Damaliscus lunatus*), Southern Elephant Seal (*Mirounga leonina*) and Humpback Whale (*Megaptera novaeangliae*).

South Africa’s flora shows very high levels of species diversity and endemism: 13 763 of the 20 401 taxa (67%). Of all groups assessed to date, plants have the absolute highest number of threatened taxa with 2 804 taxa (14%) threatened with extinction (Figure 44), the vast majority of which are endemics (2 722 taxa). A further 1 500 taxa (7% of the flora) are listed under South Africa’s national conservation category of Rare. Approximately 5% of the sample of 900 plant taxa used to calculate the Red List Index increased in threat status over the 28 year period between 1990 and 2018 (Figure 45). The main pressures causing plant taxa to increase in threat status are competition from invasive plant species (affecting 40% of

taxa); crop cultivation (affecting 33% of taxa); urban development (affecting 20% of taxa) and habitat degradation as a result of livestock overgrazing (affecting 11% of taxa). The ability to detect change in status of plant species is hindered by lack of monitoring data available on the impacts of overgrazing and medicinal harvesting, the proportion of plants that have changed statuses is therefore likely to be underestimated.

Threatened plants are concentrated in the Fynbos biome, with 67% (1 893 taxa) of all threatened plant taxa occurring there (Figure 46). The Succulent Karoo and Grassland biomes are also rich in endemic plants,

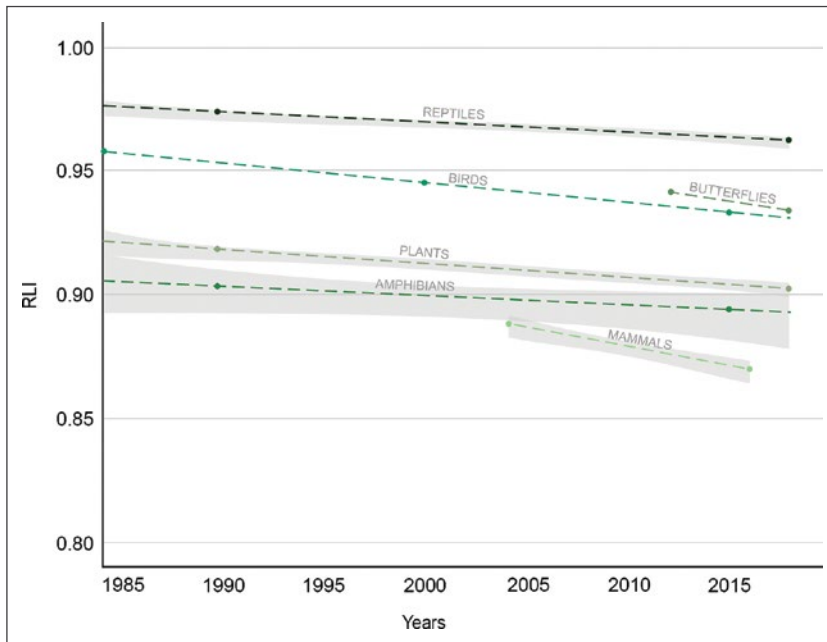


Figure 45. Trends in status of South Africa's terrestrial species: reptiles, amphibians, birds, mammals, plants and butterflies based on the Red List Index. The slope of the line indicates the rate at which species groups are becoming more threatened over time, grey shading indicates uncertainty of trends and is most strongly influenced by number of Data Deficient species within a taxonomic group.

and with high rates of habitat loss in the Grassland biome and significant degradation from livestock ranching in the Succulent Karoo there are resulting high numbers of threatened plant taxa occurring in both biomes (Figure 46).

Amphibians are the third most threatened taxonomic group with 13% of all species and 26% of endemics threatened with extinction (Figure 44). A large proportion (50%) of endemic species fall into a category of conservation concern. Six species have become more threatened since 1990, primarily as a result of loss of habitat to plantation forestry and housing development as well as competition from invasive species. Overall 79% of amphibian Taxa of Conservation Concern are impacted by invasive alien plants (Figure 39). Threatened amphibians are concentrated along the east coast of KwaZulu-Natal, on the Drakensberg foothills, and on the Cape Peninsula, Cape Hangklip and Agulhas Plain (Figure 46).

One in four of South Africa's endemic birds is threatened with extinction (26%) and overall 9% of South Africa's terrestrial birds are threatened (Figure 44). Birds became more threatened between 2000 and 2015, with 27 taxa (4% of the 732 birds assessed) shifting into higher risk categories and only two species improving in status. Crop cultivation (affecting 38% of taxa); plantation forestry (affecting 25% of taxa) and poisoning (affecting 21% of taxa) are the main pressures that have caused increase in threat status. The highest numbers of threatened birds are concentrated in the northeastern parts of South Africa in the Savanna, Grassland and Indian Ocean Coastal Belt biomes (Figure 46).

Approximately 5% of South Africa's reptiles are at risk of extinction. There appears to be only a small increase in extinction risk over the last 25 years, with the Red List Index (RLI) showing a small decline between 1990 and 2018. Most of the species now at risk were already at risk in 1990 and that risk has not substantially increased or decreased in the interim (Figure 45), as most of the habitat loss impacting South Africa's reptiles took place prior to 1990. As a result, only 14 (3.6%) of 391 reptiles assessed in 2018 changed status between 1990 and 2015. The highest concentrations of threatened taxa for reptiles are in northern KwaZulu-Natal, within the Maputaland Centre of Endemism (Figure 46).

To date butterflies are the only terrestrial invertebrate group to have been assessed, of which 10% of taxa are threatened and 18% listed as of conservation concern (Figure 44). More than 50% of South Africa's butterfly species are endemics with restricted ranges, making them highly vulnerable to changes in land-use. The RLI for butterfly species (Figure 45) shows the sharpest decline of any terrestrial group, with 13 species becoming more threatened in the short period between 2013 and 2018. Leading causes of decline are habitat alteration as a result of spreading invasive alien plant species (affecting 46% of taxa); drought (affecting 38% of taxa); loss of habitat to crop

Thirteen butterfly species have become more threatened between 2013 and 2018. The synergistic impacts of climate change linked to drought, increase in invasive alien plants and the resulting increase in fire intensity are the main causes of their decline. The species include: (A) White-spotted Sapphire (*Iolais lulua*), Vulnerable; (B) Highveld Giant Cupid (*Lepidochrysops praeterita*), Endangered; (C) Brenton Blue (*Orachrysops Niobe*), Critically Endangered. © Steve Woodhall.

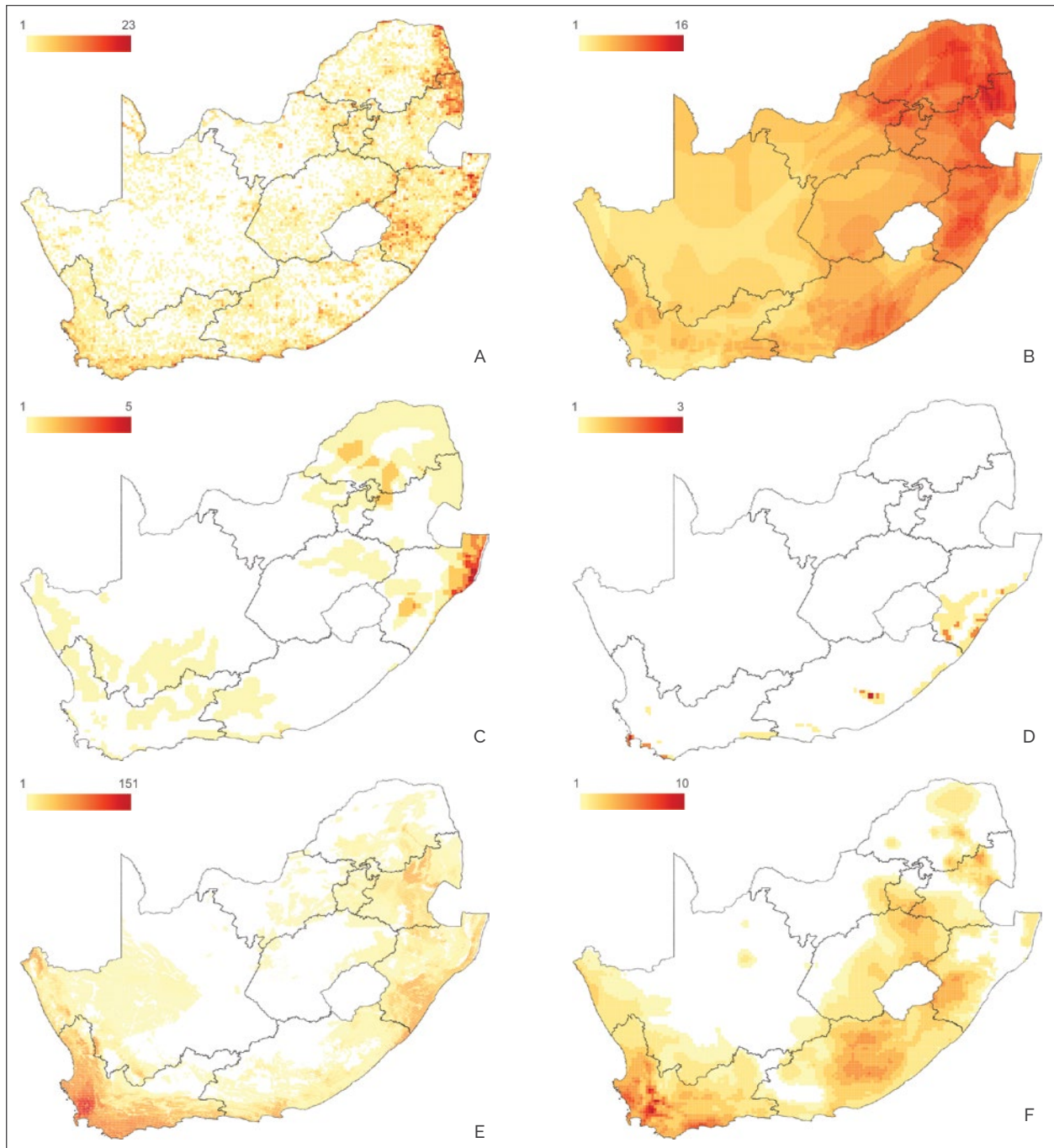
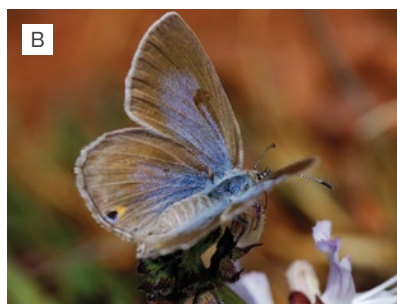


Figure 46. Spatial distribution of threatened species for the six taxonomic groups included in the terrestrial realm assessment: (A) birds, (B) mammals, (C) reptiles, (D) amphibians, (E) plants and (F) butterflies. The legend reflects the number of threatened species per 10 km × 10 km grid cell. Maps are based on a combination of expert interpreted species distributions, modelled distributions and species range maps.



cultivation (affecting 15% of taxa); habitat degradation as a result of too frequent fire (affecting 15% of taxa) and heavy livestock grazing (affecting 15% of taxa). Threatened butterflies are concentrated in the southern Cape, the Cape Fold Mountains of the southwestern Cape and in the Drakensberg foothills of the Eastern Cape and KwaZulu-Natal (Figure 46).

3.1.7 Species protection level in the terrestrial realm

South Africa's protected areas network provides relatively good protection for birds and reptiles with over 85% of their taxa categorised as Well Protected (Figure 47). Protected area expansion has improved the representation of threatened birds within protected areas from 80% represented in 1990 to 94%. Despite this, 53 threatened birds are under-protected (Figure 48).

Of the 389 reptile species included in the analysis, all non-endemics (100%) and 87% of endemics were classified as Well Protected (Figure 47). Protected area expansion since 1990 has increased the representation of threatened reptiles from 63% to 89%. This is most likely due to the increase in protected area estate associated with the declaration of the iSimangaliso Wetland Park in 2000, an area of high concentration of threatened reptiles and the expansion of protected areas in the arid western regions of the country. Despite this, seven threatened taxa remain under-protected, and crucially, this includes the two most threatened reptiles in South Africa – the Critically Endangered Durban Dwarf Burrowing Skink (*Scelotes inornatus*) and the Critically Endangered Geometric Tortoise (*Psammodates geometricus*) (Figure 48).

Due to South Africa's extremely high diversity of plant taxa (20 401 taxa), the protection level for plants was determined using a statistically representative random sample of 900 taxa. Based on this sample, plants have the highest proportion of under-protected taxa with 17% in the category Not Protected (Figure 47). Of concern is the fact that 81% of the threatened taxa included in the sample were classified as under-protected (Figure 48). Interestingly, 18% of widespread least concerned plant taxa included in the sample were also under-protected. This is due to large parts of South Africa, in particular Bushmanland, the Great Karoo and northwestern Limpopo, having very few protected areas and also low rates of habitat loss. The northern Namaqualand coast, western border of Bushmanland between Platbakkies and Gamoep and Steytlerville Karoo have areas with high numbers of Not Protected range-restricted endemic plants. Protected area expansion in these areas offers good opportunities to improve the representation of plant species in protected areas.

As long-term persistence in protected areas is determined by the ability of protected areas to mitigate against threats, it was necessary to determine to what extent protected areas are effectively protecting plant populations. Our analysis showed that 6% of plant taxa included in the sample dropped a category of protection, due to the rapid expansion of invasive alien plant species and inappropriate fire return intervals occurring in protected areas in the Fynbos biome and the grazing of livestock taking place in certain Grassland and Savanna protected areas.

An analysis of the intersection between the expanding protected area network and South Africa's 2 804 threatened plant taxa showed that representation of threatened plant taxa in the network has increased steadily since 1990 to 69% in 2018. Since 2010, 62 previously unprotected threatened plant taxa have

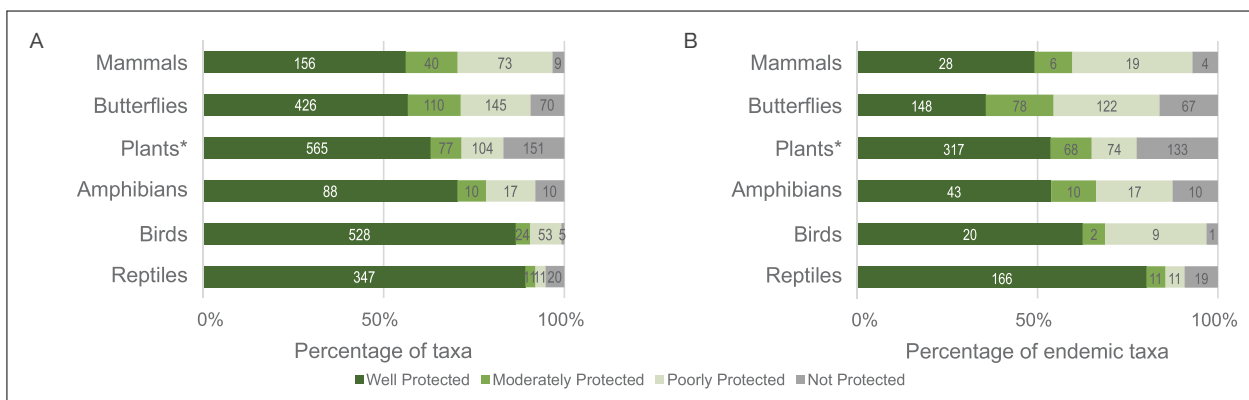


Figure 47. Protection level for South Africa's indigenous terrestrial taxonomic groups. Analysis conducted for both threatened and non-threatened taxa, but excluded peripheral taxa (those with less than 5% of distribution range occurring in South Africa); (A) shows all analysis for all taxa; (B) shows protection level for South African endemics. *Due to the extremely high number of plants occurring in South Africa, a representative sample of 900 plants were assessed.

come under protection. Unfortunately, during this same period 265 plant taxa were added as threatened to South Africa's Red List of plants. There is therefore a need to accelerate the expansion of protected areas to sites with high concentrations of threatened plants. Currently 875 threatened plant taxa in South Africa have no form of protection.

Only 57% of South Africa's butterfly taxa are Well Protected (Figure 47), with a high proportion (89%) of the threatened taxa also classified as under-protected (Figure 48). Since 2000, protected area expansion has brought only one previously unprotected threatened butterfly into protection, and 36 (46%) of threatened butterfly taxa have no populations represented in protected areas. This suggests that invertebrates have not been sufficiently considered in protected area expansion to date. Furthermore, when considering the effectiveness of protected areas to mitigate pressures that impact butterflies, increases in invasive alien plant species and livestock grazing within protected areas, often coupled with poor fire management, has resulted in 49 butterfly taxa (7% of all taxa assessed) dropping a category of protection.

Just over a quarter of all South African amphibians (28%) are under-protected (Figure 47). The situation is worse for species endemic to South Africa (84 species), of which 44% are under-protected. Most threatened amphibians (94%) have at least one population

represented within South Africa's protected area network (Figure 48). However, protection is not adequate for many species; for example, three South African endemic frogs: *Heleophryne rosei*, *Capensibufo rosei* and *Arthroleptella subvoce*, which occur almost exclusively within protected areas, did not qualify as Well Protected (Box 6). This reflects the insufficient mitigation of threats to these species within the protected areas, resulting in population declines. Overall, 9% of amphibian species drop down a category of protection due to threats within protected areas not being effectively mitigated. Drivers for this include the presence of considerable stands of invasive or alien plant species in protected areas and changes in habitat structure and function due to disrupted natural fire regimes.

Mammals have the lowest levels of protection, with 56% of species assessed as Well Protected (Figure 47). Of the 47 threatened terrestrial mammals, 42 (89%) are under-protected (Figure 48). Mammals typically have large home ranges and hence require larger areas to be effectively protected. Simultaneously, high levels of poaching for bushmeat or illegal wildlife trade mean that protection is not effective for many species. Eleven mammal taxa (4%) drop to a lower category of protection due to insufficient mitigation of pressures within protected areas boundaries. There is a need to bring more threatened mammal species into protection. While representation of threatened mammals within South Africa's protected area

Box 6. Three amphibians are under-protected despite mostly occurring in protected areas

Three South African endemic amphibians (*Heleophryne rosei*, *Capensibufo rosei* and *Arthroleptella subvoce*), despite occurring almost exclusively within protected areas, qualify as under-protected. This reflects the fact that protected areas where these species occur are not mitigating against pressures and processes causing population decline. Each of these species also carries a highly threatened Red List status of Critically Endangered signalling the urgent need for protected area managers to ensure management supports the ecological requirements of these species.

(A) Northern Moss Frog (*Arthroleptella subvoce*), Critically Endangered, © Atherton de Villiers; (B) Rose's Mountain Toadlet (*Capensibufo rosei*), Critically Endangered, © Atherton de Villiers; (C) Table Mountain Ghost Frog (*Heleophryne rosei*), Critically Endangered, © Luke Verburgt.



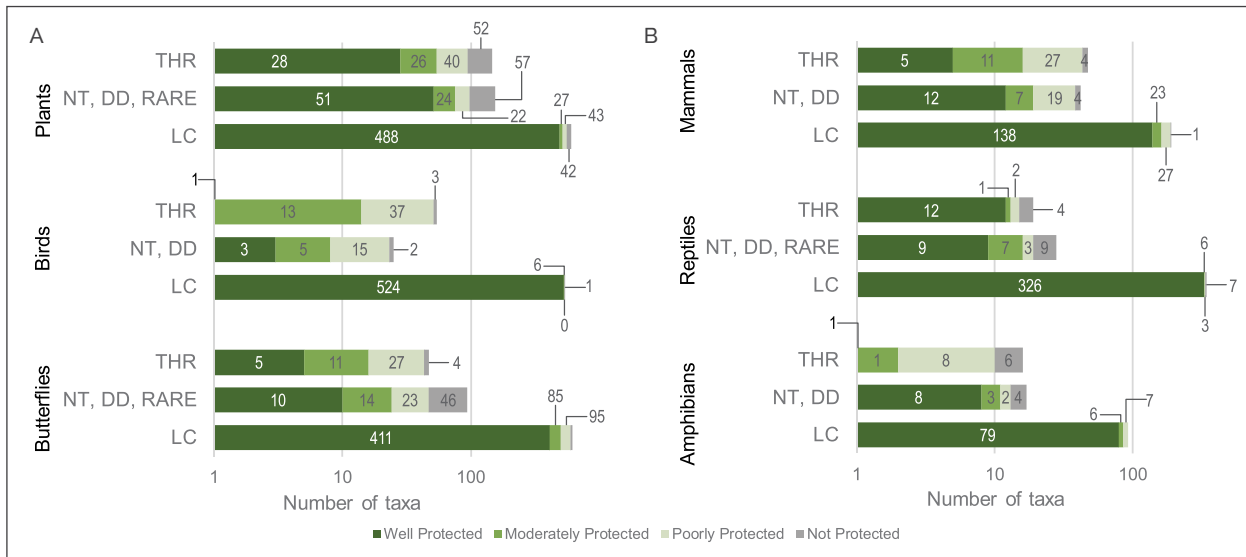


Figure 48. Protection level for South Africa's indigenous terrestrial taxa disaggregated into three categories: threatened (THR) species [CR, EN, VU]; Near Threatened, Data Deficient and Rare (NT, DD, RARE); and species of Least Concern (LC). The assessments are comprehensive (covering the whole taxonomic group) except for plants where a representative sample of 900 species was used. Panel (A) plants, birds and butterflies; panel (B) mammals, reptiles and amphibians. Note the logarithmic x-axis for the two panels.

network has grown from 56% to 61% since 1990, a number of restricted and threatened endemic small mammals, such as golden moles (*Chrysochloridae*), are poorly represented in the protected area network.

The results of the protection level analyses for species show that protected area expansion needs to focus on under-protected and threatened taxa for all taxonomic groups. Protected area expansion in Bushmanland, Steytlerville Karoo and northwestern Limpopo, as well as the Namaqualand coastline, where there are still large areas of intact natural habitat, offer opportunities to enhance the representation of under-protected taxa.

Our analysis also indicates that protected areas are not meeting ecological requirements for 9% of amphibian, 6% of plant, 7% of butterfly and 4% of mammal taxa. A mechanism to share data on priority threatened taxa that are declining within protected areas is currently being developed for use by protected area managers.

3.1.8 Genetic diversity in the terrestrial realm

Life on Earth relates directly to the diversity of genes in space and time. The genomes of organisms encode the basic physiological, phenological, behavioural and biological structures that define them and allow species to survive and persist through time in changing environments. Genetic diversity is recognised as an important component of biodiversity together with

species and ecosystem diversity. The maintenance of genetic diversity is of utmost importance as it equates to evolutionary potential, and thus allows species or populations to adapt to an ever-changing environment. Risks to genetic diversity include genetic erosion through anthropogenic impacts on the landscape and directly on individual species. For example, habitat fragmentation, hybridisation and inbreeding as well as overutilisation causing population declines can contribute to genetic erosion. In addition, genetically modified organisms present a risk through the escape of undesirable genes into native populations.

Long-term monitoring is well recognised as a way to detect genetic erosion for populations or species; however, there is a lack of temporal genetic datasets globally, as well as a lack of genetic diversity indicators and thresholds with which data can be compared. A genetic monitoring framework is required that outlines how to prioritise species for monitoring, what genetic markers to use, how often populations should be monitored and which metrics to consider. Ideally, genetic monitoring should also be carried out at the landscape level to identify areas on the overall landscape that might be subject to genetic erosion, yet such an approach has not been put into effect. In South Africa, two short-term monitoring studies have been carried out in the terrestrial realm that explicitly monitor temporal shifts in the genetic diversity of South African species, and these studies provide valuable insight into establishing monitoring programmes.

Although genetic erosion is important to track for priority species, this approach cannot provide insight

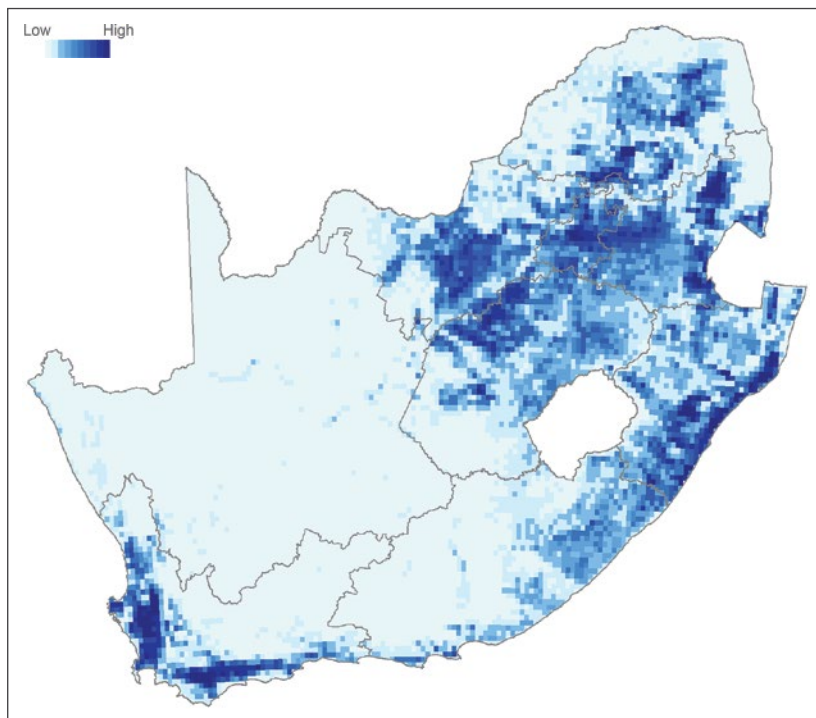


Figure 49. Spatial distribution of areas subject to genetic erosion for South African reptiles. Darker shading shows areas most at risk.

regarding genetic erosion overall (e.g. over the landscape or nationally). A single national indicator would require tracking changes in genetic diversity for numerous species across their distributions, yet this exercise is logistically and financially unworkable. For the NBA 2018, a proxy indicator to track genetic erosion at the national level was developed and applied to a group of terrestrial vertebrates as a case study (Figure 49). The indicator is an integration of phylogenetic richness indicators (e.g. phylogenetic diversity or similar metrics) and land cover, resulting in a spatial metric that indicates areas prone to loss in phylogenetic richness due to land transformation. For the case study (reptiles), the metric showed areas of impact are in the northeast (Limpopo, Mpumalanga, and Gauteng provinces), southwest (Western Cape Province) and the coastal margin of KwaZulu-Natal.

The case study highlights types of indicators that could be used, but the method will need to be tested further, and applied to other taxonomic groups to provide an assessment regarding landscape-wide genetic erosion over time.

Maintaining genetic diversity ensures that species have the potential to adapt to our changing environment. Risks contributing to genetic erosion include habitat loss and fragmentation, decreased connectivity between populations, inbreeding and contamination from genetically modified organisms. These risks could undermine the ecosystem function, evolutionary potential and species resilience, and as such, the inclusion of genetic information brings a valuable and much needed component to biodiversity assessments.

3.2 Inland aquatic realm

ECOSYSTEMS

64%

of 222 river
ecosystem types
Threatened

79%

of 135 inland wetland
ecosystem types
Threatened

13%

of 222 river
ecosystem types
**Well
Protected**

6%

of 135 inland wetland
ecosystem types
**Well
Protected**

42%

of 222 river
ecosystem types
**Not
Protected**

61%

of 135 inland wetland
ecosystem types
**Not
Protected**

SPECIES

17%

of 658 taxa assessed
Threatened

68%

of 501 taxa assessed
**Well
Protected**

18%

of freshwater fishes
**Well
Protected**

3.2.1 Summary

River and inland wetlands ecosystem types represent the diversity of inland aquatic ecosystems of South Africa. The high temporal and spatial variability of rainfall in South Africa results in variable runoff and flow regimes for rivers, as well as a diverse range of flood regimes for wetlands. The combination of a broad range of climatic settings, high topographic variability, and variable hydrological regimes make for high ecosystem-level diversity. Limited geographic ranges for a number of taxa contribute to high species endemism. Two layers represent these ecosystem types in the South African Inventory of Inland Aquatic Ecosystems (SAIIAE): (i) the 222 river ecosystem types with 164 018 km of mainstems and tributaries; and (ii) the 135 inland wetland ecosystem types mapped in the National Wetland Map version 5 (NWM5). Inland wetlands mapped in NWM5 cover 2.2% of South Africa. Detailed catchment-level studies have, however, indicated that wetland coverage is higher in certain regions of South Africa, suggesting that the extent of inland wetland ecosystem types is currently underestimated. Continued efforts are required to improve the representation of inland aquatic ecosystem types in the national inventory.

Water security is essential for human wellbeing and livelihoods. Ecologically healthy aquatic ecosystems supply the quantity and quality of water required for survival. Freshwater is often a limiting resource for socio-economic development. Over-abstraction of water and water pollution place aquatic ecological infrastructure assets at risk. Strategic Water Source Areas (SWSAs) are landscapes where a relatively large volume of runoff produces water for the majority of South Africa. The National Freshwater Ecosystem Priority Areas (NFEPA) study initially identified high water yield areas and high groundwater recharge areas. Recently, these were refined to 22 areas for surface water (SWSA-sw), covering 10% of the extent of South Africa and supplying 50% of the country's mean annual runoff. In addition, 37 areas for groundwater (SWSA-gw) were identified, accounting for 9% of the land surface of South Africa and up to 42% of the baseflow in the respective areas, sustaining flows in the dry season. **Currently, only 13% of the SWSAs' extent fall within protected areas.** Catchment-level planning and management are thus critical



- 1 Changes to the hydrological regime
- 2 Pollution
- 3 Habitat loss
- 4 Biological invasions
- 5 Climate change

Section based on:

Van Deventer, H., et al. 2018. *South African inventory of inland aquatic ecosystems (SAIIAE)*. CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A. South African National Biodiversity Institute, Pretoria.
<http://hdl.handle.net/20.500.12143/5847>.

Van Deventer, H., et al. 2019. *South African National Biodiversity Assessment 2018 Technical Report Volume 2: Inland Aquatic (Freshwater) Realm*. CSIR report number CSIR/NRE/ECOS/IR/2019/0004/A. South African National Biodiversity Institute, Pretoria.
<http://hdl.handle.net/20.500.12143/6230>.



South Africa's rivers and wetlands range from small ephemeral pools and streams in the Karoo to lakes such as Lake Sibaya in KwaZulu-Natal and raging rivers such as the Orange River in the Northern Cape (A) or the uThukela River that powers down from the Drakensberg (B). Freshwater ecosystems are not only essential for our everyday survival, they are also places for rituals (C) and enjoyment (D). Unique to headwater streams of the Cape Floristic Region, the Cape Kurper (*Sandelia capensis*, Data Deficient) with its iridescent gill covers (E), looks more like the kind of fish one would expect to see while snorkelling a coral reef.



for ensuring that the ecosystem diversity, functionality and connectivity are maintained.

Inland wetlands are highly threatened and under-protected. Nearly 80% of inland wetland ecosystem types are threatened (107 of 135; 61% Critically Endangered, 9% Endangered and 9% Vulnerable), constituting more than 2.3 million ha of >2.6 million hectares of inland wetlands mapped in NWM5. **Approximately 75% of inland wetland ecosystem types are both threatened and under-protected.** Only 6% of inland wetland ecosystem types are considered Well Protected, while 61% are Not Protected. Compared to the NBA 2011, where wetlands were found to be poorly mapped, highly threatened and Poorly Protected, the trends in ecological condition and protection level appear to be declining further. Action ought to be taken to improve maps in planning and prioritisation, involve citizens in stewardship programmes, improve awareness and accountability of all citizens, and implement the National Wetland Monitoring Programme.

River ecosystem condition declined by 11% between 1999 and 2011. Of the 222 river ecosystem types assessed, 64% were found to be threatened (43% Critically Endangered, 19% Endangered and 2% Vulnerable). River ecosystem types are also Poorly Protected with only 13% considered Well Protected and 42% Not Protected. The majority of rivers (67% of total river length) are degraded. Tributaries are generally less heavily impacted than main rivers with 38% of tributary length in natural condition compared to 28% of mainstems. The percentage of threatened river ecosystem types is higher for lowland and lower foothill rivers (67%) than for the upper foothills and mountain streams (25%), which is a reflection of multiple pressures accumulating and increasing from river source to sea. River protection levels are higher for mountain stream types (16% Well Protected) than for lowland types (6% Well Protected), reflecting the general bias of protected areas to mountainous regions. During the NFEPA project 62 free-flowing rivers were identified, but the decline in ecological condition between 2011 and 2018 resulted in 14 rivers losing this status. Of these 14 rivers, four lost more than half and the remainder lost all of their extent in a natural condition. Cooperative governance linked to integrated water resource management partnerships at catchment scale is required to address the decline in the ecological condition of rivers and to ensure effective river conservation.

The 19 free-flowing rivers identified as flagships rivers in the NFEPA project of 2011 have remained intact over the past seven years. Despite the general

decline in ecological condition of river ecosystem types, the value of effective conservation planning through the NFEPA project and implementation of these priorities at various scales, ensured that the ecological condition of these rivers were maintained. It is crucial that these flagship rivers retain their free-flowing character since they provide important ecosystem services to the communities along their shores. The flagship rivers represent some of the few remaining examples of connected river ecosystem types that are intact from source to sea, both in South Africa and globally.

South Africa has eight unique freshwater lakes (freshwater bodies greater than 2 m in depth, also known as limnetic depressions), all of which are Critically Endangered and under-protected. South Africa's largest lake, Lake Sibayi (8 400 ha) on the Maputaland Coastal Plain in KwaZulu-Natal, provides freshwater to communities in the vicinity. The remaining freshwater lakes include Baberspan (1 730 ha), Chrissiesmeer (1 300 ha), De Hoop (950 ha), Groenvlei (360 ha), Tevredenpan (330 ha), Lake Fundudzi (200 ha) and Lake Banagher (185 ha). All eight of the freshwater lakes are considered Critically Endangered since <20% of the spatial extent of these systems is in a natural or near-natural ecological condition. The key pressures on these systems are changes to the hydrological regime, water pollution, habitat modification, invasive species and climate change. Five of the freshwater lakes are Not Protected while three are Poorly Protected.

A total of 658 indigenous freshwater taxa associated with rivers and inland wetlands, from seven taxonomic groups, were assessed for this NBA. Of these freshwater fishes are the most threatened (36% of all taxa and 66% of endemic taxa threatened). Amphibians, birds, Odonata (dragonflies and damselflies), mammals, freshwater fishes, reptiles and a sample of aquatic plants were assessed. Of these taxa, 160 taxa are endemic and 65 (41%) of endemic taxa are threatened with extinction. All freshwater-associated taxonomic groups exhibited a gradual decline in Red List Index threat status over the assessment period, indicating that pressures are impacting species in aquatic ecosystems. While freshwater fishes had the highest threat levels, freshwater mammals had the steepest decline. Based on a meta-analysis of species Red List assessments, the major pressures causing decline were invasive alien species, habitat loss and degradation due to pollution, urban expansion, poor dam and water management activities and agricultural activities. Despite multiple threats to freshwater fish species, including pollution, invasive species and over-abstraction of water, no freshwater

fish taxa have yet gone extinct, largely owing to active management interventions by conservation agencies. The high levels of endemism of this group (49%) means that urgent conservation interventions are required. Multiple and integrated mechanisms are essential for curbing the pressures on freshwater fishes. Successful invasive fish eradication methods trialled by CapeNature during this past assessment period need to be expanded and rolled out nationally.

The first protection level assessment for species found that the majority of freshwater-associated taxa, with the exception of freshwater fishes, are Well Protected: 100% of freshwater-associated reptiles, 83% of birds, 65% of mammals and 76% of amphibians. Only 18% of freshwater fish species are Well Protected, which can be attributed to their sole dependence on rivers and the fact that only 14% of South African river lengths occur within the protected area network. Moreover, only 43% of South Africa's rivers are in a natural/near-natural condition. Pressures not mitigated through the protected area network have resulted in 20 freshwater fish taxa (21%) and eight amphibian taxa (8%) dropping down a category of protection. Twenty-three Taxa of Conservation Concern were assessed as Not Protected and these should be prioritised. There is an urgent need to increase the representation of inland aquatic systems within the protected area network, prioritising rivers and inland wetlands inhabited by under-protected species. Furthermore, there is a need to bolster management interventions that mitigate threats to freshwater Taxa of Conservation Concern within protected areas.

3.2.2 Input data and method for the inland aquatic realm

Ecosystems

River ecosystem types and condition assessment

The river ecosystem delineation and classification system used in the NBA 2018 remains largely unchanged from the previous NBA. The NFEPA river network spatial layer was classified using 31 Level 1 ecoregions, flow variability (permanent to not permanent) and geomorphological zones or slope categories (mountain stream, upper foothill, lower foothill and lowland river) to produce 222 distinct combinations

of river ecosystem types (Figure 50). Ecoregions broadly characterise the landscape through which a river flows, such that rivers in the same ecoregion share similar broad ecological characteristics (e.g. topography, rainfall and geology), though shortcomings of this dataset have recently been noted. Future updates should include improved landscape classification and validation of the river ecosystem types with species data.

The ecological condition for each river ecosystem type was assessed using aggregated ecological condition categories produced as part of the Present Ecological State/Ecological Importance/Ecological Sensitivity national dataset (referred to as PES data) developed by the DWS⁷. The process included mainstems and tributaries at a sub-quaternary catchment level and was expert driven, considering six underlying indicators (flow modification, physico-chemical modification, in-stream habitat and habitat continuity modification, riparian/wetland zone habitat and habitat continuity modification) and describing the extent of ecosystem modification. The aggregated ecological condition categories range from natural (A) to critically modified or extremely degraded (F) (Table 2, p. 54).

Inland wetland ecosystem types and condition assessment

Inland wetland ecosystem types are represented in the NMW5. They consist of a combination of vegetation bioregions (37) and four simplified hydrogeomorphic units (depressions, floodplains, seeps and valley-bottom wetlands), relating to Levels 2 and 4A respectively of the *Classification system for wetlands and other aquatic ecosystems in South Africa*. The digital map contains 135 wetland ecosystem types of the potential 148 combinations. In the data capturing process, the principles of the original and maximum extent of inundation or soil saturation were followed.

The ecological condition for inland wetlands was modelled based on available datasets reflecting primarily the location or extent of pressures; however, no information on the duration, magnitude or severity of these pressures were available. This introduces considerable uncertainty in this assessment that will hopefully be reduced for future assessments, as the National Wetland Monitoring Programme becomes operational and reliable in situ monitoring data becomes available. Datasets used to model the ecological condition included degraded rivers, active and abandoned mines, Waste Water Treatment

⁷ The national dataset was updated with information from a range of catchment-level studies that took place between 2011 and 2017.

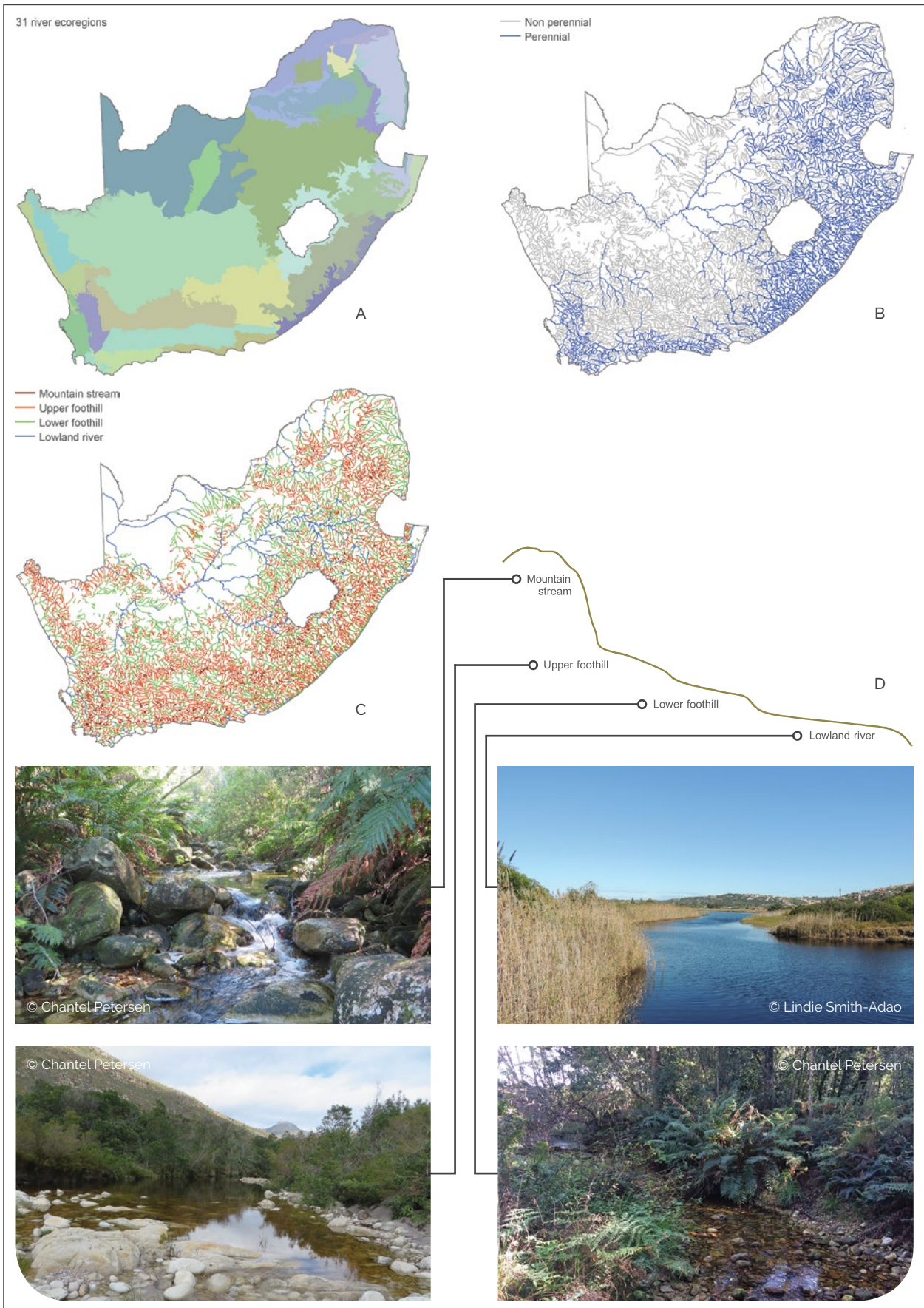


Figure 50. The classification of river ecosystem types includes (A) Level 1 ecoregions, (B) flow variability (perennial /non-perennial) and (C) slope categories. The combination of the above datasets results in 222 distinct river ecosystem types. Panel (D) illustrates the slope categories.

Works (WWTWs), aquaculture facilities, roads and railways, artificial wetlands (including dams), burning peatlands, and anthropogenic land cover classes.

The assessment of river and inland wetland ecosystem threat status focussed on the degree of degradation of each ecosystem type, while for freshwater lakes restricted extent and degradation were used as the basis for the assessment. The methods used followed that of previous NBAs, but is broadly aligned with Criterion B (limited extent) and C (environmental degradation) of the IUCN Red List of Ecosystems.

Ecosystem assessments

To determine the threat status of inland aquatic ecosystems, the proportion of each ecosystem type in a natural/near-natural condition was assessed against a series of thresholds (Table 6). Owing to insufficient data in determining ecologically differentiated targets, a wide range of stakeholders from related sectors (water, environment and agriculture) agreed to a biodiversity target of 20% for inland aquatic ecosystems at a cross-sectoral policy process held in 2006. This target means that at least 20% of each ecosystem type should remain in a natural or near-natural ecological condition, defined as the A or B ecological category (referred to as Present Ecological State or PES). Similar to the NBA 2011, rivers and inland wetlands were evaluated against this 20% biodiversity target and a set of additional thresholds (Table 6). Consequently, ecosystems with <20% of their spatial extent in a natural/near-natural ecological condition, were considered Critically Endangered. Thresholds of 35% and 60% were used for Endangered (EN) and Vulnerable (VU) categories, whereas ecosystems with >60% in a natural or

near-natural ecological condition were considered of Least Concern (LC).

For the protection level assessment, which involved intersecting ecosystem maps with the protected areas layer, only inland wetland and river features in a natural or near-natural condition were considered to be contributing to the 20% target assigned to each ecosystem type. For the inland wetlands an additional step involved assessing the contribution of South Africa's 23 Ramsar sites to ecosystem protection. These sites are not by definition protected areas, but in many cases do overlap with existing protected areas and must have management plans. The extent of inland wetlands in a natural/near-natural ecological condition that are within Ramsar sites not falling within the existing protected area boundaries are reported on separately.

Rivers and inland wetlands within protected areas may however still be exposed to a number of pressures imposed from beyond the protected area, such as water abstraction or detrimental land uses in their catchments, which may result in fragmentation and water pollution. As a result of the high level of longitudinal and latitudinal connectivity between inland aquatic ecosystems, as well as dependency on baseflow, this indicator may tend to overestimate protection of aquatic systems.

Detecting changes to the free-flowing and flagship rivers

Free-flowing rivers (62 identified by the NFEPA project in 2011) are characterised as stretches of river that flow undisturbed without any dams, and serve as examples of river ecosystem types that are intact from

Table 6. Thresholds used in determining the ecosystem threat status of rivers and inland wetlands. PES refers to ecological condition using the Present Ecological State framework (see Table 2, p. 54)

	CR	EN	VU
Thresholds applied to river ecosystems	Where the length of river ecosystem type in a natural or near-natural ecological condition (PES = A or B) is $\leq 20\%$ of the total length for that ecosystem type.	Where the length of river ecosystem type in a natural or near-natural ecological condition (PES = A or B) is $\leq 35\%$ of the total length for that ecosystem type.	Where the length of river ecosystem type in a natural or near-natural ecological condition (PES = A or B) is $\leq 60\%$ of the total length for that ecosystem type.
Thresholds applied to inland wetland ecosystems	Where the extent (area) of each inland wetland modelled in a natural or near-natural ecological condition is $\leq 20\%$ of the total extent for that ecosystem type.	Where the extent (area) of each inland wetland modelled in a natural or near-natural ecological condition is $\leq 35\%$ of the total extent for that ecosystem type.	Where the extent (area) of each inland wetland modelled in a natural or near-natural ecological condition is $\leq 60\%$ of the total extent for that ecosystem type.

source to mouth (estuary) along their route through different geomorphological zones. They meet the following ecological condition criteria:

- Permanent or seasonally flowing rivers (ephemeral rivers that do not flow every year were not considered).
- Length of ≥ 50 km for inland rivers, with no length threshold for coastal rivers.
- The majority of the length of the rivers is in a natural or near-natural ecological condition.

Of these 62 free-flowing rivers, 19 were selected as flagship rivers in 2011, being representative of free-flowing rivers across the country with importance for ecosystem processes and biodiversity value.

Species

Within the rivers and inland wetlands of South Africa, more than 5 000 species have been described, with the majority being invertebrates. Seven taxonomic groups were assessed for threat status and protection level, including all vertebrates (birds, mammals, reptiles, amphibians and freshwater fishes), one invertebrate group (Odonata – dragonflies and damselflies) and a sample of aquatic plants. Animal groups were assessed comprehensively for the NBA 2018 and species dependent on rivers and inland wetlands were then disaggregated; resulting in 20 mammals, 141 birds, 102 amphibians, 15 reptiles, 118 freshwater fishes and 162 dragonflies. More than 600 river and inland wetland plants occur in South Africa, so a random sample of 100 of these aquatic plants were included in this assessment.

3.2.3 Key drivers and pressures for rivers and inland wetlands

Four key pressures impact inland aquatic biodiversity, namely: (i) changes to the hydrological regime and subsequent fragmentation; (ii) water pollution and subsequent fragmentation; (iii) invasive species; and (iv) loss of natural habitat (habitat degradation) and subsequent fragmentation. The increase in temperatures observed and predicted globally affects the hydrological cycle. An increase in droughts, storm surges and floods would intensify negative impacts on inland aquatic ecosystems. Climate change is

therefore considered an important multiplier of threats to ecosystems and species.

The extent, magnitude and severity of impacts have not been established for the different river and inland wetland ecosystem types in South Africa. The DWS's river monitoring programmes that operated between the late 1990s and 2011 contributed significantly to assessments and plans for river ecosystem types across the country. Sufficient funding should be allocated to continue the monitoring of rivers and to the implementation of the National Wetland Monitoring Programme. Monitoring is essential for detecting change and to address uncertainties, particularly with the increased impacts resulting from climate change. Cooperative governance, research and citizen science are key elements of inland aquatic ecosystems monitoring.

Changes in hydrological regime

Modifications to the hydrological regime of rivers and inland wetlands negatively impact their biodiversity with the potential to lead to ecosystem collapse. Water is the key driver of river and inland wetland formation and essential to their functionality. Changes to the hydrological regime are caused by abstraction and diversion of water, inter-basin transfers, dam construction, water addition (e.g. agricultural return flows) and changes outside the natural inter- and intra-annual hydrological regime cycle of ecosystems. More than 70% of water abstracted from rivers and groundwater is used for agriculture, livestock and plantation forestry in South Africa.



More than 70% of water abstracted from rivers and groundwater in South Africa is used for agriculture, livestock and plantation forestry. © Oscar Max / AfriPics.



Excessive water abstraction in the Molopo River catchment (North West) has resulted in the lowering of the groundwater levels below what it has been for the last $\pm 7\,000$ years. Consequently, approximately 46 ha of the wetland's peat substrate has been burning since May 2016, and the system is therefore considered to have collapsed. © Piet-Louis Grundling.

Since South Africa is a water scarce country, many dams have been built to sustain water supply, resulting in linear fragmentation of river ecosystems that inhibit the migration of biota along the river channel as required for various parts of their life-cycles. Large dams in mainstem rivers have the capacity to store up to two-thirds of the country's total annual runoff. Changes in the natural sediment regimes of rivers are often significantly altered by these dams, particularly on mainstem rivers. Dam walls trap sediment, thereby reducing the ability of rivers to deliver sediment loads to downstream catchments, the beach and the ocean. Inter-basin transfers have also been built to secure continuous water supply, resulting in changes of hydrological regimes. For example, in one of the largest inter-basin transfers in South Africa, the Orange River to Great Fish and Sundays River, transfers of 1.7 billion m^3 of water per year results in a six- to nine-fold increase in flow in the recipient catchment. Excessive abstraction can even result in the total collapse of wetland ecosystem types. For example, a quarter of the riparian Lowveld Riverine Forest has been lost between 1990 and 2000 as a result of water abstraction and drought.

To date, at least 17 peat wetlands have collapsed. A combination of over-abstraction of water and drought resulted in the desiccation, and ultimately the burning, of the peat layer, converting these wetlands that typically act as carbon sinks into to carbon sources. The structural and functional diversity of hydrological regimes and their dependency on groundwater for baseflow (i.e. aquifer dependent ecosystems) are poorly understood in South Africa and are not being adequately monitored.

Disrupted flow regimes are not only a pressure on biodiversity, but also affect water security.

Water security is one of the most important issues for South Africa. As a semi-arid, water scarce country with variable rainfall, droughts are a regular feature of the country's climate. Between 2014 and 2018, drought was experienced in many parts of the country, and was particularly severe in the Western Cape. Intact ecological infrastructure in the form of healthy rivers, wetlands and riparian vegetation plays a crucial role in water security in the form of flow regulation, sediment regulation, water purification and groundwater recharge. Initiatives at the catchment level, such as clearing of invasive alien plants and restoring wetlands, is a far cheaper option than supply-side interventions such as desalination or groundwater extraction. See Compendium of Benefits of Biodiversity (SANBI 2019).

Water quality

Water pollution is a major cause of the decline in freshwater species, particularly freshwater fishes. A combination of sediment, nutrient, chemical and thermal water pollution cumulatively impact the biodiversity and functioning of river and inland wetland ecosystem types and their associated freshwater species. Pollution (such as poorly or untreated wastewater effluent from industries and WWTWs, mining waste, acid mine drainage and agricultural return flows) not only significantly increases nutrients,

metals, pesticides and other toxic compound loads, but can also change the natural temperature ranges and turbulence of aquatic environments. Furthermore, pharmaceuticals and micro-plastics are emerging contaminants that act as endocrine disruptors, impacting the productivity of aquatic species, and are of grave concern. Water pollution has dire, long-lasting consequences for aquatic organisms and hence ecosystems function. The Olifants River, which flows through the Kruger National Park, is a prime example of a river at the receiving end of a heavily utilised and degraded landscape. The impact of pollutants entering the river system have led to the demise of Endangered species such as the Nile Crocodile (*Crocodylus niloticus*), attributed to pansteatitis, as well as the mortality of several fish species in Loskop Dam. A decline in piscivorous bird species has also been observed, including Pel's Fishing Owl (*Scotopelia peli*).

A third of South Africa's 859 WWTWs are considered dysfunctional and 46 are under critical review. The resulting nutrient enrichment of water courses contributes to eutrophication in rivers such as the Orange-Senqu and several large dams across the country, escalating the cost of treating water to potable standards. The recent collapse of the Vaal River WWTW, and subsequent risk posed to the health of people, emphasises the urgent need to invest in upgrading these systems, which would improve the functionality and biodiversity of water ecosystems and reduce risks to human wellbeing. Although some river systems have the capability to recover from water pollution events, prolonged impacts on arid systems may be more severe and long-lasting as a result of longer reset intervals between rains.

Biological invasions

Alien invasive species cause substantial changes to ecosystem structure and function and negatively impact aquatic biota. Rivers and inland wetlands are the most heavily invaded ecosystems globally, largely due to their inherent connectivity and the intensity of anthropogenic activities. Of the 191 listed alien species in the inland aquatic realm, 65 are invasive. Of these invasive species, 27 severely impact biodiversity (5 fish species and 15 plant species). Nationally, 81% of freshwater fishes of conservation concern are impacted by invasive alien fishes. Many of these native species are endemic to the mountains of the Western Cape. The invasive species (e.g. Bass [*Micopterus*] species) impact on native species mainly through predation of juveniles and outcompeting adults for resources. This reduces population sizes and has caused population extirpation of many native species. In some cases, invasive species have hybridised with native species (e.g. invasive Nile Tilapia (*Oreochromis niloticus*) and the native Mozambique Tilapia (*Oreochromis mossambicus*)). Invasive plants in natural rivers and wetlands threaten ecosystem integrity, alter fire regimes and change hydrological processes due to their high water consumption.

Habitat loss and degradation

Rivers, inland wetlands and their catchment areas are directly impacted through habitat loss and fragmentation, and through land degradation linked to overgrazing and inappropriate fire regimes. Seasonal and intermittently inundated or saturated wetlands and rivers are often (illegally) ploughed, leading to a complete loss of habitat structure and associated species. Ploughing also leads to erosion and increased

The endemic and range-restricted Pickersgill's Reed Frog (*Hyperolius pickersgilli*) is only found at 25 sites along KwaZulu-Natal's unique coastal wetlands. In 2010 it was listed as Critically Endangered, owing to habitat decline and fragmentation. After efforts to restore habitat and a captive breeding programme managed by the Endangered Wildlife Trust, the Johannesburg Zoo and Ezemvelo KZN Wildlife, the status of this frog has been down-listed to Endangered in 2016. © Jeanne Tarrant.



sedimentation of rivers. Both the suppression of fires and planned burning practices for grazing result in changes to the natural fire regimes and subsequently the species composition of vegetation associated with rivers and inland wetlands in the landscape. Suppression of fire in the Fynbos biome, for example, has led to the densification of vegetation and decline in habitat of Rose's Mountain Toadlet (*Capensibufo rosei*). Habitat fragmentation can result from land conversion as well as infrastructure development, impacting dispersal and migration of amphibians.

Climate change

Changes in climate, particularly rise in temperature and changes to the amount, intensity and season of precipitation, are expected to exacerbate the impacts of current pressures on inland aquatic ecosystems. Global temperatures have increased by almost 1°C over the past 50 years and could increase another 1–2°C by 2050. Increasing temperature will impact the hydrological cycle, and consequently the functioning of rivers and inland wetlands. Significant reductions in amphibians' range sizes are probable early impacts. In southern Africa, large lakes have shown increases in aquatic temperature, while the tropical cyclones that bring rain to the Maputaland Coastal Plain may move eastward, away from the African continent. Climate change is widely considered as a multiplier of other pressures on biodiversity, both exacerbating the effects of these pressures and altering the frequency, intensity and timing of events. Many of these shifts are predicted to benefit the survival of invasive species over native species and increase the outbreak potential and spread of disease. Considering that many freshwater species are range-restricted and that the fragmented state of ecosystems may prohibit range shift migrations, increasing the connectedness and size of the protected area network, including Ramsar sites, are key components of climate change adaptation strategies. In the inland aquatic realm, human responses to climate change are likely to further increase some pressures, for example, reduced rainfall due to climate change (exacerbated by biological invasions in catchment areas) drives an increase in water abstraction (for human settlements and agriculture), which compounds the pressure on the aquatic ecosystem and species.

Emerging pressures

Emerging pressures on rivers and inland wetlands include micro-plastics, pharmaceuticals, sand and clay mining, shale gas exploration and potential extraction, and aquaculture farming. New methods for the detection and purification of micro-plastics and pharmaceuticals are required, while citizen



Illegal sand mining is an emerging pressure in seasonal and ephemeral rivers. Excessive sand mining reduces recharging of the aquifer, and degrades river ecosystem habitats. © Protect the Paardeberg Coalition.

science could contribute to the reporting and regulation of sand and clay mining in rivers.

3.2.4 Ecological condition in the inland aquatic realm

River condition

Only a third of the total length of the river ecosystems in South Africa are in a natural/near-natural ecological condition, leaving two-thirds in a moderately modified or worse condition. Tributaries are generally less heavily impacted than mainstem rivers;

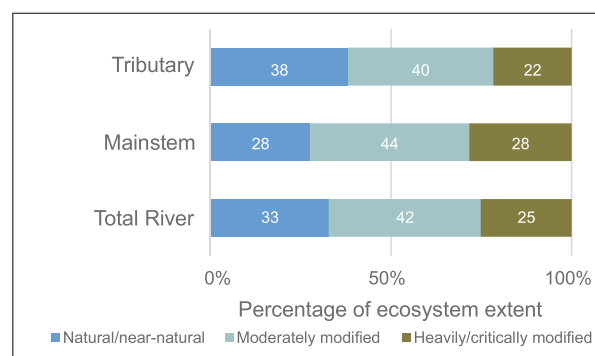


Figure 51. Extent of river tributaries and mainstems within each ecological condition class (expressed as a percentage of total extent).

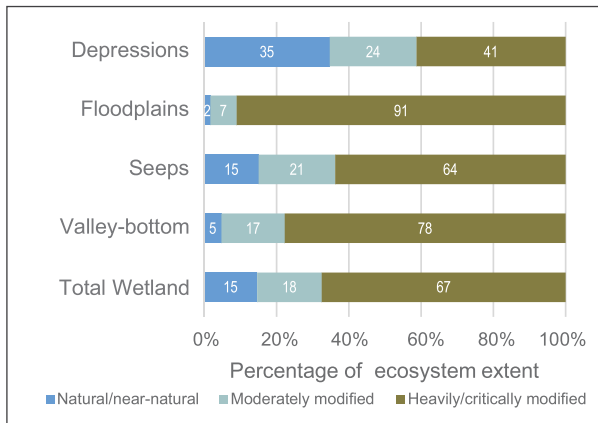


Figure 52. Extent of each inland wetland hydrogeomorphic unit within each ecological condition class (expressed as a percentage of total extent).

with 38% of tributary length in a natural/near-natural condition compared to 28% of mainstems (Figure 51). The extent of ecosystem modifications in the inland aquatic realm reflects the wide array of pressures that are concentrated in rivers and inland wetlands that negatively impact on ecosystems and species.

Inland wetland condition

The majority of inland wetlands are in a poor ecological condition with only 15% of the inland wetlands in a natural/near-natural ecological condition (Figure 52). Floodplains and valley-bottom wetlands are in the worst ecological condition, with less than 5% of their extent in a natural/near-natural state. The extensive

depressions in the arid Northern Cape remain largely in a natural to moderately modified state.

3.2.5 Ecosystem threat status in the inland aquatic realm

River ecosystem threat status

Of South Africa's 222 river ecosystem types, 43% are Critically Endangered, 19% are Endangered, 2% are Vulnerable, and 36% are of Least Concern (Figure 53). Ecosystem threat status varies across geomorphological zones with 67% of lowland river types being Critically Endangered compared to only 25% of mountain streams types (Figure 54A). This reflects a global trend where productive lowland areas are subject to intense land and water-use pressure. Critically Endangered and Endangered ecosystem types are concentrated around major cities and production landscapes where pressures on water resources are highest (independently of geomorphological zone) and protection is most challenging. The Vaal Water Management Area (containing South Africa's largest urban area and extensive croplands) has an alarming proportion of Critically Endangered ecosystems associated with its rivers (>70% of their length contains Critically Endangered ecosystem types).

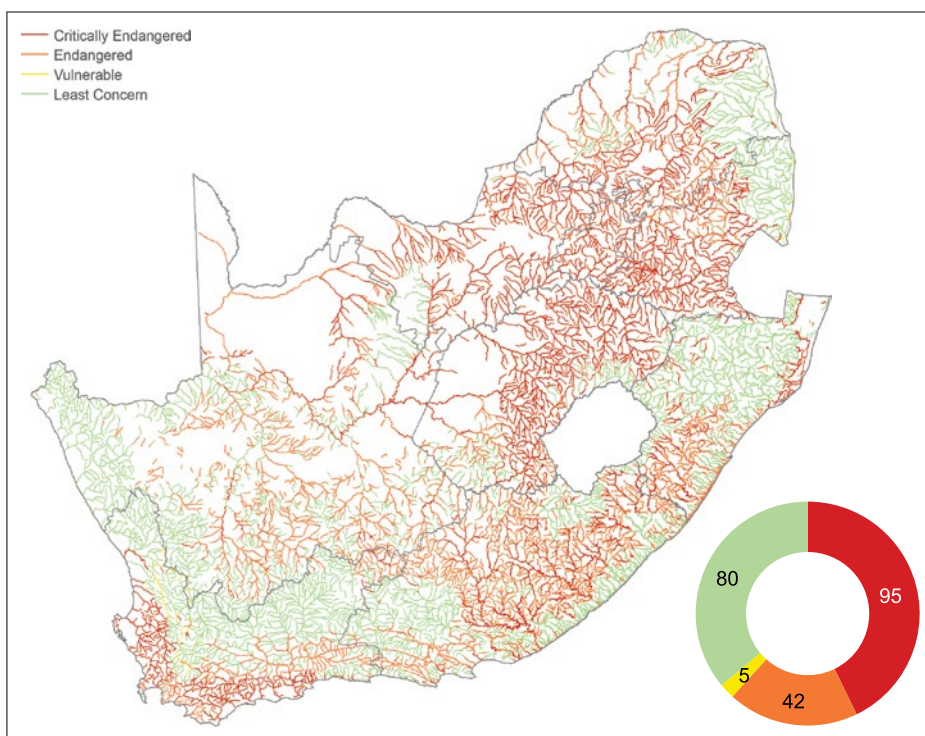


Figure 53. Ecosystem threat status for river ecosystem types. The inset doughnut shows the number of ecosystem types per threat category.

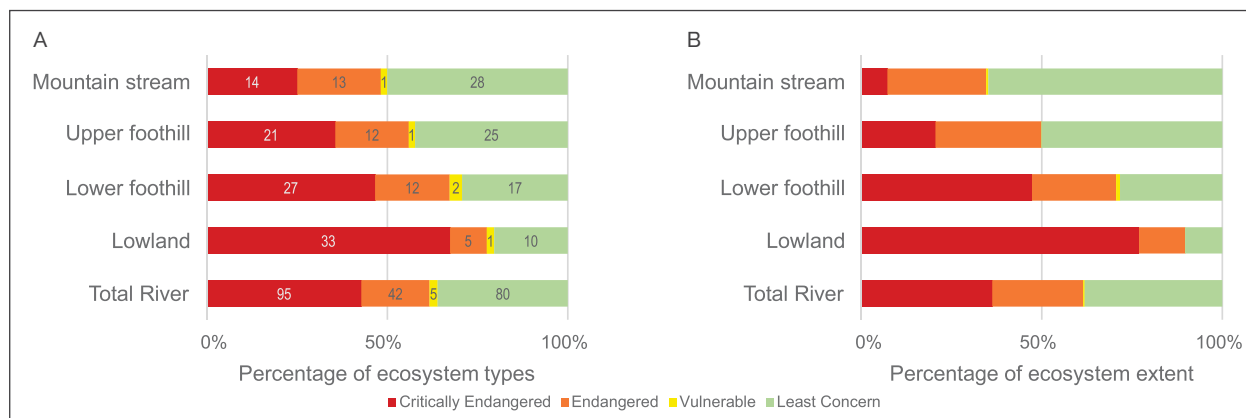


Figure 54. River ecosystem threat status within each geomorphological zone (i.e. slope category). (A) The percentage of ecosystem types per threat category (labelled with actual value) with the total for all rivers at the bottom (n = 222); (B) the percentage of river length (km) within each threat category with the total length for all rivers (length = 147 180 km) at the bottom – providing an indication of the relative extent of each category.

Inland wetland ecosystem threat status

Inland wetlands are highly threatened, with almost 80% of South Africa’s 135 inland wetland ecosystem types categorised as threatened (61% CR, 9% EN, 9% VU). When considered by extent, this amounts to almost 88% of South Africa’s estimated 2.6 million ha (26 000 km²) area for inland wetlands being threatened (Figure 55). Modelling of ecological condition showed valley-bottom systems to be the most threatened of all hydrogeomorphic wetland units (94% of types), followed by floodplain systems (93%), seeps (71%) and depressions (60%) (Figure 56A). These findings concur with those of the river ecosystem types, where the majority of lowland rivers (>70%)

are threatened, reflecting the cumulative impacts of catchments at these receiving systems.

The use of the land cover dataset introduces bias at hydrogeomorphic unit level, since many depressions are classified as natural and yet they are exposed to pressures often not mapped in the available spatial datasets. Therefore, the limitations associated with the input datasets and the lack of reference data prohibits an accuracy assessment for this NBA. The results should, therefore, be considered indicative of the status at a country-wide scale rather than definitive. Work is underway to refine the condition assessment of inland wetlands at a provincial scale.

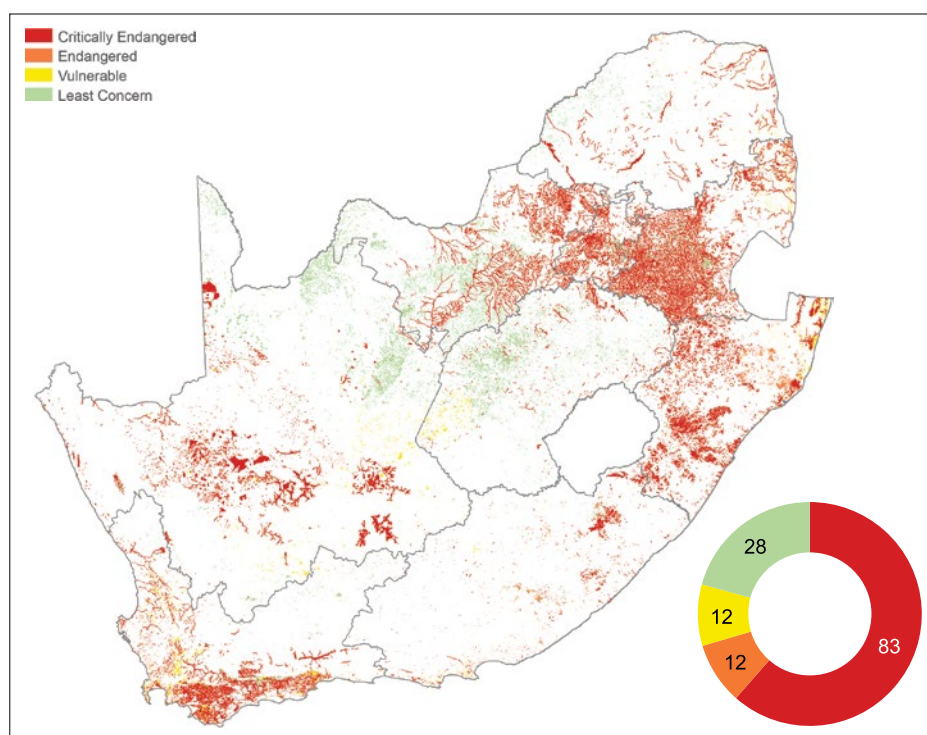


Figure 55. Ecosystem threat status of inland wetland ecosystem types with the boundaries of the wetlands exaggerated to enable better visualisation. The inset doughnut shows the number of ecosystem types per threat category.

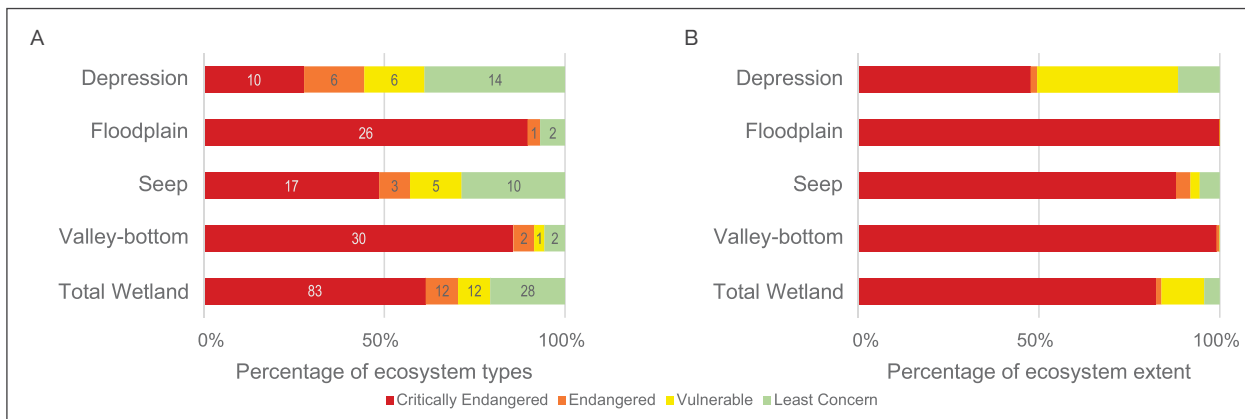


Figure 56. Ecosystem threat status of inland wetland ecosystem types within each hydrogeomorphic unit: (A) the percentage of ecosystem types per threat category (labelled with actual value) with the total for all inland wetland at the bottom (n = 135); (B) the percentage of inland wetland area (km²) within each threat category with the total for all wetlands (26 000 km²) at the bottom providing an indication of the relative extent of each category.

Verification and refinement of the inland wetland ecosystem types are required for future assessments and biodiversity planning. The overall extent of the ecosystem types in the current classification system range from less than 100 ha to over 300 000 ha. Further work is therefore required to ascertain whether wetland ecosystem types with very limited overall extents are valid unique ecosystem types or if they are artefacts of the mapping and classification process. Improved information on ecological condition of more extensive types would be crucial for informing conservation planning.

All eight of South Africa’s freshwater lakes are considered Critically Endangered since <20% of the spatial extent of these systems is in a natural or near-natural ecological condition (Figure 57). The Department of Water and Sanitation is currently investigating the depth and water quality of these systems, while

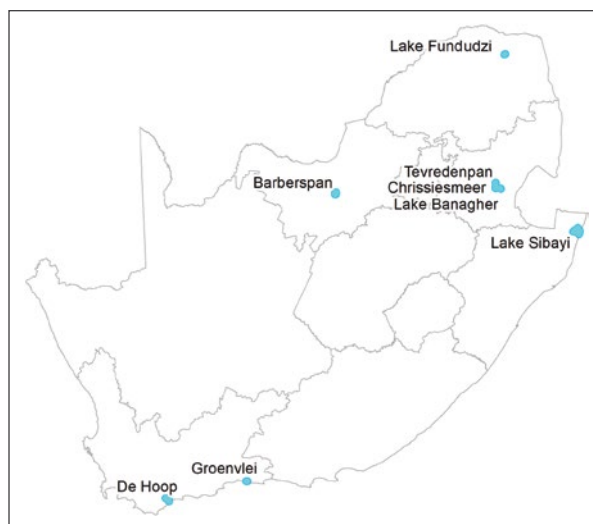
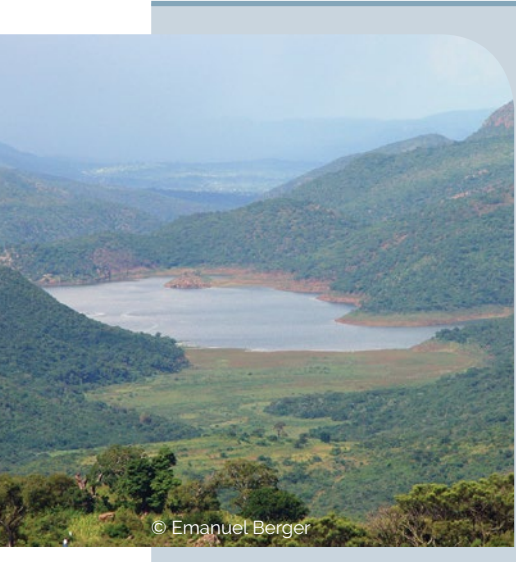


Figure 57. Location of South Africa’s eight freshwater lakes (freshwater bodies with average depth of over 2 m, also known as limnetic depressions).



© Emanuel Berger

Lake Fundudzi as a sacred site

There are many places in South Africa that are important cultural or spiritual sites, and freshwater sources such as rivers, streams, lakes and springs are often preferred sites for practices such as baptism. Lake Fundudzi is found in the northern part of South Africa in the Limpopo Province along the Mutale River and is South Africa’s largest inland lake. Several beliefs are upheld about Lake Fundudzi, including that it is inhabited by the god of fertility in the form of a python. It is also an important final resting place for the Vha-Venda ancestors and is treated like a holy shrine. Deceased members of the tribe are first buried in a grave by the kraal, but after a number of years their bones are exhumed and then cremated and thrown into the lake. A white crocodile is also believed to live in the lake, and guards the ancestors. When Venda kings die their remains are placed in the lake and the white crocodile will cough up a stone, which the new king has to swallow.

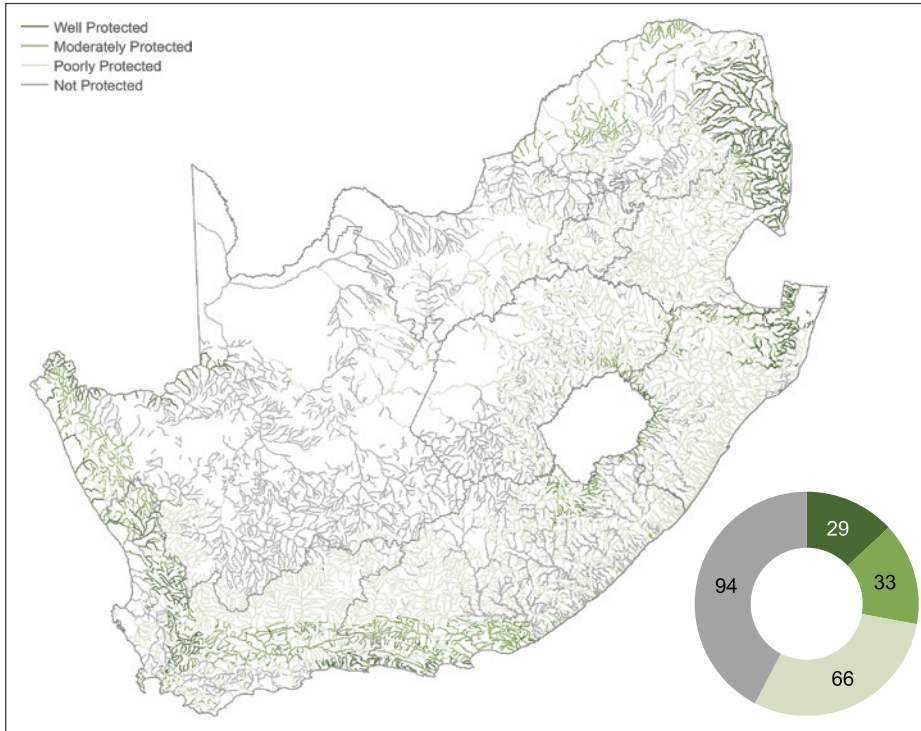


Figure 58. Ecosystem protection level for river ecosystem types. The inset donut shows the number of ecosystem types per protection level.

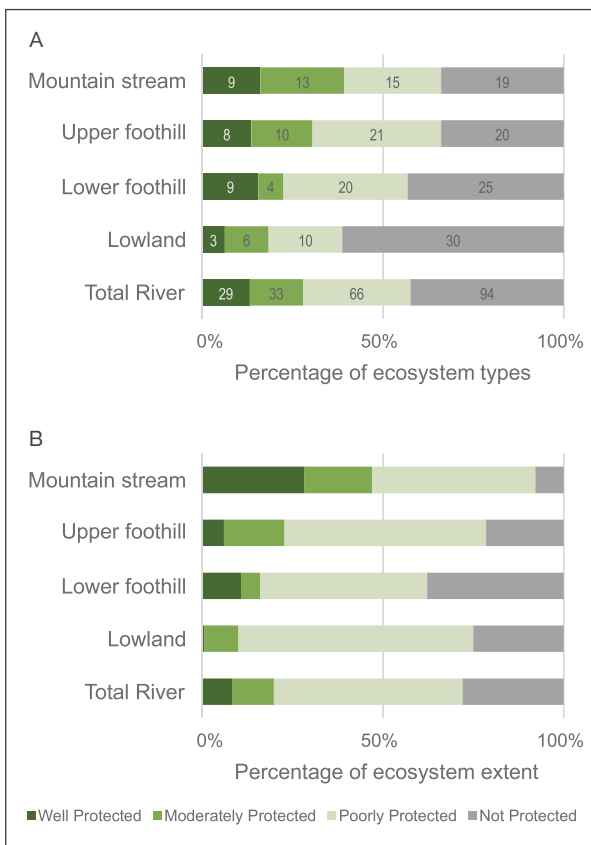


Figure 59. River ecosystem protection level within each geomorphological zone (i.e. slope category); (a) the percentage of ecosystem types per category (labelled with actual value) with the total for all rivers at the bottom; (b) the percentage of river length (km) within each category with the total length for all rivers at the bottom – providing an indication of the relative extent of each category.

further work would be required to determine whether they qualify for red listing under the IUCN Red List of Ecosystems.

3.2.6 Ecosystem protection level in the inland aquatic realm

River ecosystem protection level results

Protection level analysis for river ecosystems revealed that only 14% of the country’s river length occurs in protected areas with 43% of these in a natural or near-natural condition. Protection levels are particularly low in the northern interior of the country, reflecting the geography of the current protected areas network (Figure 58). Only 13% of river ecosystem types in South Africa are considered Well Protected, while 42% are Not Protected (Figure 59) In terms of river slope category, only 16% of the river ecosystem types within the lower foothill and mountain stream geomorphic zones are Well Protected. More than half of lowland river ecosystem types are Not Protected (61%), reflecting the globally observed biases of the protected areas networks towards mountain areas versus lowland. It is evident that formal protection does not guarantee biodiversity conservation as rivers are highly connected linear ecosystems that are impacted by

Box 7. Changes in the status and ecological condition of the free-flowing and flagship rivers

All 19 of the flagship rivers remained intact, but the deterioration in ecological river condition of 14 of the 62 free-flowing rivers resulted in a loss of their status (Figure 60). Of these 14 rivers, four have lost more than half of their natural/near-natural extent and were found to be dammed. These are the Mdumbi, aMahlongwa, Nsonge and Ngogo rivers. Ecological deterioration also occurred due to agriculture, rural and semi-urban communities, road construction and sedimentation. The remaining ten have lost all of their extent in a natural/near-natural ecological condition. These are the Homtini, Mgwalana, Ntlonyane, Mzintlava, Mzamba, Mpambanyoni, Matigulu, Nondweni, Nyalazi and Upper Vaal rivers.



Hermien Roux, aquatic scientist, sampling in the Groot Marico River in the dry season. This is the only free-flowing river remaining in the arid regions of the country and the North West Province, and its continuous baseflow provides drinking water to many communities. © Alida Britz.

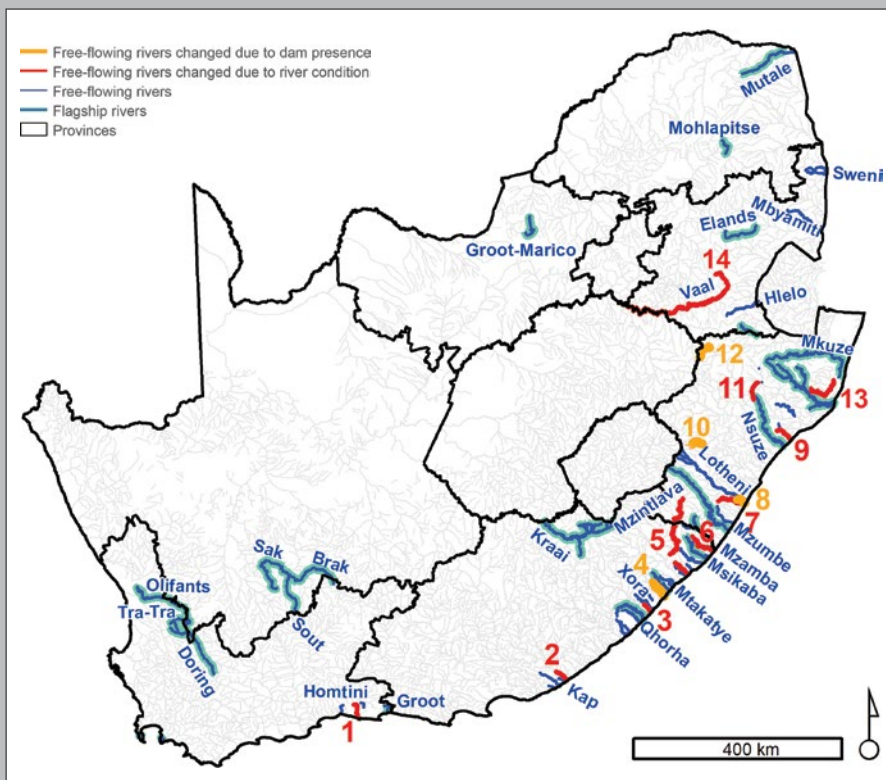


Figure 60. Changes observed in free-flowing and flagship rivers between 2011 and 2017. Rivers shown in red have seen a decline in their ecological condition.



The Seekoeivlei floodplain system is characterised by depressions on both sides of the Klipspruit River, which seasonally floods to the full extent of ± 4 200 ha of the floodplain. The floodplain falls within the Seekoeivlei Nature Reserve (Free State), which was declared as a Ramsar Wetland of International Importance in 1997. © Georg Wandrag.

human activities throughout their catchments (Figure 59). A whole catchment approach to river conservation is therefore required since most land-based protected areas were not designed to protect rivers.

Inland wetland ecosystem protection levels

Inland wetlands are severely under-protected with only 6% of inland wetland ecosystem types Well Protected. Nearly 61% of the inland wetland ecosystem types (82 of 135) are Not Protected. Well Protected wetland ecosystem types are clustered in the eastern part of Mpumalanga (within the Kruger National Park), the Maputaland Coastal Plain in

KwaZulu-Natal (situated in the iSimangaliso Wetland Park World Heritage Site) and parts of the Western Cape (Figure 61). More than 80% of the extent of floodplain systems and more than 70% of valley-bottom systems are Not Protected (Figure 62). Seeps have the highest extent of protection levels, with 17% of the ecosystem types and 37% of the extent having some level of protection respectively. Depressions are comparable with 14% of the number and 30% of the extent having some level of protection.

While Ramsar sites are not considered protected areas in South Africa, the government is obliged to have management plans for these areas and report periodically on their conservation status, including ecological

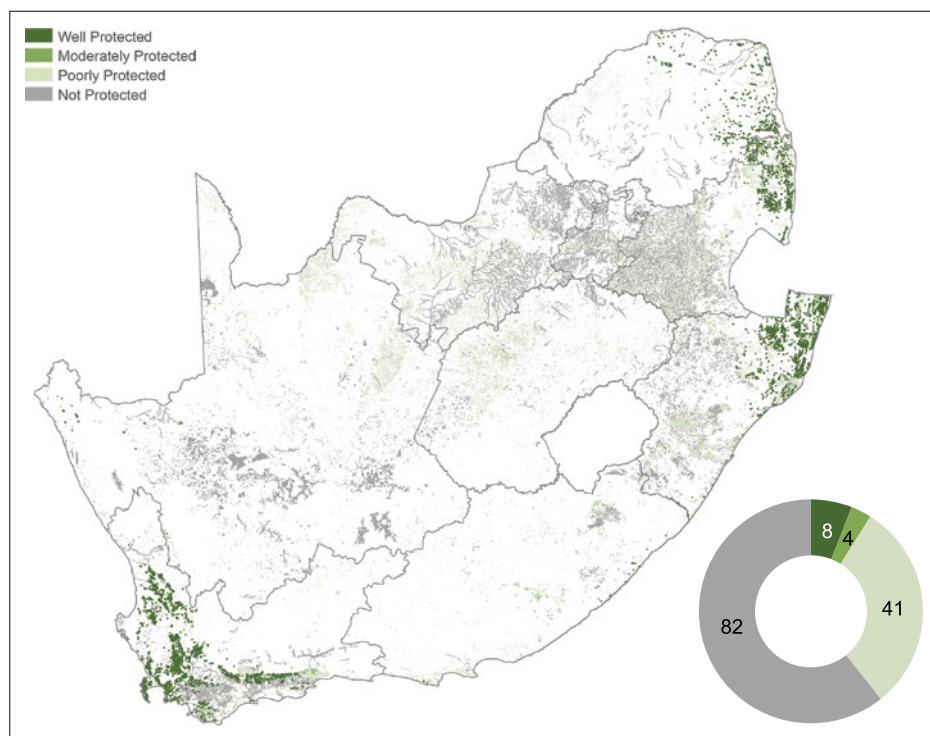


Figure 61. Inland wetland ecosystem protection levels with the boundaries of the wetlands exaggerated to enable better visualisation. The inset doughnut shows the number of ecosystem types per protection level category.

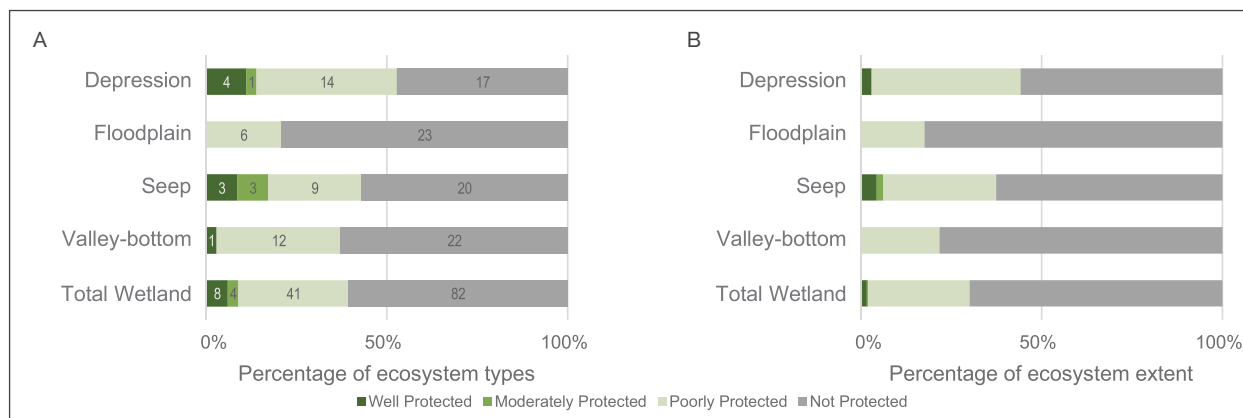


Figure 62. Ecosystem protection levels of inland wetland ecosystem types within each hydrogeomorphic unit: (A) the percentage of ecosystem types per category (labelled with actual value) with the total for all wetlands at the bottom; (B) the percentage of inland wetland area (km²) within each category with the total for all wetlands at the bottom – providing an indication of the relative extent of each category.

condition, level of protection as well as realised or potential threats. Twelve of South Africa's 23 Ramsar sites were nominated primarily for hosting inland wetlands. These 12 sites include, *inter alia*, Nylsvley (the largest floodplain wetland in South Africa) as well as Seekoeivlei in the Free State and three of the freshwater lakes (Barberspan, De Hoop and Lake Sibayi). Other areas include inland wetlands within the landscape of the uKhahlamba-Drakensberg Park, as well as inland wetlands in the Ndumo Game Reserve, Ntsikeni Nature Reserve, the Makuleke Wetlands, uMgeni Vlei Nature Reserve and the Verloren Valei Nature Reserve.

Approximately 98% of the Ramsar network falls within South Africa's protected area network, affording legal protection to the majority of wetland ecosystems they contain. However, owing to the degraded ecological condition of most of these wetlands, the ecosystem types to which they belong are not considered to be Well Protected.

Five of South Africa's eight freshwater lakes are Not Protected while three are Poorly Protected. Water abstraction, especially during times of droughts (intensified by climate change), pose a severe and immediate pressure on these lakes, as evident from the decline of the water levels of Lake Sibayi since 2000. Consequently, setting Ecological Flow Requirements and Resource Quality Objectives are crucial for better management of these unique ecosystems.

Threatened and under-protected ecosystem types

For both rivers and inland wetlands there is a strong correlation between threat status and protection level. The majority of threatened ecosystem types are under-protected. A total of 101 (75%) of inland wetland types (total $n = 135$) are threatened and under-protected with the majority distributed on the Highveld, along the eastern escarpment, in the Cape Fold Mountains and the arid Northern Cape (Table 7).

Table 7. Ecosystem threat status and protection level for rivers (A) and inland wetlands (B)

A						B					
	Not Protected	Poorly Protected	Moderately Protected	Well Protected	Total		Not Protected	Poorly Protected	Moderately Protected	Well Protected	Total
Rivers						Inland wetlands					
Critically Endangered	65	26	4		95	Critically Endangered	61	21	1		83
Endangered	10	20	11	1	42	Endangered	2	9		1	12
Vulnerable	1	3		1	5	Vulnerable	4	2	1	5	12
Least Concern	18	17	18	27	80	Least Concern	15	9	2	2	28
Total	94	66	33	29	222	Total	82	41	4	8	135

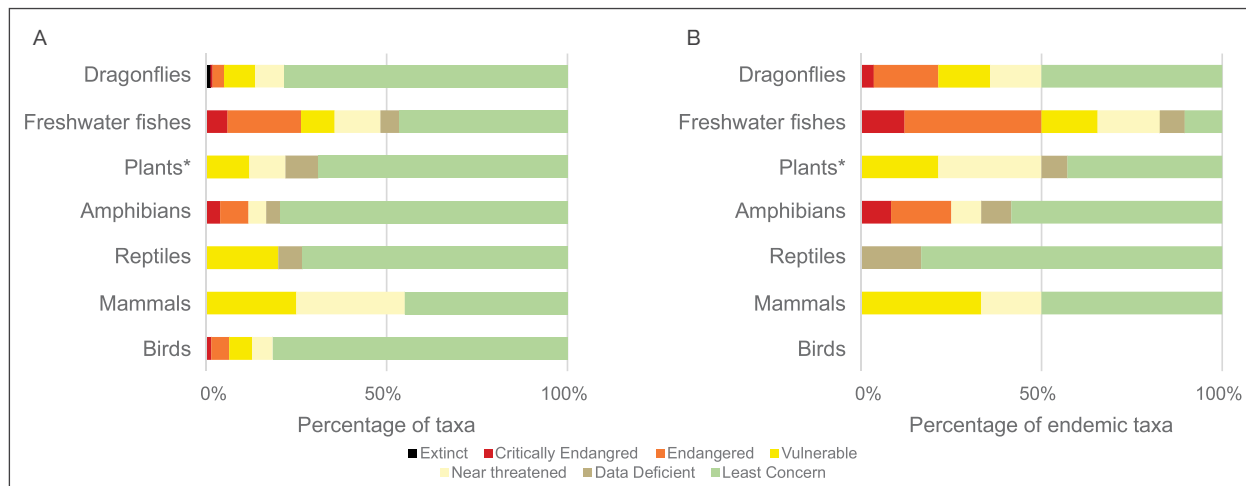


Figure 63. The proportion of indigenous taxa (A), and endemic indigenous taxa (B), in each of the IUCN Categories: Extinct (EX), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Data Deficient (DD), Least Concern (LC).

Box 8. Rivers and inland wetlands in the updated Strategic Water Source Areas

Strategic Water Source Areas (SWSAs) are defined as areas of land that: (a) supply a disproportionate (i.e. relatively large) quantity of mean annual surface water runoff in relation to their size and so are considered nationally important; or (b) have high groundwater recharge and where the groundwater forms a nationally important resource; or (c) areas that meet both criteria (a) and (b). They include transboundary Water Source Areas that extend into Lesotho and Swaziland.

The NFEPA project identified sub-quaternary catchments with relatively high mean annual runoff as high water yield areas, as well as high groundwater recharge areas. This work was reported on in the NBA 2011 and taken further in a study by WWF-SA and the CSIR (2013). This dataset has now been replaced by a refined dataset (referred to as the 2018 dataset) produced by a Water Research Commission funded study (Le Maitre et al. 2018). There are now 22 Strategic Water Source Areas for surface water (SWSA-sw) and 37 Strategic Water Source Areas for groundwater (SWSA-gw) that are considered to be strategically important areas for national water and economic security.

These multi-purpose landscapes are key ecological infrastructure assets for South Africa, supporting growth and development needs. The SWSA-sw cover about 124 075 km² (10% of South Africa’s extent) and provide a mean annual runoff of 24 954 million m³ (50% of the total). The SWSA-gw cover around 9% of the land surface of South Africa. They account for up to 42% of the baseflow in their areas and have a key role in sustaining surface water flows during the dry season.

Only 13% of all the SWSAs are within protected areas. The protection and restoration of SWSAs is of direct benefit to all downstream users and this dependence needs to be considered in decisions about these primarily headwater catchments. The protection of both water quantity (flows) and quality should be addressed.

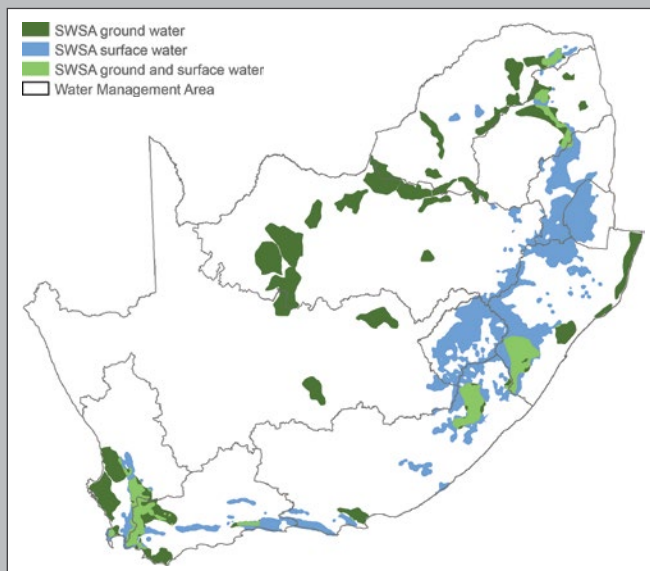


Figure 64. Strategic Water Source Areas (SWSAs) for surface water (sw) and ground water (gw) (map based on Le Maitre et al. 2018).



A



B



C

- (A) The indigenous Eastern Cape Rocky (*Sandelia bainsii*), Endangered. © Albert Chakona.
 (B) Clanwilliam Sawfins (*Cheilobarbus serra*), Near Threatened. © Jeremy Shelton.
 (C) Fiery Redfin (*Pseudobarbus phlegethon*), Endangered. © Riaan van der Walt.

Box 9. Freshwater fishes threatened by invasive alien species

One in every three freshwater fish species in South Africa is threatened with extinction, making them South Africa's most threatened taxonomic group. The vast majority (81%) of Taxa of Conservation Concern are declining due to predation by invasive alien fishes. Freshwater fishes have become even more threatened over the past ten years. However recent trials to eradicate invasive fishes by CapeNature have been successful and resulted in threatened species recovery (see example of *Pseudobarbus phlegethon* below). Resources to roll out eradication programmes in important fish areas are required to change the extinction trajectory for freshwater fishes.

The iconic and Endangered Eastern Cape Rocky, *Sandelia bainsii*, is endemic to the Eastern Cape Province of South Africa. This species has suffered severe reduction in its historical distribution range and population size due to multiple human impacts, mainly invasion by non-native species, pollution and complete loss of habitat due to water abstraction. Remaining populations require urgent protection.

The Clanwilliam Sawfin, *Cheilobarbus serra*, is endemic to the Olifants and Doring river systems in the Western Cape. The species' historical distribution range has been severely reduced due to invasion of the mainstem sections of the rivers by non-native species. Remaining populations precariously persist in a few upland tributaries that have not been invaded by non-native species.

The Fiery Redfin, *Pseudobarbus phlegethon*, is endemic to the Olifants–Doring river system in the Western Cape. It is one of the species that extended its range following the rehabilitation of the Rondegat River through eradication of an invasive alien fish species (Smallmouth Bass – *Micropterus dolomieu*) by CapeNature.

The situation for river ecosystems is similar, with 140 (64%) of types categorised as threatened and under-protected. Further work is required at provincial scale to verify the extent of these systems and improve the modelling of their ecological condition, and thus to verify whether these modelled results are suitable for prioritisation in spatial planning.

3.2.7 Species threat status in the inland aquatic realm

A total of 658 indigenous freshwater species associated with rivers and inland wetlands from seven taxonomic

groups (amphibians, birds, dragonflies, mammals, freshwater fish, reptiles and a sample of freshwater plants) have been assessed for this NBA. Of these 658 species, 24% are endemic and 41% are threatened with extinction; a further 20% fall into additional categories of conservation concern. The first Red List Index produced for South Africa shows that all freshwater-associated taxonomic groups showed a gradual decline in their threat status over the assessment period, indicating that pressures are continuously impacting species across the different taxonomic groups within aquatic systems. Based on a meta-analysis of species Red List assessments, the major pressures driving increased threat status are impacts of invasive alien species, habitat loss and degradation due to pollution,

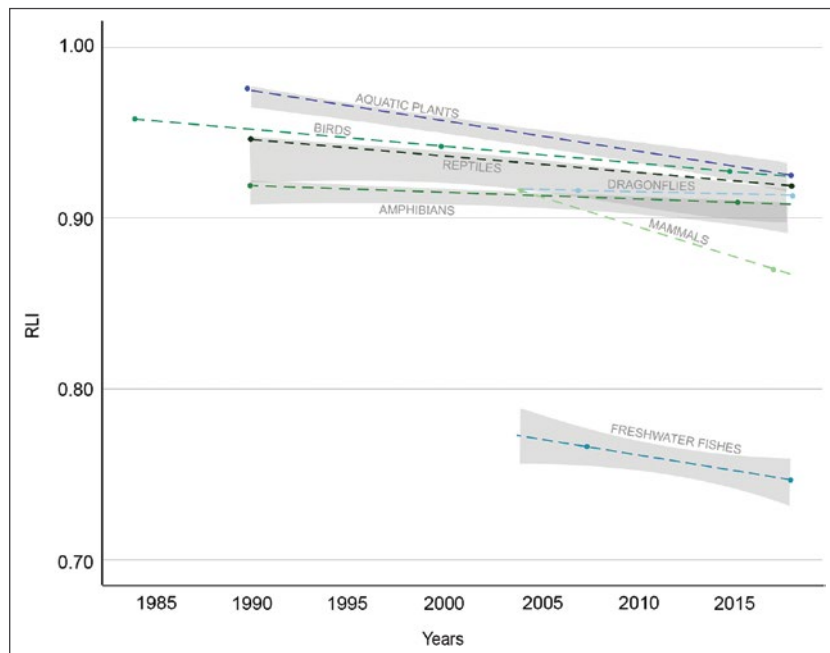


Figure 65. Trends in status of South Africa's freshwater species: amphibians, aquatic plants, birds, dragonflies, freshwater fish, mammals and reptiles, based on the Red List Index. The slope of each line indicates the rate at which species groups are becoming more threatened over time. Grey shading indicates uncertainty of trends and is most strongly influenced by number of Data Deficient species within a taxonomic group.

urban expansion, damming and water abstraction, and agricultural activities.

Freshwater fishes were found to be the most threatened aquatic associated taxonomic group in South Africa (36% of taxa threatened) (Figure 63). Nearly 50% of freshwater fish taxa are endemic with 66% of these threatened with extinction (Figure 46). The overall status of freshwater fishes has declined significantly since the last assessment in 2007 (Figure 65). The pressures driving this continued decline are: invasive alien species (impacting 81% of Taxa of Conservation Concern, see Box 9); followed by pollution (impacting 70% of taxa); and dams and water management activities (impacting 63% of taxa) (Figure 66). These impacts have caused reduction and extirpation of some populations and degradation of their habitat. As part of the NFEPA process, important fish areas (referred to as 'fish sanctuaries' in NFEPA reports) were identified to designate the most important catchments for the conservation of threatened and range-restricted fish species. Many of these important fish areas are not situated in formal protected areas and remain susceptible to a range of anthropogenic pressures. These areas should be prioritised for protection and active conservation efforts to improved species threat status and to reduce pressures impacting these threatened species.

Only 20 mammals of the 343 South African taxa are associated with river and inland wetland systems. Of these 25% are threatened (Figure 63). Mammals associated with rivers and inland wetlands show a steeper decline in their threat status over the assessment period than terrestrial mammals (Figure 65).



The Yellowbelly Mud Turtle (*Pelusios castanoides*) has recently changed in IUCN status from Least Concern to Vulnerable as a result of losing 46% of its natural wetland habitat in KwaZulu-Natal between 1994 and 2011. © Magda Botha.

A total of 12% of the assessed sample of plant taxa were found to be threatened, however a further 10% were assessed as Near Threatened (Figure 63). The main pressure driving the threat status of these freshwater plants are impacts of invasive plant species (competition for resources), and habitat loss and fragmentation due to crop cultivation. An alarming number of species are assessed as Data Deficient (9%) indicating the need to increase knowledge and data collection for freshwater plants. Although a number of freshwater plants are subjected to severe pressures, the



The Cape Flats Frog or Micro Frog (*Microbatrachella capensis*) is Critically Endangered as all known subpopulations are impacted by urban development and by invasive alien trees that dry up its habitat. © CapeNature.



The Saddle-billed Stork (*Ephippiorhynchus senegalensis*) is Endangered as a result of loss of suitable habitat due to a decline in water quality and quantity of the rivers and other waterbodies in which it occurs. © Martin Taylor.

majority are resilient to habitat change as evidenced by the fact that 69% of the plants assessed qualify as Least Concern.

There are 141 bird taxa classified as dependent on and making use of freshwater systems included in the assessment. The majority are widespread and qualify as Least Concern, however 26 (18%) are assessed under a category of conservation concern (Figure 63). Bird Taxa of Conservation Concern (ToCC) are mainly impacted by natural system modification, due to dams and water management activities (77% ToCC affected) (Figure 66). Pollution from agricultural activities follows in severity (58% ToCC affected), with climate-related events including drought, storms and flooding also having a serious impact (50% ToCC affected) (Figure 66). Eleven birds are riverine specialists, and six of these taxa are listed under a category of conservation concern.

Fifteen of the 407 reptile species indigenous to South Africa are species associated with rivers and inland wetlands. Only three of these species are assessed as threatened and one as Data Deficient. The main pressure on these species are: (i) pollution originating from agriculture and forestry effluent; (ii) agriculture (specifically crop farming); (iii) the prevalence of fire and fire suppression (e.g. unseasonal fires affecting species during their hibernation period); and (iv) mining (Figure 66). Mining is an increasing pressure especially on the coastal dunes north of Mtunzini, KwaZulu-Natal, and should be monitored.

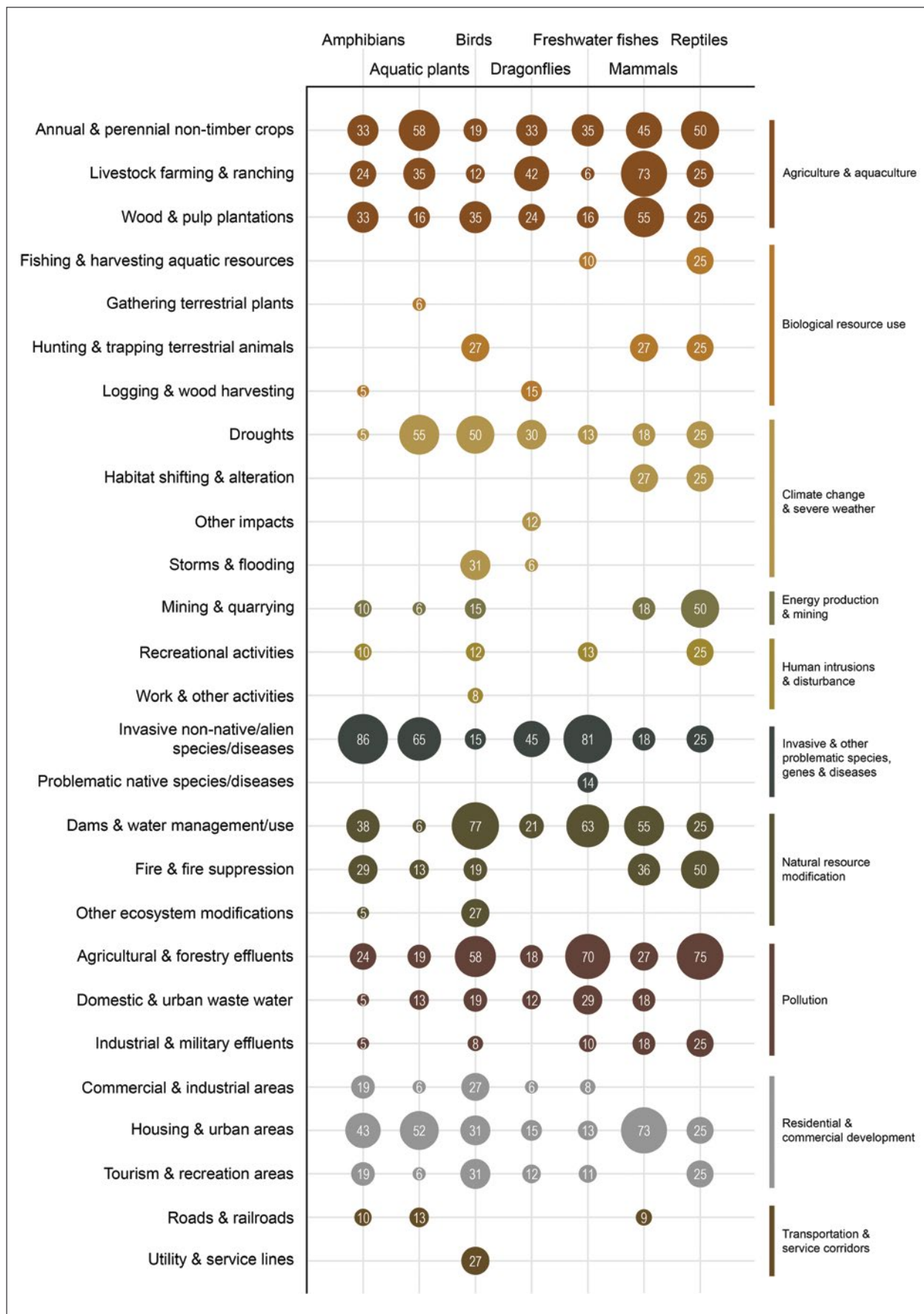


Figure 66. The key pressures for Taxa of Conservation Concern (ToCC) in the inland aquatic realm based on a meta-analysis of the South African Species Red List Database. The size of the bubble corresponds to the percentage of ToCC in the taxonomic group that is subject to each pressure. The pressures categories follow the IUCN threat classification system.

Dragonflies and damselflies (Odonata) were found to be the least threatened group of species, with 79% of taxa assessed as Least Concern. This is possibly due to their ability to disperse with many taxa being relatively widespread (Figure 63). This group shows little change in their Red List status over the past ten years, as measured using the RLI (Figure 65). Some taxa are, however, range restricted and 33 taxa (20%) are of conservation concern (Figure 63). The main pressure faced by dragonflies is the shading of their habitat by invasive alien trees (45% of ToCC impacted), but they are also threatened by habitat transformation due to livestock farming (42% of ToCC) and non-timber crop cultivation (33% of ToCC) (Figure 66). Some reprieve for the taxa facing impact from invasive alien trees has come from invasive tree eradication programmes (e.g. DEFF's Working for Water Programme), with some remarkable success stories of re-colonisation of habitats following the removal of these trees (e.g. *Proischnura polychromatica* – CR, *Spesbona angusta* – EN, *Pseudagrion newtoni* – VU). This supports the importance of continued efforts to control and eradicate invasive species where possible. Some threatened taxa have been impacted by El Niño – Southern Oscillation events that exacerbated impacts of other threats, such as drying or flooding of habitat in conjunction with habitat trampling by livestock (Figure 66).

3.2.8 Species protection level in the inland aquatic realm

Freshwater fishes are the most under-protected of South Africa's freshwater-associated taxonomic groups. Only 18% of freshwater fish taxa included in

the analysis were Well Protected (17 taxa), while the majority (83%) of taxa are under-protected (Figure 67). Freshwater fishes are under-protected due to the spatial distribution of protected areas, with most protected areas not including catchment areas and/or a sufficient extent of rivers to mitigate against pressures. Only 14% of South African river length occurs within the protected area network and, of this, as little as 43% is in a natural or near-natural condition. In contrast, the majority of aquatic associated birds, mammals, amphibians and reptiles are Well Protected (Figure 67). This difference is illustrated by the fact that for freshwater fishes, even Least Concern wide spread species are under-protected (Figure 68). Overall, levels of protection of endemic taxa are lower than for all taxa (Figure 67B) and, with the exception of reptiles, most threatened species within these taxonomic groups are under-protected (Figure 68).

Pressures impacting species within protected areas include lack of effective management of invasive alien species and disruption of natural fire regimes. Few protected areas have specific management plans for rivers and inland wetlands, which could be used to mitigate against specific pressures impacting these ecosystems and the species inhabiting them. Furthermore, rivers are often used as boundaries to protected areas and many have upstream reaches occurring outside of the protected area network which results in limited control of the land-use and their impacts on rivers. Similarly, inland wetlands within protected areas can be impacted by neighbouring land-use activities that are in conflict with conservation efforts. The impact of certain pressures such as pollution and water abstraction that originate upstream and outside of protected areas cannot be mitigated against from within, but need to be managed at the catchment level. As many as 20 freshwater fish taxa (21%) and eight amphibian taxa (8%) drop down a category of

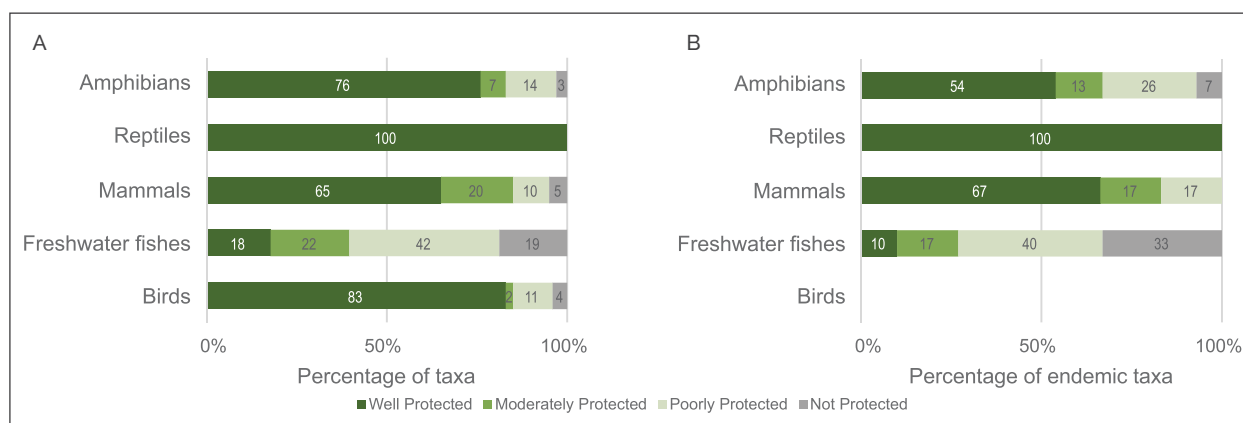


Figure 67. Protection level of taxa depended on rivers and inland wetlands; (A) overall (amphibians [98 taxa], reptiles [15 taxa], mammals [20 taxa], freshwater fishes [96 taxa] and birds [95 taxa]) and (B) endemic species (amphibians [46 taxa], reptiles [5 taxa], mammals [6 taxa], freshwater fishes [52 taxa] and birds [0 taxa]).

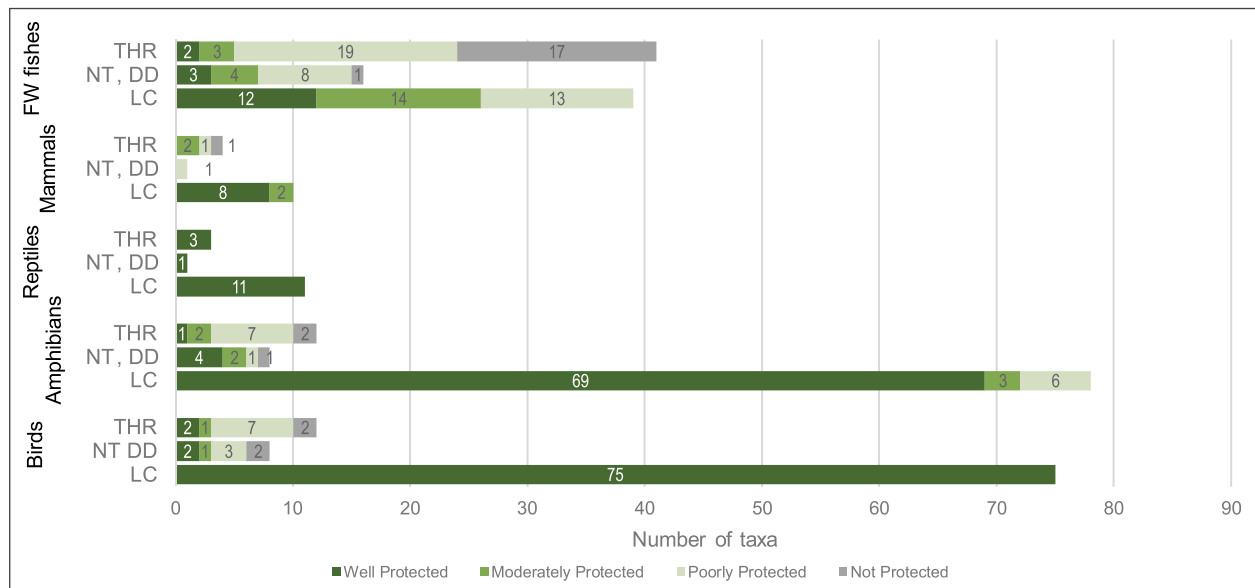


Figure 68. Protection level for South Africa's indigenous freshwater taxa disaggregated into three categories: Threatened (THR) species (CR, EN, VU); Near Threatened and Data Deficient species (NT DD); and species of Least Concern (LC).

protection as a result of protected areas not effectively mitigating against pressures.

Even though many species are protected within the protected areas network, in each of the taxonomic groups there are species that are Not Protected. These include mostly Threatened and Near Threatened freshwater fishes (18 – all endemic), birds (4 taxa – not endemic), amphibians (3 taxa – all endemic), and mammals (1 taxon – not endemic) (Figure 68). These taxa are assessed as Not Protected due to their distribution ranges having poor or no overlap with the existing protected areas network as well as lack

of protection effectiveness within protected areas. At least 76% of these Not Protected species are endemic to South Africa, making South Africa solely responsible for their protection (Figure 67B).

There is urgent need to increase the representation of aquatic systems, such as rivers and inland wetlands, within the protected area network and to prioritise those inhabited by under-protected species identified in this assessment. During this first species protection level assessment no invertebrate group nor freshwater plants were included in the analysis. These will be prioritised in future assessments.

3.3 Estuarine realm

ECOSYSTEMS

86%

of 22 ecosystem types
Threatened

18%

of 22 ecosystem types
Well Protected

14%

of 22 ecosystem types
Not Protected

SPECIES

27%

of 66 taxa assessed
Threatened

3.3.1 Summary

South Africa has 290 estuaries and 42 micro-estuaries that have been classified into 22 estuarine ecosystem types and three micro-estuary types. This represents a high diversity of estuary types stemming from diverse climatic, oceanographic and geophysical drivers. Some ecosystem types and estuarine species only occur in South Africa, with some species confined to a few estuaries.

More than 60% of South African estuaries are relatively healthy, but this amounts to only 22% of total estuarine extent, consisting mostly of small estuaries. More than 63% of estuarine area is heavily or critically modified with important ecological processes under severe pressure, which reduces productivity, food security, fisheries livelihoods, property values and recreational enjoyment. Multiple interventions are required to avoid further decline in health. These include protection of freshwater inflow, restoration of water quality, reduction in fishing effort and avoidance of mining, infrastructure development and crops in the Estuarine Functional Zone (EFZ).

The estuarine realm is the most threatened of all realms in South Africa, both for the number of ecosystem types (86% threatened) and for area (99% threatened). Of estuary types 10% are Critically Endangered, 45% are Endangered and 32% are Vulnerable. By area 77% are either Critically Endangered or Endangered. This emphasises the need for strategic interventions across multiple sectors to restore estuarine health and protect benefits to people. To avoid further compromising of the benefits of these ecosystems, Strategic Estuarine Management Plans – including freshwater allocation, fish resource use, water quality management and land-use planning – should be developed and implemented in a coordinated, cross-sectoral manner.

South Africa's 12 estuarine lakes are in crisis with all four ecosystem types threatened. This includes St Lucia, Kosi, uMgobezeleni, iNhlabane, uMhlathuze/Richards Bay, Touws/Wilderness, Swartvlei, Klein, Bot/Kleinmond, Heuningnes, Seekoeivlei and Verlorenvlei. This group of estuaries has seen extensive infrastructure development in the Estuarine Functional Zone (EFZ), substantial flow reduction, nutrient pollution, overfishing (especially gillnetting) and are



- 1 Freshwater flow modification
- 2 Overfishing and bait collection
- 3 Pollution
- 4 Habitat loss
- 5 Climate change
- 6 Biological Invasions

Section based on:

Van Niekerk, L., et al. 2019. *South African National Biodiversity Assessment 2018 Technical Report Volume 3: Estuarine Realm*. CSIR report number CSIR/SPLA/EM/EXP/2019/0062/A. South African National Biodiversity Institute, Pretoria.
<http://hdl.handle.net/20.500.12143/6373>.



South Africa's estuaries are scattered along the entire coastline – from the arid Orange Estuary in the Northern Cape to the Kosi Estuary in northern KwaZulu-Natal. Some of these estuaries are in protected areas like the Heuningnes Estuary in De Mond Nature Reserve (A); others are lightly developed such as the Breede River Estuary (B); or actually within cities such as the highly modified Diep/Rietvlei Estuary system (C).



The St Lucia Estuarine Lake system in iSimangaliso Wetland Park is South Africa's largest estuary. © iSimangaliso Wetland Park.



subjected to artificial breaching or mouth manipulation. In addition, the lakes are highly vulnerable to climate change. These impacts have reduced their ability to provide key services such as flood regulation, nutrient cycling, nursery habitat, and have compromised recreational and tourism values. To ensure future climate change resilience, a strategic programme is needed to restore habitat, improve water quantity and quality, reduce pressure on resources and increase protection levels.

Estuaries are under-protected in South Africa with only 18% of ecosystem types and 1% of estuarine area Well Protected. Since 2011 the situation has worsened with a loss of protection caused by removal of no-take restrictions and developing commercial fisheries in MPAs. This said, several under-protected ecosystem types can advance to Well Protected solely with improved management of fishing and water quality. For example, 10% of estuarine area could be categorised as Well Protected if fishing effort in just three estuaries were better controlled – Langebaan, Knysna and Kosi.

Salt marsh, seagrass and mangrove habitats require greater protection. Mangroves no longer occur in ten out of 26 Subtropical estuaries and nearly 30% of salt marsh habitat has been lost as a result of poor land-use practices, flow reduction and related mouth closure, direct harvesting and overgrazing. Priority systems for protection are the Groot Berg, Knysna, Mngazana, uMlalazi, St Lucia and Kosi estuaries. The Berg Estuary, with its expansive floodplain marshes, is especially unique and should be prioritised for rehabilitation and protection; while greater protection of the Endangered seagrass *Zostera capensis* (also known as Cape Eelgrass) and large intertidal salt marsh areas of Knysna Estuary is also needed.

Several estuarine-dependent fish species are threatened by overfishing (especially gillnetting), declining water quality, and reduced flows with their concomitant influence on recruitment and marine connectivity. For example, Dusky Kob (*Argyrosomus japonicus*) is considered Critically Endangered (possibly Endangered) at <2% of pristine reproductive adult biomass, White Steenbras (*Lithognathus lithognathus*) is Endangered at <6%, and Leervis (*Lichia amia*) is Vulnerable at <14%. Many more estuarine invertebrate and fish species may be threatened and are as yet undetected due to lack of monitoring and assessments. Stock or population recovery should be facilitated by reducing fishing pressure (e.g. prohibition on fishing at night in estuaries), increased enforcement of fishing regulations, ensuring adequate freshwater inflow, decreasing nutrient pollution, and managing noise pollution and boating activity.

There has been a loss of at least 265 000 waterbirds from South African estuaries, most of which are waders from larger estuaries, especially in the Cool Temperate bioregion. Overall, non-passerine waterbirds have declined by 68% in 40 years. Some of these declines are externally driven (e.g. global habitat loss), but are also significantly related to estuary health, and not mitigated by level of protection alone. Bird numbers are still decreasing, emphasising the need to manage the overall decline in estuary condition, habitat loss, impact of gillnetting on birds, solid waste (plastics), hunting and human disturbances in key foraging and roosting areas.

Estuaries are under pressure and there is a lack of long-term monitoring data to inform conflict resolution and support high confidence decision making. This results in poor decision making and hinders maximising the benefits that flow from estuaries. Estuary abiotic and biotic surveys are urgently needed country-wide to ensure optimum resource allocation, use and protection.

3.3.2 Input data and method for the estuarine realm

Ecosystems

The estuaries were grouped according to a recently revised estuary classification system into four bioregions and 22 distinctive estuarine ecosystem types. Langebaan is now included as an estuarine lagoon, and the small, arid predominantly closed estuaries on the west coast have also been incorporated. 'River mouths' have been renamed 'fluviially dominated' estuaries and divided into two types to distinguish between the larger, sediment-rich systems and the small black-water estuaries draining Table Mountain Sandstone catchments. The large temporarily open/closed group of estuaries was also divided into large and small temporarily closed estuaries.

A revised delineation of the EFZ of South Africa's 290 estuaries served as the primary spatial ecosystem assessment unit for the NBA 2018. In South Africa, estuaries are primarily spatially defined by the +5 m topographical contour that includes all the estuarine open water area, habitat and adjacent floodplain area. It, therefore, encompasses not only the estuary water body, but also all areas that support physical and biological processes that characterise an estuarine system (e.g. tidal action, mixing zones, backflooding areas and long-term sedimentary

processes). It encapsulates all estuarine associated habitats (e.g. saltmarsh, mangroves, swamp forest, reeds and sedges, mud/sand banks) as well as 'estuarine shores' to the back of the surfzone. The EFZ was mapped to the maximum of the historical extent, with the exception of the inclusion of modifications brought about by marina and harbour developments adjacent to estuaries. In steeply incised small systems a more conservative topographical contour (e.g. +10 m) was adopted.

Nine different macrophyte (aquatic plants large enough to be seen by the naked eye) habitats are recognised in South African estuaries. These cover a total area of 100 500 ha, with reeds and sedges overall the dominant habitat type. Supratidal salt marshes are major components of estuaries in the Cool Temperate and Warm Temperate bioregions, reeds and sedges are prevalent in the Subtropical bioregion, and swamp forest is found in the Tropical bioregion.

The Estuarine Health Index (EHI), developed for Ecological Water Requirement studies, was used to determine the condition of South Africa's estuaries (expressed as a PES score) (Table 2, p. 54). The assessment considered both change in abiotic and biotic components, namely: hydrology, hydrodynamics and mouth condition, water chemistry, sediment processes, microalgae, macrophytes, invertebrates, fishes and birds. An estuary was assigned a condition category ranging from natural (A) to critically modified (F) (Table 2), which relate to decreasing levels of ecosystem function. It is important to note that the A to F scale represents a continuum, and that the boundaries between categories are conceptual points along the continuum. The method requires that a multidisciplinary group of estuarine scientists assess the health of a particular estuary based on their collective understanding of likely impacts affecting that system. Where available, data were sourced from DWS Ecological Water Requirement classification studies.

The estuarine threat status assessment for the 22 ecosystem types focussed on IUCN RLE Criterion C3 (historical degradation of ecosystems), supplemented with Criterion A3 (historical habitat loss within the Estuarine Functional Zone) and B3 (restricted geographic range and ongoing decline in limited locations).

For estuarine ecosystems, ecosystem protection level was the proportion of each ecosystem type that is in a reasonably functional state (i.e. PES category A–D) that falls within the protected area network. The

protection level indicator was adjusted for estuaries by applying two additional rules: i) only natural/near-natural condition (PES = A–B) estuaries were eligible for the WP category, only natural to moderately modified (PES = A–C) estuaries were eligible for the MP category and only natural to heavily (largely) modified (A–D category) estuaries were eligible for the PP category; ii) to reflect the impact that overutilisation of living resources has on the faunal component of estuaries, good condition systems (PES = A–B) that were subject to high or very high levels of fishing pressure were not eligible for the WP category.

Species

In South Africa there are 176 estuarine-associated plant species, the majority of which are associated with salt marsh habitat. Macrophyte species are distributed in 58 families, predominantly Cyperaceae (23 species), Chenopodiaceae (18), Mesembryanthemaceae (14) and Asteraceae (11), while 33 other families had only one representative species. Only *Juncus kraussii* and *Phragmites australis* occurred in more than half of South African estuaries. Approximately 20 of the 150 fish species that regularly occur in estuaries are endemic and approximately 30 are near endemic. Some estuarine faunal species are found in a small number of locations. For example, the iconic Knysna Seahorse (*Hippocampus capensis*) occurs in three estuaries (Knysna, Swartvlei, Keurbooms), the Botriverklipvis (*Clinus spatulatus*) in two estuaries (Bot/Kleinmond and Klein) and the Estuarine Pipefish (*Syngnathus watermeyeri*) in five estuaries (Bushmans, Kariega, Kasouga, West and East Kleinemonde). Even important bait invertebrate species Sandprawn (*Callichirus kraussii*), Mudprawn (*Upogebia africana*) and *Macrobrachium petersii* are southern African endemics, while the Freshwater Sand-shrimp (*Palaemon capensis*) is a South African endemic. A total of 35 bird species were considered dependent on estuaries as more than 15% of their regional population is found in coastal lagoons and estuaries.

Selected invertebrates, plants and fishes were included in this assessment with criteria for selection including endemism, economic importance and whether they were crucial for estuarine habitat formation. Bird taxa associated with estuaries were extracted from a comprehensive national assessment. In total 66 species were assessed: 35 birds, 20 fishes, five invertebrates and six plants. Future assessments will increase the number of endemic invertebrates assessed.

3.3.3 Key drivers and pressures in the estuarine realm

Freshwater flow reduction

A third of South Africa's freshwater flow in rivers no longer reaches the coast, with present inflows down from 36 900 to 24 800 million cubic metres per annum. Twenty per cent of estuaries are very highly or highly impacted by freshwater flow reduction, especially the large permanently open estuaries in the Cool Temperate bioregion (e.g. Orange, Great Berg and [Western Cape] Olifants). A further 14% of South African estuaries are moderately impacted by reduced flow modification, with the highest proportion in the Cool Temperate (33%) and Warm Temperate (14%) bioregions. This affects estuary–marine connectivity (mouth state), estuarine productivity, water quality, sedimentary processes, invertebrate and fish recruitment, and nursery function. To avoid further compromising the benefits of these ecosystems, Strategic Estuarine Management Plans – including freshwater allocation, fish resource use, water quality management and land-use planning – should be developed and implemented.

Water quality issues

There has been a significant increase in pollution pressure in estuaries (e.g. 840 million litres of waste water

flows daily into estuaries, either directly into or just above the estuaries) with deteriorating water quality driving change on regional scales. Thus, about 33% of estuaries are under severe (very high and high) pollution pressure, with the majority of those located in the Cool Temperate (63%), followed by the Subtropical (39%) and Warm Temperate (18%) bioregions. This reduces ecosystem resilience and nursery function; kills invertebrates and fish; and makes estuaries vulnerable to invasive species, parasites, pathogens and diseases (e.g. *Tirebia* and epizootic ulcerative syndrome). Poor water quality also impacts estuarine resilience to natural stresses such as droughts and climate change over longer time scales. Furthermore, declining water quality threatens habitat diversity such as loss of seagrass habitat in Knysna due to macroalgal blooms, the increase in alien invasive aquatic plants in small KwaZulu-Natal estuaries, and the persistent algal blooms in the upper reaches of systems with agricultural return flow. Maintaining and restoring water quality in estuaries requires reducing/recycling waste water, compliance with DWS and DEFF waste water discharge policies, innovative engineering solutions to stormwater management and improved agricultural practices (e.g. prudent application of agricultural fertilisers and pesticides).

Fishing pressure

A total of 3 730 t of fish was caught in estuaries in 2018 in contrast with 3 030 t caught in 2011, with 20% of estuaries subjected to high or very high fishing pressure. Up until a decade ago, excessive pressure or fishing effort was mostly confined to three large



A



B



The Kosi Estuary is famous for its woven fish traps, a method of fishing passed down through generations for well over 700 years by the local Thonga (the Tembe community). The palisade fish kraals consist of a guide fence that curves in towards a fish trap, allowing fish easy entry, but no escape. Historically the traps were designed for small fish to escape, but recently the practices of narrowing gaps between fencing and lining the traps with netting, together with a significant increase in the number of fish traps, are impacting on the fish nursery function of Kosi. © Peter Chadwick

estuaries in the Cool Temperate bioregion and one in the Tropical bioregion. Since then, there has been a substantial increase in fishing effort in estuaries elsewhere on the coast, especially in the Subtropical and Tropical regions. The latter was exacerbated by the effective open access to resources that arose with the collapse of fisheries compliance in KwaZulu-Natal. Currently, severe to excessive fishing pressure occurs in 15% of Cool Temperate estuaries and 23% of Subtropical estuaries, compared to 100% of Tropical systems. Fishing pressure in estuaries increased considerably between 2011 and 2018, with the majority of the increase occurring in the Warm Temperate and Subtropical bioregions. Less than one per cent of estuaries are free of fishing pressure as few have national, provincial or municipal protection or 'no-take' status. In addition, the integrity of estuarine protected areas is being eroded by both sanctioned and unlawful fishing in these areas. In many instances, fishing effort is now five times higher inside than outside restricted areas (e.g. estuaries in Dwesa-Cwebe MPA and reserve).

Other biological resource use

Certain estuarine plants are harvested for traditional crafts, including Ncema Grass (*Juncus kraussii*) and Common Reed (*Phragmites australis*), and mangroves

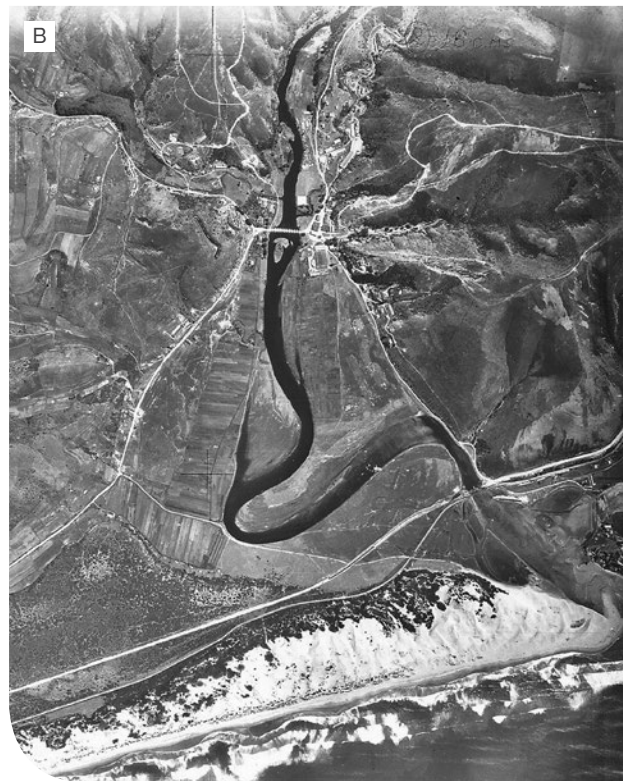
are targeted for construction in some estuaries such as Mkomazi, Mngazana and Nxaxo-Ngqusi.

Habitat modification

Overall, 29% of South African estuaries are subject to severe (high and very high) pressure from habitat modification as a result of urban, industrial, agricultural and infrastructural development, mostly in the Cool Temperate (63%) and Subtropical (34%) regions. Less than 10% of all estuaries in South Africa are under no pressure from development; most of these being confined to national, provincial or municipal protected areas. Key activities contributing to habitat modification in estuaries include urban development, transport infrastructure (roads, crossings and culverts), riparian infrastructure (fences, bank stabilisation and low-lying developments), agriculture (clearing for crops, grazing), in-stream infrastructure (jetties and launching sites), raw material harvesting for housing (reeds, sedges and mangroves), mining, harbour and marina infrastructure, and salt works. Some of the more notable impacts include changes to erosion/depositional cycles, direct habitat loss during construction, changes to flow velocity and circulation patterns, reduced tidal prism, premature mouth closure, smothering of submerged habitats by excessive sedimentation, increased turbidity, reduced



Estuaries can be impacted by habitat modification through agriculture and built infrastructure like houses, roads and jetties. The Groot Brak floodplain, pictured recently (A), © Pierre de Villiers, has had substantial development since the 1940s (B), © SAEON.



primary production, destruction of riparian and in-stream habitats and biota, contamination and associated poor water quality. Considering habitat loss; the land cover data indicate that, overall, about 16% of the natural habitat within the EFZs has been lost to human settlements (4%), croplands (10%), and mines, dams and other infrastructure ($\pm 2\%$). Agriculture in Subtropical estuaries is mainly sugar cane farming. In the Warm Temperate estuaries, floodplains were intensively cultivated in the 1950s to 1970s but then abandoned, (e.g. Keiskamma and Great Fish estuaries). Cattle grazing and growth of alien plants are now common in these areas. In the Cool Temperate systems, floodplain areas are also prone to agricultural development (e.g. grain and fodder, fruit orchards, vineyards) and livestock grazing.

The small-scale mining of sand, diamonds and heavy minerals is causing permanent habitat destruction in about 12% of estuaries, with especially sand mining impacting on critical habitats, estuary hydrodynamics, sediment structure (grain size) and depleting sediment reservoirs needed to replenish physical habitat after scouring by floods. This ultimately results in the deepening of estuaries and the loss of meandering channels and sheltered backwater areas that provide refuge to

The artificial breaching of estuaries has systemic consequences and the manipulation of an estuary mouth should only be allowed under exceptional circumstances. Here the Disa Estuary breaks naturally through to sea. © Anisha Dayaram.

estuarine biota from floods and large predators. The loss of physical structure increases the vulnerability of estuaries to floods and lengthens the recovery period between floods, i.e. post-flood sediment deposition rates are significantly reduced. This reduction in sediment reservoirs also has knock-on effects for the replenishment of beaches and foredunes that play a crucial role in coastal protection. Strategic spatial planning is required to consider which areas could be carefully mined. At present data are lacking to assist with such endeavours on a national scale.

Estuary mouth manipulation

The mouths of 15% of South African estuaries are artificially manipulated, and these estuaries represent more than 60% of the total estuarine habitat in the country. Artificial breaching at lower water levels



causes premature closure, reduced marine connectivity and accumulation of marine sediments in the lower reaches. This reduces estuarine productivity and nursery function, and increases flood risks to coastal communities in the long term. The systemic consequences of artificial breaching at low water levels needs to be more broadly appreciated. Artificial breaching is a listed activity that should only be allowed under exceptional circumstances that are guided by a uniform national breaching policy (unfortunately only provisional guidelines exist at present).

Biological invasions

Twenty-two alien, extralimital or translocated fish species have been recorded in 25% of South Africa's estuaries. These freshwater species are generally intolerant of salty water and confined to the headwaters of estuaries. It is here that they may become an impenetrable barrier to the upstream movement of eggs, larvae and juveniles of estuary-dependent fishes and catadromous eels. Four of the alien fishes are voracious predators of eggs and larvae, eight are predominantly piscivores and two are habitat altering. Many of these are also vectors of disease, such as epizootic ulcerative syndrome. Further invasions can be limited by stricter import controls and management of the aquarium trade and aquaculture industry. Barring poisoning, existing populations can be controlled by directed and innovative fishing to the benefit of local communities.

A third of estuaries have invasive terrestrial plants occurring within the EFZ, with 18 of these plants considered to be highly invasive. Aquatic invasive plant species occur in 23 estuaries in the country. In total 70 invasive plant species were reported. Invasive

Acacia species, particularly Rooikrans (*Acacia cyclops*), and *Eucalyptus* trees are abundant along the Cool and Warm Temperate coastline. Kikuyu grass (*Pennisetum clandestinum*) is prevalent, even in protected areas. Invasive plant diversity is highest along the Subtropical KwaZulu-Natal coastline. Dominant tree species include Brazilian Pepper Tree (*Schinus terebinthifolius*), *Casuarina equisetifolia* and *Sesbania punicea*. The urbanised estuaries of KwaZulu-Natal are highly disturbed and often the riparian vegetation consists only of invasive alien plants. Although there has been a biological control programme, Water Hyacinth (*Eichhornia crassipes*) still remains the worst aquatic weed in South Africa displacing rare submerged macrophyte species. Eradication programmes are urgently needed to address this growing concern.

Climate change

Climate change has the potential to change the processes and functioning of South Africa's estuaries dramatically. Major climate change impacts in order of importance are: changes in rainfall and runoff, shifts in ocean processes, temperature regime shifts, sea-level rise, increase in the frequency and intensity of sea storms, and coastal acidification. Overall, the Subtropical KwaZulu-Natal and Cool Temperate west coast estuaries will be the most influenced from structural and functional perspectives. In the Subtropical bioregion, the major driver of change is increased runoff into the numerous small, perched temporarily open/closed estuaries, resulting in more open mouth conditions, a decrease in retention time and a related decrease in primary productivity and nursery function. Tropical and Subtropical estuarine lakes will be subjected to more severe climate fluctuations, i.e. major floods and increasing droughts, potentially

South Africa's successful eradication of the highly invasive cordgrass (*Spartina alterniflora*) in the Great Brak Estuary. This species is habitat-transforming and would have spread to adjacent estuaries if not for the quick eradication. Early warning systems and quick intervention for invasive species are the most successful.



Estuaries epitomise **pressure hotspots**, and, unfortunately, there is a dearth of long-term monitoring data to inform conflict resolution and provide for high confidence decision making. While some new data are being collected on larger systems, this is not the case for the numerous smaller estuaries. In the long term, this weakens decision making processes that could ensure that the benefits that flow from estuaries to all users are secured. Country-wide estuary abiotic and biotic surveys are urgently needed to ensure optimum resource allocation, use and protection

disrupting marine connectivity. Cool Temperate west coast estuaries will experience a decline in primary production and loss of nursery function as a result of reduced freshwater input. Warm Temperate estuaries will show some shifts in mouth state, nutrient supply, salinity regime and ultimately production. The most obvious impacts of climate change along Warm Temperate coastal bioregions will be the change in temperature (water and air) and associated species range expansions or contractions and changes in community structure. Climate change will not only increase the risks to estuary ecosystems under significant pressure at present, but also to the human communities and associated infrastructure and property surrounding them. It is essential that climate change, and the projected effects thereof, be integrated into current plans and policies dealing with management and governance of estuaries, specifically the fishing, water and coastal management sectors. This requires an adaptive management approach that is supported by monitoring and frequent review.

3.3.4 Ecological condition in the estuarine realm

This assessment determined that 21% of estuaries in South Africa are in a natural state (A category), 40% in a near-natural state (B category), 20% in a moderately modified state (C category), 12% in a heavily modified state (D category), and 8% in a severely / critically modified state (E/F category). Estuaries in natural and near-natural state are mainly located in the Tropical (100%), Warm Temperate (73%) and Subtropical (56%) bioregions, while the Cool Temperate bioregion is characterised by estuaries in a heavily modified or worse state (54%) (Figure 69). This analysis is biased towards the state of the large number of small estuary types occurring along the South African coast.

When analysed by estuarine area rather than the number of estuaries, most (63%) estuarine area is in a heavily modified state or worse, and only about 23% is in a natural/near-natural state; the latter mainly located in the Warm Temperate bioregion and Tropical bioregion (Figure 69). An additional 15% is in a moderately modified state. Part of this result arises because the Subtropical system of Lake St Lucia accounts for 56% of South African estuarine area. Lake St Lucia is currently classified as being in a heavily modified state, an improvement from the 2011 NBA, in which it was considered severely modified. The poor condition of the lake system was largely due to the artificial diversion of the uMfolozi River away from the lake and an extended drought in the region. As many of these pressures are reversible, a restoration programme is now being implemented that aims to reconnect the uMfolozi River and St Lucia Estuary, thereby increasing freshwater inflow.

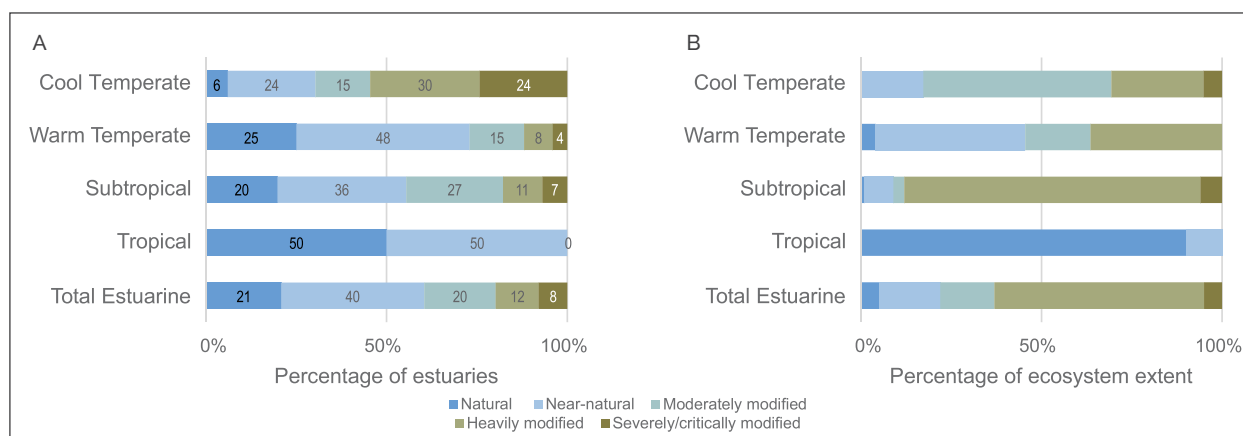


Figure 69. Different perspectives arise when the National Health Assessment is presented either as percentage of estuaries (A); or percentage of estuarine area (B). The percentage area analysis highlights the fact that the majority of South African estuarine area is in a degraded state.

Estuaries are highly productive ecosystems that contribute R4.2 billion per annum to the South African economy. Estuaries provide warm, shallow and calm waters along our rugged, wave-exposed coast, and are highly productive, thanks to inputs of nutrients from both the land and sea. These characteristics, together with their scenic appeal, make them focal points for development, tourism and recreation, as well as important for supporting biodiversity, livelihoods and marine fisheries. Just over 70% of this value is manifest in property and tourism value as a result of the use of the amenities that they provide. However, the development of estuaries and their catchments has come at a cost of about R700 million per annum in terms of lost fishery benefits, as well as unknown costs to society from the heavy use of resources and loss of biodiversity. This has reduced the diversity of benefits delivered by estuaries and the diversity of beneficiaries enjoying their services. Development and resource use needs to be carefully planned to ensure the equitable sharing of benefits derived from these highly productive systems. The protection and rehabilitation of estuaries through the implementation of ecological water requirements and protecting the EFZ and its structural habitat from poorly planned coastal development is critical for maintaining resilience and enhancing future estuary benefits. See Coastal Ecological Infrastructure (EI) Case Study 1 in the Compendium of Benefits of Biodiversity (SANBI 2019) for more information.



Goukamma Estuary. © CapeNature.

Over the next few decades the long-term recovery of St Lucia is likely to continue to have a marked effect on the overall health status of South African estuaries.

The Cool Temperate bioregion has a high proportion of estuaries in a heavily modified or worse condition, especially temporarily open systems near Cape Town and other coastal urban centres. The Warm Temperate bioregion, on the other hand, is characterised by estuarine habitat in natural/near-natural condition, possibly due to the undeveloped nature of large parts of this bioregion. The Subtropical bioregion had the second highest number of estuaries in a heavily modified or worse condition, mainly due to urban development, waste water discharges and storm water, overfishing and intensive sugar cane farming in the catchments and EFZ.

From an estuarine ecosystem type perspective, the Cool Temperate bioregion has the most ecosystem types in a severely/critically modified state with Large Fluvially Dominated (100%), Large Temporarily Closed (99%), Arid Predominantly Closed (78%), Small Temporarily Closed (55%) and Estuarine Lakes (37%) reflecting key pressures such as flow reduction, pollution and fishing pressure of the bioregion.

In the Subtropical bioregion, the highest number of ecosystem types in a severely/critically modified state are the Estuarine Lakes (100%), Estuarine

Bays (100%), and Large Fluvially Dominated (88%) systems reflecting habitat transformation, pollution and fishing pressure of the bioregion. In the Warm Temperate bioregion only the Estuarine Lakes (77%) reflect significant degradation due to development in the EFZ, flow reduction and artificial breaching. In addition, 21% of both Predominantly Open and Large Temporarily Open ecosystems are also significantly degraded. None of the ecosystem types in the Tropical bioregion are in a severely modified state.

3.3.5 Ecosystem threat status in the estuarine realm

The first implementation of the IUCN RLE for South African estuarine ecosystems (22 types) for the NBA 2018 resulted in the listing of two Critically Endangered, ten Endangered and seven Vulnerable ecosystems (Figures 70 & 71). While 9% of ecosystem types are Critically Endangered, this amounts to <5% of the extent of estuarine area in South Africa. In contrast, Endangered ecosystems make up 45% of ecosystems by type and 74% by extent. About 41% of ecosystems types are Vulnerable, amounting to 22% of the estuarine area in South Africa (Figures 70 & 71). The most influential criteria in the RLE assessment were Criterion

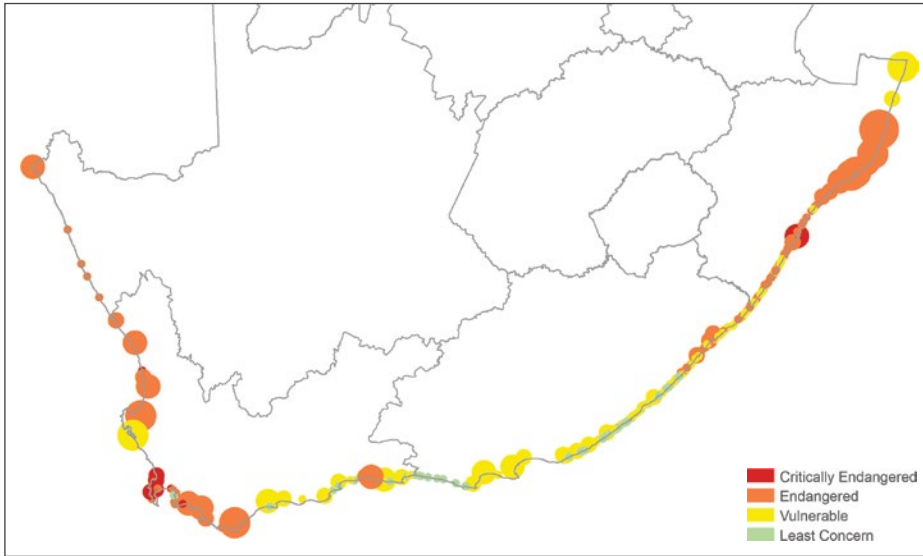


Figure 70. Schematic representation of estuarine ecosystem threat status. The size of the dot represents the area of the individual estuary. Note: there are many overlaps between points that can obscure the status of smaller estuaries. The maps and data can be found at <http://nba.sanbi.org.za/>.

C3 (historical environmental degradation), which contributed to the listing of ten ecosystem types. The supplementary assessment of Criterion A (historical and future reductions in geographic range) contributed to the listing of seven types, while Criterion B (restricted distribution with continuing declines in geographic distribution) contributed to the listing of two types.

About 75% of the Cool Temperate bioregion ecosystem types are Critically Endangered or Endangered, while 13% are Vulnerable. While most of Warm Temperate types are Vulnerable (57%) and of Least Concern (29%). About 83% of the Subtropical bioregion ecosystem types are Critically Endangered or Endangered, while 17% are Vulnerable. In comparison, 100% of the Tropical bioregion is Vulnerable (Figure 71A). However, if analysed by estuarine area, nearly 84% of the Cool Temperate bioregion habitat is Critically Endangered or Endangered, while less than 13% is Least Concern. In contrast, most of the ecosystem types in the Warm Temperate are Vulnerable and Least

Concern, representing 64% and 29% respectively of the area in this zone. About 98% of the Subtropical estuarine area is Critically Endangered or Endangered (Figure 71B).

While there is a noticeable increase in key pressures such as pollution (i.e. increase in waste water treatment discharges), with an expected related impact in condition, there have also been a number of refinements to methods and approaches to assessing estuary condition. It was thus not appropriate to compare the NBA 2018 results with that of the NBA 2011 to establish overall trends.

Although the condition assessments for most systems have been updated, the survey data underpinning these assessments are between 20 and 30 years old. It is, therefore, crucial that more up-to-date national surveys be conducted to improve our overall confidence in the estimated change for the different ecosystem types and to inform future assessments. Estuaries are

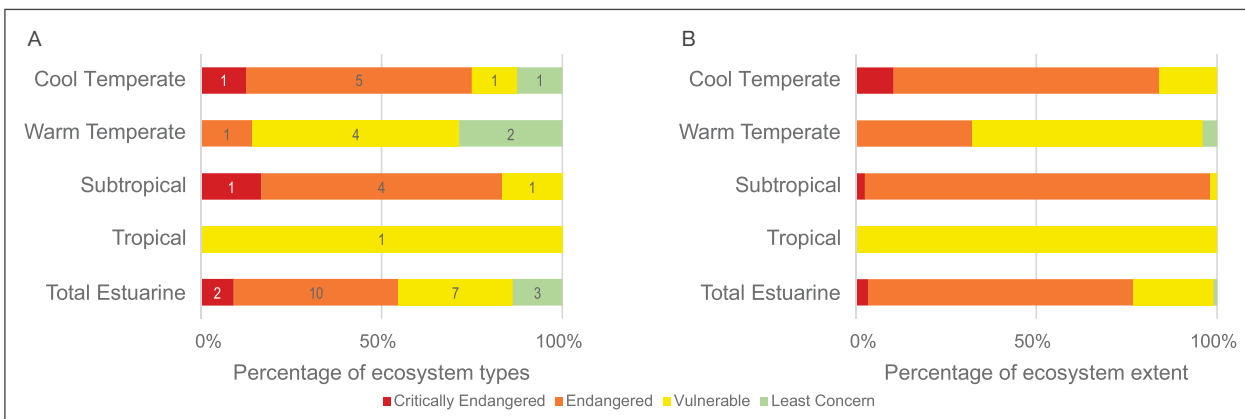


Figure 71. Ecosystem threat status of South Africa's estuaries presented as percentage of ecosystem types (A); and percentage area of ecosystem types (B).



The groundwater fed Langebaan Estuarine Lagoon is partly incorporated into the West Coast National Park. Fishing pressure needs to be managed in this iconic estuary to bring its ecosystem protection level to Well Protected and protect its nursery function. © Peter Chadwick.

interconnected over local, bioregional and global scales. Ecosystem threat status is just one of a range of measures that document the decline in condition. The results of the ecosystem threat status assessment should not be decoupled from the overall regional findings.

3.3.6 Ecosystem protection level in the estuarine realm

Estuarine ecosystem protection levels are low, both in terms of number of types and in area. Overall, nearly 82% (19 out of 22 types) of South Africa's estuarine

ecosystem types are under-protected. Only 18% of estuarine ecosystem types are Well Protected (four types), while about 36% are Moderately Protected (eight types) and 32% are Poorly Protected (seven types) (Figures 72 & 73). The picture becomes even more disturbing if evaluated by estuarine area, with less than 2% of systems Well Protected, 25% Moderately Protected and 69% and 11% Poorly and Not Protected, respectively.

On a more positive note, this headline indicator is sensitive to the condition of the greater St Lucia Estuarine Lake System, thus, as St Lucia improves in condition in the short to medium term, the overall protection levels will increase. Immediate gains can also be achieved through the management of fishing pressure in three key priority estuaries: Langebaan,



Figure 72. Schematic representation of estuarine ecosystem protection levels (size of the dot represents area of the individual estuary). Note: there are many overlaps between points that can obscure the status of smaller estuaries. The maps and data can be found at <http://nba.sanbi.org.za/>.

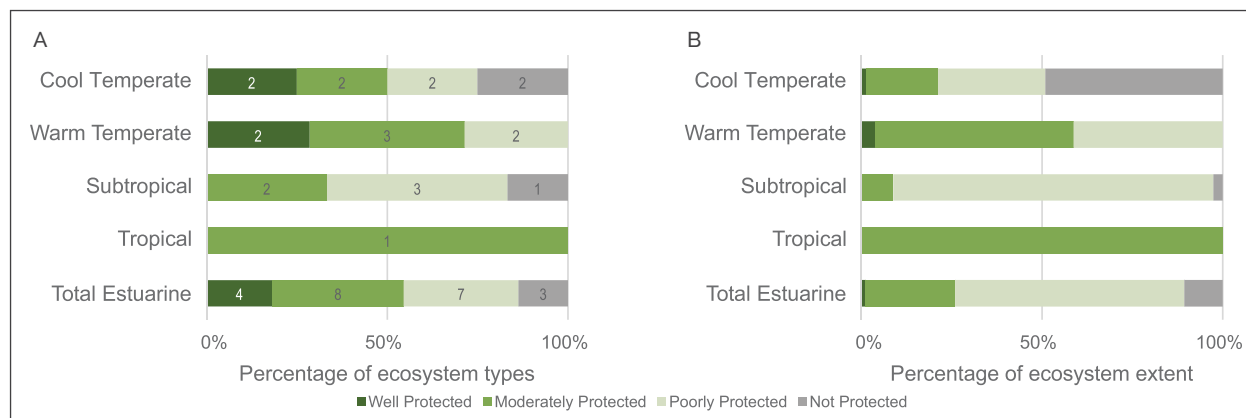


Figure 73. (A) Estuarine ecosystem protection levels in South Africa by percentage types; and (B) percentage area.

Knysna and Kosi. This will allow the Well Protected category to increase from 18% to 32% (10% of total estuarine area) without any additional declarations or legislation. This, in turn, will also assist with the recovery of key fish species such as Steenbras.

While the National Estuaries Biodiversity Plan was endorsed by government, there has been no significant increase in the estuarine protected estate since the NBA 2011 (the uThukela and Sundays estuaries received an additional 12 km² of protection from the recent MPA declarations) and fishing restrictions within protected areas have been relaxed in some recent cases. This represents an effective erosion of protection levels for estuaries since 2011. This compromises nursery function and increases the need to control fishing in the open systems.

Ecosystem protection level is just one of a range of measures that document the progress in the protection of estuaries. The results of the ecosystem protection level assessment should not be decoupled from progress in environmental flow allocations, fisheries control measures, and land-use and infrastructure development measures. Estuaries are open systems and can only be judged to be Well Protected if all of these aspects are addressed concurrently.

Threatened and under-protected ecosystem types

Of the 22 estuarine ecosystem types, 18 are threatened and under-protected. Three of these are highly threatened (Critically Endangered or Endangered) and Not Protected (Table 8). These estuary types, which include most of the Large Fluvially Dominated, Estuarine Bays, Predominantly Open types of the Western Cape and KwaZulu-Natal, represent urgent priority estuarine ecosystem types for protected area expansion and management planning.

3.3.7 Species threat status in the estuarine realm

Of the 66 species included in this assessment, 18 (27%) are threatened with extinction. While this finding corresponds well with the ecosystem assessment which found estuaries to be highly threatened, it is based on a limited set of species assessments that include a high proportion of range-restricted endemics, economically important species or habitat-forming species. Of the groups considered, only birds were comprehensively assessed. Future assessments need to include all representatives of a taxonomic group to remedy this bias.

Fourteen per cent of estuarine birds are threatened with extinction (Figure 74). Of particular concern is the reported loss of ±265 000 waterbirds from South African estuaries, most of which are waders from larger estuaries, especially in the Cool Temperate bioregion (a decline of 68% in 40 years). These declines

Table 8. Estuarine ecosystem threat status and protection level, highlighting those types that are under-protected and highly threatened

Estuary	Not Protected	Poorly Protected	Moderately Protected	Well Protected	Total
Critically Endangered	1	1	0	0	2
Endangered	2	4	3	1	10
Vulnerable	0	2	5	0	7
Least Concern	0	0	0	3	3
Total	3	7	8	4	22

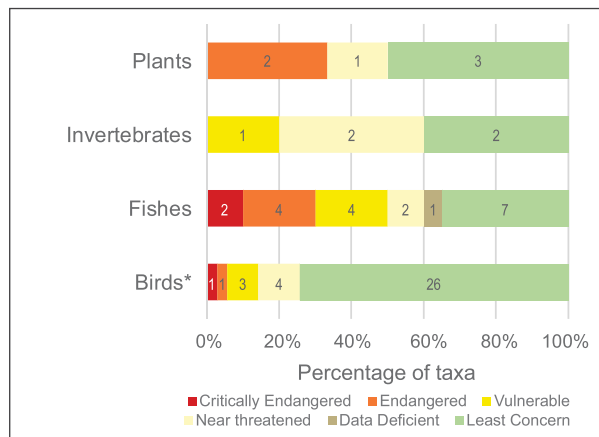


Figure 74. The proportion of indigenous estuarine species assessed to date in each of the IUCN categories of extinction risk: Extinct (EX), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Data Deficient (DD), Least Concern (LC). Labels shows the number of species in each category. *Only birds were assessed comprehensively.

are partly externally driven (e.g. global habitat loss), but are also closely related to estuary health, and are not mitigated by level of protection alone. Bird numbers are still on a significantly negative trajectory, emphasising the need to manage the overall decline in estuary condition, habitat loss, impact of gillnetting on birds, solid waste (plastics), hunting and human disturbances in key foraging and roosting areas.

Several economically important linefish species that are estuarine dependent are threatened by overfishing (especially gillnetting), reduced flow and concomitant influence on recruitment and marine connectivity; and declining water quality. These include: Dusky Kob (*Argyrosomus japonicus*), which is considered Critically Endangered (possibly Endangered) and at

<2% of pristine reproductive adult biomass or breeding potential; White Steenbras (*Lithognathus lithognathus*) is Endangered at <6%; White Stumpnose (*Rhabdosargus globiceps*) Vulnerable at <22%; Spotted Grunter (*Pomadasys commersonnii*) Vulnerable at <24%; and Leervis (*Lichia amia*) Vulnerable at <14% of pristine reproductive adult biomass.

Of further concern is that unique endemic fish species restricted to South Africa's estuaries are all highly threatened. These include the iconic Knysna Seahorse (*Hippocampus capensis*), which historically occurred in nine estuaries and is currently restricted to three – the Knysna, Swartvlei and Keurbooms. Listed as Endangered, the biggest threat is the continued increase in nutrient inputs from surrounding catchments into the Knysna Estuary, which has resulted in ongoing algal blooms that displace its seagrass habitat. The Estuarine Pipefish (*Syngnathus watermeyerii*) is even more threatened. Historically it occurred in the Bushmans, Kariega, Kasouga, and East and West Kleinemonde estuaries on the Eastern Cape coast, but has recently only been recorded in the Bushmans and Kariega. Amongst other life-history constraints, the Estuarine Pipefish depends on regular freshwater influxes to maintain its zooplanktonic food resource. Excessive freshwater abstraction and deteriorating water quality are reducing this food resource and causing ongoing decline of this species. It is listed as Critically Endangered due to there being less than 250 animals in total and less than 50 mature individuals in each estuarine subpopulation, with extreme fluctuations linked to the availability of macrophyte habitat. Until a programme is in place that regulates freshwater pulses into South African estuaries, which are needed to maintain Estuarine Pipefish food supplies,

The White Steenbras (*Lithognathus lithognathus*) is an economically important linefish that is dependent on estuaries. It is Endangered and has <6% of its adult breeders left. © CapeNature.





The Estuarine Pipefish (*Syngnathus watermeyerii*) historically occurred in five estuaries on the Eastern Cape coast, but excessive freshwater abstraction and poor water quality affect its habitat and food resource. The species has recently been recorded in only two estuaries. © Fred Fourie.

the species will remain at high risk of extinction. The Bot River Klipvis (*Clinus spatulatus*), listed as Endangered, is known only from two estuaries – the Bot River and Klein River estuaries in the south Western Cape. Both estuaries are impacted by reduction in freshwater inflow, pollution or eutrophication, over-fishing, human settlements and agriculture, with these pressures causing ongoing decline in habitat quality.

The Freshwater Mullet (*Pseudomyxus capensis*) is more widespread, occurring in 80% of South Africa's estuaries. Despite its wide range, it has experienced extensive declines in the period since the last assessment. Predation by alien invasive fish species and damming of rivers have markedly reduced its available habitat, particularly limiting use of upstream habitat. Recent increases in gillnetting have also caused rapid declines; although not itself a target, this species makes up a large proportion of gillnet bycatches.

Estuarine macroinvertebrates are also declining, for example the Giant Mud Crab (*Scylla serrata*) has experienced a significant increase in fishing pressure over the past five years. Traditionally this species was subjected to very low fishing pressure in South Africa, however, the establishment of formalised syndicates along the Eastern Cape coastline to supply the rapidly growing demand for seafood, has led to increases in illegal harvesting. Furthermore, enforcement efforts have decreased on the KwaZulu-Natal coastline, which has resulted in increased pressure



The Knysna Seahorse (*Hippocampus capensis*), Endangered, historically occurred in nine estuaries, but is currently restricted to only three, as its habitat is the Endangered Eelgrass (*Zostera capensis*). © David Harasti.

Box 10. Eels

Species with many life history stages that cross different realms are most at risk. Eels (four species of the genus *Anguilla* are present in South Africa), for example, have five life history stages across the river–estuary–sea continuum. Eels are vulnerable to pressures in all of these realms, including: flow reduction, pollution, habitat loss, fishing pressure, loss of river–estuary–sea connectivity, atmospheric ozone depletion resulting in ultraviolet radiation, and climate change. They are top predators in the aquatic food chain, maintaining trophic structure. Historically they were also a significant source of protein to rural communities and have cultural significance in some areas, for example, in Pondoland. To maintain the benefits from species that are dependent on healthy ecosystems across different realms, we need to identify essential linkages between realms and implement effective biodiversity management. Specifically, we need to protect key habitats, control harvesting/fishing pressure, manage water quantity and quality, and enhance connectivity between realms.



African Longfin Eel (*Anguilla mossambica*). © Jeremy Shelton.

from cross-border subsistence fishing. Another invertebrate in decline is the important bait species, the Sandprawn (*Callichirus kraussii*), whose sandbank habitat is declining in central KwaZulu-Natal as a result of sand mining. Sand mining is increasing due to freshwater draw down from water abstraction to support agriculture; abstraction exposes river beds, making these far easier to mine. Sand mining is causing large-scale sand movement downstream with new sand deposits smothering the burrows of this species. Many municipalities in KwaZulu-Natal are also pumping raw sewage into estuaries, this leads to rapid eutrophication facilitating invasion by invasive aquatic plants and invertebrates, which displaces indigenous invertebrates.

Six plants were included in this assessment – five species of mangrove and seagrass (*Zostera capensis*). The majority of mangrove species have a very small

distribution on the South African coast relative to their global distribution. However, with this being their southernmost distribution, conservation of their habitat is critical to provide opportunity to respond to climatic change. Mangroves are relatively resilient and are able to recolonise sites after disturbance, but there have been a number of cases of permanent losses, when river mouths are closed for extended periods. One species has been assessed nationally as Endangered (*Lumnitzera racemosa*), one as Near Threatened (*Rhizophora mucronata*), while three species are assessed as Least Concern (*Ceriops tegal*, *Bruguiera gymnorrhiza*, *Avicennia marina*). Major pressures impacting the two species of conservation concern are harvesting, habitat degradation by agricultural activities causing eutrophication and, in the past, habitat loss to urban and industrial development. While species assessed as Least Concern are also facing pressures, their overall population in South

Africa have remained stable with reductions in certain estuaries offset by increases in others.

Seagrass (*Zostera capensis*) occurs along the southeast coast of Africa from South Africa to Kenya, yet, despite its seemingly large global distribution, the species occupies a very small area. Seagrass provides habitat in the form of substrate for epiphytes and periphyton, and foraging and nursery areas for many fishes and invertebrates. Globally seagrass is assessed as Vulnerable, but in South Africa it qualifies as Endangered based on the very small areas of occupancy mapped to be between 11–13 km². It is experiencing continued loss of populations and degradation of habitat from extended mouth closures, dredging, eutrophication and recreational disturbances. Its largest population in South Africa occurs in an area of 3.53 km² in the Knysna Estuary. It has been lost from both the Durban Bay and St Lucia systems. It experiences extreme fluctuations in population size, due to the dynamic changes in cover abundance in response to floods, droughts, sedimentation and freshwater abstraction.

Many other estuarine invertebrate and fish species may be threatened, but as yet are undetected due to lack of monitoring data being available and Red List assessments not having been conducted. South Africa has a unique fauna of invertebrates that occur in estuaries, many of which are endemic. Endemic invertebrates are priorities for inclusion in future species assessments. Further monitoring of invertebrate and fish species response to changing estuarine condition is required.

3.3.8 Genetic studies in the estuarine realm

Macrophytes

Preliminary research was completed on the population genetics of estuarine macrophyte species (intra- and interspecific genetic diversity). The aim was to identify estuaries that contain evolutionary significant units (ESUs) at intraspecific level, as well as those that contain a high level of phylogenetic diversity. In total 31 estuaries had unique haplotypes or ESUs. These include large systems such as the Langebaan lagoon, Olifants and Groot Berg estuaries that contain unique ESUs of *Salicornia pillansii*, *Triglochin striata* and *Salicornia tegetaria*. However, some smaller estuaries were also identified as having unique ESUs; for example, the Hartenbos, Verlorenvlei and Uilkraals contain unique haplotypes for *Juncus kraussii*, *Salicornia tegetaria* and

S. pillansii. These data can be used to prioritise estuaries for conservation.

Connectivity is important in estuary conservation priority setting where the gene exchange of organisms across different habitats is crucial for the persistence of populations and their productivity. Most of the systems listed above are conservation priorities.

Fishes and invertebrates

As indicated above, stock assessment of Dusky Kob (*Argyrosomus japonicus*) shows the biomass of reproductive adults at <2% of pristine. This is supported by data showing that, in recent years, there are <500 successful breeding pairs on South Africa's coast and <50 pairs in some regions. Population bottlenecks identified have been linked to abrupt increases in fishing effort in estuaries and overfishing of juvenile and adolescent kob, drought, and anomalous flood events. Hybridisation is occurring between the estuarine-dependent Dusky Kob and the predominantly marine Silver Kob (*A. inodorus*). This is only between large dusky males and smaller silver females, which mature at 1100 mm and 400 mm respectively. So, it appears that silver females are more attracted to large dusky males than to the small males of their own species, or both species are at critical levels and the probability of encounter with the opposite sex is very low, but greater with a large noisy dusky male.

Bot River Klipvis (*Clinus spatulatus*) only occur in the Bot and Klein estuaries in Walker Bay. They diverged from the marine Super Klipvis (*Clinus superciliosus*) since the last Ice Age (at the start of the Holocene) with sea-level rise and increased isolation of Walker Bay and these two systems. Compared with the relatively stable *C. superciliosus* population, *C. spatulatus* is characterised by low genetic diversity from repeated population crashes arising from the opening and closure of these two estuaries. However, *C. spatulatus* is much more physiologically tolerant of salinity extremes, water temperature and low oxygen levels. Population genetics and genetic structure of *C. spatulatus* have also verified that the Bot/Kleinmond and Klein estuarine lakes have been functioning this way and driving this species' evolution for millennia.

Population genetics data are needed to delineate discrete stocks or populations of fish and invertebrate species, particularly in increasingly isolated estuarine ecosystems where connectivity should be maintained. Such studies are crucial in spatial planning, stock assessment, the setting of protection levels and the implementation of appropriate management interventions. From a resource management perspective, population bottlenecks, manifested in



The threatened status of the Dusky Kob (*Argyrosomus japonicus*) is evident in genetic studies. The variability in estimates for generation length and rate of population decline creates uncertainty in threat status assessments, which range between Endangered or Critically Endangered. © JD Filmater, SAIAB.

shrinking effective population size, need to be identified and linked to the causes (e.g. overutilisation, disease, drought, flood and physiological stress). This said, most estuaries are subject to some degree of isolation that varies according to the locality and characteristics of individual systems. Distinct lineages often display physiological and behavioural adaptations to the habitats in which they arise, which in turn drives further divergence. These discrete lineages and genetic adaptations need to be considered when setting biodiversity and conservation targets, especially with regard to future climate change scenarios.

Aside from the understanding of population genetics, molecular forensics is emerging as a crucial tool for identifying and tracking plants and animals in the wildlife trade. Recent confiscations of contraband indicate a thriving illicit trade for pipefishes and seahorses (Syngnathidae) from within and via South Africa. Catching or possession of any member of either the pipefish and/or seahorse family is prohibited in this country. Molecular forensics helps identify these confiscated animals and determine their country of origin. It also helps investigators determine the global markets in which South African species are traded.

3.4 Marine realm

ECOSYSTEMS

50%

of 150 ecosystem types
Threatened

31%

of 150 ecosystem types
Well Protected

13%

of 150 ecosystem types
Not Protected

SPECIES

18%

of 376 taxa assessed
Threatened

3.4.1 Summary

South Africa's marine environment includes the Atlantic, Indian and Southern oceans with the contrasting cold Benguela upwelling region and the warm, fast-flowing Agulhas current interacting with the diverse geological setting and topography to drive exceptional marine biodiversity. The broad range of climatic, oceanographic and geological settings result in a wide array of ecoregions and 150 different marine ecosystem types. Globally, South Africa is reported to have the third highest marine endemism with an estimated 33% of its marine fauna found only in South Africa. There is high marine endemism in the Warm Temperate Agulhas ecoregion on the south coast, which is geographically very isolated from other Warm Temperate regions.

The NBA 2018 substantially advanced South Africa's map of marine ecosystem types, drawing from major efforts to collate and increase bathymetric, oceanographic, sediment and biodiversity data. Key advances in the map of marine ecosystem types included very fine-scale shore mapping with alignment and integration in the coast; the inclusion of kelp forests, bays and fluvial fans as distinct types; and the introduction of finer depth strata across shelves and on the slope. Finer scale pressure mapping was conducted and additional pressures were mapped to support the analyses of ecosystem degradation and threat assessment. Of the 31 pressures included, six are new; including abalone fishing (South African Abalone, *Haliotis midae*), disposals of ammunition and dredge material, beach seine netfishing, gillnet fishing and oyster harvesting.

The main pressures impacting marine ecosystems and species include fishing, freshwater flow reduction, coastal development (including ports and harbours), pollution and climate change. South African ocean activities are expanding and diversifying as South Africa develops its ocean economy. Emerging pressures include increasing pollution concerns, desalination and ocean noise. A total of 96 introduced marine species, of which 55 are invasive, have been reported. Climate change causes changes in currents, upwelling, water temperatures and turbidity, while elevated atmospheric carbon dioxide results in increasing ocean acidification.

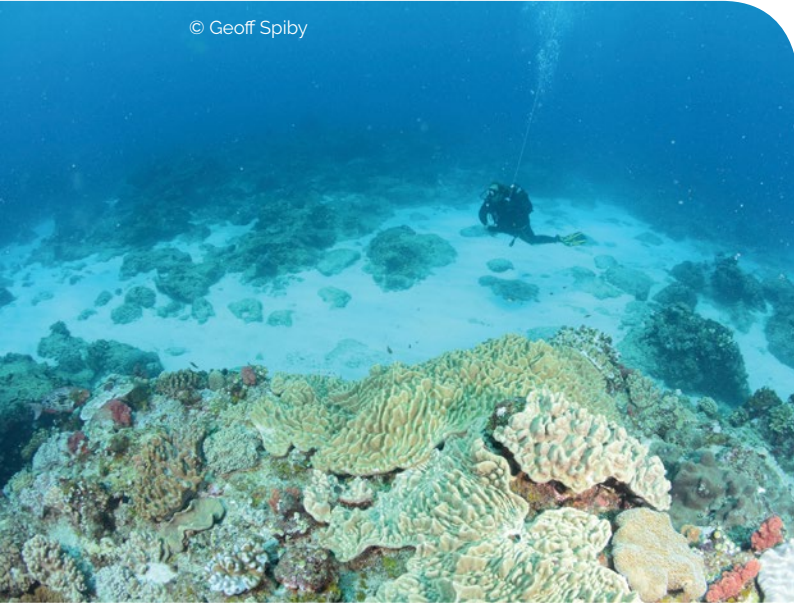


- 1 Fishing
- 2 Ports and harbours
- 3 Freshwater flow modification
- 4 Mining
- 5 Pollution
- 6 Climate change
- 7 Biological invasions

Section based on:

Sink, K.J., et al. (eds). 2019. *South African National Biodiversity Assessment 2018 Technical Report Volume 4: Marine Realm*. South African National Biodiversity Institute, Pretoria. <http://hdl.handle.net/20.500.12143/6372>.

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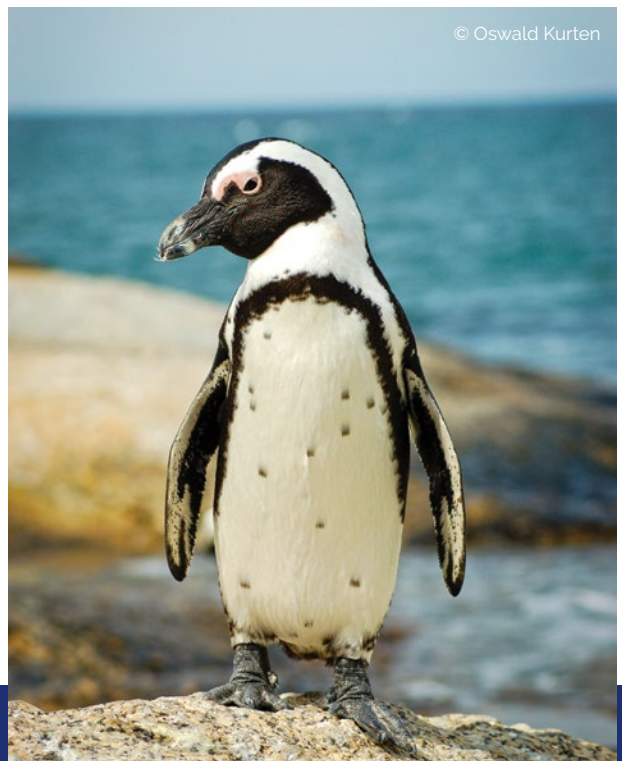


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South Africa's marine realm includes the Atlantic, Indian and Southern oceans – each with their own special characteristics that result in a large diversity of ecosystems types and unique species. We still know very little about marine life as the ocean is less accessible, taxonomic knowledge is lacking and only a small portion of marine species have been assessed. The map of marine ecosystem types has, however, been substantially revised as a result of extensive fieldwork to collect data. There are now 150 marine ecosystem types in five marine ecoregions.

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Climate change and invasive species exacerbate other pressures and further research is needed to understand the complex interactions between pressures. Long-term data series are crucial to enable ecosystem assessment.

Approximately half of marine ecosystem types are threatened; by area this equates to only 5% of the ocean space around South Africa with more inshore and shelf ecosystem types threatened than those in the slope and abyss. Only two ecosystem types (1% of types) are Critically Endangered, with 22 Endangered (15%) and 51 Vulnerable (34%). The most threatened functional ecosystem groups include bays, islands, muddy ecosystem types, and rocky ecosystems on the shelf and shelf edge. The cold temperate Southern Benguela ecoregion is more threatened than the Warm Temperate Agulhas ecoregion, with the Subtropical Natal–Delagoa ecoregion being less threatened. Data to improve this assessment should be acquired as a matter of priority and further work is needed to determine the appropriate scale for ecosystem red listing.

Twenty new MPAs were approved for declaration in 2018, and MPAs now cover 5% of the ocean around South Africa. The placement of these new protected areas has resulted in a marked improvement in ecosystem protection levels for many ecosystem types and has contributed to better protection in all ecoregions. The new MPA network is helping to protect marine ecosystems, rebuild fish stocks, support climate resilience and sustain South Africa's emerging ocean economy. Of the 150 marine ecosystem types in the ocean around South Africa, 87% have some representation in the MPA network, but only 31% of ecosystem types are Well Protected. Of the 70 ecosystem types that were Not Protected in 2018, 51 (73% of these 70 types) received their first protection in 2019.

South Africa's oceans provide a high diversity of marine resources with more than 770 marine species harvested. Fisheries stock status is not assessed for 90% of these species. Of the assessed resources, more than a third are overexploited or collapsed. South African Abalone (*Haliotis midae*) and West Coast Rock Lobster (*Jasus lalandii*) resources are in crisis with escalating poaching preventing resource recovery. Given the importance of fisheries to food and job security in South Africa, it is essential that fisheries stocks are well managed. We need to gather reliable data for stock assessments, maintain fisheries science expertise and develop stronger interventions to rebuild stocks in line with scientific recommendations.

The number of species assessments conducted using the IUCN Red List criteria is increasing with 376 South African marine species assessed to date through a combination of national, regional and global assessments. Of these, approximately 18% of taxa are threatened. However, this may not be representative of the actual proportion of taxa threatened as there has been a focus on assessing economically important species and few marine taxonomic groups have been comprehensively assessed. Seabirds, seabreams and turtles are particularly threatened. Marine species have the highest levels of data deficiency across all realms, signalling the need to address knowledge gaps and increase capacity for marine species red listing. A lack of knowledge and techniques limits our ability to assess the risks to the genetic component of marine biodiversity.

Climate change is impacting marine species and ecosystems, decreasing resilience and threatening coastal communities and livelihoods. The complexity and variability of South Africa's marine systems, in concert with multiple anthropogenic stressors, make future impacts difficult to predict, nevertheless there is high certainty that impacts on biodiversity, ecosystem function, food security and valuable economic industries will continue to escalate. Additional climate change vulnerability assessments and focussed monitoring of species and ecosystems are required to enhance the detection and attribution of climate change impacts on marine ecosystems, species and genes.

3.4.2 Input data and method for the marine realm

Ecosystems

A completely revised marine ecosystem classification system and map was produced in 2018 with short descriptions provided for 150 marine ecosystem types in five marine ecoregions. Figure 75 shows ecosystem types in the transition area between the Agulhas and the Natal–Delagoa ecoregions, as an example of the new map. More than five years of research was consolidated to inform the revised map. Updated biogeographic information was used to refine marine ecoregions, and sub-regions nested within ecoregions (such as the KwaZulu-Natal Bight) were introduced to better represent marine biodiversity pattern. Key advances in the map of marine ecosystem types included very fine-scale shore

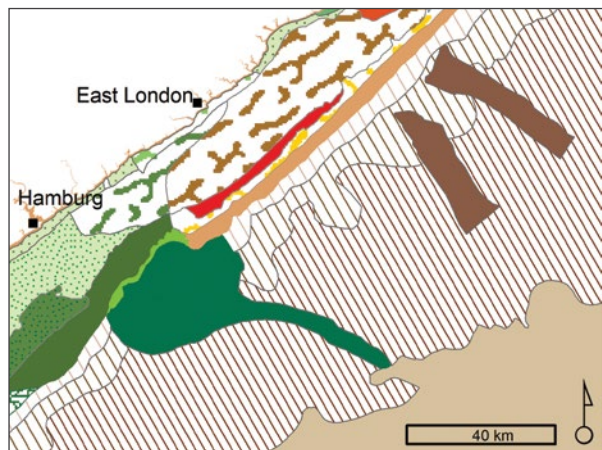


Figure 75. A map of the transition area between the Agulhas and Natal-Delagoa ecoregions, illustrating the progress made in refining and updating ecosystem type delineation and mapping.

mapping with alignment and integration in the coast; the inclusion of kelp forests, bays and fluvial fans as distinct types; and the introduction of finer depth strata across shelves and on the slope. This is a result of a major effort in collating and increasing relevant historic and current abiotic and biological datasets for ecosystem classification and mapping (Figure 76).

A comprehensive assessment was undertaken of South Africa’s 150 marine ecosystem types using criteria aligned to the conceptual framework for the IUCN Red List of Ecosystems (RLE) and drawing from previous marine NBA assessments. The primary assessment results were based on IUCN Criterion C3 (ecosystem degradation) as this was most relevant to the established South African approach for marine ecosystem assessment based on cumulative pressure mapping, and geographic extent was also considered in line with IUCN Criterion B2 (ecosystems of limited

extent). Both the extent and severity of ecosystem degradation were considered and an ecosystem pressure matrix was used to weight the impact of each pressure on each ecosystem type.

The protection level assessment for marine ecosystems used the standard approach with an additional rule applied: for a marine ecosystem type to qualify in the Well Protected category, at least 20% of the ecosystem type (i.e. the ecosystem target) needed to be in a natural/near-natural ecological condition, within the protected area. If this rule was not met, the ecosystem was categorised as Moderately Protected.

Pressures

Data from several sectors were received as either spatial or raw data. All data were analysed and converted to the appropriate spatial scale per pressure type. A total of 31 pressures on marine biodiversity were mapped to assess ecosystem degradation at a finer scale than in 2011. Of the 31 pressures included, six are new; including abalone fishing, disposals of ammunition and dredge material, netfishing (beach seine and gill-netting) and oyster harvesting. The threat assessment advanced with the pixel resolution of pressure maps improving from a 5’ grid (approximately 8 × 8 km) in 2011 to 30 × 30 m pixels in 2018. Pressures are a surrogate for ecosystem degradation with both the extent and intensity of pressure considered where feasible.

Species

Substantial efforts were made to collate and assess marine species status drawing from fisheries stock information and national, regional and global IUCN Red Lists. Inadequate taxonomic knowledge, limited

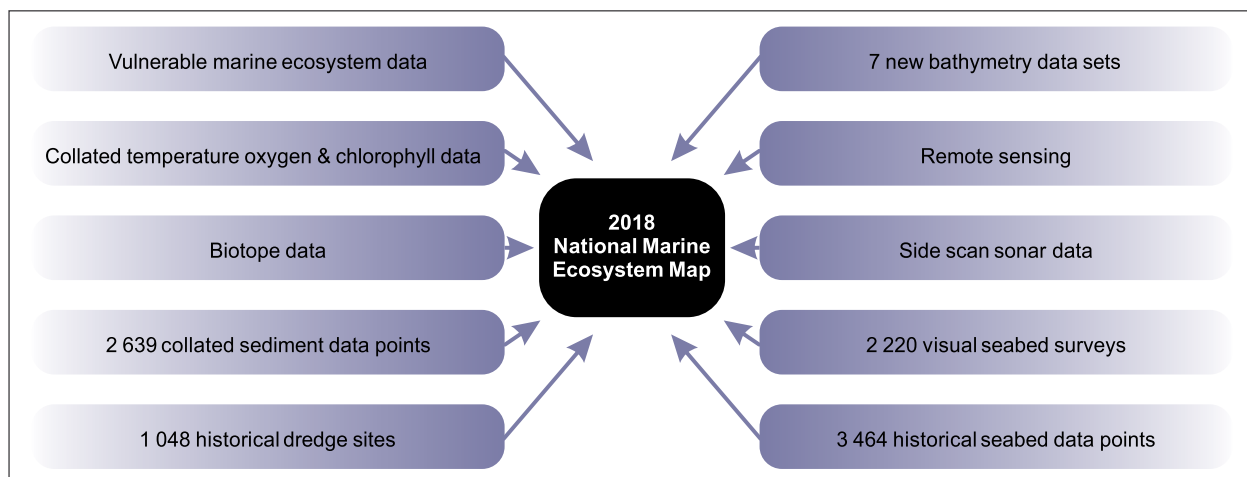


Figure 76. The range of data that have been used to inform the revised map of marine ecosystem types. Increased investment in research has improved the marine ecosystem classification and map to support spatial biodiversity assessment and management.



The largest pressure in the marine realm is fishing, with 770 marine species harvested. The stock status is not known for 90% of these species. © Kerry Sink.

occurrence data, a lack of abundance and long-term population trend data, and insufficient knowledge of species life histories and ecology, limit marine species threat assessments. Only four taxonomic groups (birds, mammals, reptiles and seabreams) have been comprehensively assessed to date. Most linefish were assessed in new national assessments to report on this important group of resource species. Seabreams were the only family of linefish that were comprehensively assessed, with efforts to prioritise this group due to their high endemicity in South Africa and their life history characteristics that make them vulnerable to overutilisation. The threat status of corals as assessed through global assessments were reported but no national assessments have taken place despite the increasing risks to corals from climate change. Due to limited comprehensive species group assessments and a lack of temporal monitoring data for marine species, using the Red List Index (RLI) to track trends in status was not possible. Protection level for marine species has not yet been assessed.

Protected areas

For the marine assessment the additional step of adding the new Operation Phakisa MPA network was taken (as approved by the South African cabinet in October 2018 and mapped by the Phakisa technical team in January 2019).

3.4.3 Key drivers and pressures in the marine realm

Marine ecosystems and species face pressures from an increasing range and intensity of human activities (see Figure 60 [p. 102] for more details on pressures on marine species). These include 22 fisheries sectors, petroleum activities, mining, shipping, ports and harbours, coastal development, mariculture, freshwater flow reduction, pollution and climate change. Fishing, coastal development, mining, trawling and mariculture have the highest impact scores among the 31 marine pressures included in this ecosystem assessment. Emerging pressures include plastic, other emerging pollution problems and increased underwater noise.

Pressures on ecosystems

Fishing (including commercial, recreational, subsistence, small-scale and illegal fishing) remains the biggest pressure on most inshore and offshore ecosystems, with greater impact on inshore resources than on the deep ocean systems.

Freshwater flow reduction to the coastal and marine environment occurs when water is abstracted from

rivers or dammed higher up in the catchment, and/or the cycle of an estuary has been disrupted. This results in freshwater, and the accompanying sediment that is vital to some marine biodiversity processes, failing to reach the ocean. Altogether, approximately a third of South Africa's freshwater flow in rivers no longer reaches the sea. Approximately two-thirds of the contribution of the Orange River and nearly a third of the freshwater flow of the uThukela no longer reach the sea; these are the two largest catchments in South Africa.

Coastal development, including port development, is the greatest pressure on coastal ecosystems as it results in ecosystem loss, interruption of physical and biological process, and compromises ecosystem resilience; all of which result in loss of coastal ecosystem services. Ports and harbours are the main points of introduction and refugia for alien and invasive species, and activities occurring in ports and harbours contribute to ecosystem degradation from smothering, pollution, underwater noise and anchorage.

Coastal and offshore mining, depending on the method of extraction, can have moderate to very severe impacts on biodiversity. The implementation of phosphate mining remains a concern as the impacts of this activity could severely modify large areas of biodiversity and could jeopardise the sustainability of the fisheries sector. Oil and gas production has remained stable, but exploration activities have increased and the deregulation of some prospecting activities has raised concern for the impacts of seismic surveys on mega- and macrofauna. Underwater noise is recognised as an emerging pressure as ocean industrialisation and shipping is planned for expansion. [The Operation Phakisa Oceans Economy identified petroleum, shipping and aquaculture as key areas of growth for South Africa.] Petroleum infrastructure provides refuge for alien and invasive species, and the increased transport of foreign infrastructure into South African waters could lead to new introductions and/or proliferation of non-native species unless well managed.

Like petroleum and shipping, **aquaculture** remains an area of projected growth, although there has been little success in sea-based aquaculture of bony fish. Currently sea-based aquaculture of shellfish is only being undertaken in Saldanha and Algoa Bay. Bays are known to have high retention and, therefore, lower rates of flushing of pollution and elevated nutrient inputs from aquaculture facilities, which exacerbate the impacts of sea-based aquaculture operations. Other impacts include the incubation of parasites and pathogens which may then transfer to wild stocks, introduction and spread of invasive alien species,



Coastal and offshore mining can have severe impacts on biodiversity, and underwater noise from seismic surveys and shipping is an emerging pressure that requires further research. © Oswald Kurten.

and modification of marine ecosystems through the construction of infrastructure.

Marine pollution in this NBA was focussed on waste water discharge from land-based sources. In general, waste water consists of industrial and municipal effluent and expert opinion attributes greater impact to municipal effluent than industrial. The increase in the number of planned desalination plants is recognised as an additional potential emerging pressure and is linked to climate change and changing rainfall patterns that have increased drought episodes. The impacts of hyper-saline discharge are not well understood in South Africa and further research is needed in this regard. Land-based pollution is also the main source of plastic pollution in the ocean, which is another recognised emerging pressure in the ocean. Plastic, both micro- and macro-plastic, is pervasive and has been recorded at great depths and distance from shore.

Climate change impacts marine species and ecosystems, decreasing resilience and threatening coastal communities and livelihoods. South Africa's oceans are changing with increased winds, upwelling and cooling, and warming observed in some areas. Increased storm events, sea-level rise, intensification of current variability, ocean acidification, and increased frequency and intensity of extreme events have also been observed. The pressures imposed by these changes are already associated with impacts across a wide variety of marine taxa, including kelp, fish, seabirds, molluscs, corals, sponges, crustaceans, copepods and foraminifera. Shifts in the distribution of species and communities, changes in species abundance, altered behaviour, hybridisation, increased spread of invasive species, and long-term declines in fished stocks and copepods have been reported.

Plastics are a global problem affecting all realms. Besides entangling marine life, scientists are finding evidence that ocean plastic is linked to disease on coral reefs and the decrease in the reproduction and population growth rates in zooplankton. International Coastal Cleanup days (usually September) are encouraging awareness about this massive problem. In 2017, South Africans collected 174 575 items, weighing 12 694 kg.



The complexity and variability of South Africa's marine systems, combined with multiple anthropogenic stressors, make future impacts difficult to predict, but there is high certainty that negative impacts on biodiversity, ecosystem function, food security and valuable economic industries will continue to escalate. Additional climate change vulnerability

assessments and focussed monitoring of species and ecosystems are required to enhance the detection, quantification and attribution of climate change impacts on marine ecosystems, species and genes. The observed changes impact the ability to cope with extreme environmental events, compromise biodiversity heritage, degrade tourism assets and, in most cases, have a negative impact on fisheries livelihoods, fishing effort and catches. Linefishing, net fisheries and small pelagic fisheries are currently considered most vulnerable to the changing climatic conditions. Sustainable, adaptive, ecosystem-based management is crucial for helping South Africa adjust to future climatic impacts. Additional research and monitoring is needed to track and understand climate change impacts on marine systems, including their interaction with other pressures and the effectiveness of measures taken to minimise the impacts. Importantly, we need to maintain, enhance and expand time-series monitoring efforts and improve our understanding of change to enable effective adaptation measures.

Pressure maps

As mentioned in the previous section, the current assessment analysed the impacts of the combined suite of pressures and threats to produce a cumulative pressure map (Figure 77). The results of cumulative pressures mapping indicate that the highest cumulative pressure occurs in Saldanha Bay with all other bays also facing high cumulative pressures (Figure 77B). Additional high pressure areas include the area offshore of the Orange River, the shelf edge on the west and south coast, large portions of the Cape inner and middle shelf, the Agulhas Bank and the KwaZulu-Natal Bight (Figure 77).

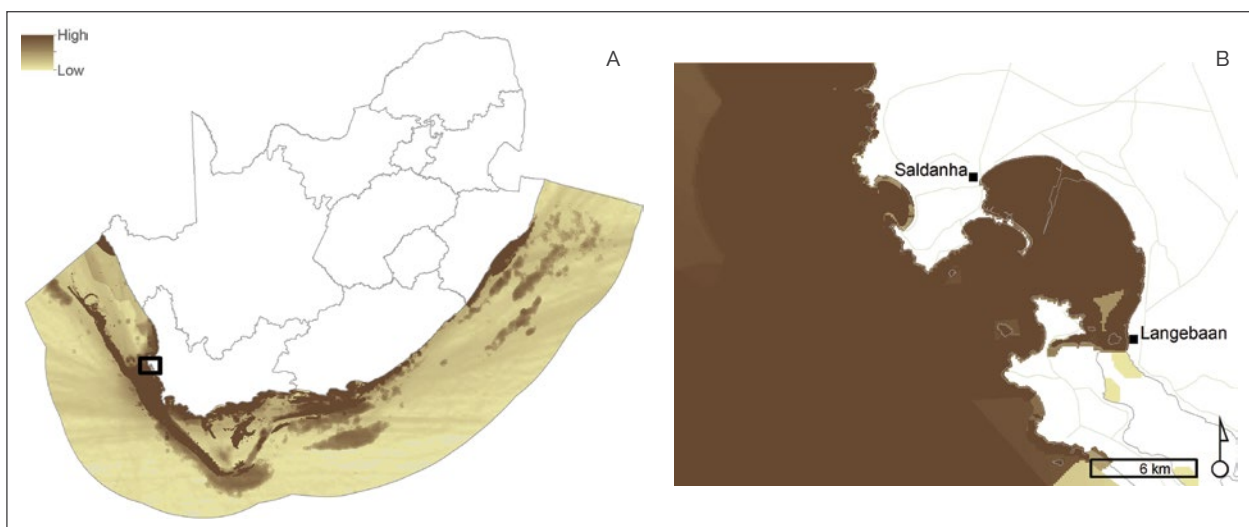


Figure 77. (A) Map of cumulative pressure in the marine realm where dark areas indicated higher levels of cumulative pressures and light areas indicate lower levels of cumulative pressure; and (B) the highest cumulative pressure was recorded in Saldanha Bay. All bays face high cumulative pressures.

Pressures on species

A meta-analysis of pressures documented during the threat assessments for species show that fishing remains the greatest pressure to marine species (Figure 78).

Between 56% and 100% of Taxa of Conservation Concern (ToCC) across all taxonomic groups assessed are threatened by fishing. Fishing impacts range from targeted and unintentional (bycatch) exploitation, incidental mortality as a result of direct interaction with fishing gear (birds), competition with fisheries sectors

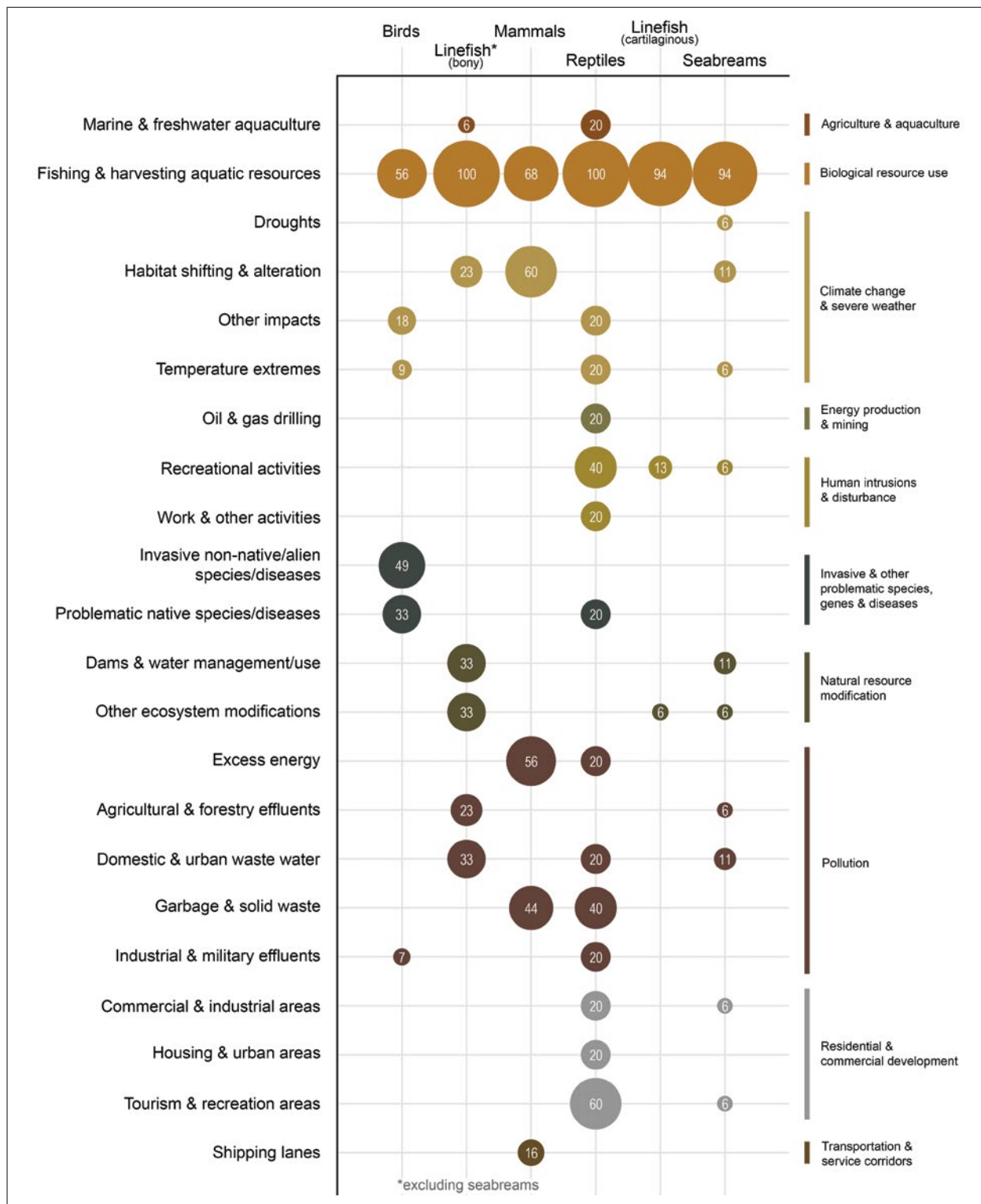


Figure 78. The key pressures for Taxa of Conservation Concern (ToCC) in the marine realm based on a meta-analysis of the South African Species Red List Database. The size of the bubble corresponds to the percentage of ToCC in the taxonomic group that is subject to each pressure. The pressures categories follow the IUCN threat classification system.

for food resources (birds) and incidental catches in bather protection nets (mammals; sharks, skates and rays; turtles). Pollution (plastics, underwater noise, waste water and effluent) is having an ever-increasing impact on marine species. Plastics and solid waste impacts 44% and 40% of mammal and reptile ToCC respectively. Underwater noise impacts on 56% of mammal ToCC. The effects of coastal waste water discharge (33% of ToCC impacted) and agricultural effluent (23% of ToCC impacted) are pronounced among commercially important linefish species due to their often nearshore and estuarine distribution. Furthermore, 33% of commercially important linefish and 11% of seabreams are threatened by freshwater flow modification as a result of their estuarine association or dependence. Marine alien and invasive species and problematic native species are contributing to the threatened status of 49% and 33% of seabirds respectively. Climate mediated shifts in food resources and changing ecosystem state exacerbate the impacts of fishing and alien and invasive species and are causing declines to 60% of marine mammal, 23% of linefish and 11% of seabream ToCC (Figure 78).

3.4.4 Ecological condition in the marine realm

Areas of high cumulative pressures are assumed to translate into areas of poor ecological condition, and have been identified particularly in the inner

shelf, shelf edge and in much of the KwaZulu-Natal Bight (Figure 79). The accessibility of the inner shelf contributes to a diversity of pressures in this zone. The key pressures on the shelf edge included the hake trawl fishery, the mid-water trawl fishery and the large pelagic longline fishery. In the KwaZulu-Natal Bight, crustacean trawl fisheries, linefishing and flow reduction degrade ecosystem condition. Despite this degradation, 81% of the ocean around South Africa remains in natural or near-natural condition. Cumulative pressure mapping provides a simple surrogate measure of ecological condition that is relatively reliably collated from data provided by various sectors. However, there is a gap in our ability to understand thresholds of condition (tipping points) and there are challenges in measuring the subtler forms of habitat degradation. As a result, the impacts of pelagic fishing in particular, may have been underestimated, resulting in an underestimation of ecological modification.

3.4.5 Ecosystem threat status in the marine realm

A comprehensive assessment was undertaken of South Africa's 150 marine ecosystem types using criteria aligned to the IUCN guidelines for red listing ecosystems. Only two ecosystem types (1% of types) are Critically Endangered and these only cover 0.3% of the ocean area. There are 22 Endangered ecosystem types (15%) which cover 1% by extent. Vulnerable

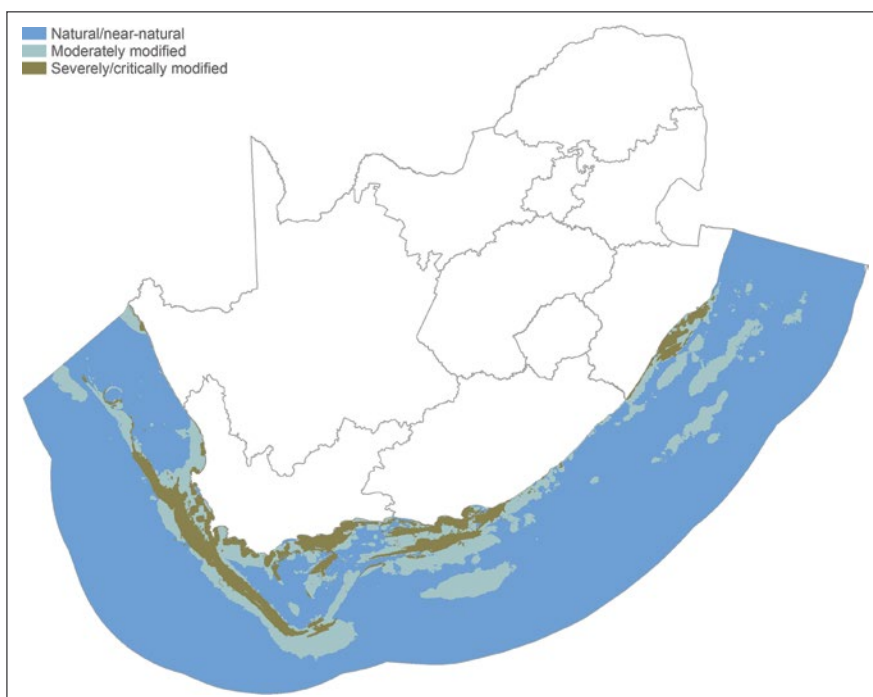


Figure 79. Map of marine ecological condition, or level of ecosystem degradation. The highest levels of degradation are in the inshore and shelf edge.

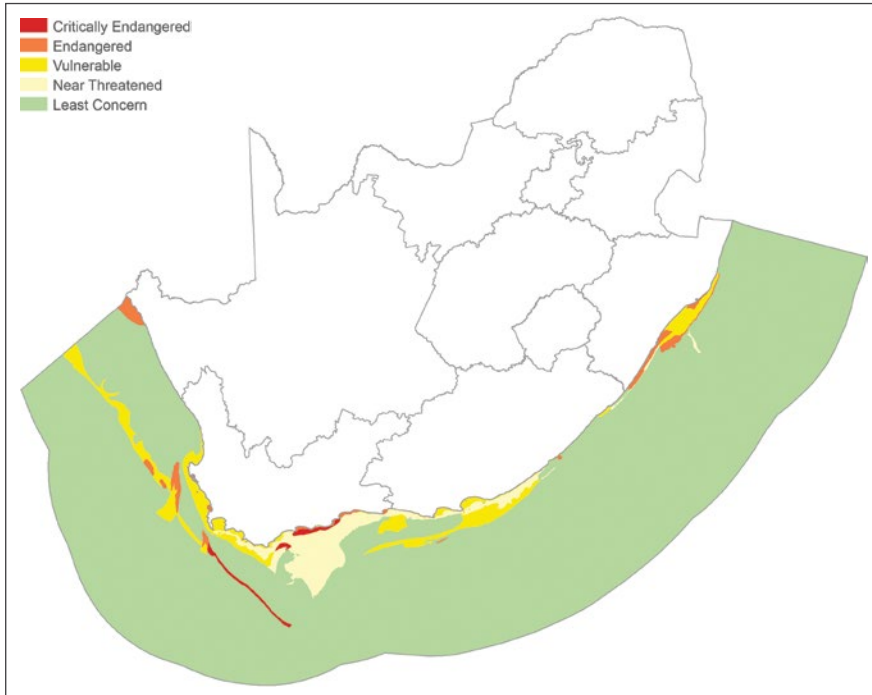


Figure 80. A map of the ecosystem threat status for 150 marine ecosystem types.

ecosystem types cover 4% of the ocean space, with 51 ecosystem types (34%) falling within this category. For the remaining ecosystem types, 17 (11%) and 58 (39%) were respectively Near Threatened and Least Concern. The locations of the threatened ecosystem types is shown in Figure 80. The cold temperate Southern Benguela ecoregion is more threatened than the Warm Temperate Agulhas ecoregion with the Subtropical Natal–Delagoa ecoregion being less threatened. The two deep ocean ecoregions have a low number and intensity of pressures, and few threatened ecosystem types. This contributes to the difference in overall threat status between inshore and offshore ecosystem types (Figure 81). The most threatened functional ecosystem groups are shores, bays and ecosystem types on the shelf and shelf edge (Figure 82).

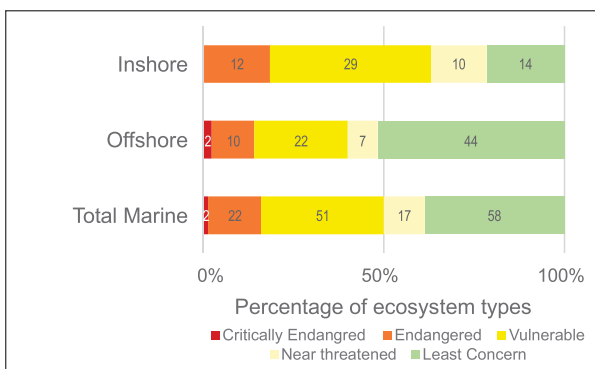


Figure 81. Inshore ecosystem types (within the shallower, more wave-influenced area) were more threatened than offshore ecosystem types with the inner shelf and shelf edge being more threatened than other depth zones.

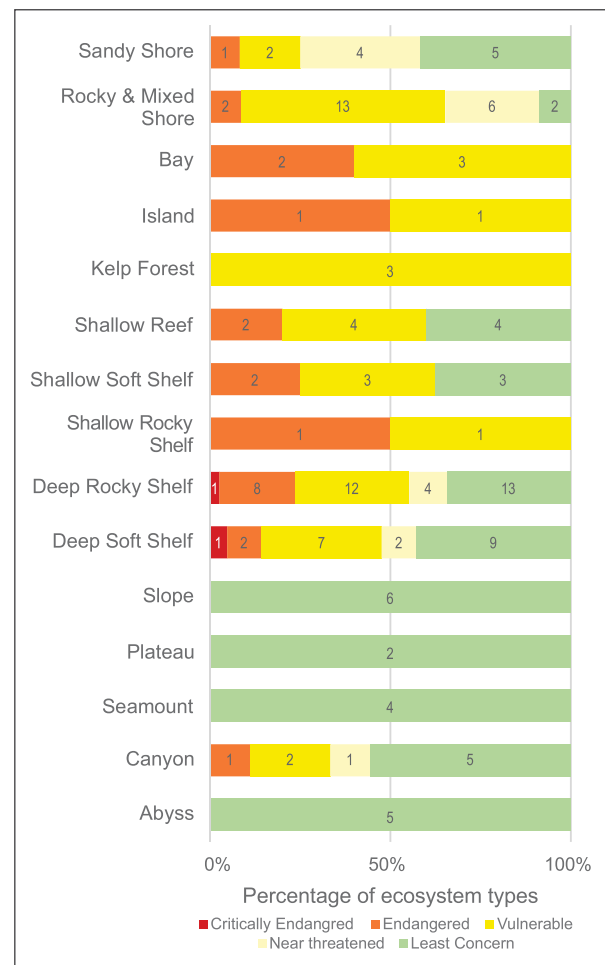


Figure 82. A graph illustrating the spread of threatened ecosystems by functional ecosystem group. The most threatened functional ecosystem groups included bays, islands, muddy (soft) ecosystem types and rocky ecosystems on the shelf and shelf edge.

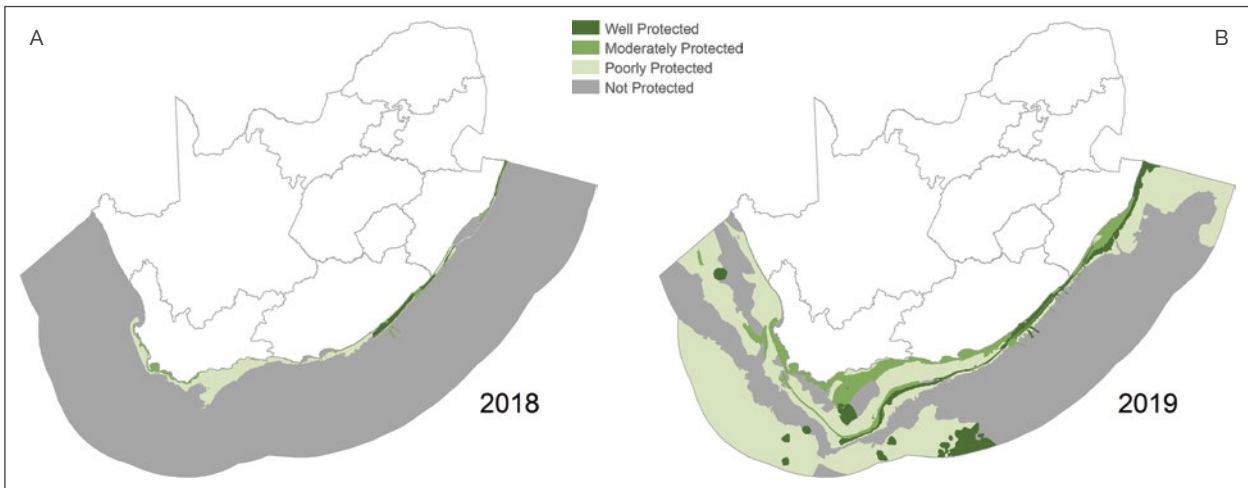


Figure 83. Comparison of ecosystem protection levels (A) before (2018); and (B) after the declaration of the Phakisa MPA Network (2019).

3.3.6 Ecosystem protection level in the marine realm

In 2018, South Africa had 25 coastal MPAs covering less than 0.5% of the ocean around South Africa (4 957 km²), up from 0.44% (4 711 km²) in 2011. The MPA estate increased significantly between 2018 and 2019 and now covers over 5% of the ocean around South Africa (57 736 km²). This was the result of 20 new MPAs that were approved for declaration in 2018 (including iSimangaliso MPA that both replaced and expanded two existing MPAs, and a far larger Aliwal Shoal MPA); bringing the total number of MPAs to 42 (Figure 83). The new MPA network will help to protect marine ecosystems, rebuild fish stocks, support climate resilience and sustain South Africa's emerging ocean economy.

Of the 70 ecosystem types that were previously Not Protected, 51 have received their first protection.

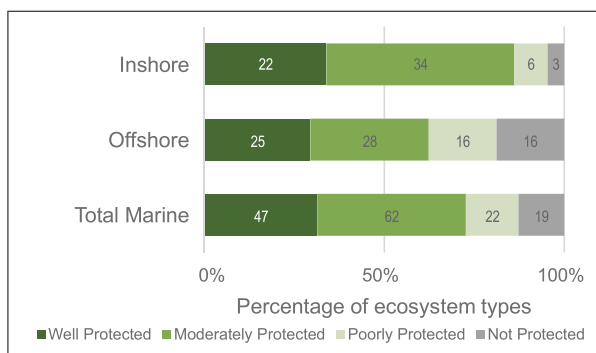


Figure 84. As a result of the substantial MPA expansion in 2018/2019, inshore and offshore ecosystem types have similar protection levels.

An additional 17 ecosystem types have advanced to Well Protected with a total of 31% of ecosystem types now falling within this category. As a result of the new MPAs, offshore and inshore ecosystem types now have similar protection levels

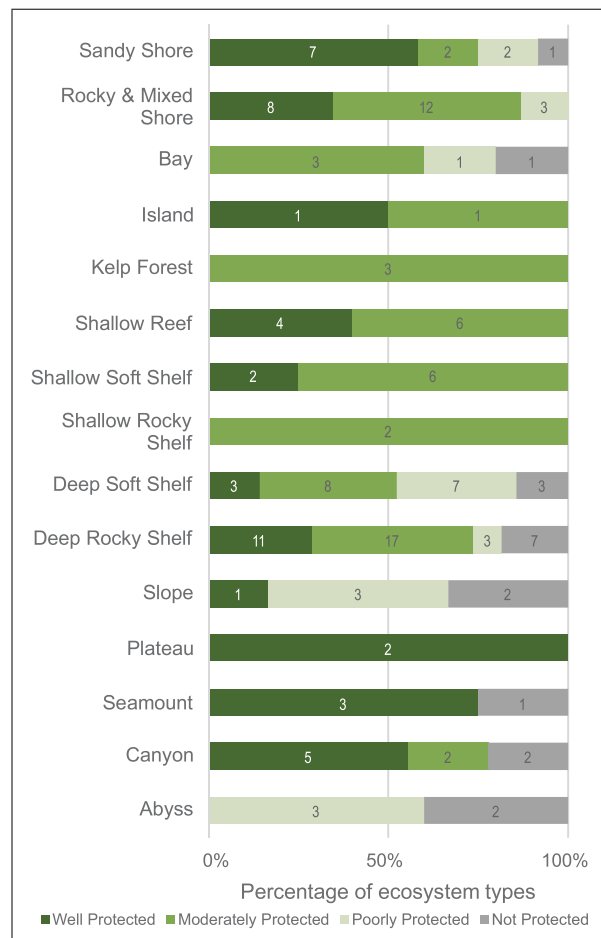
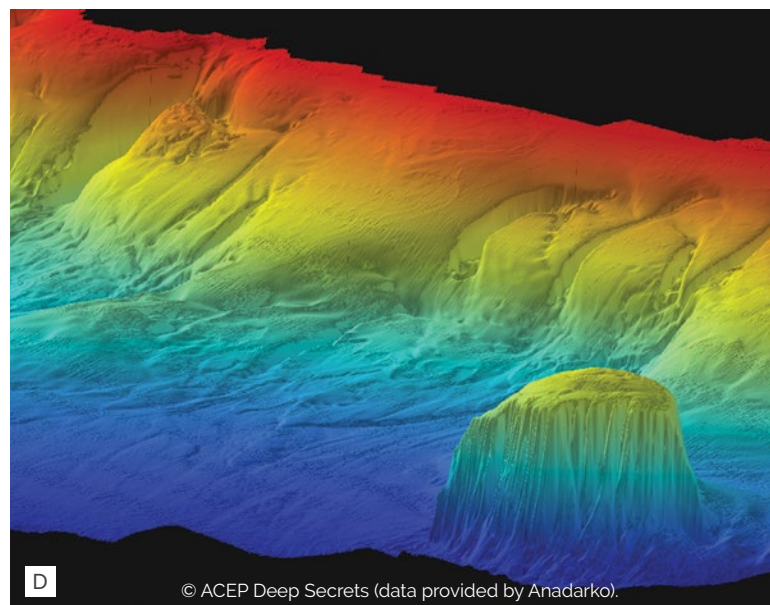
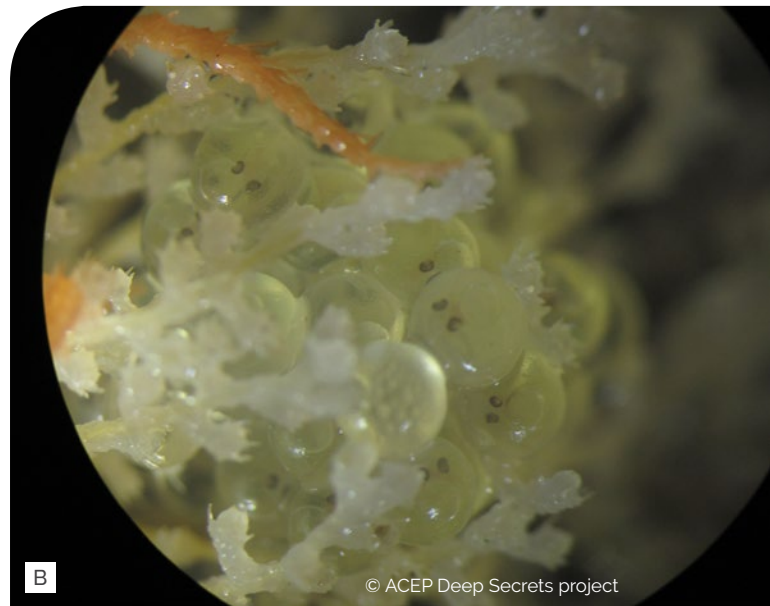
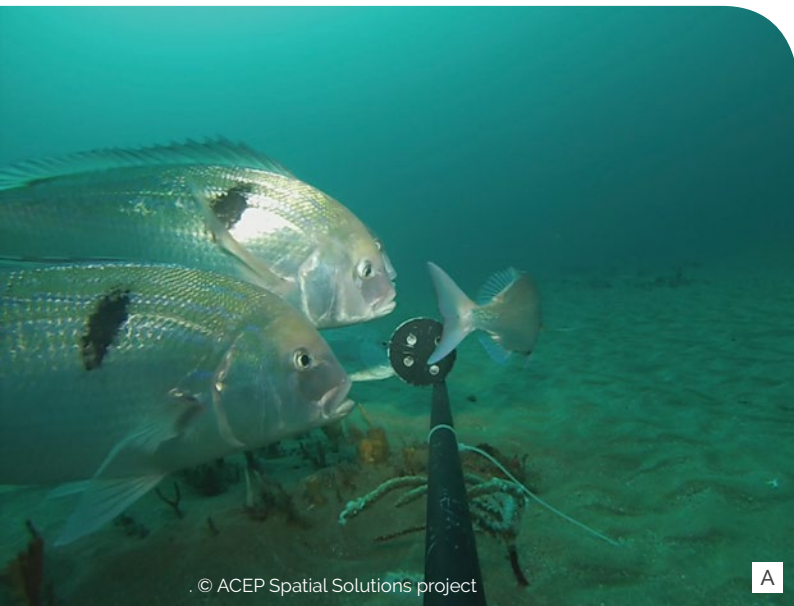


Figure 85. Ecosystem protection level per functional ecosystem group showing that the majority of the Not Protected ecosystem types occur in the deep shelf (soft and rocky), slope, abyss and canyon functional groups.



- (A) Protection of these large adult seabreams Seventy-Four (*Polysteganus undulosus*, Critically Endangered) in the uThukela Banks MPA may help support recovery of this seriously overexploited resource.
- (B) The eyes of future fish can be seen in the fish eggs in the arms of this soft coral in the new Browns Bank Corals MPA.
- (C) Like underwater fynbos these beautiful lace corals are only known from an ecosystem type in the new Amathole Offshore MPA.
- (D) South Africa's undersea mountains will receive their first protection in the new Southeast Atlantic and Southwest Indian Seamount protected areas. This three dimensional image shows a seamount and canyons on the slope of the Southeast Atlantic.
- (E) The new Agulhas Bank Complex MPA includes volcanic pinnacles that rise from 80 to 15 m below sea level, with a deep water kelp forest of *Ecklonia radiata* crowning the shallowest area.





The new Namaqua National Park MPA is the Northern Cape's first MPA and took more than 40 years to implement. It will protect rocky and sandy shores that are vulnerable to mining impacts and exploited species such as these limpets. © Peter Chadwick.

(Figure 84). There is an opportunity to advance many of the Moderately Protected ecosystem types to Well Protected through ecosystem restoration and re-zonation of existing MPAs to reduce ecosystem degradation. Additional offshore MPAs will need to be established to represent ecosystem types that are Not Protected or to advance Poorly Protected ecosystem types towards Well Protected. The Natal–Delagoa ecoregion is the best protected of the shelf ecoregions and the Southern Benguela is the least protected. Protection in the deep ocean beyond the shelf edge is weaker than in the shelf ecoregions, but this region is also less threatened (Figure 85).

Threatened and under-protected ecosystem types

There are 23 marine ecosystem types that are both threatened and under-protected. The highest priority are three Endangered ecosystem types that are Not Protected; two muddy ecosystem types on the shelf off the Orange River (Figure 86) and a reef complex in the mid shelf of the KwaZulu-Natal Bight (Table 9). Reef mosaic and deep coral habitats in the trawl grounds of the Agulhas ecoregion are Vulnerable and need protection. In the Southern Benguela, St Helena Bay (a unique ecosystem type) and the slope component of the Cape canyons still need to be represented in South Africa's MPA network (Figure 83B). These threatened and under-protected ecosystem types are candidates for improved protection through MPA expansion and those for which protection level can be improved by improving condition in established and new MPAs.

Table 9. Marine ecosystem threat status and protection level, highlighting those types that are under-protected and highly threatened

	Not Protected	Poorly Protected	Moderately Protected	Well Protected	Total
Marine					
Critically Endangered	1	1			2
Endangered	3	3	16		22
Vulnerable	3	2	5	7	17
Near Threatened	9	10	6	33	58
Least Concern	12	12	11	40	75
Total	19	22	62	47	150

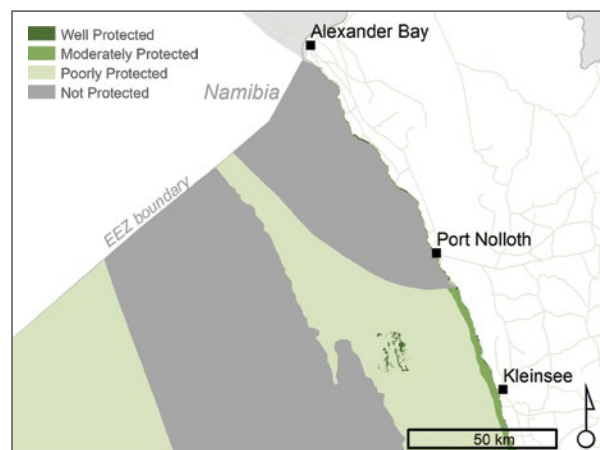


Figure 86. Map showing the low protection level of ecosystem types in the Orange River mouth region on the Namibian border, a potential future MPA expansion focus area.

3.4.7 Species threat status in the marine realm

South Africa's oceans provide a high diversity of marine resources with more than 770 marine species harvested. Stock status is known for less than 10% of these taxa and more than a third of assessed stocks are overexploited or collapsed. Effective science-based management has supported recovery of Deep-water Cape Hake (*Merluccius paradoxus*) and linefish species such as Carpenter (*Argyrozona argyrozona*) in the last two decades.

Stock assessments are conducted for fisheries species and constitute a more rigorous approach to assess species stock status than the IUCN approach to assess extinction risk, and can be used to strengthen Red List findings. IUCN species red listing assessments are being increasingly applied and 376 South African marine species have been assessed to date

Small-scale fishing is a crucial source of protein for many South Africans. There are $\pm 29\ 000$ people who catch fishes from the shore and/or from small boats in estuaries or close to the shore.

by a combination of national, regional and global assessments (Figure 87). Of these, approximately 18% are threatened, representing a relatively high threat status that may not be representative of actual threat patterns because of a focus on assessment of perceived threatened marine taxa.

Seabirds, endemic seabreams and marine reptiles are particularly threatened. More than a third (37%) of South Africa's seabird species are threatened (Figure 87), driven primarily by fishing (which impacts prey availability), invasive species and problematic native species (Figure 78). Fishing impacts include mortality

Box 11. Marine species requiring IUCN Red List assessments: South African Abalone and West Coast Rock Lobster

South African Abalone (*Haliotis midae*) and West Coast Rock Lobster (*Jasus lalandii*) resources are in crisis due to highly overexploited stock status and escalating poaching. Both these inshore resources are collapsed and have experienced major declines over the past decades with abalone legal commercial catch having declined from 613 tonnes in 1993 to 95 tonnes in 2015 (84.5% decline). West Coast Rock Lobster commercial catch declined from 18 000 tonnes in the 1950s to 10 000 tonnes in the 1960s and 2 000 tonnes in recent years (89% decline since the 1950s), with male biomass currently estimated at less than 3% of pre-fished levels. While declines in West Coast Rock Lobster can be attributed to a combination of factors, including changes in fishing methods, spatial shifts in distribution, changes in management measures, reduced growth rates and overutilisation; decline in abalone is primarily attributed to illegal harvesting coordinated largely through complex criminal syndicates. Illegal abalone trade is estimated to be almost double the volume of legally caught abalone or abalone produced by aquaculture operations. Given the important contribution of fisheries to South Africa, it is essential that fisheries stocks are well managed to ensure long-term food and job security.





A



B

South Africa serves as nesting ground for the Near Threatened Loggerhead Turtle (*Caretta caretta*) (A), © Linda Harris, and the Critically Endangered Leatherback Turtle (*Dermochelys coriacea*) (B), © Shutterstock. Protection of these species and their nesting habitat is therefore crucial for maintaining their global populations.

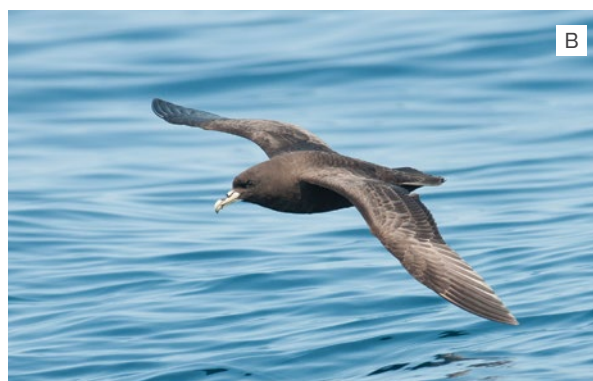
from direct seabird–fishery interactions and reduced prey linked to climate-mediated shifts in prey abundance and overfishing. Seabirds are more threatened than terrestrial, river and wetland or estuarine birds. More than 30% of endemic seabream species are threatened and a further 27% are Near Threatened (Figure 87). Iconic endemic seabreams such as Seventy-Four (*Polysteganus undulosus* – CR), Red Steenbras (*Petrus rupestris* – EN) and Dageraad (*Chrysolephus cristiceps* – CR) have not yet recovered since the linefish ‘State of Emergency’ declared in 2000. Four out of five turtle taxa are threatened (Figure 87), mainly by fishing (as bycatch), coastal development (tourism and housing) and pollution in the form of plastics and entanglement in fishing gear (Figure 78, p. 137). These pressures are present across the very large geographic range that turtles utilise. South Africa serves as nesting ground for two south-west Indian Ocean turtle subpopulations, namely the Near Threatened Loggerhead Turtle (*Caretta caretta*) and Critically Endangered Leatherback Turtle (*Dermochelys coriacea*) and, therefore, protection at national level is crucial for maintaining these populations globally.

Of the 56 marine mammal species assessed, 16% are threatened while more than 20% listed as Data Deficient (Figure 87). Marine mammals are mainly

More than a third (37%) of South Africa’s seabird species are threatened mainly as a result of fishing (which impacts prey availability), invasive species and problematic native species. Shown are (A) the Cape Gannet (*Morus capensis*), Endangered; and (B) the White-chinned Petrel (*Procellaria aequinoctialis*) and (C) the Caspian Tern (*Sterna caspia*), which are both listed as Vulnerable on South Africa’s Red List of species. © Martin Taylor, Aves Africa. © Martin Taylor, Aves Africa.



A



B



C

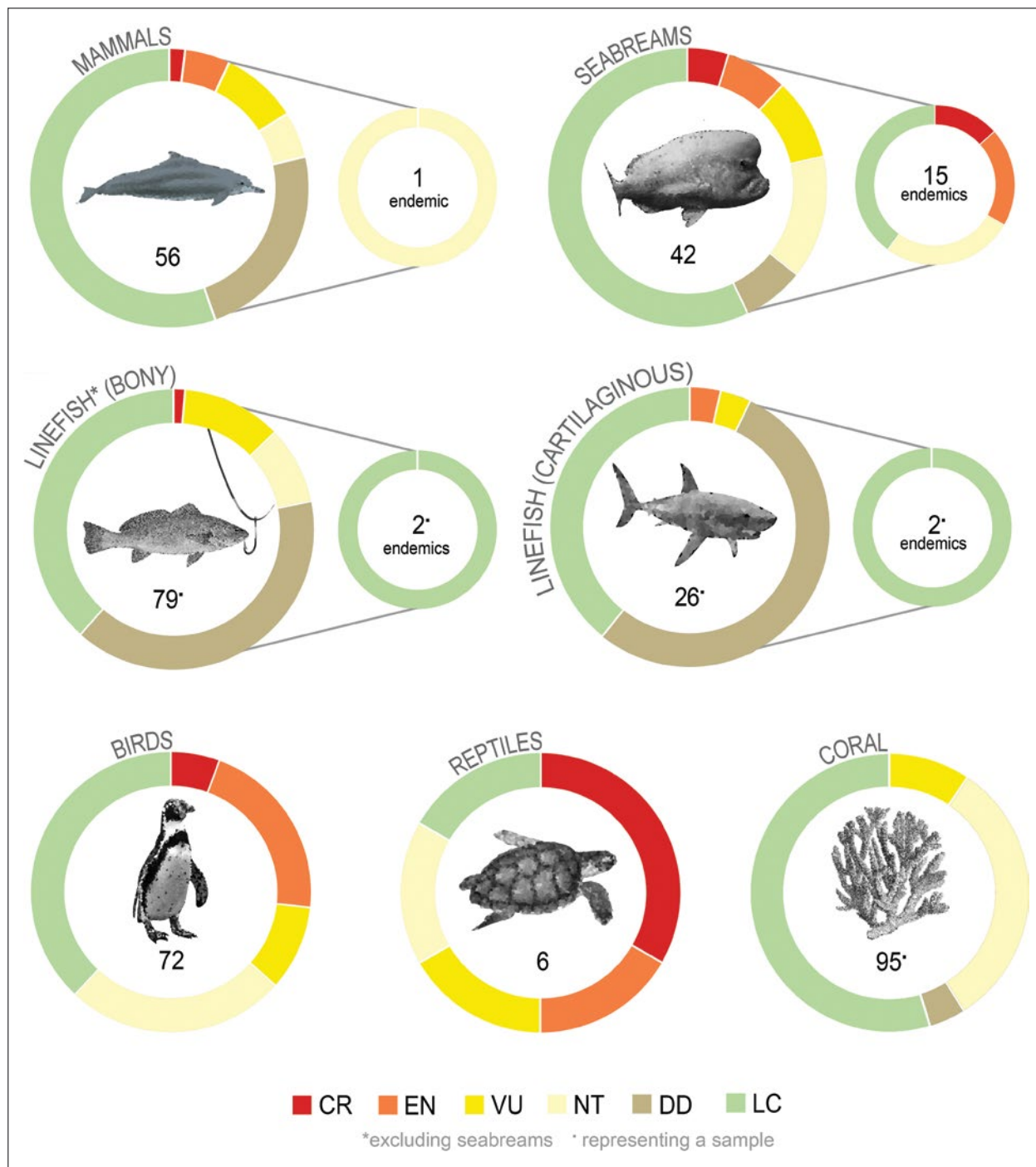


Figure 87. The proportion of indigenous marine species assessed to date in each of the IUCN Categories of extinction risk: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Data Deficient (DD), Least Concern (LC). Labels shows the number of species in each category.

impacted by fishing (entanglement of fishing gear, bycatch and incidental capture in bather protection shark nets), habitat alteration as a result of climate change (reduced habitat suitability and food availability), ocean noise and pollution (Figure 78, p. 137).

Almost 20% of 121 commercially important bony fishes are threatened while 34% are Data Deficient. More than 7% of 26 cartilaginous fishes (sharks, skates

and rays) are threatened while 50% are Data Deficient (Figure 87). Fishing (targeted and bycaught) and pollution are currently driving the threatened status of many commercially important bony and cartilaginous fish species, while poor catchment management resulting in freshwater flow reduction and reduced estuarine function is increasing the extinction risk of many commercially important estuarine-dependent fish species (see section 3.3.8, p. 128). The high

incidence of data deficiency for bony and cartilaginous fishes is due to knowledge gaps in life history, lack of long-term fisheries catch and effort data, impaired data integrity, and challenges in data management.

To date, no national IUCN assessments have been conducted for marine invertebrate species due to inadequate taxonomic knowledge, limited distribution data, a lack of systematic surveys and limited

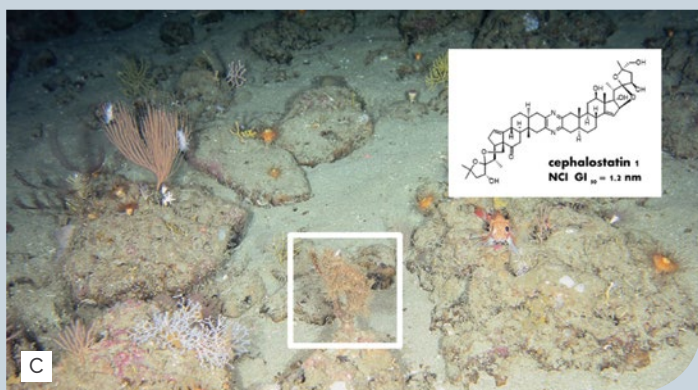
capacity to advance species red listing. Approximately 40% of South Africa's estimated 10 000 marine animal species are endemic, the vast majority of which are invertebrates. With such high levels of endemism and South Africa holding high proportions of certain species groups (e.g. almost a quarter of the global cephalopod species [octopus, squid, cuttlefish] occur in South African waters), it is crucial that the statuses of these taxa are assessed. New datasets are



A



B



C

Bioprospecting is 'the process of discovery and commercialisation of new products based on biological resources', and South Africa's marine biological resources are being explored for bioprospecting leads. A 2015 survey found that there are 549 retail products that contain South African indigenous plant resources and/or bee products – but these are from just 24 South African species, so there is probably large potential for growth in this sector. The survey showed that at least 15 products contained marine resources. The green algae, *Ulva* sp., is intensively farmed as feed for commercially farmed abalone, while large kelp species like the brown alga, *Ecklonia maxima*, are also harvested for abalone feed and plant-growth stimulants that are incorporated into agricultural crop feed. Other commercial uses of kelps include the extraction of the colloid agar from red algae for their use in food products and cosmetics, and several seaweeds are being investigated for their disease-resistant properties. The South African hemichordate worm *Cephalodiscus gilchristi*, sea squirt *Lissoclinum* sp. and the marine sponge *Topsentia pachastrelloides* have been the subject of international biochemical research for their production of secondary metabolites that inhibit the growth of cancer cells. Recent research in the sub-Antarctic has also revealed marine sponges with cytotoxic activity against certain cancer cell lines. There is still further potential for research in this field for the development of marine drugs from marine invertebrates to treat cancer and infectious diseases such as malaria.

- (A) Kelp harvesting is a substantial industry in South Africa. © Kerry Sink
- (B) Many marine invertebrates, including sea slugs, have potent compounds that can fight cancer and other diseases. © Eve Marshall
- (C) The tube worm *Cephalodiscus gilchristi* (shown in the square in the photograph) produces one of the most effective compounds ever tested for anti-cancer properties (compound shown in the insert). © ACEP Deep Secrets.

being established through increasing foundational biodiversity research and citizen science atlas efforts, but this work requires further investment to consolidate and analyse data, and address key gaps.

Fishing remains the greatest driver of extinction risk across all marine species assessed to date. As it is not

feasible to manage all South Africa's harvested species using traditional fisheries management tools, spatial management measures such as a representative MPAs network and other Effective Area-Based Conservation Measures can play an essential role in ensuring the long-term integrity and recovery of marine resources and the ecosystems that support them.

3.5 Coast

ECOSYSTEMS

60%

of 186 ecosystem types
Threatened

24%

of 186 ecosystem types
Well Protected

13%

of 186 ecosystem types
Not Protected



- 1 Fishing
- 2 Habitat loss
- 3 Freshwater flow modification
- 4 Pollution
- 5 Mining
- 6 Biological invasions
- 7 Climate change

Section based on:

Harris, L.R et al. (eds). 2019. *South African National Biodiversity Assessment 2018: Technical Report. Volume 5: Coast*. South African National Biodiversity Institute, Pretoria. <http://hdl.handle.net/20.500.12143/6374>.

3.5.1 Summary

For the first time, there has been substantial effort to align the ecosystem-level assessments of the four realms at the land–sea interface, recognising the cross-realm linkages and dependencies. A seamless, cross-realm map of ecosystem types was created, from which an ecologically determined coast was defined, spanning the terrestrial, estuarine and marine realms. Rivers and inland wetlands were not considered as part of this coastal assessment but collaborative efforts ensured that inland wetland ecosystem types and river reaches were spatially aligned with estuarine features in particular. The integrated coastal map of ecosystem types represents a powerful new tool for coastal planning and assessments.

The South African coast comprises a wide range of coastal vegetation types (from forests to arid shrublands), dunes, cliffs, beaches, rocky and mixed shores, estuaries, mangroves, kelp, reefs, bays, and river-influenced shelf regions that extend as far offshore as the shelf edge in some places. The country's coastal biodiversity is thus exceptional with high levels of endemism, especially among dune plants and beach fauna. The coast provides South Africans with food, jobs and protection from extreme weather and waves, and it is a place to play and enhance human health and wellbeing. However, the coast has been overlooked as an ecological entity in its own right, with piecemeal management of the different realms. Some management actions in the past have been inappropriate due to an incomplete understanding of coastal processes, with current managers facing many erosion and sand-inundation issues as a result of this legacy. This holds true both internationally and in South Africa.

Given the geographic position of the coast, it is exposed to pressures from both land and sea. Key drivers and pressures in the coast include: fishing and other biological resource use; inappropriate land-use and development, especially on the fore-dunes and in Estuarine Functional Zones (EFZs); decreased water and sediment flowing through estuaries to the sea; pollution; ports and harbours; and mining. Many of these are cross-realm pressures and/or are more concentrated on the coast compared



The South African coast provides South Africans with food, jobs, protection from extreme weather events, and is a place to play and relax.

to that in the rest of the country. For example, there is five times more mining, three times more development and plantations, a third more croplands, 50% more overall habitat loss, and twice the rate of natural habitat loss than the rest of the country. Furthermore, these pressures are exacerbated by climate change, particularly stressors such as sea-level rise, extreme storms, droughts and floods. As a result, the ecological condition of the coast is generally worse than that further inland and offshore, which in turn has consequences for coastal ecosystem threat status.

There are more threatened ecosystem types in the coast (60%) compared to that for the rest of the land and sea (16%). Within the coast, there are more Critically Endangered coastal ecosystem types on land (18) compared to the other two realms (3). However, a much larger proportion of estuarine and marine ecosystem types are threatened overall (19/22 and 57/85 respectively) compared to that for

the terrestrial realm (34/79). These trends are probably driven by the fact that terrestrial pressures largely result in more localised areas of habitat loss related to a direct pressure (e.g., mining, urban development), whereas estuarine and marine ecosystem types are more impacted by multiple diffuse pressures that cause chronic degradation of ecosystem functioning (e.g. flow modification, pollution, trophic cascades from overfishing).

Approximately 87% of coastal ecosystem types have some level of protection and, overall, coastal ecosystem types have slightly higher protection levels than non-coastal ecosystem types. Coastal marine ecosystem types generally have higher levels of protection than their terrestrial and estuarine counterparts, with 27% in the Well Protected category, compared to 22% (coastal terrestrial) and 18% (estuarine). It is expected that implementation of the new coastal and marine systematic biodiversity plan (that

The Hole-in-the-Wall is one of the most imposing landmarks along the entire South African coastline.

Standing at the mouth of the Mpako River, the cliff consists of dark-blue shales, mudstones and sandstones dating back ± 260 million years. The local Bomvana people named the formation EsiKhaleni, or 'the Place of the Sound'. Local legend has it that the Mpako River once formed a landlocked lagoon as its access to the sea was blocked by the mighty cliff. One day, a beautiful girl living in a village near the lagoon was seen by one of the sea people (semi-deities who look like humans but have flipper-like hands and feet) who became overwhelmed by her beauty and was determined to win her. But the village was horrified at the match, and when the girl's father found out he forbade her to see him again. So, at high tide one night, the sea people came to the cliff and, with the help of a huge fish, rammed a hole through the centre of the cliff. As they swam into the lagoon they shouted and sang, causing the villagers to hide in fear. In the commotion, the girl and her lover were reunited and disappeared into the sea. At certain times of the year or when a certain wind blows, the music and singing of the sea people can still be heard. See Compendium of Benefits of Biodiversity (SANBI 2019).



© Peter Chadwick

explicitly considered coastal integration) and ongoing negotiations towards even further expansion of the coastal and marine protected area network will see this indicator moving from strength to strength in the near future.

3.5.2 Input data and method for the coast

Substantial efforts have been made to align the four realms at the land–sea interface to better assess headline indicators for ecosystem types that have cross-realm linkages and dependencies. To do this, a seamless, cross-realm map of ecosystem types was conceptualised and created, from which an ecologically determined coastal zone was defined that spans the terrestrial, estuarine and marine realms (Figures 88 & 89). Individual inland aquatic features were reviewed for possible inclusion in the coast (based on their ecology rather than proximity to the shore), and it was decided that rivers and inland wetlands should not be included in the ecologically determined coast. Therefore, the coastal integration in this assessment is focussed on the other three realms, noting though that there was cross-realm collaboration to ensure spatial alignment between rivers, inland wetlands and estuaries. Consequently,

where summary statistics for the coast are compared to those of the non-coastal portions of the country, the latter excludes the inland aquatic realm. On the landward side, vegetation types are included in the ecologically determined coast if they are described as purely coastal or having a coastal affinity, and if at least 70% of their extent is within 10 km of the shore. On the seaward side, all ecosystem types that are influenced by the land were classified as coastal. These included marine ecosystem types up to the back of the inner shelf, the full extent of bays, and all river-influenced ecosystem types. All EFZs were included as part of the coast.

The input data underpinning assessment of the headline indicators are explained in more detail in each of the three realm sections. The most salient input dataset for the coast is the integrated map of ecosystem types that facilitated this coastal assessment. There was substantial investment by all realms

The **coast** or **coastal zone** was determined ecologically, by identifying terrestrial and marine ecosystem types with strong coastal affinities. In addition, all estuarine ecosystem types were considered coastal. It is recognised that this is different to the definition of coastal zone in the Integrated Coastal Management Act.

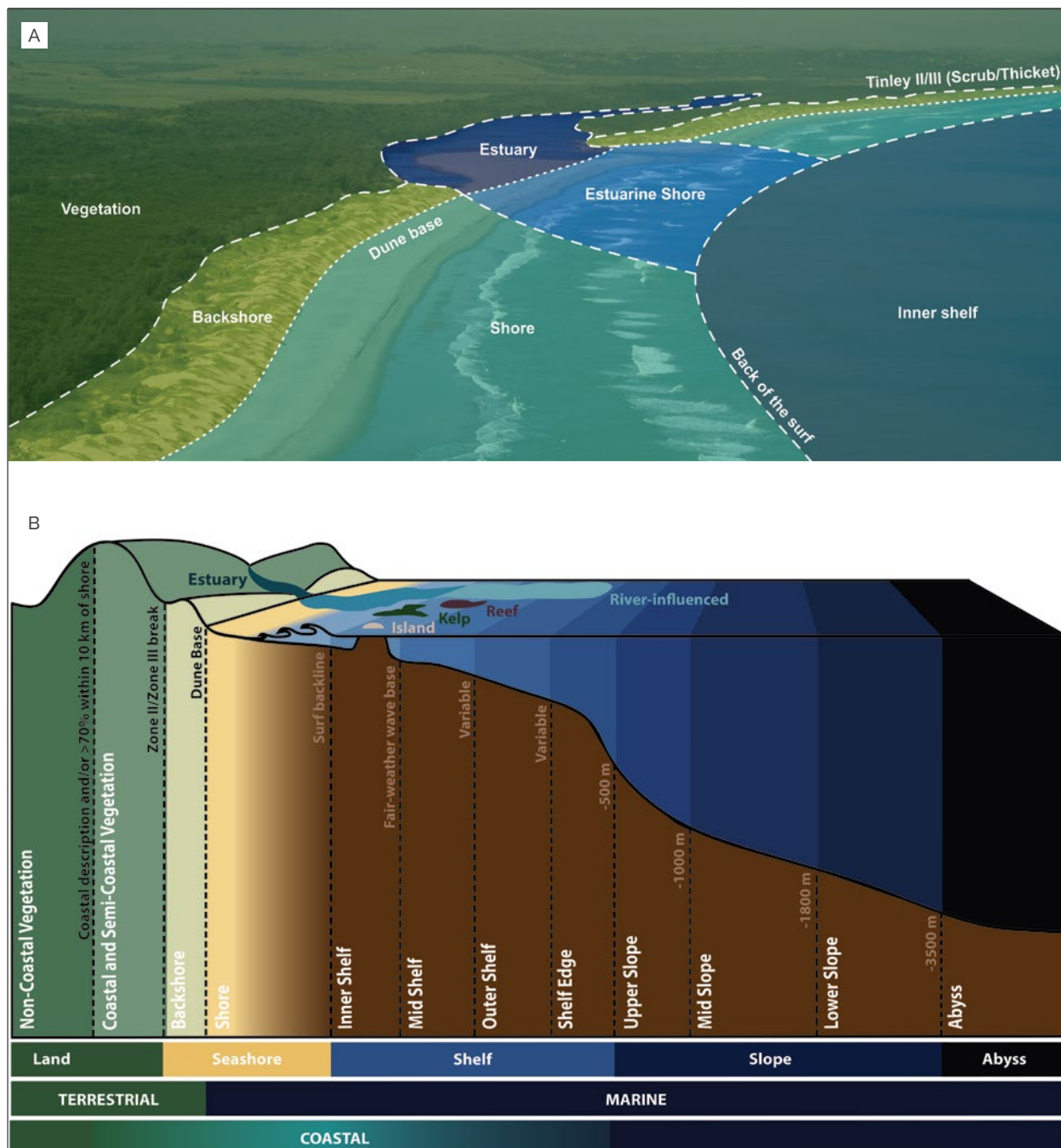


Figure 88. Conceptual framework for seamlessly mapping ecosystem types across the land-sea interface (A) across the seashore; and (B) relative to the other realms.

to ensure that the respective ecosystem type classifications were updated to include the latest scientific evidence, and that the respective maps aligned seamlessly. Coarse-scale mapping (1:50 000) of many ecosystem types was refined to better represent the underlying features (e.g. shore types and seashore vegetation were mapped at a scale of <1:3 000). Similarly, the pressure data have been refined and improved. This is especially evident in the marine realm, with the pixel resolution of pressure maps improving from a 5' grid (approximately 8 × 8 km) in 2011 to 30 × 30 m pixels in 2018. In turn, this

has resulted in more accurate measures of ecological condition and ecosystem threat status.

3.5.3 Approach to analyses in the coast

Given that the coast is a cross-realm zone rather than a discrete realm, the coastal assessment is a summary of

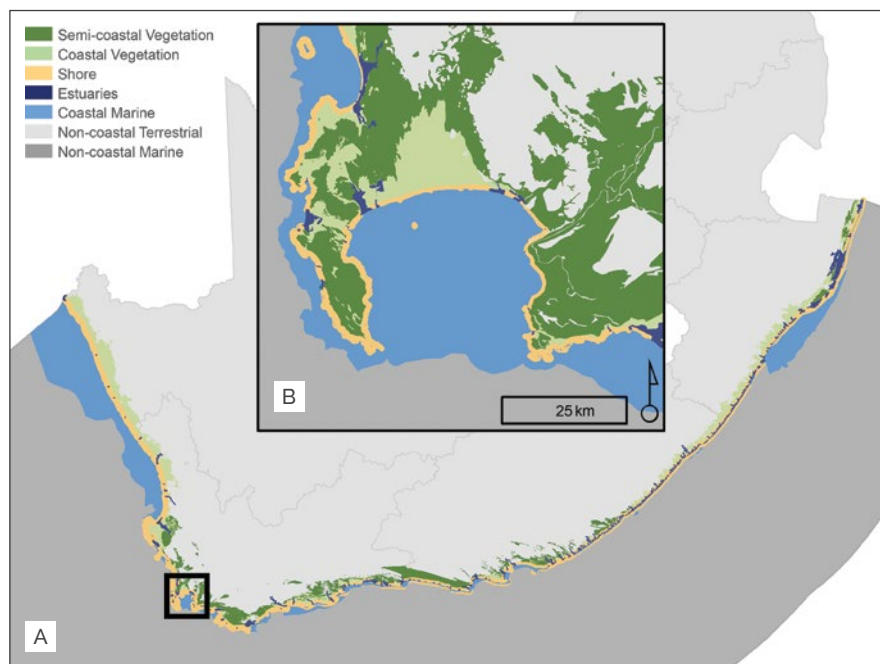
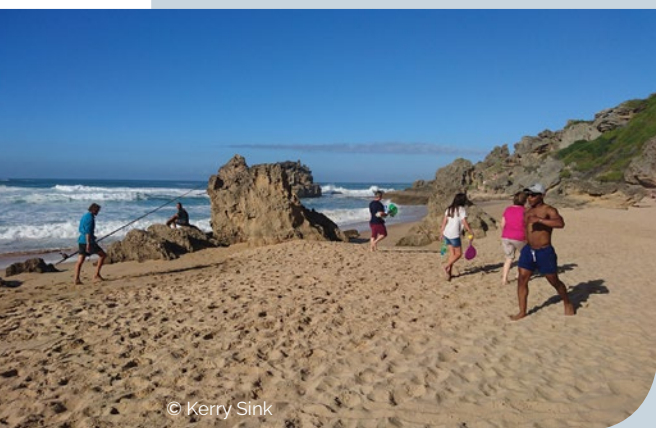


Figure 89. (A) South Africa's ecologically defined coastal zone displayed by sub-realms; and (B) a zoomed section of the south Western Cape.

existing analyses rather than new, independent analyses. Headline indicators of each coastal ecosystem type were thus assessed using the methods described for each of the respective realms (see previous chapters of this report and the realm technical reports for details) and repackaged into summaries of headline indicators for the ecologically determined coast. Although no new analyses were conducted, consideration was given to the influences of adjacent realms

when the terrestrial, marine and estuarine ecological condition was determined, which in turn influenced the ecosystem threat statuses. For example, coastal development on the dunes (seashore vegetation types assessed in the terrestrial realm) was considered a pressure to adjacent sandy beaches (assessed in the marine realm) because of the strong linkages between beaches and dunes, such that they are recognised as a single geomorphic unit called the littoral active zone.



© Kerry Sink

Beaches and dunes are crucial ecological infrastructure in South Africa providing numerous benefits to people.

Trips including beach activities rank the most popular for domestic tourists, while visiting a beach ranks similar in popularity to undertaking wildlife activities for foreign tourists (see tourism section in Compendium of Benefits of Biodiversity (SANBI 2019)). Visiting a beach allows a diversity of activities to suit every taste (e.g. bathing, fishing, surfing, kayaking, swimming, walking, sunbathing, picnicking, beach-related sports, and observing birds and mammals). Many cultural and spiritual ceremonies are performed on beaches, and beaches are a key place for environmental education and citizen science initiatives.

The harvesting of marine flora and fauna for food, medicine and bait is common practice along beaches and rocky shores. Beaches filter up to 10 000 litres of water per 1 m strip of beach per day, keeping the surf clean for the enjoyment and health of both humans and fishes. Beaches and dunes protect nearby settlements from wave damage, wind stress and flooding. As a testament to the excellent beach-visiting opportunities and conditions in South Africa, the country was the first outside of Europe to be awarded Blue Flags in 2001. Blue Flags are awarded annually, ensuring that high standards are maintained at the sites. For 2018/2019, South Africa has 66 Blue Flags, 46 of which are for beaches (the others are for marinas and sustainable tourism boats). Most of the Blue Flag beaches are in the Western Cape (30); the rest are in the Eastern Cape (7) and KwaZulu-Natal (9).

Although there are differences in methods to assess ecological condition among realms (terrestrial: land cover; estuarine: estuarine health; marine: cumulative pressures), all realms calculated ecosystem threat status following the IUCN guidelines for the Red List of Ecosystems (RLE). This is the first time that there has been integration of the realms at the coast, and thus the first time that headline indicators have been compiled for this zone. Consequently, no trend analyses for the coast can be undertaken in this assessment.

3.5.4 Key drivers and pressures in the coast

Coastal ecosystems and species are exposed to a wide range of pressures from both land and sea (Figure 24, p. 48). Given the many benefits provided by the coast, human population densities are much higher closer to the shore compared to that in the hinterland. The result is that pressure in the coastal zone is higher than that further inland and offshore. In South Africa, the coast contains about five times more mining, three times more development and plantations, a third more croplands, 50% more overall habitat loss, and twice the rate of natural habitat loss (0.2% pa vs.

Table 10. Percentage extent of the coastal (coastal and semi-coastal vegetation types) and non-coastal land in South Africa in each different land cover category

	Non-coastal	Coastal
Natural	79.7	66.7
Cropland	16.1	22.0
Plantation	1.4	4.5
Built-up	2.0	5.4
Mine	0.2	1.1
Artificial water body	0.5	0.3

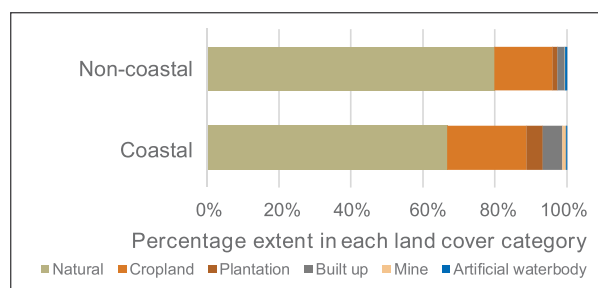
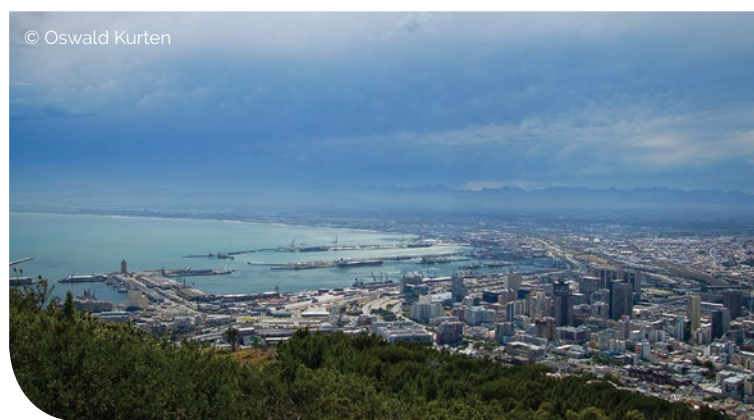


Figure 90. Percentage extent of the coastal (coastal and semi-coastal vegetation types) and non-coastal land in South Africa in each different land cover category.



Harvesting biological resources is the largest pressure on coastal biodiversity in the shallow sea and estuaries. Development at the coast is a key pressure on terrestrial coastal ecosystem types and species. There is 50% more overall habitat loss and twice the rate of habitat loss on the coast than for the rest of the country.

0.1% pa) than the rest of the country. Notably, the mining footprint within the coastal vegetation types (i.e. excluding semi-coastal vegetation types; 1.8%) is eight times more than that further inland. (Figure 90 & Table 10).

A key pressure in the coast is fishing and other forms of biological resource use, especially in estuaries and the sea. On land, inappropriately located development and land-use change on the foredunes and in EFZs is most important, with the impacts extending beyond the immediate development footprint to adjacent ecosystems, such as beaches and estuaries. Flow modification, such that the amount of freshwater and sediment that naturally reaches the coast is altered, is a critical cross-realm pressure that severely affects estuaries and downstream beaches, dunes, and river-influenced marine ecosystem types. Pollution (e.g. coastal discharges, stormwater and agricultural return flow) is an ever-intensifying pressure in the coast, with effects felt especially in the estuarine and marine realms because of the connectivity of these aquatic

systems. Plastic (especially micro-plastic) pollution and chemical pollution are particularly important, yet often difficult to quantify at a national scale. Ports and harbours play a key role in cumulative coastal pressures. Apart from the direct habitat loss and habitat modification in adjacent areas following construction (e.g. building breakwaters and modifying natural sand movement along the shore), they provide access points from which urban development burgeons. Along with increasing human settlement comes increasing pressure on coastal resources and increasing levels of pollution. As much as ports and harbours are economic hubs, they also have a significant impact on coastal biodiversity that compromises delivery of many other benefits from natural and near-natural systems.

3.5.5 Ecological condition in the coast

There is more than twice the proportion of modified habitat in the coastal zone compared to the rest of the country (Figure 91, Table 11), with almost half (47%) of the coastal extent in a modified state compared to only a fifth (20%) of the rest of South Africa. This confirms the disproportionate amount of pressure on coastal zones compared to other zones, especially non-coastal marine areas (Table 11). Among realms within the coastal zone (Table 11), estuaries have the largest extent of modified habitat (77%), but the least amount of critically modified habitat (5%). There is more natural/near-natural terrestrial habitat compared to that for coastal marine habitat, but also more heavily modified habitat on the landward side of the coast. This is because, as noted above,

terrestrial pressures tend to be binary, usually resulting in very severe degradation or loss of natural habitat, compared to marine (and estuarine) pressures that overlap spatially and accumulate over time.

3.5.6 Ecosystem threat status in the coast

Of the 186 coastal ecosystem types, 112 are threatened, consisting of 21 Critically Endangered, 37 Endangered, and 54 Vulnerable ecosystem types (Figure 92 & Table 12). The majority of the threatened ecosystems in the coast are from the aquatic realms, with estuaries being the most threatened ecosystem types: 86% of types and 99% by area are threatened.

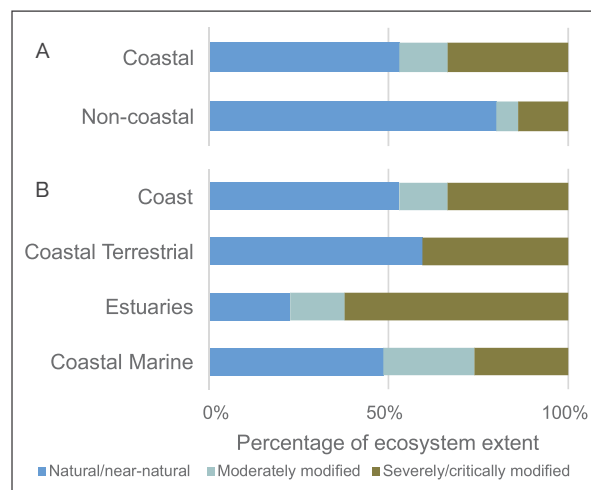


Figure 91. (A) Comparison of extent in the simplified ecological condition classes between coastal and non-coastal areas in South Africa; and (B) comparison of extent in the simplified ecological condition classes among realms within the coastal zone.

Table 11. Percentage coastal extent within each of the ecological condition classes, per realm, and compared to the rest of South Africa. Note that the terrestrial realm does not evaluate a moderately modified category, and that percentages may not add up to 100 due to rounding.

Zone	Natural / near-natural	Moderately modified	Heavily modified	Critically modified	Total modified extent
Coastal Terrestrial	60		3	38	41
Semi-coastal	59		5	37	42
Coastal	60		2	38	40
Estuaries	23	15	58	5	78
Coastal Marine	49	25	10	16	51
Shore	37	31	10	23	64
Inner shelf and river-influenced	49	25	10	16	51
Total (Coastal)	53	14	8	26	48
Non-Coastal	80	6	2	12	20



Estuaries are the most threatened component of the coast, but provide enormous benefits to people. South Africa needs to reduce the pressures on estuaries so that these benefits can be enjoyed in generations ahead. This is the Sundays Estuary. © Linda Harris.

The marine realm follows with second-most threatened ecosystems in the coastal zone: 67% of types and 69% by area are threatened. Within that, 83% of the shore extent is threatened. Although the terrestrial coastal ecosystem types are less threatened (43% of types; 26% of extent), most of the Critically Endangered ecosystem types are within this zone, especially among the semi-coastal vegetation types (26% of types; 16% of extent). This means that pressures on land act more locally and intensively than they do in the aquatic realms. Coastal development and

mining, for example, have a distinct footprint causing complete habitat loss within that footprint. Pressures in the estuarine and marine realms, on the other hand, tend to have wide-reaching, chronic impacts that accumulate over time and that escalate as the intensity increases (e.g. pollution and fishing). The result is many more threatened aquatic ecosystem types over a much broader area in the Endangered and Vulnerable categories, compared to fewer threatened ecosystem types in the highest risk category (Critically Endangered) on land.

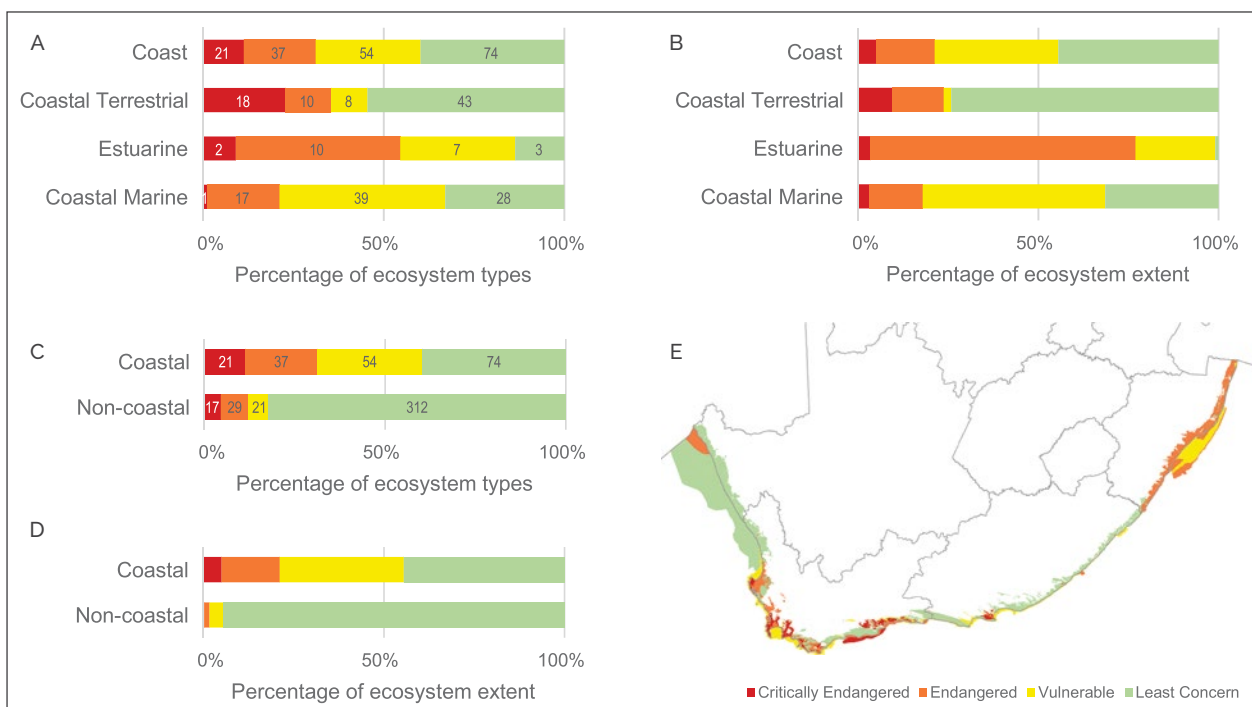


Figure 92. (A) The percentage of ecosystem type; and (B) ecosystem extent in each threat status category for the coast and for the coastal ecosystem types in each realm. (C) The percentage of ecosystem types; and (D) ecosystem extent in each threat status category for the coast compared to the rest of South Africa (land and sea combined). (E) Spatial distribution of threatened coastal ecosystem types in South Africa.

Table 12. Number of ecosystem types per threat category, given per across-shore zone (inland to offshore). Percentage of ecosystem types per threat category is given in round brackets, and the percentage extent is given in square brackets (extent of terrestrial ecosystem types is given as the percentage of remaining natural habitat)

Zone	Threatened Ecosystem Types (CR, EN, VU)					Total
	Critically Endangered	Endangered	Vulnerable	Least Concern		
Coastal Terrestrial	18 (23) [10]	10 (13) [14]	8 (10) [2]	36 (43) [26]	43 (54) [74]	79
Semi-coastal	8 (26) [16]	4 (13) [11]	7 (22) [5]	19 (61) [32]	12 (39) [68]	31
Coastal	10 (21) [6]	6 (12) [16]	1 (2) [<0.1]	17 (35) [22]	31 (65) [78]	48
Estuaries	2 (9) [3]	10 (45) [74]	7 (32) [22]	19 (86) [99]	3 (14) [1]	22
Coastal Marine	1 (1) [3]	17 (20) [15]	39 (46) [51]	57 (67) [69]	28 (33) [31]	85
Shore	-	3 (9) [24]	15 (43) [59]	18 (52) [83]	17 (48) [17]	35
Inner shelf and river-influenced	1 (2) [4]	14 (28) [14]	24 (48) [49]	39 (78) [77]	11 (22) [33]	50
Total (Coastal)	21 (11) [5]	37 (20) [16]	54 (29) [34]	112 (60) [55]	74 (40) [45]	186
Non-coastal	18 (4) [<1]	34 (8) [2]	33 (7) [4]	85 (19) [6]	359 (81) [94]	444

3.5.7 Ecosystem protection level in the coast

It is positive that the coast is proportionately more protected than the rest of the land and sea, given the myriad of benefits it provides and given its threatened status. However, although 87% of coastal ecosystem types have some level of protection (162 of 186 types), only one-third are Well Protected

(36%), which accounts for $<10\%$ of the coastal extent (Figure 93 & Table 13).

It is especially important to cross-tabulate under-protected and threatened ecosystem types to guide prioritisation of protected area expansion (Table 14). Those ecosystem types at highest risk (Critically Endangered or Endangered and Not Protected) urgently need improved conservation and management to safeguard the biodiversity and benefits of these ecosystem types. Furthermore, careful and

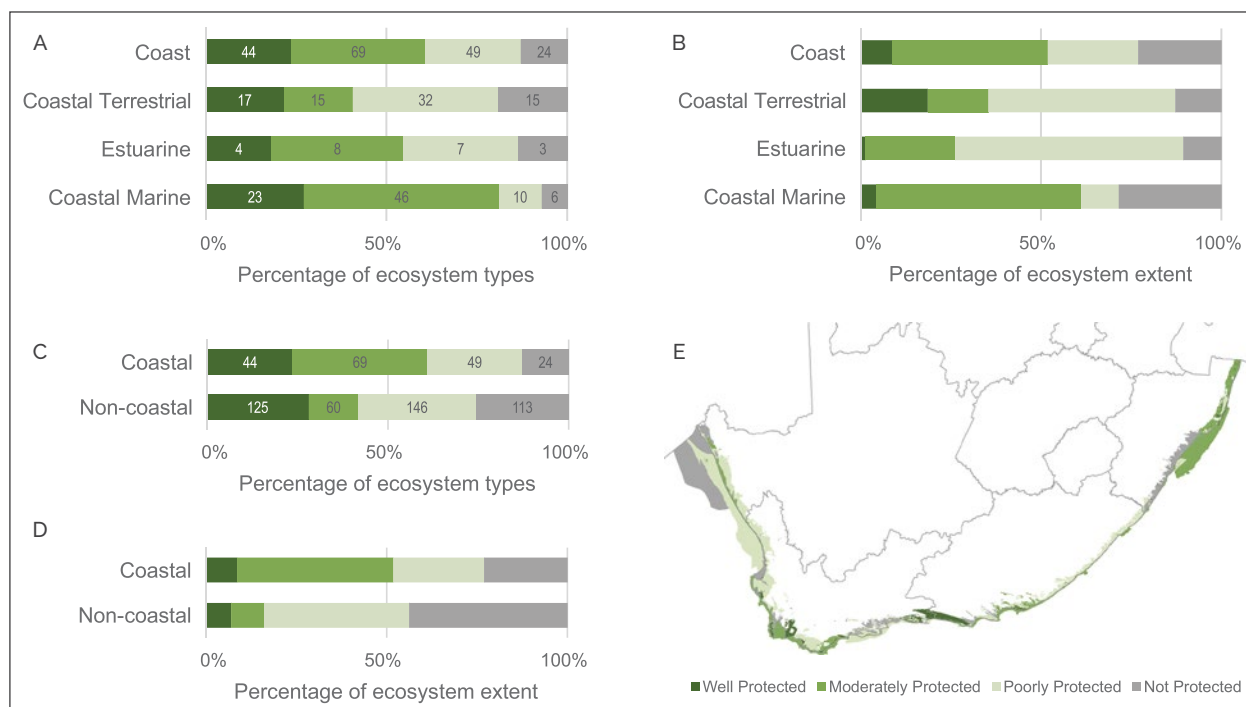


Figure 93. (A) The percentage of ecosystem types; and (B) ecosystem extent in each protection level category for the coast and for the coastal ecosystem types in each realm. (C) The percentage of ecosystem types; and (D) ecosystem extent in each protection level category for the coast compared to the rest of South Africa (land and sea combined). (E) Spatial distribution of protection levels of coastal ecosystem types in South Africa.



The expanded protection of Addo Elephant National Park to include the Bird Island Marine Protected Area and the new Algoa Bay MPA is an excellent example of consolidating conservation efforts and creating cross-realm connections. © Timothy Scott.

deliberate attention needs to be paid to cross-realm, land–sea protection to enhance the benefits of conservation and management efforts. For example, where options exist to expand protected areas to include under-represented ecosystem types in adjacent realms versus protecting those under-represented ecosystem types in separate protected areas,

the former should ideally be preferred. This is especially important for beaches and estuaries that have critically important cross-realm linkages, and the condition and threat status of which strongly depend on that of the surrounding ecosystem types. For example, a beach that is protected up to the high water mark, but has urban development replacing

Table 13. Number of ecosystem types per protection level category, given per across-shore zone (inland to offshore). Percentage of ecosystem types per protection level category is given in round brackets, and the percentage extent is given in square brackets (extent of terrestrial ecosystem types is given as the percentage of remaining natural habitat)

Zone	Well Protected	Moderately Protected	Poorly Protected	Not Protected	Total
Coastal Terrestrial	17 (22) [18]	15 (19) [17]	32 (40) [52]	15 (19) [13]	79
Semi-coastal	6 (19) [32]	5 (16) [19]	13 (42) [41]	7 (23) [8]	31
Coastal	11 (23) [10]	10 (21) [16]	19 (39) [58]	8 (17) [16]	48
Estuaries	4 (18) [1]	8 (36) [25]	7 (32) [63]	3 (14) [11]	22
Coastal Marine	23 (27) [4]	46 (54) [57]	10 (12) [10]	6 (7) [29]	85
Shore	15 (43) [30]	14 (40) [69]	5 (14) [1]	1 (3) [<0.1]	35
Inner shelf and river-influenced	8 (16) [<1]	32 (64) [55]	5 (10) [12]	5 (10) [32]	50
Total (Coastal)	44 (24) [9]	69 (37) [43]	49 (26) [25]	24 (13) [23]	186
Non-Coastal	125 (28) [7]	60 (14) [9]	146 (33) [40]	113 (25) [44]	444

the foredunes behind it, is at severe risk of being inundated and lost to coastal squeeze as sea levels rise. The more cross-realm linkages that can be built into the design of coastal conservation and management areas, the better.

Threatened and under-protected ecosystem types

There are 102 threatened ecosystem types that are under-protected (Table 14). In other words, almost

Table 14. Coastal ecosystem threat status and ecosystem protection level, highlighting threatened and under-protected types

	Not Protected	Poorly Protected	Moderately Protected	Well Protected	Total
Critically Endangered	6	8	5	2	21
Endangered	7	11	17	2	37
Vulnerable	4	8	36	6	54
Least Concern	7	22	11	34	74
Total	24	49	69	44	186

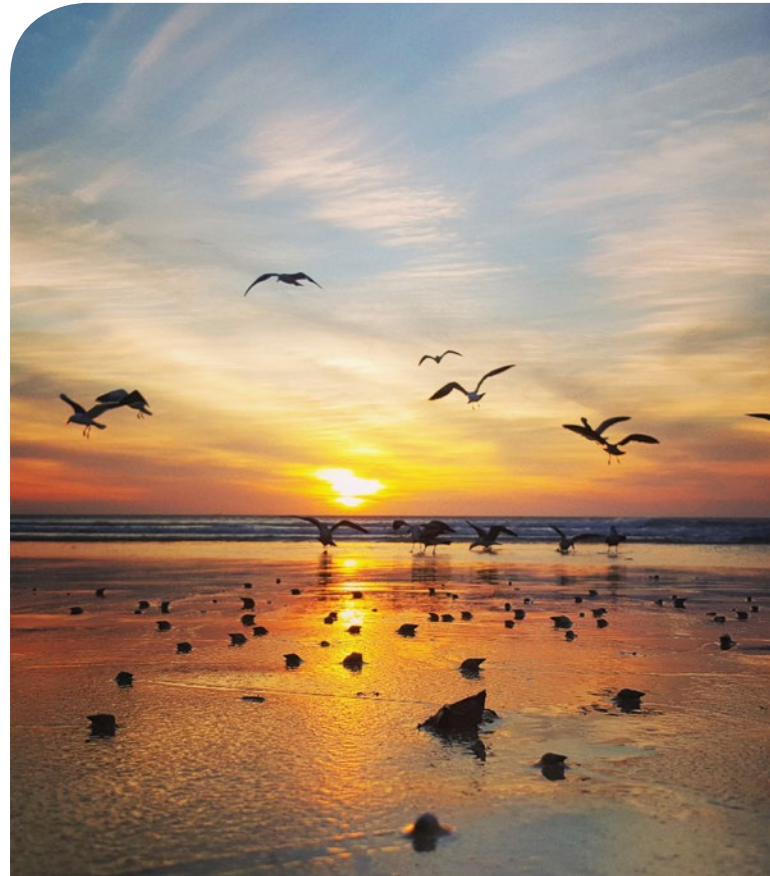
all of the threatened types are under-protected. Of these, 13 are at the greatest risk, being Critically Endangered or Endangered and Not Protected: seven terrestrial, three estuarine and three marine ecosystem types (Table 15). There are two hotspots of these high-risk ecosystem types: one around the Orange River (five high-risk types) and one around Durban Bay (three high-risk types). Identifying these ecosystems allows for their inclusion in various coastal and marine planning processes and protected area expansion strategies.

Table 15. List of high-risk ecosystem types by realm (in realm colours)

Terrestrial (7)	<p>CR: Cape Flats Sand Fynbos</p> <p>CR: Garden Route Granite Fynbos</p> <p>CR: Mossel Bay Shale Renosterveld</p> <p>CR: Motherwell Karroid Thicket</p> <p>CR: Namib Seashore Vegetation</p> <p>EN: Alexander Bay Coastal Duneveld</p> <p>EN: KwaZulu-Natal Coastal Belt Grassland</p>
Estuarine (3)	<p>CR: Subtropical – Estuarine Bay</p> <p>EN: Cool Temperate – Large Fluvially Dominated</p> <p>EN: Cool Temperate – Predominantly Open</p>
Marine (3)	<p>EN: KwaZulu-Natal Bight Mid Shelf Reef Complex</p> <p>EN: Orange Cone Inner Shelf Mud Reef Mosaic</p> <p>EN: Orange Cone Muddy Mid Shelf</p>

iSimangaliso Wetland Park is a land–sea reserve that protects ecosystems and species cross-realm. © iSimangaliso Wetland Park.

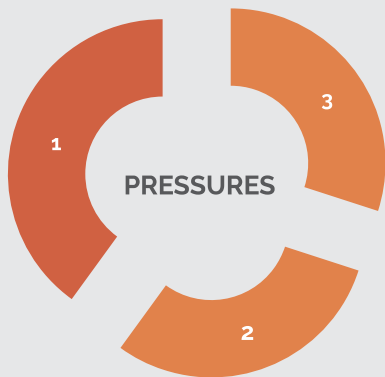
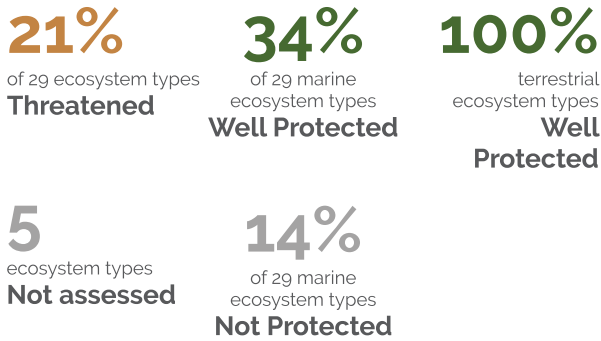




Intact beaches and dunes are national assets for South Africans. Despite their seemingly barren appearance, they support a rich and unique biodiversity. As critical ecological infrastructure, beaches, dunes and their associated biological communities provide benefits like protection against extreme storms and sea-level rise, sites for recreation and tourism, and filtering and purifying of seawater. It is imperative to maintain the cross-realm ecological connections from mountain catchments, through estuaries, to the coast to secure these benefits for current and future generations. © Linda Harris.

3.6 Sub-Antarctic territory

ECOSYSTEMS



- 1 Invasive house mouse
- 2 Patagonian Toothfish fishery
- 3 Climate change

Section based on:

Whitehead, T.O., et al. (eds). 2019. *South African National Biodiversity Assessment 2018 Technical Report Volume 6: Sub-Antarctic Territory*. South African National Biodiversity Institute, Pretoria.
<http://hdl.handle.net/20.500.12143/6375>.

3.6.1 Summary

For the first time, South Africa’s southernmost territory, the Prince Edward Islands (PEIs) and the surrounding territorial sea and Exclusive Economic Zone have been included in the NBA. These sub-Antarctic islands are situated approximately 1 700 km southeast of the mainland and consist of Marion Island and the smaller PEI. The sub-Antarctic region has unique terrestrial and marine ecosystem types not found on the South African mainland or in its surrounding oceans. The PEIs support abundant marine and terrestrial biodiversity and are a crucial breeding and feeding ground for globally threatened seabirds and for seals. Decades of research conducted at the PEIs by a network of institutions have placed South Africa at the forefront of sub-Antarctic and Antarctic science, and highlight the role of the PEIs as a natural laboratory for global change studies. Including the PEIs in the NBA provides a valuable addition for regular reporting of past and current research on the islands, which could ultimately make an important contribution to the management and conservation of their unique biota by identifying and directing future research and monitoring priorities. The terrestrial and marine biodiversity has been assessed using the IUCN Red List of Ecosystems guidelines, and

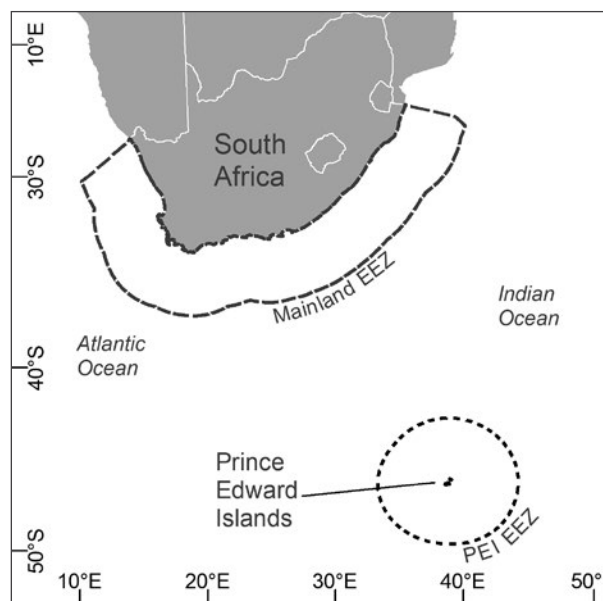


Figure 94. South Africa’s sub-Antarctic territory, lying 1 700 km southeast of the mainland, consists of Prince Edward Island and Marion Island, and their surrounding seas.



Marion Island and Prince Edward Island are situated 1 700 km southeast of South Africa. Together with their surrounding territorial sea and exclusive economic zone, they constitute South Africa's sub-Antarctic territory. These unique terrestrial ecosystem types are afforded the highest protection under South African law, being a Special Nature Reserve, and is primarily used as a research base. Although 30% of the ocean area is protected, commercial fishing is allowed in 25%.



The PEIs are important breeding grounds for seabirds and seals, including (A) the Vulnerable Wandering Albatross (*Diomedea exulans*); (B) the South Indian Ocean sub-species of iconic King Penguin (*Aptenodytes patagonicus halli*); and (C) the Southern Elephant Seal (*Mirounga leonina*). The courting display of the Wandering Albatross can be seen during the breeding season, the only time they visit land, as they spend most of their lives at sea.



this first attempt at national assessment will highlight knowledge gaps and research priorities for the sub-Antarctic research community research community to focus on moving forward.

The PEIs are a Special Nature Reserve and a Ramsar Wetland of International Importance, and 36% of the surrounding ocean is proclaimed as an MPA, however, there are pressures on biodiversity – particularly from invasive species, fishing and climate change. Activities in this area are restricted to research, conservation management and commercial fishing. However, the ecological integrity of the PEIs has been affected by invasive species and climate change, which have brought about changes in both terrestrial and marine ecosystems. Of particular concern on Marion Island is the invasive House Mouse (*Mus musculus*), which has profoundly impacted indigenous invertebrates, plants and seabirds. As the impacts of invasive species are exacerbated by climate change, the two threats to the ecosystems are interactive and compounding. Marine invasive species are an emerging concern in the sub-Antarctic region, but their presence and potential impact around the PEIs is poorly understood due to limited research in the ecosystem types beyond the shelf. The commercial longline fishery for Patagonian Toothfish (*Dissostichus eleginoides*) has been a key pressure in the marine ecosystems of the shelf and slope. The potential impacts of this fishery, including impacts on Toothfish predators and prey, require further research. Elsewhere in the Southern Ocean, demersal longline fishing has impacted seabed ecosystems, particularly in fragile areas constituting Vulnerable Marine Ecosystems (VMEs). An improved understanding of the ecosystem impacts of this fishery is a research priority.

The first map of marine ecosystems for the sub-Antarctic territory has been developed for this assessment, including 29 marine ecosystem types. As for the mainland, these marine and coastal ecosystem types merge seamlessly with the existing terrestrial ecosystem types mapped in 2006. The new marine ecosystem types include shore types, shelf types, as well as ecosystem types of the slope, plateau, ridges, seamounts, rift valleys and abyss. On the islands, five terrestrial ecosystem types have been previously described in the two biomes: Sub-Antarctic Tundra and Polar Desert. However, challenges remain in mapping these types at an appropriate scale. The majority of the marine and terrestrial ecosystem types described are likely to occur on and around other sub-Antarctic islands, indicating the need for regional work in ecosystem classification and mapping.

The preliminary national assessment of the PEI marine ecosystem types found that 21% of types

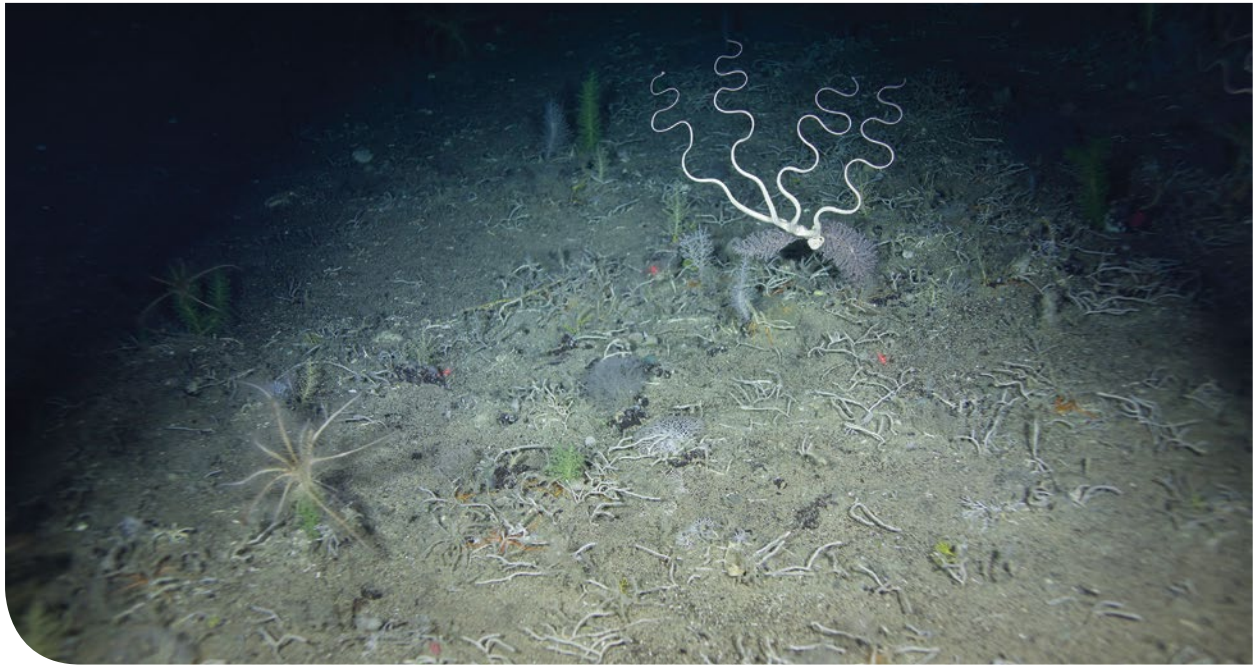
are threatened by historical or current fishing, including one Endangered ecosystem type and five Vulnerable ecosystem types. Terrestrial ecosystem types are currently categorised as Data Deficient. While the terrestrial ecosystems of the PEIs are free from the typical direct pressures of the mainland (e.g. croplands), they are subject to biological invasions and climate change. Both of these pressures are the subject of ongoing research and a preliminary regional assessment will be possible in the near future. Marine ecosystem threat status is driven largely by historical and current pressure from the longline fishery for Patagonian Toothfish. This includes substantial illegal, unreported and unregulated (IUU) fishing, particularly between 1994 and 2004. These assessments may be updated as new information on ecological condition becomes available (linked to the impacts of climate change, invasive species and Toothfish fishing) and global or regional assessments may be undertaken when the full extent of ecosystem types are considered. Regional assessment will require additional ecosystem mapping efforts on nearby islands and surrounding seas. There are also 28 threatened or Near Threatened bird species breeding on the islands. Birds were assessed as part of the marine assessment for the mainland, since those species occurring on the islands also frequent South Africa's mainland waters. While understanding of the PEIs' species and ecosystems has developed substantially over the last few decades, there is considerable room for improving knowledge of ecological condition and species population trends, especially under accelerated climate change.

A first assessment of ecosystem protection levels was completed for both terrestrial and marine ecosystems. This national assessment found that 10 of 29 marine ecosystem types are Well Protected, 14 are Moderately Protected, one is Poorly Protected and four are Not Protected. All five of the terrestrial ecosystem types were categorised as Well Protected. Regional assessments are needed to better understand protection levels for those ecosystem types that also occur outside of South Africa's territory in the sub-Antarctic.

3.6.2 Input data and method for the sub-Antarctic

Ecosystems

The key input dataset for the terrestrial ecosystem assessment was the National Vegetation Map. This



Typical seabed habitat around 250 m offshore of the Prince Edward Islands hosting a rich abundance of bryozoans, soft corals, feather stars and brittle stars. The charismatic White Basket Star (*Astrotoma agassizii*) attached to a soft coral *Thouarella* spp. with arms outstretched feeding in the current, is the largest known specimen belonging to the Class Ophiuroidea reaching up to 1 m diameter and is reported to live up to 90 years. © Charles von der Meden, SAEON.

digital map delineates five vegetation types (equivalent to ecosystem types) within the PEIs. The five ecosystem types are likely to extend beyond South African borders to nearby sub-Antarctic islands, but with no data available for these islands a comprehensive global threat status assessment is not possible.

The first detailed map of the marine ecosystem types of the sub-Antarctic territory was produced as part of the NBA 2018 (Figure 95). The map was based on extensive research, consolidating historical and current information on regional biogeographic pattern, bathymetry and benthic ecosystems. The

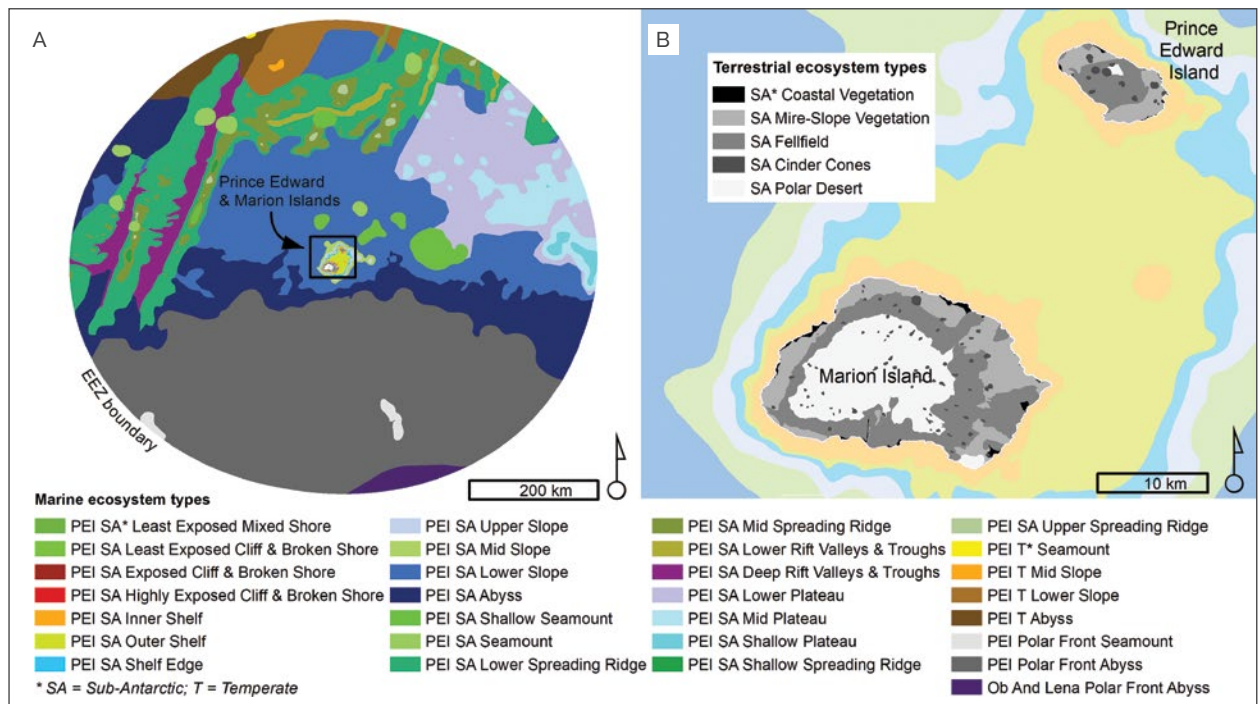


Figure 95. Ecosystem classification map of the PEIs and surrounding territorial waters, including its Exclusive Economic Zone (EEZ). (A) Ecosystem types across the entire EEZ; and (B) terrestrial on the islands and shelf ecosystem types around the islands.

ecosystem types are, therefore, within regional ecosystems and some extend beyond national jurisdiction. The 29 marine ecosystem types are nested within nine functional groups and four ecoregions to represent marine biodiversity pattern. Increased investment in research has improved the sub-Antarctic marine ecosystem classification.

A preliminary national threat status assessment, following the IUCN Red List of Ecosystems framework, was undertaken for the 29 newly described marine ecosystem types. Criterion C1 (recent ecosystem degradation) was applied using the Patagonian Toothfish fishery footprint. The extent of the fishing footprint was calculated for each ecosystem type, and the severity of the impact was estimated to be moderate throughout. Ecosystems with 80% or more of their extent within the fishing footprint were categorised as Endangered, those with 50% or more were categorised as Vulnerable, and those with less were considered Least Concern. At this stage, the presence and abundance of potential VME indicator species was not considered in the assessment of threat status.

The ecosystem threat status assessment for the five terrestrial PEI ecosystems was hampered by the lack of appropriate data on ecological condition and, following the IUCN Red List of Ecosystems guidelines, these ecosystems were assessed as being Data Deficient.

With biological invasion and climate change being key threats to the PEIs, disruption of biological processes and ecosystem degradation is an increasing concern. There is a gap in our ability to understand thresholds of condition and there are challenges in measuring the subtler forms of habitat degradation. As a result, the level of modification of terrestrial and marine ecosystems, particularly the impact of demersal fishing on potential Vulnerable Marine Ecosystems, may be underestimated. Better information on biotic disruptions (especially by house mice, invasive plants and invertebrates) and environmental degradation (climate change and human impacts) are required for a meaningful assessment.

The protection level assessment for marine ecosystems used the standard approach with an addition rule applied: in order for a marine ecosystem type to qualify in the Well Protected category, at least 20% of the ecosystem type (i.e. the ecosystem target) needed to be within the zones of MPA in which no fishing is permitted (12 nautical mile sanctuary zone and restricted zone AB); if this rule was not met, the ecosystem was categorised as Moderately Protected.

Vulnerable Marine Ecosystems

VMEs are areas in the ocean that are characterised by their structural functionality and their vulnerability to bottom contact fishing gear.

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) advanced the information for mapping of potential VMEs in the sub-Antarctic territory since 2007 and this is the first map of relative density of VME indicator species in the PEIs (Figure 96). The map shows which ecosystem types are more sensitive to activities that may impact the seabed, including the Patagonian Toothfish fishery that is the main offshore activity in the region at present.

Species

Except for birds and prominent marine mammals, dedicated species assessments have not been conducted for the PEIs, as few taxa are endemic to the PEIs and very limited foundational data are available to conduct species threat assessments. The seabirds of the islands also frequent the mainland waters, and are included in the marine realm report. While the limited evidence suggests that genetic diversity is surprisingly high in the terrestrial ecosystems of the PEIs, data limitations are a challenge in assessing genetic diversity.

Pressures

While the terrestrial ecosystems of the PEIs are free from the typical direct pressures of the mainland (e.g.

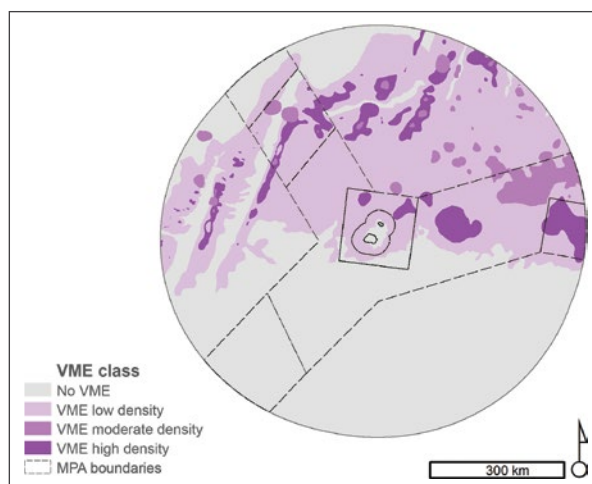


Figure 96. A map showing the known distribution and relative abundance of indicator species for potential Vulnerable Marine Ecosystems based on CCAMLR data. Darker purple areas have more VME records and are likely to be more fragile ecosystem types that are sensitive to activities that may damage the seabed.

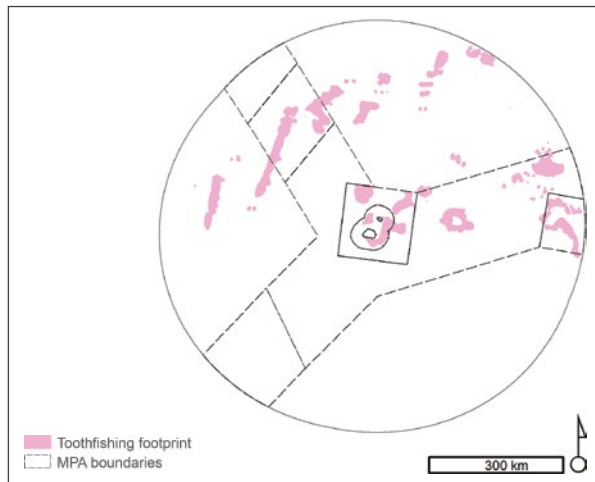


Figure 97. Patagonian Toothfish fishery footprint in the EEZ of the PEIs.

land clearing for croplands, human settlements), they are subject to pressure from biological invasions and climate change. Unfortunately, spatial data on the impact and severity of these biological disruptions are a key limitation. A regional assessment will require additional ecosystem mapping efforts and condition data on nearby islands. These pressures are the subject of ongoing research and in the near future regional assessments may be undertaken. Research is underway to address the ecological impacts of biological invasions, particularly the House Mouse, and climate change.

The only pressure affecting the marine environment in the sub-Antarctic territory that could be mapped with available data is the commercial Patagonian Toothfish (*Dissostichus eleginoides*) fishery (Figure 97). Extensive illegal fishing took place until late 1996, when sanctions were put in place to curb and monitor catches. Fishing effort data (total number of hooks set) was therefore available from 1997 and used to map fishing footprint until 2016 using a kernel density approach (95% value).

Protected areas

The South African Protected Areas Database (SAPAD), maintained by the DEFF and released quarterly, formed the core of the protected area dataset for the protection level assessment. The islands were designated as a Special Nature Reserve in 1995, were recognised as a Ramsar Wetland of International Importance in 2007, and the PEI MPA covering 36% of South Africa's marine territory in the sub-Antarctic was declared in 2013. The PEI MPA is the largest protected area of any type in South Africa, approximately 16% of which is completely closed to fishing.

3.6.3 Key drivers and pressures in the sub-Antarctic

Fishery for Patagonian Toothfish

The commercial Patagonian Toothfish fishery is the most notable non-research associated activity occurring within the PEIs. Biodiversity concerns associated with the fishery include stock status concerns (as Toothfish are slow-growing), interactions with seabirds and marine mammals, and potential impacts on the seabed particularly in Vulnerable Marine Ecosystems. This highly valued resource has led to substantial illegal, unreported and unregulated fishing within the PEIs EEZ. This experimental fishery was initiated in 1996 and was converted to a commercial fishery in 2006. Catches of Toothfish during the legal experimental fishery were high with even higher illegal catches estimated in the mid-90s until 2004. Currently stock status and fishing pressure are considered optimal, with two rights holders currently in operation. Additionally, bycatch of seabirds has reduced from 0.19 birds killed per 1 000 hooks in 1996/1997 season, to 0.001 birds killed per 1 000 hooks in the 2001/2002 season in the legal fishery. However, poaching in the Southern Ocean remains a threat and the potential indirect impacts of intensive illegal fishing have not been studied.

Invasive species

The terrestrial and marine ecosystems of the sub-Antarctic territory are generally well conserved and in considerably more natural condition than the terrestrial and marine ecosystems on and around mainland South Africa. However, the PEIs face pressures from an increasing range and intensity of direct human activities and, perhaps more importantly, through indirect disruption of biotic processes and degradation. The key biotic disruption to the terrestrial ecosystems in the sub-Antarctic is alien species. These include 26 alien invertebrates, one alien vertebrate (the House Mouse, *Mus musculus*) and 18 alien plant species (many of which have become invasive). These species have severely impacted the ecology of the islands and caused alarming decreases in abundance of the indigenous biota. *Sagina procumbens* is one such invasive plant species, which has had the fastest rate of spread across the islands due to its wide ecological tolerance and ability to reproduce vegetatively and by seed. *Sagina procumbens* increases the richness and abundance of invasive invertebrate species, indicating the

Box 12. The House Mouse on Marion Island

Mice (the House Mouse, *Mus musculus*) were accidentally introduced to Marion Island by sealers in the 1800s. Cats were brought to the island in an attempt to control the mice in 1949, but they were eradicated in 1991 because of their devastating impact on seabirds. Without sufficient control mechanisms, the mice have become the key threat to the island, impacting terrestrial and marine species and severely disrupting the ecology of these sensitive island ecosystems. The rapid increase in the mice population is due to an interactive effect of the lack of natural control, alien plant and invertebrate species, and climate change. Mice have impacted all trophic levels, initially depleting macroinvertebrate populations and seed stock and, more recently, preying on petrel and albatross chicks and eggs. With 2.5 million pairs of seabirds breeding at the PEIs, they are particularly vulnerable to mammal invasions when aggregating in such vast numbers. This is in addition to the pressure of fishing activity in their foraging areas.



Wounds on Endangered Grey-headed Albatross chicks from scalping by the House Mouse. The chicks have no defence against the small mice and often die from the wounds. © Peter Ryan.

The burrowing activity of mice directly affects indigenous plants, even causing mortality in a keystone species, *Azorella selago*. This is the foundational cushion plant species on the island, without which many of the island's biota would not be able to live in some of the harsher environments on the island. Furthermore, the House Mouse's excessive predation on terrestrial invertebrates has caused a considerable decline in the invertebrate-feeding, endemic Lesser Sheathbill, the islands' only terrestrial bird. The impacts of mice also have knock-on ecosystem-level effects, such as decreased decomposition and nutrient cycling as a result of heavy predation on the invertebrates that are an integral component of decomposition at the island – thereby affecting ecosystem structure and functioning.

Fortunately, South Africa has committed to eradicating the mice in a collaborative effort led by the Department of Environment, Forestry and Fisheries, BirdLife South Africa and the Fitzpatrick Institute of African Ornithology. When completed, this will be the largest island-wide eradication of rodents in the world. For more details visit www.mousefreemarion.org.za.

interactive effect of invasive species. These terrestrial invasive species affect marine species that breed on the islands. Marine invasive species are also an emerging concern with some introduced marine taxa detected at other islands in the sub-Antarctic islands, but their impact at the PEIs is difficult to predict due to limited research in deep ecosystem types. Although the impact of many terrestrial and marine alien invasive species are an increasing concern, none have been studied as extensively, or have had a more profound effect, than the House Mouse (Box 12). Nine alien plant species have been effectively controlled since

2012 and ongoing research is being conducted on these and other species to better understand their impacts and inform appropriate control measures.

Climate change

The oceanic nature of the PEIs makes them highly sensitive to climate change. Since the mid-20th century, mean annual air and sea temperatures at the islands have increased by 1.2 and 1.4°C respectively – more than twice the mean global rate – emphasising the islands' global importance as 'sentinels' of climate change.

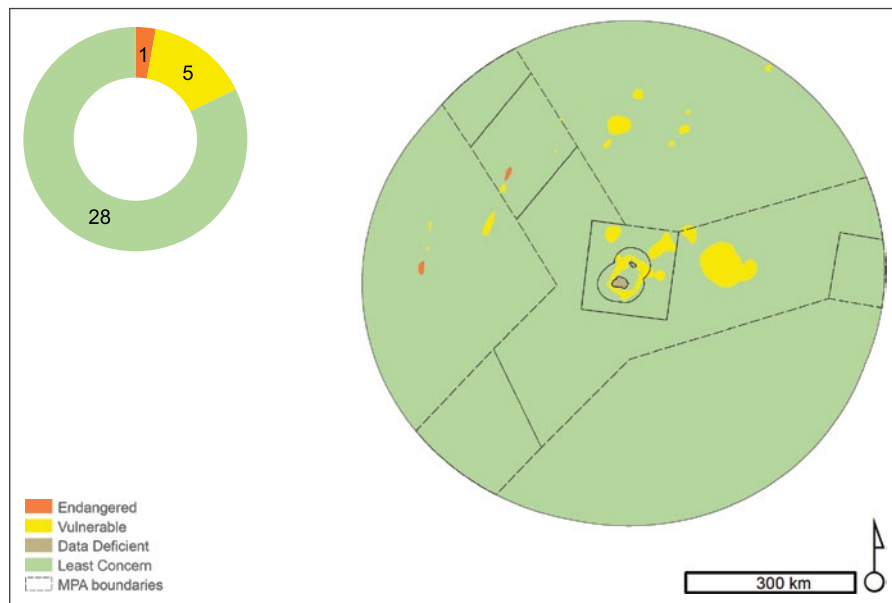


Figure 98. Distribution of threatened ecosystems in PEIs and surrounding Exclusive Economic Zone. The five terrestrial ecosystems are listed as Data Deficient. The inset shows the number and proportion of ecosystems types in each IUCN RLE category.

On land, warmer air temperatures and more northerly winds have coincided with a considerable drying of the islands, with annual precipitation having decreased by 34% over the past 50 years. This has directly impacted the ecology of many terrestrial taxa, which evolved under a cool and wet sub-Antarctic climate. Impacts on native species include range expansions, especially to higher and cooler altitudes. Warmer conditions have exacerbated the spread of alien invasive species and compounded their negative effect on native species, which is expected to worsen with continued warming. Such fundamental changes in the terrestrial community have major implications for ecosystem structure and functioning at the PEIs.

In the marine environment, warmer waters and faster currents linked to the southward movement of the sub-Antarctic Front have become more common, reducing local productivity and changing the trophic structure and composition of benthic communities. Decreased rainfall on land has reduced runoff of freshwater and nutrients into the sea, contributing to changes in local productivity and benthic ecosystems. Epipelagic communities near the islands have changed in species composition, with Antarctic species decreasing and temperate species becoming more common. As the Antarctic Circumpolar Current and its associated fronts continue to migrate poleward, eddy generation at the Southwest Indian Ridge is expected to decrease, reducing the advection of zooplankton and micronekton to the PEIs. These changes may reduce food availability for short- to medium-range predators such as the Crozet Shag (*Phalacrocorax melanogenis*), and Gentoo (*Pygoscelis papua papua*), Eastern Rockhopper

(*Eudyptes chrysocome filholi*), Macaroni (*Eudyptes chrysolophus*) and King (*Aptenodytes patagonicus halli*) penguins – many of which have declined in recent decades.

3.6.4 Ecosystem threat status in the sub-Antarctic

Of the 29 marine ecosystem types described in this region/in the sub-Antarctic, six (21%) are threatened by fishing (including the effects of historical illegal fishing) (Figure 98). There are five Vulnerable ecosystem types including the PEI Shelf Edge, Upper Slope and Mid Slope, which were threatened by historical fishing within the 12 nm territorial sea (now a sanctuary zone of the MPA). More than 65% of the PEI sub-Antarctic Shallow Seamount and Upper Spreading Ridge are fished, making them Vulnerable. Only one ecosystem type is considered Endangered, the PEI sub-Antarctic Shallow Spreading Ridge, which has been fished over its entire extent. The remaining marine ecosystem types have been fished over less than half of their extent and so are considered Least Concern at this stage (Figure 98). Climate risks need to be incorporated in future assessments which should also adopt a regional rather than a national approach.

All five terrestrial ecosystem types are categorised as Data Deficient (DD) based on the IUCN Red List of Ecosystems guidelines. These are national assessments and comprehensive regional or global

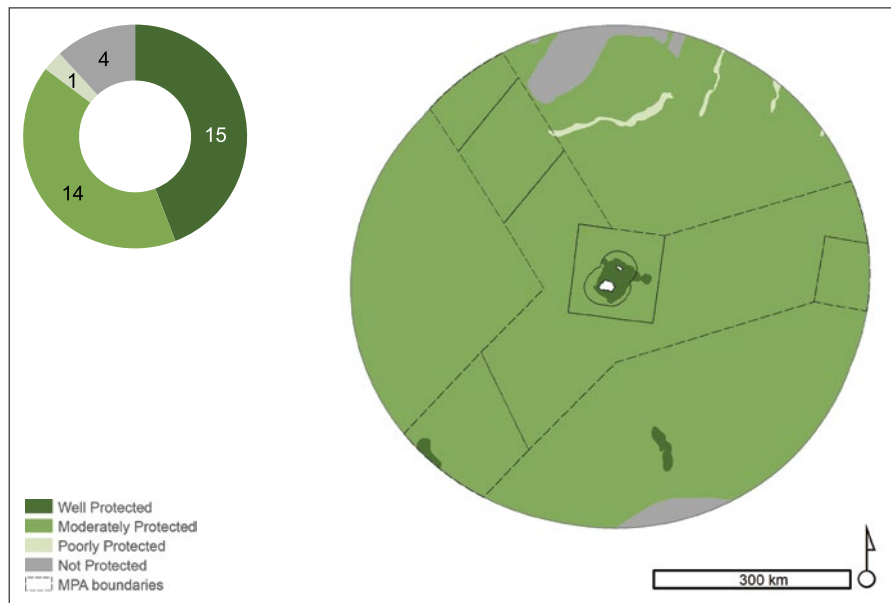


Figure 99. Ecosystem protection level (PL) map of the PEIs and surrounding EEZ. Terrestrial ecosystems, represented in white, are all Well Protected. The inset shows the number and proportion of ecosystem types in each PL category.

assessments should remain the goal for these ecosystem types in future. This highlights the opportunity for cooperation with international partners to determine the distribution and condition of the PEIs' ecosystem types beyond South Africa's boundaries. It is possible that when the global situation is considered, some ecosystem types currently assessed as Least Concern or Data Deficient in the PEIs may change to threatened.

3.6.5 Ecosystem protection level in the sub-Antarctic

Overall, 86% of marine ecosystem types are afforded some protection by the MPA network. Ten marine ecosystem types are Well Protected (34%), 14 are Moderately Protected (48%), one is Poorly Protected (4%) and four are Not Protected (14%). All five terrestrial ecosystem types were categorised as Well Protected (Figure 99). As with the ecosystem threat status assessment, these are preliminary results that do not yet consider the regional or global extent of ecosystem types and better data on ecological condition could also affect future protection level assessments.

Terrestrial ecosystems were declared a Special Nature Reserve in 1995, in terms of the Environment Conservation Act (No. 73 of 1989) and thus enjoy the highest level of protection afforded to any natural area under South African law. The PEI MPA is South Africa's largest protected area across realms (169 966 km² or 36% of

the PEIs EEZ) and has a core sanctuary zone around the islands and one restricted zone (zone AB) in which no fishing is permitted (together making up 6% of the EEZ). There are a further three restricted zones in which fishing is limited (8% of EEZ), and a large controlled zone that accommodates the commercial Patagonian Toothfish fishery (22% of the EEZ). Where fishing overlaps with VMEs and threatened ecosystem types, additional measures are needed to protect these ecosystems (e.g. the Southwest Indian Ridge in the northern portion of the EEZ).

The marine environment of the PEIs was heavily exploited by the commercial longline fishery for Patagonian Toothfish in the early 1990s, and the spawning biomass of this species may only be a fraction of what it was pre-exploitation. The establishment of the MPA was intended to contribute to the recovery of Toothfish populations, as well as provide protection for vulnerable and unique species and habitats. The zonation of fishing activity needs to be re-examined and fishing effort needs to be reduced in restricted zones to improve protection of marine ecosystem types.

3.6.6 Species assessments in the sub-Antarctic

Although plant and invertebrate species threat assessments could not be conducted due to insufficient data, there are 28 threatened or Near Threatened seabird species breeding at the PEIs that are Taxa of Conservation Concern. These include the endemic

Lesser Sheathbill (*Chionis minor*, NT), the Crozet Shag (*Phalacrocorax melanogenis*, CR), Macaroni Penguin (*Eudyptes chrysolophus*, VU), Eastern Rockhopper Penguin (*Eudyptes chrysocome filholi*, EN), Wandering Albatross (*Diomedea exulans*, VU), Sooty Albatross

(*Phoebetria fusca*, EN), Indian Yellow-nosed Albatross (*Thalassarche carteri*, EN) and Grey-headed Albatross (*Thalassarche chrysostoma*, EN). Future species assessments will require data from entire species' distributions to assess threat status.



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There are 28 Threatened or Near Threatened seabird species breeding at the PEIs that are Taxa of Conservation Concern. These include: (A) the Wandering Albatross (*Diomedea exulans*), Vulnerable; and (B) the Grey-headed Albatross (*Thalassarche chrysostoma*), Endangered.

Part Four

Priority Actions for South Africa's Biodiversity and Future NBAs

Parts 2 and 3 contain key messages and findings of the NBA 2018, including highlighting the benefits that biodiversity assets and ecological infrastructure provide for people, and reviewing the status of ecosystems and species in South Africa with the intention of synthesising the best available science to inform policy and action. Part 4 focuses on the implications of this for required action to manage and conserve biodiversity, including making links with the National Biodiversity Strategy and Action Plan (NBSAP), the National Biodiversity Framework (NBF), and spatial prioritisation tools such as biodiversity plans. This section concludes with knowledge gaps and priority research, monitoring and data management needs for strengthening future iterations of the NBA.

4.1 The NBSAP–NBF–NBA relationship informs priority actions

South Africa has a well-developed suite of policy and legislation for the management, conservation and sustainable use of biodiversity, including two overarching national tools: the NBSAP and the NBF. These documents, developed through thorough stakeholder consultation, set out South Africa's strategic objectives for managing and conserving biodiversity and are the primary reference points for related priority actions. The NBA both informs the development of the NBSAP and NBF, and supports their implementation. Together the NBSAP, NBF and NBA provide three key, inter-related anchors for the work of the biodiversity sector in South Africa.

An NBSAP is a requirement that all contracting parties to the CBD are obliged to fulfil. South Africa's first NBSAP was completed in 2005 and the second in 2015, in both cases drawing on the preceding NBA. The NBSAP 2015–2025 sets out an integrated and coherent national strategy for the conservation, management and sustainable use of the country's biodiversity to ensure equitable benefits to the people of the country. It outlines how South Africa will fulfil the objectives of the CBD and contribute to the global sustainable development agenda. It also provides a framework for the integration of biodiversity considerations into national development plans and a wide

range of other sectoral strategies, placing effective management and protection of biodiversity at the heart of the sustainable development agenda. The NBSAP identifies six strategic objectives, under each of which key outcomes, activities (designated as high, medium and low priority), and medium- to long-term targets are described in detail.

The NBF is developed as a requirement of the Biodiversity Act, and published by the Minister of Environment, Forestry and Fisheries, with the purpose of coordinating and aligning the efforts of the many organisations and individuals involved in conserving and managing South Africa's biodiversity in support of sustainable development. The first NBF was developed in 2008 and the second in 2017. The NBF is a short- to medium-term coordination tool that shows the alignment between the strategic objectives and outcomes identified in the NBSAP and other key national strategies, frameworks and systems that currently guide the work of the biodiversity sector, building on the consultative processes through which all of these other products were developed. This is complemented by an overview of national policy and legislation and international commitments relevant to the biodiversity sector, and a description of national level coordination mechanisms and communities of practice through which sector representatives can



South Africa's NBSAP 2015–2025 sets out an integrated national strategy for the conservation, management and sustainable use of the country's biodiversity.

coordinate their work and exchange information and experiences. The NBF also identifies a set of interventions or 'acceleration measures' that can unlock or fast-track implementation of the NBSAP, and indicates the relative roles of the many agencies involved in implementing these activities.⁸

The NBA relates to the NBSAP and NBF in two main ways: 1) the NBA informs the *development* of the NBSAP and NBF, by providing a strong scientific foundation on the pressures on biodiversity and how they are impacting on its status, and thus directing

⁸The background information in the above two paragraphs is directly from the NBSAP and NBF documents.

the key focus for society's interventions; 2) the NBA supports the *implementation* of the NBSAP and NBF, by providing science-based evidence that helps to ensure effective action in the right places. In brief, the NBA provides the science that informs the strategic objectives and priority actions of the NBSAP and NBF. Together, the NBSAP, NBF and NBA provide three key anchors for the work of the biodiversity sector (Figure 100).

The NBA directly supports the implementation of Strategic Objectives 1, 2 and 3 of the NBSAP and NBF and also has direct links with Strategic Objective 6, while most of the other objectives are also informed or supported by the NBA (Table 16). Strategic Objective 1 focuses on managing biodiversity assets, and includes outcomes related to expanding the protected area network and management of species of special concern. Strategic Objective 2 focuses on maintaining and restoring ecological infrastructure, including key ecological infrastructure features highlighted in the NBA. Strategic Objective 3 includes the science-based planning and decision making tools that the NBA is major contributor to, including maps of threatened ecosystems which are a key input into land-use planning and environmental authorisations. The NBA headline indicators of threat status and protection level are key indicators as to whether interventions are making progress towards achieving the outcomes for these strategic objectives. Several of the outcomes and activities in Strategic Objective 6 directly strengthen the NBA – in other words, if relevant foundational datasets are

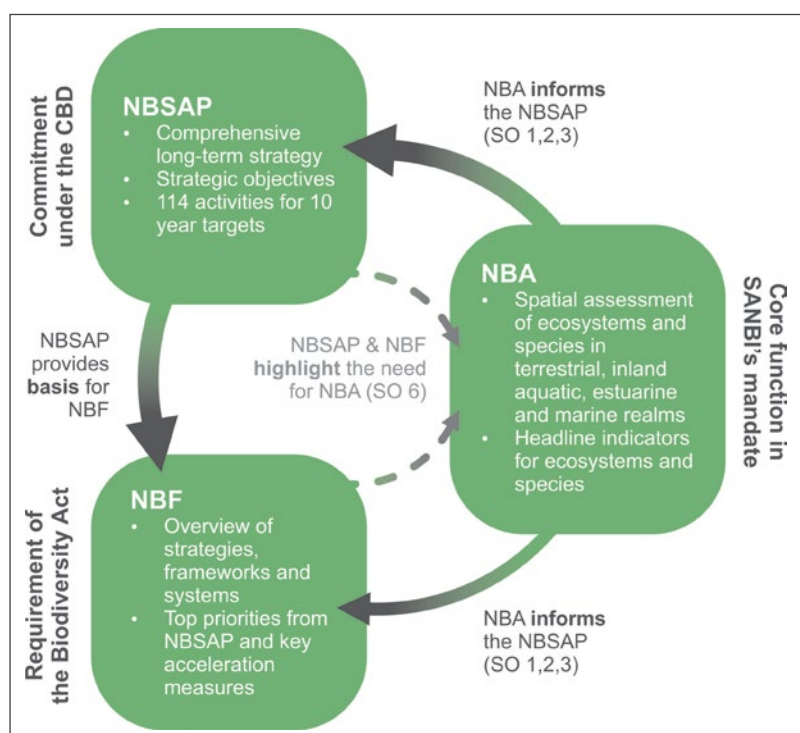


Figure 100. The NBSAP, NBF and NBA together provide key anchors for the work of the biodiversity sector. The NBA synthesises best available science to inform the development and implementation of the NBSAP and NBF. Strategic Objectives (SO).

Table 16. Strategic Objectives and Outcomes in the NBSAP and NBF. Most have direct or indirect links to the NBA

Strategic Objectives	Outcomes
1. Management of biodiversity assets and their contribution to the economy, rural development, job ceation and social wellbeing is enhanced	1.1 The network of protected areas and conservation areas includes a representative sample of ecosystems and species, and is coherent and effectively managed.
	1.2 Species of special concern are sustainably managed.
	1.3 The biodiversity economy is expanded, strengthened and transformed to be more inclusive of the rural poor.
	1.4 Biodiversity conservation supports the land reform agenda and socio-economic opportunities for communal landowners.
2. Investment in ecological infrastructure enhances resilience and ensures benefits to society	2.1 Restore, maintain and secure important ecological infrastructure in a way that contributes to rural development, long-term job creation and livelihoods.
	2.2 Ecosystem-based adaptation is shown to achieve multiple benefits in the context of sustainable development.
3. Biodiversity considerations are mainstreamed into policies, strategies and practices of a range of sectors	3.1 Effective science-based tools inform planning and decision making.
	3.2 Embed biodiversity considerations into national, provincial and municipal development-planning and monitoring.
	3.3 Strengthen and streamline development authorisations and decision making.
	3.4 Compliance with authorisations and permits is monitored and enforced.
	3.5 Appropriate allocation of resources in key sectors and spheres of government facilitates effective management of biodiversity, especially in biodiversity priority areas.
	3.6 Biodiversity considerations are integrated into the development and implementation of policy, legislative and other tools.
4. People are mobilised to adopt practices that sustain the long-term benefits of biodiversity	4.1. People's awareness of the value of biodiversity is enhanced through more effective coordination and messaging.
	4.2. People are mobilised to conserve and sustainably use biodiversity.
5. Conservation and management of biodiversity is improved through the development of an equitable and suitably skilled workforce	5.1 Macro-level conditions enabled for skills planning, development and evaluation of the sector as a whole.
	5.2 An improved skills development system incorporates the needs of the biodiversity sector.
	5.3 Partnerships are developed and institutions are capacitated to deliver on their mandates towards improved service delivery.
6. Effective knowledge foundations, including indigenous knowledge and citizen science, support the management, conservation and sustainable use of biodiversity	6.1 Relevant foundational data sets on species and ecosystems are in place and well-monitored and available to the public in a useful format.
	6.2 The status of species and ecosystems is regularly monitored and assessed and communicated.
	6.3 Geographic priority areas for the management, conservation and restoration of biodiversity assets and ecological infrastructure are identified based on best available science.
	6.4 Management-relevant and policy-relevant research and analysis is undertaken through collaboration between scientists and practitioners.
	6.5 Knowledge base is accessible and presented in a way that informs decision making.

continually being updated through research and monitoring programmes and such data are available, then the indicators in the NBA can be calculated more regularly and with a higher confidence of accuracy.

Because of the two-way relationship in which the NBF informs the development of the NBSAP and NBF, as well as supporting their implementation, there is no

perfect sequence for the production of these three key documents. In practice, the NBA, NBSAP and NBF have been produced in that order to date, with the exception of the current NBA which has been produced in parallel with the current NBF. The timing of the NBA 2018 means that it is particularly well placed to support the implementation of the NBSAP 2015–2025 and the NBF 2017–2022.

4.2 Spatial biodiversity priorities for managing and conserving biodiversity

South Africa's biodiversity is not evenly distributed across the country and when this is combined with limited resources for action, it means that it is essential to prioritise spatially. An important feature of South Africa's biodiversity-related action to the pressures on biodiversity has been spatial planning to identify priority areas in the landscape and seascape for intervention. This is particularly important for the implementation of Strategic Objectives 1 (Management of biodiversity assets), 2 (Investment in ecological infrastructure) and 3 (Biodiversity considerations are mainstreamed) of the NBSAP and NBF (Table 16), which otherwise run the risk of being spread too thin geographically to be effective. The production of many spatial planning tools at the national and sub-national level relies heavily on the spatial data layers and datasets that are compiled and collated for the NBA. Efforts to strengthen foundational data for the NBA thus also supports the development of high quality spatial biodiversity plans.

The NBA provides a first take on spatial priorities by highlighting the location of the most threatened ecosystems and species. However, it is not only threatened biodiversity that needs attention; often there are strategic gains to be made from focussing on areas that are still in good ecological condition and where there are relatively easy opportunities for protection or effective management.

Complementing the NBA, which provides a spatial assessment of biodiversity, South Africa has several established spatial *prioritisation* tools for informing the work of the biodiversity sector. Principle among these are provincial spatial biodiversity plans, which provide maps of Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs), and the National Protected Area Expansion Strategy (NPAES). Others include maps of Strategic Water Source Areas (SWSAs) and Freshwater Ecosystem Priority Areas (FEPAs). Together, these tools provide a comprehensive set of biodiversity priority areas that collectively meet biodiversity targets for ecosystems, species and ecological processes. Increasingly, critical ecological infrastructure assets are

also included in this set of biodiversity priority areas. Maps of biodiversity priority areas directly support the implementation of the NBSAP and NBF, especially Strategic Objectives 1, 2 and 3.

Maps of CBAs and ESAs, referred to as **CBA maps**, are produced by all provincial conservation authorities, marine planners and some metropolitan municipalities; based on the principles of systematic biodiversity planning (Figure 101). They are a form of strategic planning for the natural environment, identifying a set of geographic areas that provide a spatial plan for ecological sustainability at the landscape and seascape scale. Guidelines, published by SANBI, encourage consistency between the CBAs prepared by different agencies. Protected areas, CBAs and ESAs together form a network of natural and semi-natural areas that enable ecologically functional landscapes in the long term, designed to be spatially efficient and to avoid conflict with non-compatible land and ocean uses wherever possible. CBAs should be kept in a natural or near-natural state to support ecological sustainability of the landscape and seascape. ESAs do not need to be natural, but should be kept at least semi-natural so that they retain their ecological processes. These natural and semi-natural areas can co-exist in a matrix of multiple uses, including urban development, agriculture, fisheries, plantation forestry, mining and others. Land-based CBA maps have been produced for over a decade, while the first map of CBAs and ESAs for the coast and ocean has recently been completed (Figure 101).

CBA maps are the biodiversity sector's input into decisions on appropriate land and sea uses. There are two main ways that CBA maps should be used: to inform spatial planning that shows the desired future uses of the land or ocean (often in the form of Spatial Development Frameworks produced by municipalities); and in decision making in response to development applications (such as environmental authorisations). CBA maps are essential for the effective implementation of Strategic Objective 3 of the NBSAP and NBF. Additional tools such as DEFF's recently developed Land-Use Screening Tool, further enhance planning and decision making.

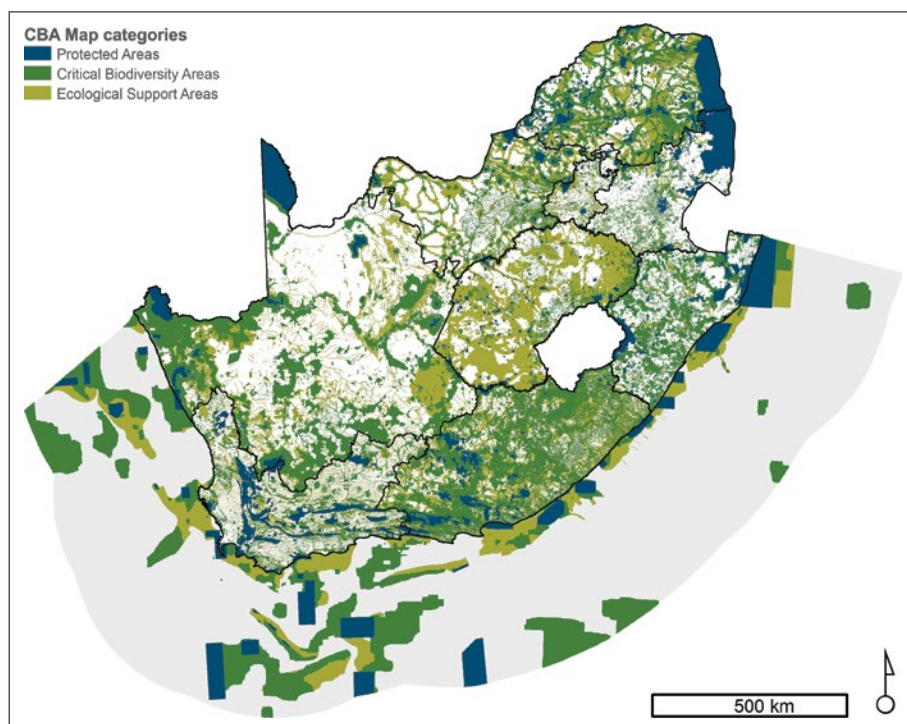
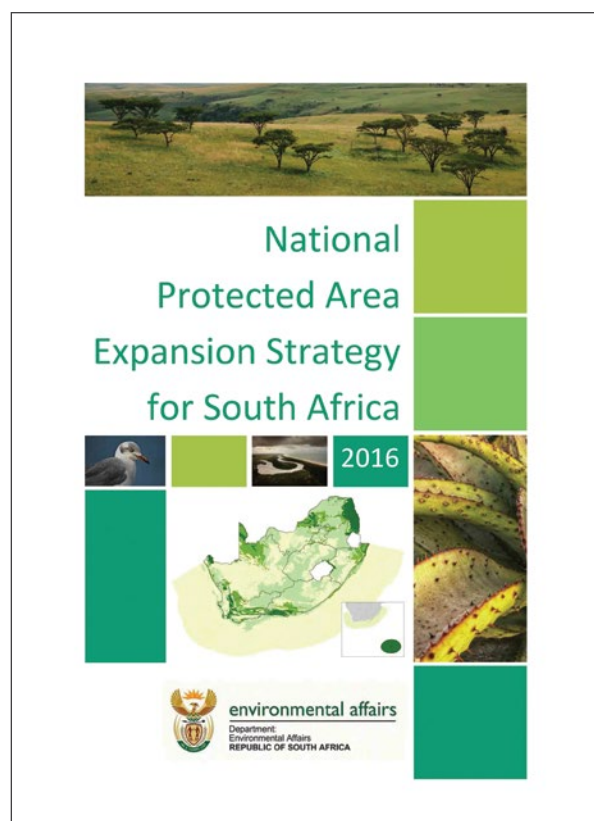


Figure 101. CBA Maps, prepared at provincial or metropolitan scale, now cover the whole of South Africa's landmass. A preliminary coastal and marine CBA Map (developed in early 2019) now complements the land-based CBA Maps. Together, these maps provide key inputs into strategic planning and decision making processes.

The **NPAES** identifies geographic priority areas for expansion of the protected area network, with a focus on under-protected ecosystems. It draws on provincial protected area expansion strategies and provides the primary reference point for consolidating existing protected area and establishing new ones, whether state-owned protected areas or contract protected areas through biodiversity stewardship programmes. The NPAES 2008 was highly effective in ensuring that protected area expansion in the decade that followed resulted in increased protection for previously under-protected ecosystem types, with particularly dramatic increases in the marine realm. The NPAES 2016 builds further on this and is essential for the effective implementation of Strategic Objective 1 of the NBSAP and NBF.

At least eight key institutions invested in the National Freshwater Ecosystems Priority Areas (NFEPAs) project, which in 2011 produced the first national map of **FEPAs** in South Africa. Several priority areas for rivers and inland wetlands, as well as important fish areas (formerly termed fish sanctuaries) were identified during the project, and incorporated into provincial biodiversity plans and used in Environmental Impact Assessments, as well as informing water resource planning and water authorisations. The project further stimulated an interdepartmental Wetland Policy that is currently being drafted by national Departments of Water and Sanitation, and Environment, Forestry and Fisheries. The lack of sufficient representation of inland wetlands in the datasets has stimulated several research and modelling projects across universities, conservation

agencies and private companies, to develop automated means of predicting the extent and ecological condition of inland wetlands.



The National Protected Area Expansion Strategy identifies priority areas for expansion of the protected area network, with a focus on under-protected ecosystem types.

Protected area expansion through biodiversity stewardship: the establishment of protected areas is a key intervention to pressures on biodiversity. The protected area estate for mainland South Africa increased by 11% between 2010 and 2018. While some state purchases and transfers were involved, biodiversity stewardship programmes underpinned the majority of this expansion by establishing protected areas through contractual agreements between conservation agencies and private or communal landowners. This socially and economically effective mechanism has become firmly embedded in South Africa's various conservation agencies as the preferred approach to expansion of the protected areas estate.

Expansion of MPA network stimulated by the Operation Phakisa initiative: exceptional progress has been made, with 20 new MPAs approved for declaration in 2018. This major event is the culmination of many years of collaborative cross-sectoral work

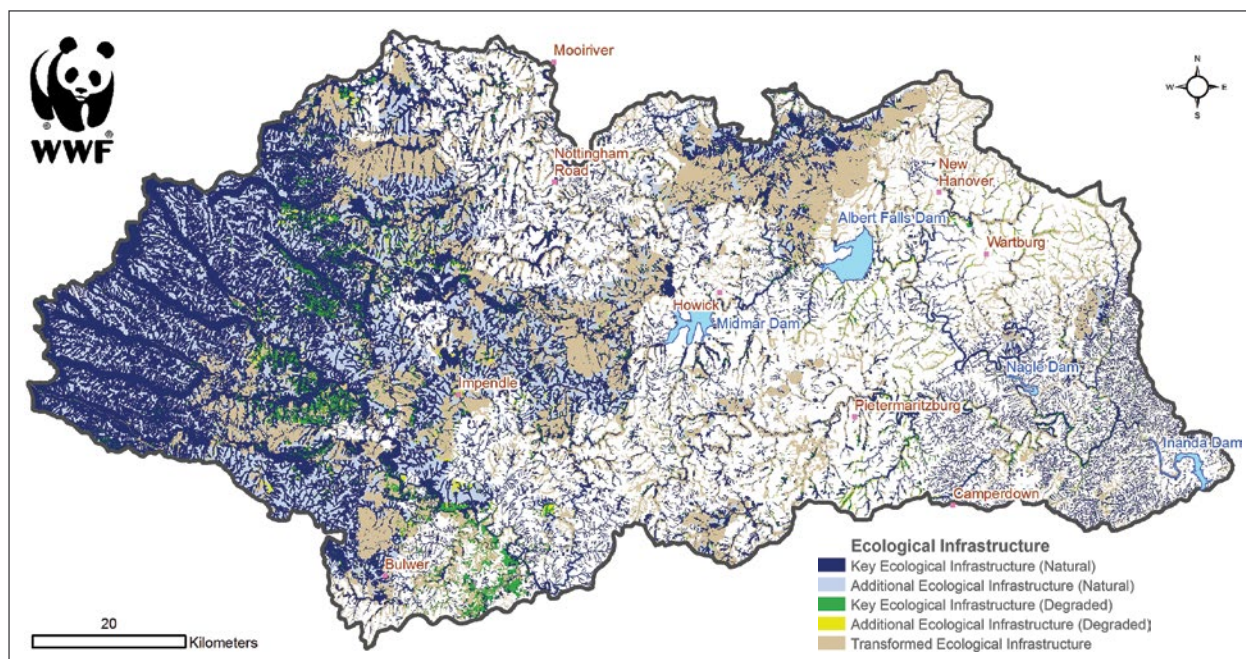
The NBA paves the way for improved planning

The development of spatial planning tools described above relies heavily on many of the spatial data layers and datasets that are compiled and collated for the

NBA. Efforts to strengthen foundational data for the NBA thus also support the development of high quality spatial biodiversity plans at the national and sub-national level.

NBA 2018 provide a basis for improved planning in the following ways:

- The new and improved maps of ecosystem type, condition and threat status, and new data on threatened species, allow for the update of provincial biodiversity plans, marine spatial plans and any bioregional plans that are based on them.
- The careful integration of the maps of ecosystem types, particularly along the coast, pave the way for cross-realm / land-sea planning, including coastal and marine CBA maps that can feed into Marine Spatial Planning.
- The new river and inland wetland ecosystem data (maps, condition and threat status) together with new data on fish provide a strong basis for the update of NFEPA, though the findings of the NBA also highlight the need for greater confidence in inland wetland maps if the update of NFEPA is to be maximally useful.
- The new marine ecosystem map and assessment results for the PEIs provides a scientific basis to: (i) improve the spatial management of the Patagonian Toothfish fishery to improve the status of



The mapping of ecological infrastructure is complex and requires fine-scale GIS work of crucial features in the landscape. This was trialled in 2013 for the greater uMngeni catchment, through a project funded by WWF-South Africa. The prospects of doing this on a national scale have been enhanced by the high resolution mapping of the coast for NBA 2018.

threatened ecosystem types; and (ii) to improve the protected area network to advance more marine ecosystem types to the Well Protected category. The new indicator of species protection level provides a powerful new input into provincial protected area expansion strategies that would also benefit from the improved species and ecosystem data in general.

- The prospects of mapping and assessing the status of ecological infrastructure at a national scale are

enhanced by new and integrated ecosystem data in the NBA 2018. The high resolution mapping of the coast in particular, with its high concentration of ecological infrastructure assets, is a significant advance in this regard.

- The indicators used in the NBA are maturing to a point where they could be used to test the impact of spatial biodiversity plans on the ground, and investigate whether they moderate or at least influence risks to species and ecosystems.

4.3 Additional priority actions for managing and conserving biodiversity

The NBSAP and NBF highlight a wide range of interventions that are priorities for managing and conserving biodiversity. These are confirmed and reinforced by the findings of the NBA 2018. The key priorities for improving the effectiveness of interventions emerging from this NBA include the need to improve compliance with existing laws, strengthen cross-sectoral planning, strengthen adaptive management, improve implementation of conservation projects, and build and maintain capacity.

The NBA 2018 technical reports for each realm explain some of these interventions in more detail and articulate additional priority actions resulting from the NBA 2018 findings. There are, however, several general priority actions that support the successful implementation of many of these interventions, and ultimately affect South Africa's ability to meet the NBSAP and NBF goals. These general priorities can be clustered into the following themes:

- Strengthening compliance and enforcement.
- Strengthening cross-sectoral and cross-realm planning.
- Strengthening evaluation for adaptive management.
- Conservation project implementation.
- Maintaining and further strengthening capacity.

Enforcing the law can be extremely challenging. Very few resources are available for regular patrols. Here are some of the tools and instruments used to check compliance for abalone and lobster harvesting that the CapeNature marine patrol boat will have on board.
© CapeNature.



4.3.1 Strengthening compliance and enforcement

The NBF recognises that South Africa has good policy and legislation for biodiversity conservation, but acknowledges that there are implementation challenges. In some cases there is limited technical capacity to utilise existing policy tools, in others there is limited capacity to enforce legislation or regulations. The NBF highlights the need to monitor and enforce the



The Eastern Cape Department of Economic Development, Environmental Affairs and Tourism undertakes helicopter surveys to check for illegal land clearing of Albany Thicket vegetation near Alexandria. © DEDEAT.

conditions contained in environmental authorisations and permits, including through strengthening environmental regulatory and compliance frameworks and implementing the National Compliance and Enforcement Strategy for the Environmental Management Inspectorate, which was developed by the Department of Environmental Affairs (DEA) in 2014.

Examples of compliance and enforcement challenges listed in the NBA technical reports include:

- Limited capacity for evaluating EIAs, implementing environmental authorisations, and monitoring compliance with the conditions of environmental authorisations (Records of Decision).
- Limited capacity and budget in departments to monitor compliance with and enforce relevant environmental laws (e.g. laws prohibiting poaching and the clearing of indigenous vegetation, as well as those governing fishing quotas, the protection of threatened ecosystems, water quality and water abstraction).

4.3.2 Strengthening cross-sectoral and cross-realm planning

South Africa has a well-articulated system of spatial planning governed by the Spatial Planning and Land Use Management Act (Act 16 of 2013) (SPLUMA), which operates across different spatial scales and

includes a National Spatial Development Framework, Provincial Spatial Development Frameworks and municipal SDFs. SDFs provide a tool for integrating and reconciling spatial priorities of different sectors, especially in relation to land-use. Catchment management strategies required in terms of the National Water Act (Act 36 of 1998) play a similar role in relation to integrated management of water resources between multiple stakeholders, although they are as yet less developed in practice. In the marine realm, the Marine Spatial Planning Bill (2017) lays the basis for integrated spatial planning between sectors in the marine realm. Spatial biodiversity plans, for example in the form of CBA maps and maps of FEPAs, provide the biodiversity sector's input into these multi-sector, multi-stakeholder planning processes.

Notwithstanding these existing systems and planning processes, there are some clear priorities that emerge from the NBA 2018, in which planning across realms and between sectors could be strengthened, including:

- Improved **strategic resource allocation plans for freshwater**, as well as improved catchment and aquifer management plans are essential. These cross-realm efforts will ensure equitable usage of water by various sectors, as well as ensure that the ecological requirements are met for all realms. Water saving mechanisms will need to become an integral part of every citizen's behaviour and in water resource management.
- **Cross-realm planning for rehabilitation and restoration efforts**, particularly in pressure hotspots where critical degradation thresholds have not yet been crossed, is essential. Focussing efforts

Cross-sectoral planning and cooperative governance are always complex, and ensuring that that cooperation then leads to successful implementation and worthy outcomes is challenging. Nevertheless, there are many successes in South Africa from which lessons can be learnt. © SANBI





© Nancy Job



© Mike Powell

Rehabilitating and restoring biodiversity can be very complicated and labour intensive. Here a Working for Wetlands team installs erosion-prevention measures in the Pietersielieskloof wetland (A); and thicket restoration is taking place through manual planting near Somerset East (B). Regularly monitoring rehabilitation efforts for effectiveness allows lessons to be learnt for further restoration initiatives.

on improving ecological condition in these areas are more likely to succeed and improve ecosystem function, thus securing benefits to local communities and society more widely.

- **Long-term planning for economically important species** will need to ensure equitable access and benefit sharing, and sustainable ecological offtake limits. A coordinated campaign to eradicate poaching across realms should be explored.
- **Long-term, cross-sectoral planning for climate change resilience** will need to be improved, including for vulnerable human communities and specific species and ecosystem types.
- **Marine Protected Areas zonation needs to be improved** to reduce pressure on key marine ecosystems and species. For example, within the PEI MPA coordinated efforts within DEFF (between environmental officials and fisheries officials) are needed to reduce fisheries impacts on Endangered and under-protected ecosystem types.

In addition, cross-realm **learning networks on spatial biodiversity planning** (and the concept of CBAs and ESAs) will be useful as such planning expands and matures in estuarine and marine environments – as there are likely to be clear lessons to be shared from the terrestrial realm about mainstreaming and implementation of spatial biodiversity plans in cross-sectoral planning processes.

4.3.3 Strengthening evaluation for adaptive management

Interventions that are implemented to manage and conserve biodiversity are often not monitored, which makes adaptive management of the activities near impossible. Given the numerous interventions in place and the complexities of implementation, gauging success, failure or impact of any particular intervention requires a broad evaluation protocol. The protocol should contain a suite of indicators that measure the effectiveness of the interventions against biodiversity objectives like species and ecosystem conservation, as well as socio-economic objectives like improving human wellbeing and cost efficiencies. Strengthening capacity for adaptive management needs to be addressed to make progress in this arena. Box 13 provides an example: evaluating interventions for biological invasions. The following evaluation platforms are a high priority:

- An examination of the effectiveness of CBAs and ESAs in terms of preventing biodiversity loss in the terrestrial and inland aquatic realms is urgently needed. Expanding on the rate of habitat loss, indicators to track whether rates of loss for threatened ecosystem types in CBAs have been better than rates of loss outside CBAs will be useful.

- Indicators to measure restoration effectiveness are required to allow for refinement of methods – some efforts are already underway regarding monitoring rehabilitation of rivers and inland wetlands.
- Improvement of evaluation of protected area effectiveness for mitigating against threats to species and ecosystem types. Information from the protection level indicator for species in the NBA 2018 could be used to enhance existing measures of effectiveness. The protection level representation indicator for ecosystems should be complemented by an indicator of protected area effectiveness for each ecosystem type in future, which will require multi-stakeholder collaboration for data gathering and expert opinion.
- Evaluation of initiatives that make use of nature to help people adapt to climate change, for example: ecosystem-based adaptation, ecosystem-based disaster risk reduction.
- Evaluation of effectiveness of interventions to help species, ecosystems and protected areas to adapt to climate change.

4.3.4 Conservation project implementation

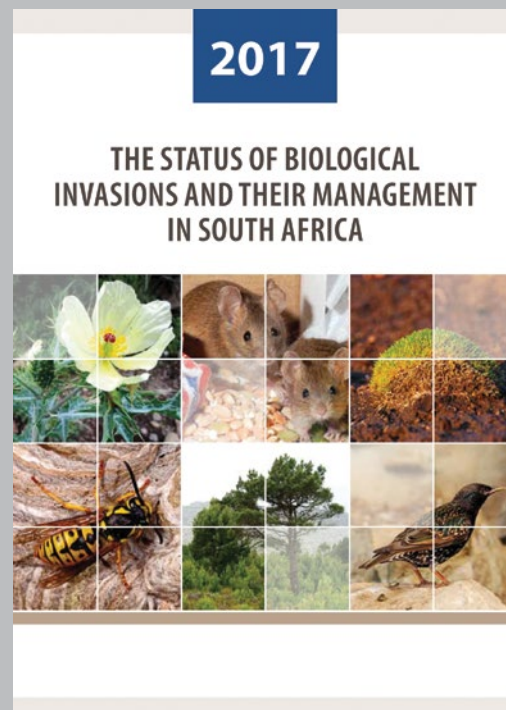
Effective planning is crucial to improved biodiversity management but conservation outcomes are often limited by implementation challenges, which are often project specific. Nevertheless, several project-level priorities were identified in the NBA 2018. These include restoration projects, protected areas expansion initiatives and efforts to eradicate alien species.

Wetland, dunes, beaches and estuaries are critical ecological infrastructure where restoration projects can deliver additional benefits. Successful implementation of biodiversity stewardship programmes can improve protection levels of ecosystems and species in a cost effective way. Eradication of alien species, such as predatory fish in rivers and mice on Marion Island, will improve the status of these ecosystems.

Even where cooperative governance is advancing plans, it is the implementation of cross-sectoral plans

Box 13. Evaluating interventions on biological invasions

The recent report *The status of biological invasions and their management in South Africa in 2017* is one of the first examples of the development of indicators to evaluate the effectiveness of interventions to a national problem. The report is structured around four aspects: pathways of introduction and dispersal; the number, distribution and impact of individual species; species richness and abundance of alien species in defined areas, and their impacts on those areas; and the effectiveness of interventions, i.e. have South African regulations and control efforts been effective in reducing the problem? A total of 21 indicators were developed to assess the status of these aspects, and four high-level indicators (one for each aspect) were developed for use in the national suite of environmental indicators on which the Department of Environment, Forestry and Fisheries reports on a regular basis. For the effectiveness of control measures, nine indicators were studied: i) quality of the regulatory framework; ii) money spent; iii) planning coverage; iv) pathways treated; v) effectiveness of pathway treatments; vi) species treated; vii) effectiveness of species treatments; viii) areas treated; and ix) effectiveness of area treatments. Full details of the results of the evaluation can be found in Chapter 6: The Effectiveness of Control Measures.



Box 14. Potential indicators to evaluate the capacity to undertake priority actions

Indicators to evaluate capacity:

- Number of people with relevant qualifications in national and provincial conservation authorities to address the conservation mandate.
- Geographic spread of science capacity across the country, as well as the spread across organisations.
- Scarce skills for the biodiversity sector and human capacity development initiatives for those scarce skills – e.g. are higher education institutions equipping graduates with the skills needed in the sector?
- Number of jobs at various levels of experience that are filled versus those vacant.
- Taxonomists per number of species (there is a skew in taxonomic focus, with more taxonomists working on the <4 000 vertebrate species than on the >65 000 invertebrate species; and terrestrial taxonomy capacity dwarfing capacity available for freshwater, estuarine and marine species).
- The budgets and staff available for crucial long-term monitoring at specific sites – e.g. water quality, harvested and traded species, introduction pathways of invasive species, etc.
- The budgets and staff available to coordinate species and ecosystem mapping, assessment and monitoring, including the ability to coordinate citizen science projects to feed into these assessments.
- Distribution of biodiversity financing across organisations.
- Total expenditure on protected areas.
- Budgets ring-fenced for resource management or regulatory functions at the provincial level.

that is the greatest challenge. Improving project financing and management are key elements in implementation success.

4.3.5 Maintaining and further strengthening capacity

A common theme across the NBA 2018 is that of human capacity. Building a capable state is an issue also highlighted in NBSAP and NBF, with Strategic Objective 5 dedicated to the issue of an equitable and suitably skilled workforce to improve the management

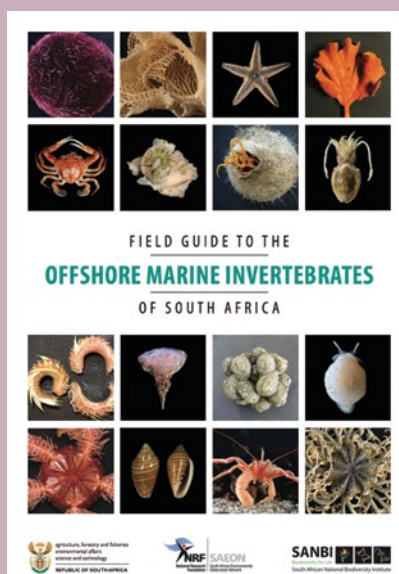
and conservation of biodiversity. The enhancement of interventions for the better management and conservation of biodiversity cannot take place without the appropriate human and financial capacity. However, evidence in the inland aquatic realm (the only realm with any detailed study on capacity to date) shows a decline in skilled personnel at national and provincial authorities. One example of the impact of this is the deterioration in the ability to maintain and update the long-term monitoring datasets of water quality and ecological condition for rivers and inland wetlands.

Several indicators should be monitored on a regular basis to inform the human capital development strategy and financial resource allocations for the environmental sector (Box 14).

4.4 Knowledge gaps and research priorities for strengthening the NBA

In this section we focus on knowledge gaps that have been encountered through the process of developing the NBA 2018. Although the NBA and the data sources available to it have evolved and grown substantially since its first iteration in 2004, a number of avenues for improvement remain. This section looks back on the research priorities identified in the previous NBA (2011), describes the main limitations of the NBA 2018 and outlines potential solutions. This is followed by a summary of priority research, monitoring and data management needs to improve future NBAs.

While taxonomic capacity is lacking for all groups, the situation is particularly dire for invertebrates. However, recent progress has been made for marine invertebrates found in offshore ecosystems. A large, collaborative team compiled information from 409 offshore invertebrate species to produce the first *Field guide to offshore marine invertebrates of South Africa*. As more data on these invertebrate species can now be gathered through research trawl sampling, this will enhance the description, mapping, assessment and management of offshore marine ecosystems in South Africa.



4.4.1 Progress since 2011

The NBA 2011 identified five main knowledge gaps and research priority areas that would strengthen future NBAs: improving taxonomy capacity for species, developing a National Ecosystem Classification System, measuring and mapping ecological condition, further researching the links between biodiversity and human wellbeing, and improving biodiversity-related monitoring work. A short analysis of the progress to date for these NBA 2011 priorities follows:

Taxonomy and the uneven distribution of taxonomists across the different groups of organisms.

Taxonomy in South Africa has received a boost in recent years with the establishment of the Foundational Biodiversity Information Programme and National Scientific Collections Facility. These provide various types of support for students and researchers in the field of taxonomy. However, most of this has gone into collection management, data digitisation and targeted field surveys. Many challenges remain as the number and the level of taxonomic posts has generally decreased over the same time period.

Need to develop an integrated National Ecosystem Classification System.

The NBA 2011 made a strong case for the importance of detailed maps of ecosystem types, and the intervening years have seen huge progress in this regard. A great deal of progress has been made technically and a seamless map of ecosystem types has been produced. Both the NBA 2004 and NBA 2011 recommended inclusion of the PEI ecosystems and this marine and terrestrial sub-Antarctic territory was included for the first time in 2018. A series of realm-specific ecosystem classification committees now operate under the National Ecosystem Classification System, convened by SANBI, ensuring progress continues in this regard.

Measuring and mapping ecological condition is crucial to ecosystem assessment.

Good progress has been made in updating and improving estimates of ecological condition across all realms, though substantial efforts are still required to ensure that the ecological condition is monitored on a regular basis. Ecological condition for rivers in particular needs regular and comprehensive updates.

Further research on the links between biodiversity and human wellbeing. Important steps taken on this issue include the DEA-SANBI project ‘Making the Case for Biodiversity’ that ran from 2010 to 2015 and helped the biodiversity sector with articulating the benefits of biodiversity, including through powerful case studies. ‘A Compendium of Benefits of Biodiversity’ was compiled for the NBA 2018, bringing together disparate areas of work on the benefits of biodiversity to demonstrate the substantial work ongoing both in South Africa and internationally in this arena.

Biodiversity-related monitoring is essential. This point remains a major priority going forward, as long-term monitoring of biodiversity remains a challenge. Emerging for the NBA 2018 are specific monitoring needs, discussed below, that focus on biological invasions, climate change, and ecological condition of rivers and wetlands.

4.4.2 Research, monitoring and data management priorities emerging from NBA 2018

Research, monitoring and data management priorities highlighted in the various technical reports of the NBA 2018 have been summarised below. Priorities have been clustered into **research needs**, **monitoring needs** and **data management needs** (with the understanding that human capacity and funding

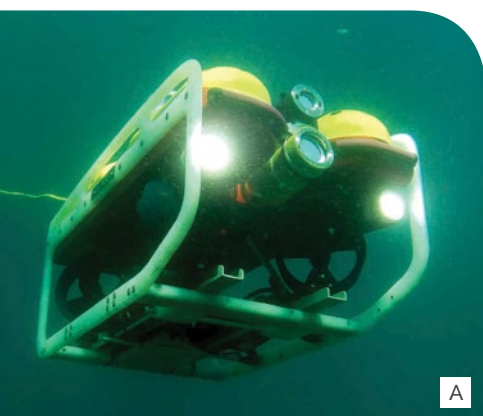
allocations play a role in each of these, see section 4.3.3). Fulfilling these needs clearly supports many other processes that require similar knowledge foundations for managing and conserving biodiversity, spatial planning or reporting. The needs are summarised below and a full description of each knowledge gap and its potential solutions or avenues for improvement are included in Table 17.

Research priorities identified from the NBA 2018

Research priorities highlighted in the various technical reports of the NBA 2018 have been collated below. It is hoped that these will inform formal research strategies such as the National Biodiversity Research & Evidence Strategy (2015–2025); the SANBI Research and Development Strategy 2019–2030; and research strategies of institutions with links to the biodiversity sector. Beyond informing these formal strategies, the information in this section can help to guide research and monitoring project development by providing clear needs linked to national level assessments and planning.

Research priorities for foundational biodiversity information:

- **Foundational ecosystem information for improved classification of ecosystem types:** The ground-truthing of ecosystem types remains crucial for the ongoing improvement of their descriptions and delineations. For example, the marine realm uses techniques such as remote operated vehicle surveys and seabed sampling (e.g. by grab samples and sleds) to collect information on biotic components



A



B



C

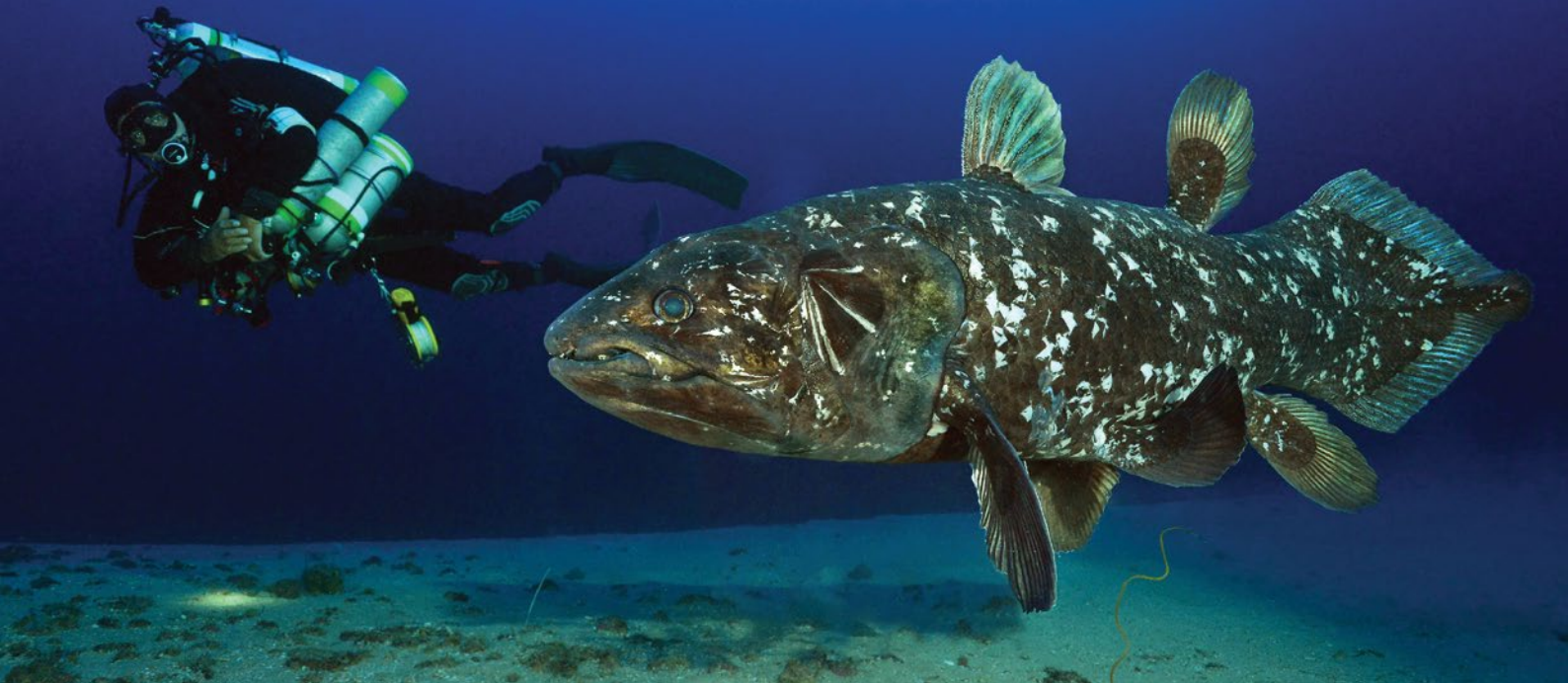
Foundational data can be hard to collect, especially if you cannot actually visit the ecosystem. This Remotely Operated Vehicle (A) is what helps marine researchers study deep water ecosystem types where diving is not possible. It surveyed several of the new offshore Marine Protected Areas, and took wonderful underwater photographs like this forest of black corals and sea fans (B), and this scorpion fish on the outer shelf of the new uThukela Banks MPA (C). These photographs provide crucial information about the ecosystems and species found in certain places, and help to map the marine ecosystem types of South Africa. © African Coelacanth Ecosystem Programme.

of ecosystem types; while abiotic data like water turbidity, bathymetry and sediments also contribute to ecosystem classification. Each realm has equivalent abiotic and biotic research priorities for strengthening the classification and delineation of ecosystem types, which all require field studies. This includes the terrestrial and marine ecosystems in our sub-Antarctic territory.

- **Foundational species information for priority taxonomic groups:** Most vertebrate and plant groups have fairly well established research priorities in South Africa, with ongoing work on mapping and modelling species distributions and active taxonomic research. However, the high levels of Data Deficient taxa for some taxonomic groups illustrate the need for improved data. Life history, population distribution data, and population trend data are required for estuarine and marine taxa, and also for highly utilised species (e.g. medicinal plants, linefish, etc.). Foundational data for invertebrates are urgently needed, specifically those with high levels of endemism in South Africa. Initial priorities include work on important terrestrial invertebrate pollinators, freshwater invertebrates that are sensitive to water quality changes, endemic estuarine invertebrates, and endemic marine invertebrates.
- **Taxonomic treatment of poorly known groups:** Most invertebrate groups are relatively poorly known, requiring taxonomic work. To fill the important gaps in our taxonomic knowledge we will need to be strategic about which taxon groups to focus on. Key priorities include nematodes, mites, beetles, flies, true bugs, small freshwater crustaceans and marine taxa. Modern technologies and approaches such as DNA barcoding and metabarcoding need to be more widely utilised.
- **Mapping and assessment of ecological infrastructure:** Ecological infrastructure refers to naturally functioning ecosystems that generate or deliver valuable services to people. The mapping of critical ecological infrastructure and the assessment of its status is an important research priority going forward, as it is essential to have a clear understanding of which features of the landscape and seascape are crucial for delivering services to people, as well as the ecological condition required for them to fulfil this role. Mapping of selected ecological infrastructure features has taken place in some parts of the country, but efforts to date have been piecemeal and methods and approaches remain experimental. Systematic mapping of critical ecological infrastructure could be integrated into or complement CBA maps to add value to spatial planning and prioritisation exercises.

Research priorities relating to pressures on biodiversity and ecological condition

- **Improving ecological condition assessments:** Improved ecological condition assessments in all realms are essential and can be achieved through better mapping of pressures and various forms of ecosystem degradation. For example, research focussed on collecting data on the distribution and abundance of invasive alien species will enhance ecological condition data in all realms. Collecting this type of ecological condition data regularly is also a crucial aspect of national monitoring.
- **Climate change impacts on biodiversity, including through interaction with other pressures:** South Africa needs a deliberate, coherent strategy for detecting and tracking climate change impacts on biodiversity. Lack of sufficient data on biological responses to climate change and interacting pressures reduces the potential to test modelled projections, and thus determine key thresholds with confidence. Furthermore, the coarse resolution of climate projections makes them biologically less meaningful; understanding how these relate to microclimatic niches and interact with different soils and specific non-climate global change drivers will improve projections of biodiversity impacts. Existing datasets (e.g. historic and long-term record sets) could be used to establish baselines and track change to date, as well as identify and prioritise gaps for additional data collection. A coordinated monitoring project is needed to track climate change impacts on South Africa's coral communities in both shallow and deep water.
- **Ecological water requirement studies for rivers, inland wetlands, estuarine and marine systems:** Hydrological regime change is a major pressure on biodiversity in the inland aquatic, estuarine and marine realms. For example, studies are needed on the freshwater flow requirements of the fluvially dependant coastal ecosystems of the major river systems (e.g. Orange, uThukela, Mzimvubu and Breede), and particularly regarding minimum flows during drought periods. Such research is needed to inform management actions, for example, the objectives of some MPAs can only be achieved when sufficient freshwater flow can be allocated based on scientific recommendations.
- **Impacts of emerging pressures on biodiversity:** Studies on the impacts of micro-plastics, herbicides, pesticides, pharmaceuticals, noise and light on biodiversity are required, as these pressures are poorly understood and have not been incorporated



Citizen scientists can help gather data on indigenous and invasive species, water quality, and the impacts of various pressures at particular sites. They also discover new species, new species records or species that were thought to be extinct – such as deep diver, Peter Timm, who discovered a living population of West Indian Ocean Coelacanth (*Latimeria chalumnae*) at Sodwana Bay. © Laurent Ballesta.

into ecological condition assessments or ecosystem threat status assessments. Where drivers and their impacts on biodiversity are poorly understood, a precautionary approach is recommended.

Research priorities for improving and growing the suite of indicators for the NBAs

- **Effectiveness of intervention measures:** Interventions are often implemented, but are often not studied objectively in terms of their effectiveness. For example, studying municipal compliance to waste water discharge permits and the effect on the environment; tracking whether the delineation of CBAs and ESAs in spatial biodiversity plans has assisted in reducing developments in these areas.
- **Incorporation of landscape and seascape level genetic diversity measures into biodiversity assessments:** Most current genetic studies are single point estimates that can be useful baselines measures for long-term studies that track genetic diversity over time. The indicators proposed in the NBA 2018 need to be applied to other taxonomic groups and additional metrics need to be tested to further explore the best possible indicators for measuring national-level genetic diversity. A national genetic monitoring framework is required to provide guidance to researchers.

Monitoring needs identified from the NBA 2018

The following should be incorporated into the five-year action plan for the National Biodiversity Monitoring Framework, and the annual plans of research and monitoring institutions:

- Long-term, focussed monitoring of biodiversity at specific sites – including long-term ecological research and observation stations – is required to enable researchers to tease apart the effects of the threats climate change and biological invasions have on specific species populations, and to track these over time to monitor ecosystem functioning.
- Regular monitoring for specific species not only provides information about species distribution and abundance patterns crucial for use in species Red List assessments, but it also gives important feedback to researchers on where to expand searches for species that are only known from a few previous records and may also reveal completely new species discoveries.
- There are several other monitoring needs mentioned in *The status of biological invasions and their management in South Africa*; including monitoring rates of alien species introductions and sites of high rates of introductions (e.g. aquaculture, ports and harbours).



Cell phone apps and web-based tools such as iNaturalist are proving valuable, as biodiversity scientists use the data provided by the citizen scientists on these platforms to update information on species distribution and abundance patterns used in Red List assessments. © Delia Oosthuizen.

- Site-based monitoring of the impacts of various pressures on biodiversity (e.g. mining, residential and commercial development, transport corridors, intensive agriculture) is needed to inform better understanding of these pressures on ecological condition and species populations.
- Detailed monitoring of harvested species (e.g. marine fish and medicinally used species) is required to support sustainable management of these crucial resources. Structured and resourced national monitoring programmes (including citizen scientists) are required. In some cases this could be an opportunity for indigenous knowledge systems to be consulted as part of an inclusive monitoring approach.
- Continued and improved monitoring of water quality and pollution sources in rivers, inland wetlands, estuaries and the inshore marine environment is crucial to gain a better understanding of these pressures on biodiversity in these sensitive systems.

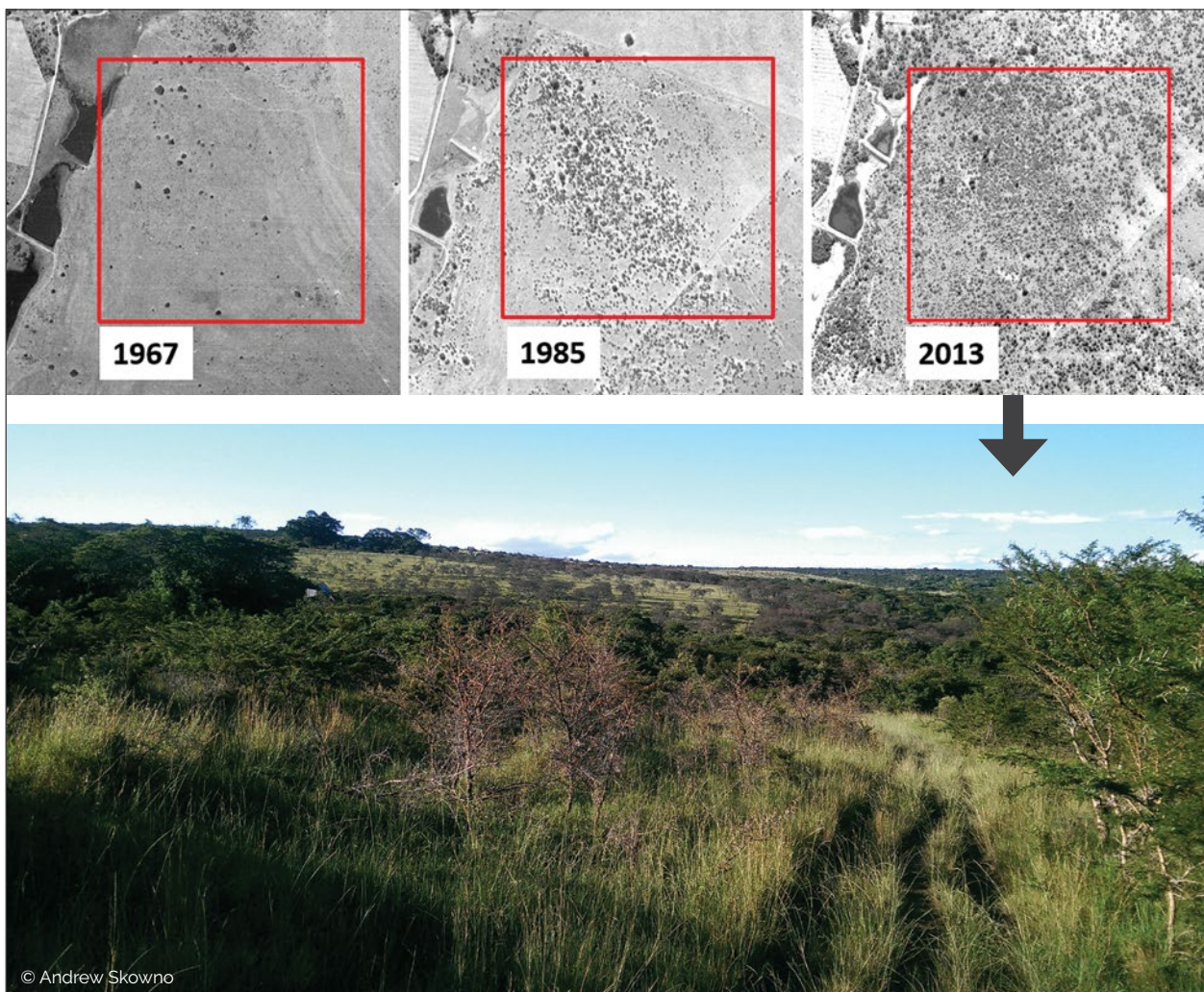


Figure 102. Aerial photographs can be used as monitoring tools to study land cover changes such as bush encroachment. The shift from open grassland to dense bush can clearly be seen from this set of images taken over nearly 50 years near Kei Road in the Eastern Cape.

- The monitoring of impacts of abstraction and recharge of groundwater on ecosystems and species is urgently required. Groundwater is the main or only source of water for numerous towns or settlements across the country, so protecting the capture zone, specifically for municipal supply well-fields, the recharge area, and the integrity of the aquifers are important.
- Monitoring of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) exports, uptake of export quotas, and implementation of non-detriment findings is required, as is the monitoring of conservation status and utilisation of species listed under the threatened or protected species (TOPS) regulations to determine if the regulations are effective.

It is vital that existing, established and useful monitoring programmes (such as the ecological condition monitoring of rivers) receive the support and funding to continue. Establishing new monitoring programmes is far more difficult than sustaining existing programmes.

Data management and sharing imperatives identified from the NBA 2018

Effective management of national biodiversity data facilitates data sharing across user groups and sectors. The principle of open access (i.e. biodiversity data being freely available) and close collaboration between South Africa's various biodiversity-related data facilities supports research and monitoring, and ultimately improves the quality and accuracy of biodiversity assessments, biodiversity planning, and underpins transparent science-based policy advice and decision making.

South Africa has subscribed to open access to biodiversity data for over a decade. The National

Biodiversity Information System, currently under development at SANBI, aims to provide users with a significantly enhanced ability to search for relevant and linked information, seamlessly across institutions (e.g. museums, conservation agencies, citizen science projects) as well as across data types (occurrence records, related ecosystems, publications, images, etc.). To do this, SANBI is investing in replicated versions of the data stores of its partners, which are then conditioned and harmonised into a single national instance for each data type, that is fully indexed and search-engine optimised. In addition, new visualisation interfaces and an updated website will provide a superior user experience, making data queries as powerful and easy as possible.

The following goals for improved data management and sharing emerged from the NBA 2018:

- A mechanism is needed to feed information from site-based assessments (such as EIAs) back into national datasets to add to foundational biodiversity information.
- It is important that biodiversity indicators are prepared and released on a more regular basis than the current NBA intervals (5–7 years). Indicator dashboards are being developed to provide users with up-to-date information for improved reporting (e.g. SDGs) and streamlined management and planning.
- Several new indicators are emerging internationally, and will need to be incorporated into NBA data management and sharing processes going forward (e.g. indicators that track the condition of ecosystems, indicators on Key Biodiversity Areas, indicators linked to the status of ecological infrastructure, indicators on genetic diversity, indicators on effectiveness of interventions).

Table 17. Summary analysis of knowledge gaps causing limitations to the NBA and priority actions for solutions

Knowledge gap causing limitation to the NBA	Priority actions for solutions
<p>Overall</p> <p>Since anthropogenic climate change is escalating at unprecedented speed, understanding, predicting and minimising its impacts in South Africa are major knowledge gaps. The reliability of models for predicting climate change impacts is improving, but these rely on input data of a high quality and confidence (e.g. species spatial and temporal distribution and weather records). Poor data quality and data gaps lead to low confidence of predictive models, with resulting challenges for decision making.</p>	<p>A cohesive framework and indicators to track biodiversity and ecosystem service impacts as a result of climate change, identify critical thresholds or points of non-return and assess the effectiveness of interventions to minimise these impacts, is essential. Ecosystem change data and dedicated species population monitoring over long timeframes are needed to detect change and inform predictive models. Ensuring that reliable weather station data are available from across South Africa also remains a priority.</p>

Table 17. Summary analysis of knowledge gaps causing limitations to the NBA and priority actions for solutions (continued)

Knowledge gap causing limitation to the NBA	Priority actions for solutions
Overall (continued)	
There are major gaps in data required to properly measure the indicators developed for the national status report on biological invasions (see chapter 8 of report). The NBA's terrestrial ecological condition indicators do not yet incorporate biological invasions data.	Spatial data on the abundance and distribution of invasive alien species should be included in ecological condition assessments. More data on the impacts of biological invasions on biodiversity, and the value of management efforts for conservation goals, is needed.
Spatial data on the benefits of biodiversity to people is currently very limited, and there is limited data available on the economic value of biodiversity's benefits to people.	More quantitative and updated data on the benefits of biodiversity will be very valuable for prioritisation and decision making processes beyond the NBA, and communicating the relevance of biodiversity.
There is insufficient knowledge of the impacts of flow reductions on rivers, wetlands, estuaries and coastal and marine environments.	An improved understanding of flow requirements for each ecosystem is needed – from rivers and wetlands to estuaries and coastal and offshore marine environments (such as fluvial fans and mud habitats). A clearer understanding of the downstream and 'knock-on' effects of flow reductions on these ecosystems is required.
Currently the NBA does not take several emerging pressures into account, as data are not available.	Data on emerging pressures is needed: the impact of herbicides, pesticides and pharmaceuticals in water and soil; impacts of noise and light pollution on species; and impact of micro-plastics on biodiversity.

Species assessments (realm-specific species needs are covered in the realm sections below)	
Gaps in taxonomic knowledge are substantial, particularly for invertebrates, many estuarine and marine groups, and for invasive alien species. Taxonomic uncertainties are a major constraint to species assessments and the ability to conduct comprehensive status assessments of groups in all realms.	A systematic process of detailed taxonomic studies on priority groups, including field collections and DNA barcoding, is essential for the enhancement of national species datasets. It is also crucial to build and maintain South African taxonomic knowledge and expertise, especially for understudied taxonomic groups.
Lack of monitoring data to detect changes in species abundance and distribution in response to pressures such as climate change, invasive aliens, biological resource use, etc. limits the ability to determine trends in species status via the Red List Index. Structured monitoring programmes are only in place for birds, butterflies and plants with citizen scientists playing a significant role in the collection of these data.	Monitoring programmes that cover a range of taxa from different realms and that include plants, vertebrates and invertebrates need to be developed and implemented using online citizen science platforms (e.g. iNaturalist).
There is still a bias in species assessments towards vertebrates and to terrestrial taxonomic groups in the current assessment, thereby limiting the utility of the species indicators.	A broader range of invertebrate groups need to be assessed and included in the NBA. Efforts should focus on groups that have a solid taxonomic basis, recent distribution data, high levels of endemism, and that are sensitive to changes in ecological condition or to overharvesting. Some examples likely to be included in the next NBA include: marine and estuarine crabs, and isopods in the genus <i>Tylos</i> ; marine invertebrates with high levels of potential threat (e.g. cnidarians, intertidal and subtidal resources); freshwater invertebrates with high endemism that are completely reliant on aquatic systems (e.g. Plecoptera – Stoneflies, Dytiscidae – Water beetles); terrestrial pollinators (selected bees and flies); and groups with high endemism including millipedes, scorpions and sun spiders (Solifugidae).

Table 17. Summary analysis of knowledge gaps causing limitations to the NBA and priority actions for solutions (continued)

Knowledge gap causing limitation to the NBA	Priority actions for solutions
Species assessments (realm-specific species needs are covered in the realm sections below) (continued)	
<p>The protection level indicator for species needs to be further tested and refined and expanded in application to the marine and estuarine realm.</p>	<p>Two PhD studies are currently underway testing the sensitivities of the indicator for a data rich group (mammals) and a data poor group (plants), and these will inform future applications. The index needs to be applied to species in the estuarine and marine realm.</p>
Genetic assessments	
<p>Available genetic studies to date are single point estimates and do not focus on tracking genetic diversity over time and are insufficient for monitoring purposes.</p>	<p>Although some studies (with appropriate indicators) could form baseline measures for future monitoring, there is a need for focussed studies that aim to track genetic diversity over time.</p>
<p>Currently, the experimental genetic indicators have only been applied to two taxonomic groups (reptiles and amphibians).</p>	<p>The proposed indicators should be tested across taxonomic groups with nearly complete phylogenies and detailed distribution maps (e.g. birds, mammals). Additional target species for genetic monitoring should be considered.</p>
<p>The current experimental indicators may not be the best possible indicators for measuring and monitoring national-level phylogenetic richness.</p>	<p>There should be testing of additional metrics to further explore the best possible indicators, and additional analyses (e.g. of pressures, of protection) could be included.</p>
<p>There is currently no consensus regarding indicators that are relevant to track genetic diversity for biodiversity assessments.</p>	<p>A genetic monitoring framework is required that outlines how to strategically prioritise taxa for monitoring, identifies appropriate genetic markers and metrics, and provides advice on the frequency of monitoring. The framework would provide guidance to researchers.</p>
Terrestrial realm	
<p>Land cover change data is a crucial input layer used for terrestrial, inland aquatic, estuarine ecosystem and species assessments. Currently the gaps between time points (1990 and 2014) are too long to detect recent rapid changes. The data used in NBA is already four years old, biennial data acquisition would be ideal for biodiversity assessments.</p>	<p>Land cover products should be available every 1–4 years, need to be directly comparable between time points and need to utilise common classification schemes. Land cover data should incorporate further drivers of degradation (e.g. invasive species abundance and distribution).</p>
<p>Pressures like overgrazing, modification of fire regimes, bush encroachment and biological invasions are not incorporated into ecological condition estimates for terrestrial ecosystem types. The NBA can only categorise ‘natural/near-natural’ and ‘severely modified and more’ in the terrestrial realm. Other realms use cumulative pressure mapping for ecological condition, which allows for nuanced analyses and more categories (e.g. ‘moderately modified’, ‘critically modified’).</p>	<p>Coordinated national effort is required to measure, model and map ecological condition in the terrestrial realm at a scale suitable for Red List of Ecosystem assessments and for reporting on international indicators. The condition assessment should be repeatable (approximately biennially) to allow for time-series analysis. Local and indigenous knowledge has potential to inform these assessments.</p>
<p>Private and local authority nature reserves, designated under old nature conservation ordinances, are currently included in the protected areas estate and therefore in protection level analyses. But there is uncertainty about their actual contribution to biodiversity conservation.</p>	<p>There is a need to understand private nature conservation efforts in South Africa in terms of biodiversity conservation activities, location of properties and extent of protection. These protected areas need to be investigated, validated and potentially removed from the database.</p>
<p>Protection level is a representation-based indicator for ecosystem types, but it ideally should be complimented by the effectiveness factor for each ecosystem type.</p>	<p>Information to formulate an indicator of protected area effectiveness for each ecosystem type is generally lacking and will require substantial effort and coordinated expert opinion.</p>

Table 17. Summary analysis of knowledge gaps causing limitations to the NBA and priority actions for solutions (continued)

Knowledge gap causing limitation to the NBA	Priority actions for solutions
Terrestrial realm (continued)	
<p>There is a lack of current information on the use and status of medicinal plants, which hampers efforts to ensure the sustainable use of this important resource, as well as for trends in the status of the resource to be measured via repeated Red List assessments.</p>	<p>Focused monitoring of the harvesting and trade in medicinal plants and its resultant impact on wild populations is required to better understand impacts of use. Research on the feasibility of cultivation schemes is essential.</p>
Inland aquatic realm	
<p>National monitoring data for river and inland wetlands are incomplete and are insufficient to show trends in ecological condition. The River EcoStatus Monitoring Programme (the former River Health Programme) is in danger of failure. The National Wetland Monitoring Programme remains to be implemented.</p>	<p>Dedicated funding for regular monitoring will strengthen ability to assess ecosystem status and determine trends. The monitoring programmes should aim at a better representation of ecosystem types across the country (spatial aspect), as well as their representation over the diversity of hydrological regimes (temporal aspect).</p>
<p>Representation of river and inland wetland extent and ecosystem types show spatial inaccuracies and inland wetlands are particularly under-represented in the National Wetland Maps. Arid regions present additional problems regarding inland wetland definition, identification and delineation.</p>	<p>Invest in improved representation and verification of these systems through a combination of citizen science, expert mapping, integration in GIS and remote sensing methods. In particular, river ecosystem types need to be refined to include riparian vegetation because these are not represented and could potentially be highly threatened.</p>
<p>Freshwater fish and aquatic plants show declining trends according to the Red List Index assessments. Insufficient representation of exclusively aquatic invertebrates hampers understanding of the impact of changing ecological condition on aquatic species. Most of the groups on the RLI currently (birds, amphibians, mammals and dragonflies) are able to disperse and potentially escape pressures. Therefore, the RLI results are likely to underestimate overall threat levels and rates of decline in the inland aquatic realm.</p>	<p>Additional inland aquatic invertebrate groups should be assessed and monitored for inclusion in the next NBA, with a specific focus on endemic groups. A comprehensive database of macro invertebrates to support assessments and planning should be prioritised and budget allocated to its ongoing maintenance. Important fish areas should be included in provincial biodiversity plans. The successful interventions of CapeNature to curb invasive fish should be rolled out to other parts of the country.</p>
Estuarine realm	
<p>Data on river inflow, bathymetry/topography, sediment structure, mouth state and water quality (salinity) is available on less than 15% of estuaries. Most planning processes and assessments are low confidence due to lack of this basic information.</p>	<p>Obtaining these data would aid in the development of a hierarchical classification and models to determine the sensitivity of different ecosystem types to pressures. Planning processes (e.g. Ecological Water Requirement studies, Estuary Management Plans, setback lines) cannot take place without these data.</p>
<p>There is a lack of understanding of the degree to which the health of adjacent estuaries influence each other. The NBA analyses do not yet take interconnectivity of systems into account.</p>	<p>Invest in research that explicitly evaluates estuary connectivity (e.g. genetic studies, population studies, and development of mathematical models that can predict impact of off reduce connectivity to a region).</p>
<p>With the exception of plants, very little is known about invasive species in South Africa's estuaries.</p>	<p>There is an urgent need to conduct a survey of invasive alien species in different estuaries and the potential environmental impact of these on both the ecosystem function and the value derived from the estuary in question. All invasive species (freshwater, marine and estuarine) should be included in the survey.</p>

Table 17. Summary analysis of knowledge gaps causing limitations to the NBA and priority actions for solutions (continued)

Knowledge gap causing limitation to the NBA	Priority actions for solutions
Estuarine realm (continued)	
Climate change has the potential to change the processes and functioning of South Africa's estuaries dramatically, but has not yet been studied sufficiently.	Large and local scale climate models are becoming better at accurately predicting the drivers of change in the near and far future. The estuarine community should make this a research priority to facilitate better adaptation strategies and ecosystem resilience.
There is lack of data on the recruitment stage of certain heavily utilised fish species.	Recruitment studies would shed light on an important bottle-neck in resource recovery plans, and identify estuaries of conservation and management importance.
Taxonomic refinements and national scale surveys for invertebrates, plants, fishes and birds in all estuaries are lacking or were last carried out too long ago. There is no up-to-date national dataset or specimen voucher system for South African estuarine invertebrates.	Invertebrate surveys need to be undertaken. Surveys for fish and birds need to be repeated in a once-off effort that is comparable with earlier surveys. Taxonomic revision of salt marsh plant species should be supported and funded so that macrophyte species lists are updated.
Marine realm	
There is uncertainty in the understanding of the impacts of some pressures on some ecosystem types and a need to better account for this uncertainty in the assessment of ecological condition.	To counter uncertainty in the assessments of ecosystem degradation and ecosystem threat status, techniques to better estimate and map indicators of ecological condition and pressures on biodiversity at appropriate scales are needed. This should be underpinned by a better understanding of biotic and abiotic degradation from a marine view. Additional research should be undertaken to assess marine ecosystems at multiple scales and investigate the implications of different criteria and different thresholds of condition and ecosystem size.
Fisheries stock status is not assessed for 90% of the >770 harvested marine taxa. Species Red List assessments and offtake allocations require certainty in stock status. Marine species have the highest levels of data deficiency across all realms meaning that many threatened marine species may be, as yet, undetected.	Increase reliable data for stock assessments. Increase the number of national stock assessments (especially for highly utilised economically important species). Stock assessments should be kept updated through ensuring the management and development of reliable long-term datasets. Maintaining and building fisheries science expertise is essential.
There is insufficient information to track and understand climate change impacts on marine biodiversity including their interaction with other pressures and the effectiveness of measures taken to minimise these impacts. In particular, the lack of a long-term monitoring programme for South Africa's coral reef communities limits our ability to track and understand the state of these ecosystems and species.	South Africa should capitalise on the opportunity provided by our high latitude coral communities that can serve as a natural laboratory for the study of these climate-sensitive ecosystems. A long-term coordinated monitoring programme with fixed transects is needed with sufficient funding to maintain time-series. Further work is needed to detect climate change impacts in other ecosystems and improve our understanding of change for effective adaptation.
Sub-Antarctic	
The regional context of terrestrial and marine ecosystem types in the sub-Antarctic is not well understood.	Dedicated research is needed, focussing on mapping and understanding the regional distribution of ecosystem types and species, especially in relation to other islands such as the nearby Crozet Islands. This may provide the opportunity for collaboration between sub-Antarctic programmes and institutions, as well as other countries.

Table 17. Summary analysis of knowledge gaps causing limitations to the NBA and priority actions for solutions (continued)

Knowledge gap causing limitation to the NBA	Priority actions for solutions
sub-Antarctic (continued)	
The threat status of terrestrial plant and both marine and terrestrial invertebrates' species need assessment.	Improve data on plant and invertebrate species distribution and abundance at the PEIs and the surrounding region through field surveys, analysis of distribution beyond South African territory and regional collaboration. There is opportunity to draw from the substantial existing data and expertise for species threat assessments.
The effect of Patagonian Toothfish fishing on marine ecosystems is not well understood limiting assessment of condition and ecosystem threat status.	Regional collaboration, new research and ecosystem modelling could advance knowledge on the impacts of Patagonian Toothfish on marine ecosystems. Improved information on the distribution of Vulnerable Marine Ecosystems is also needed.
There is insufficient understanding of seasonal zooplankton and micronekton community structure and abundance around and upstream of the PEIs. This information is particularly important during summer when large numbers of predators breed at the islands and rely on the advection of prey.	Most in situ physical and biological oceanography has been conducted during April and May due to logistical constraints. Investment in glider deployments in ecologically important areas is needed (i.e. the 'conveyor belt' of eddies upstream of the islands that originate at the Southwest Indian Ridge and hotspots identified through predator tracking). Research visits to these areas are required to perform biological oceanography.

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Acronyms and Initialisms

BIOTA	BIOdiversity Monitoring Transect Analysis in Africa
CBA	Critical Biodiversity Area
CBD	Convention on Biological Diversity
CITES	Convention on the International Trade in Endangered Species
CR	Critically Endangered
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries (former government department)
DALRRD	Department of Agriculture, Land Reform and Rural Development (formed by merging DAFF and Department of Rural Development and Land Reform in June 2019)
DD	Data Deficient
DEA	Department of Environmental Affairs (former government department)
DEFF	Department of Environment, Forestry and Fisheries (formed by merging DAFF and DEA in June 2019)
DNA	Deoxyribonucleic acid
DSI	Department of Science and Innovation (former government department)
DST	Department of Science and Technology (name changed to Department of Science and Innovation in June 2019)
DWS	Department of Water and Sanitation
EEZ	Exclusive Economic Zone
EIA	Environmental impact assessment
EN	Endangered
FBIP	Foundational Biodiversity Information Programme
FEPA	Freshwater Ecosystem Priority Areas
GIS	Geographic Information Systems
IPBES	The Intergovernmental science–policy Platform on Biodiversity and Ecosystem Services
IUCN	International Union for the Conservation of Nature
KBA	Key Biodiversity Area
KZN	KwaZulu-Natal
LC	Least Concern
MPA	Marine Protected Area
NBA	National Biodiversity Assessment
NBF	National Biodiversity Framework
NBSAP	National Biodiversity Strategy and Action Plan
NDP	National Development Plan

NE	Not Evaluated
NEMBA / NEM:BA	National Environmental Management: Biodiversity Act (10 of 2004) / Biodiversity Act
NFEPA	National Freshwater Ecosystem Priority Areas
NPAES	National Protected Area Expansion Strategy
NRF	National Research Foundation
NSBA	National Spatial Biodiversity Assessment
NT	Near Threatened
PA	Protected area
PD	Phylogenetic diversity
PEIs	Prince Edward Islands – consisting of Marion and the smaller Prince Edward Island and their EEZ
SAEON	South African Environmental Observation Network
SANBI	South African National Biodiversity Institute
SASSCAL	Southern African Science Service Centre for Climate Change and Adaptive Land Management
SDF	Spatial Development Framework
SEA	Strategic Environmental Assessment
SPLUMA	Spatial Planning and Land Use Management Act (16 of 2013)
SWSA	Strategic Water Source Areas
ToCC	Taxon of Conservation Concern
TOPS regulations	Threatened or protected species regulations under NEM:BA
UNCCD	United Nations Convention to Combat Desertification
UNE	United Nations Environment
VU	Vulnerable
WCMC	World Conservation Monitoring Centre
WRC	Water Research Commission

Glossary of Terms

Also see the Lexicon of Biodiversity Planning in South Africa, which provides standard definitions of key concepts and frequently used terms.

Benefits of biodiversity: A general term meant to encompass terminology in popular use for various purposes, such as 'ecosystem services', 'ecosystem goods', 'ecological infrastructure', and 'nature's contributions to people'. The NBA 2018 authors felt that 'benefits' is a term that is currently understood well in South Africa by multiple audiences. The work on the term 'nature's contributions to people' (defined as: all the benefits [and occasionally losses or detriments] that humanity obtains from nature), underway through the Intergovernmental Platform on Biodiversity and Ecosystem Services, is fully acknowledged and efforts to find inclusive terminology that encompasses the diverse world views on the human-nature relationship and further opportunities to incorporate non-monetary values into our discourse are welcomed.

Benthic: Relating to the seabed or ocean floor.

Biodiversity assets: Species, ecosystems and other biodiversity-related resources that generate ecosystem services, support livelihoods, and provide a foundation for economic growth, social development and human wellbeing.

Biodiversity Management Plan: A plan aimed at ensuring the long-term survival in nature of an indigenous species, a migratory species or an ecosystem, published in terms of the Biodiversity Act. Norms and standards to guide the development of Biodiversity Management Plans for Species have been developed. At the time of writing, norms and standards for Biodiversity Management Plans for Ecosystems were in the process of being developed.

Biodiversity planning: Spatial planning to identify geographic areas of importance for biodiversity. Also see Systematic biodiversity planning.

Biodiversity priority areas: Features in the landscape or seascape that are important for conserving a representative sample of ecosystems and species, for maintaining ecological processes, or for the provision of ecosystem services. They include the following categories, most of which are identified based on systematic biodiversity planning

principles and methods: protected areas, Critically Endangered and Endangered ecosystems, Critical Biodiversity Areas and Ecological Support Areas, Freshwater Ecosystem Priority Areas, high water yield areas, flagship free-flowing rivers, priority estuaries, focus areas for land-based protected area expansion, and focus areas for offshore protection. Marine ecosystem priority areas and coastal ecosystem priority areas have yet to be identified but will be included in future. The different categories are not mutually exclusive and in some cases overlap, often because a particular area or site is important for more than one reason. They should be seen as complementary, with overlaps reinforcing the importance of an area.

Biodiversity stewardship: A model for expanding the protected area network in which conservation authorities enter into contract agreements with private and communal landowners to place land that is of high biodiversity value under formal protection. Different categories of agreement confer varying degrees of protection on the land and hold different benefits for landowners. The landowner retains title to the land, and the primary responsibility for management remains with the landowner, with technical advice and assistance provided by the conservation authority.

Biodiversity target: The minimum proportion of each ecosystem type that needs to be kept in a natural or near-natural state in the long term in order to maintain viable representative samples of all ecosystem types and the majority of species associated with those ecosystem types.

Biodiversity thresholds: A series of thresholds used to assess ecosystem threat status, expressed as a percentage of the original extent of an ecosystem type. The first threshold, for Critically Endangered ecosystems, is equal to the biodiversity target; the second threshold, for Endangered ecosystems, is equal to the biodiversity target plus 15%; and the third threshold, for Vulnerable ecosystems, is usually set at 60%. Also see Ecosystem threat status.

Biodiversity: The diversity of genes, species and ecosystems on Earth, and the ecological and evolutionary processes that maintain this diversity.

Biome: An ecological unit of wide extent, characterised by complexes of plant communities and associated animal communities and ecosystems, and determined mainly by climatic factors and soil types. A biome may extend over large, more or less continuous expanses or land surface, or may exist in small discontinuous patches.

Bioregional plan (published in terms of the Biodiversity Act): A map of Critical Biodiversity Areas and Ecological Support Areas, for a municipality or group of municipalities, accompanied by contextual information, land- and resource use guidelines and supporting GIS data. The map should be produced using the principles and methods of systematic biodiversity planning, in accordance with the Guideline for Bioregional Plans. A bioregional plan represents the biodiversity sector's input into planning and decision making in a range of other sectors. The development of the plan is usually led by the relevant provincial conservation authority or provincial environmental affairs department. A bioregional plan that has not yet been published in the Government Gazette in terms of the Biodiversity Act is referred to as a biodiversity sector plan.

Coast: The coast or coastal zone was determined ecologically, by identifying terrestrial and marine ecosystem types with strong coastal affinities. In addition, all estuarine ecosystem types were considered coastal. It is recognised that this is different to the definition of coastal zone in the Integrated Coastal Management Act which uses fixed buffer distances from the high water mark.

Collapsed (CO) (Red List category): An ecosystem type is Collapsed when it is virtually certain that its defining biotic or abiotic features are lost, and the characteristic native biota are no longer sustained.

Conservation area: Areas of land not formally protected by law but informally protected by the current owners and users and managed at least partly for biodiversity conservation. Because there is no long-term security associated with conservation areas, they are not considered a strong form of protection. Also see Protected area.

Conservation planning—see Biodiversity planning

Critical Biodiversity Area: Areas required to meet biodiversity targets for ecosystems, species or ecological processes, as identified in a systematic biodiversity plan. May be terrestrial or aquatic.

Critically Endangered (CR) (Red List category): Applied to both species/taxa and ecosystems:

a species is Critically Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Critically Endangered, indicating that the species is facing an extremely high risk of extinction. Critically Endangered ecosystem types are considered to be at an extremely high risk of collapse. Most of the ecosystem type has been severely or moderately modified from its natural state. The ecosystem type is likely to have lost much of its natural structure and functioning, and species associated with the ecosystem may have been lost. Critically endangered species are those considered to be at extremely high risk of extinction.

Data Deficient (DD) (Red List category): An ecosystem type or species is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction (species) or risk of collapse (ecosystems). Listing ecosystems or species in this category indicates that their situation has been reviewed, but that more information is required to determine their risk status.

Degradation: the many human-caused processes that drive the decline or loss in biodiversity, ecosystem functions or ecosystem services in any ecosystems.

Ecological infrastructure: Naturally functioning ecosystems that generate or deliver valuable services to people. Ecological infrastructure is the nature-based equivalent of built infrastructure, and is just as important for providing services and underpinning economic development.

Ecological Support Area: An area that is not essential for meeting biodiversity targets but plays an important role in supporting the ecological functioning of one or more Critical Biodiversity Areas or in delivering ecosystem services. May be terrestrial or aquatic.

Ecoregion: A relatively large area of land or water, containing characteristic, geographically distinct assemblages of natural communities and species. Used in South African river and marine ecosystem classification systems, the ecoregion is larger than an ecosystem type. The flora, fauna and ecosystems that characterise an ecoregion tends to be distinct from that of other ecoregions.

Ecosystem protection level: Indicator of the extent to which ecosystems are adequately protected or under-protected. Ecosystem types are categorised as Well Protected, Moderately Protected, Poorly Protected, or Not Protected, based on the proportion of the biodiversity target for each ecosystem

type that is included within one or more protected areas. Not Protected, Poorly Protected or Moderately Protected ecosystem types are collectively referred to as under-protected ecosystems.

Ecosystem services: The benefits that people obtain from ecosystems, including provisioning services (such as food and water), regulating services (such as flood control), cultural services (such as recreational benefits), and supporting services (such as nutrient cycling, carbon storage) that maintain the conditions for life on Earth. Ecosystem services are the flows of value to human society that result from a healthy stock of ecological infrastructure. If ecological infrastructure is degraded or lost, the flow of ecosystem services will diminish. See also Benefits of biodiversity.

Ecosystem threat status: Indicator of how threatened ecosystems are, in other words the degree to which ecosystems are still intact or alternatively losing vital aspects of their structure, function or composition. Ecosystem types are categorised as Critically Endangered, Endangered, Vulnerable, Near Threatened or Least Concern, based on the proportion of the original extent of each ecosystem type that remains in good ecological condition relative to a series of biodiversity thresholds. Critically Endangered, Endangered and Vulnerable ecosystems are collectively referred to as threatened ecosystems, and may be listed as such in terms of the Biodiversity Act.

Ecosystem type: An ecosystem unit that has been identified and delineated as part of a hierarchical classification system, based on biotic and/or abiotic factors. Factors used to map and classify ecosystems differ in different environments. Ecosystem types can be defined as, for example, vegetation types, river ecosystem types, wetland ecosystem types, estuary ecosystem types, or marine ecosystem types. Ecosystems of the same type are likely to share broadly similar ecological characteristics and functioning. Also see National Ecosystem Classification System.

Ecosystem-based adaptation (to climate change): The use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people adapt to the adverse effects of climate change. Includes managing, conserving and restoring ecosystems to buffer humans from the impacts of climate change, rather than relying only on engineered solutions. Combines socio-economic benefits, climate change adaptation, and biodiversity and ecosystem conservation, contributing to all three of these outcomes simultaneously.

Endangered (EN) (Red List category): Applied to both species/taxa and ecosystems: A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction. Endangered ecosystem types are considered to be at a very high risk of collapse. Endangered species are those considered to be at very high risk of extinction.

Estuarine functional zone: The open water area of an estuary together with the associated floodplain, incorporating estuarine habitat (such as sand and mudflats, salt marshes, rock and plant communities) and key physical and biological processes that are essential for estuarine ecological functioning.

Free-flowing river: A long stretch of river that has not been dammed, flowing undisturbed from its source to the confluence with another large river or to the sea. A flagship free-flowing river is one of the 19 free-flowing rivers that have been identified as representative of the last remaining 63 free-flowing rivers in South Africa.

Freshwater Ecosystem Priority Area: A river or wetland that is required to meet biodiversity targets for freshwater ecosystems.

Hydrological regime / flow regime: The hydrological regime (also referred to as flow regime) includes all aspects relating to the flow of water, including: magnitude, frequency, duration, predictability and flashiness.

Invasion debt: the potential increase in the biological invasion problem that a given region will face over a particular timeframe in the absence of any strategic interventions. It is composed of the number of new species that will be introduced (introduction debt), the number of species that will become invasive (species-based invasion debt); the increase in area affected by invasions (area-based invasion debt); and the increase in the negative impacts caused by introduced species (impact-based invasion debt).

Least Concern (LC) (Red List category): An ecosystem type that has experienced little or no loss of natural habitat or deterioration in condition or a species considered at low risk of extinction. Widespread and abundant species are typically classified in this category.

Mainstem river: A quaternary mainstem, or a river that passes through a quaternary catchment into a neighbouring quaternary catchment. In situations where no river passes through a quaternary

catchment, the longest river in the quaternary catchment is the main river. Also see Tributaries.

Metapopulation: A metapopulation is the set of discrete local populations that are connected through immigration. Shrinking local populations due to habitat loss and fragmentation isolates these populations and reduces immigration between them. This loss of connectivity disrupts the metapopulation, resulting in tiny isolated populations that lack resilience to stochastic events and increases extinction risk.

Moderately Protected (MP): An ecosystem type or species that has between 50 and 100% of its biodiversity target included in one or more protected areas.

National Ecosystem Classification System: A hierarchical system for mapping and classifying ecosystem types in the terrestrial, river, wetland, estuarine, coastal and marine realm. South Africa has a well-established classification system for terrestrial ecosystems in the form of vegetation mapping, and much progress has been made in mapping and classifying aquatic ecosystems as part of the NBA 2011. Factors used to map and classify ecosystems differ in different environments, but in all cases ecosystems of the same type are expected to share broadly similar ecological characteristics and functioning. The National Ecosystem Classification System provides an essential scientific foundation for ecosystem-level assessment, planning, monitoring and management. Also see Ecosystem type.

Near Threatened (NT) (Red List category): An ecosystem type or species is Near Threatened when it has been evaluated against the IUCN criteria but does not qualify for CR, EN or VU, but it is close to qualifying for or is likely to qualify for a threatened category in the near future.

Not Evaluated (NE) (Red List category): An ecosystem type or species is Not Evaluated when it has not been assessed against any of the IUCN criteria for assessing the threat status of species or ecosystems.

Not Protected (NP): An ecosystem type or species that has less than 5% of its biodiversity target included in one or more protected areas.

Operation Phakisa: Operation Phakisa is an initiative of the South African government designed to fast-track the implementation of solutions on critical development issues highlighted in the National Development Plan (NDP) 2030 such as poverty, unemployment and inequality. Operation Phakisa is an innovative and pioneering approach to translate

detailed plans into concrete results through dedicated delivery and collaboration. Phakisa means 'hurry up' in Sesotho and the application of this methodology highlights government's urgency to deliver. Through Operation Phakisa, government aims to implement priority programmes better, faster and more effectively. www.operationphakisa.gov.za.

Pelagic: Relating to the water column in the ocean.

Poorly Protected (PP): An ecosystem type or species which has between five per cent and 50% of its biodiversity target included in one or more protected areas.

Present Ecological State (PES): A set of categories for describing the ecological condition of rivers, wetlands and estuaries, developed by the then Department of Water Affairs. Assessment of PES takes into account a range of factors including flow, inundation, water quality, stream bed condition, introduced in-stream biota, and riparian or stream bank condition. The categories range from A (natural or unmodified) through to F (critically or extremely modified), with clear descriptions linked to each category.

Protected area target: A quantitative goal for how much of an ecosystem type should be included in the protected area network by a certain date. The National Protected Area Expansion Strategy 2008 sets five-year and twenty-year protected area targets for each terrestrial ecosystem type, based on a portion of its biodiversity target. Protected area targets are revised every five years.

Protected area: An area of land or sea that is formally protected by law and managed mainly for biodiversity conservation. This is a narrower definition than the IUCN definition, which includes areas that are not legally protected and that would be defined in South Africa as conservation areas rather than protected areas. Also see Conservation area.

Spatial biodiversity plan: A plan that identifies one or more categories of biodiversity priority area, using the principles and methods of systematic biodiversity planning. South Africa has a suite of spatial biodiversity plans at national and sub-national level, which together should inform land-use planning, environmental impact assessment, water resource management, and protected area expansion.

Strategic Water Source Area (SWSA): Areas of land that (a) supply a disproportionate quantity of mean annual surface water runoff in relation to their

size and are considered nationally important; or (b) have high groundwater recharge and where the groundwater forms a nationally important resource; or (c) areas that meet both criteria (a) and (b) (Le Maitre et al. 2018).

Systematic biodiversity planning: A scientific method for identifying geographic areas of biodiversity importance. It involves: mapping biodiversity features (such as ecosystems, species, spatial components of ecological processes); mapping a range of information related to these biodiversity features and their ecological condition; setting quantitative targets for biodiversity features; analysing the information using software linked to GIS; and developing maps that show spatial biodiversity priorities. The configuration of priority areas is designed to be spatially efficient (i.e. to meet biodiversity targets in the smallest area possible) and to avoid conflict with other land and water resource uses where possible.

Taxa of Conservation Concern (ToCC): Species and subspecies that are important for South Africa's conservation decision making processes. They include all taxa that are assessed according to the IUCN Red List criteria as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Data Deficient (DD) or Near Threatened (NT). They also include range-restricted taxa (Extent of Occurrence <500 km²) that are classified according to South Africa's national criteria as Rare. Detailed information on the pressures impacting these taxa has been captured during the Red List assessment processes. Throughout the NBA, reference to the impact of a particular pressure on a taxonomic group is determined from the proportion of Taxa of Conservation Concern impacted by that pressure.

Taxon (plural taxa): Any unit used in the science of biological classification, or taxonomy. Some species have been split into subspecies and/or varieties and are assessed at these levels. Consequently, if a taxonomic group includes subspecies or varieties, the summary statistics use the term 'taxa'. If a

group contains only species then the term 'species' is used in the summary statistics.

Threatened ecosystem: An ecosystem that has been classified as Critically Endangered, Endangered or Vulnerable, based on an analysis of ecosystem threat status. A threatened ecosystem has lost or is losing vital aspects of its structure, function or composition. The Biodiversity Act allows the Minister of Environment, Forestry and Fisheries or a provincial MEC for Environment, Forestry and Fisheries to publish a list of threatened ecosystems. To date, threatened ecosystems have been listed only in the terrestrial environment. In cases where no list has yet been published by the minister, such as for all aquatic ecosystems, the ecosystem threat status assessment in the NBA can be used as an interim list in planning and decision making. Also see Ecosystem threat status.

Threatened species: A species that has been classified as Critically Endangered, Endangered or Vulnerable, based on a conservation assessment (Red List), using a standard set of criteria developed by the IUCN for determining the likelihood of a species becoming extinct. A threatened species faces a high risk of extinction in the near future.

Tributaries: Small rivers that feed into the main river within a quaternary catchment. Also see mainstem rivers.

Vulnerable (VU) (Red List category): Applied to both species/taxa and ecosystems: A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction. An ecosystem type is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for VU, and is then considered to be at a high risk of collapse.

Well Protected (WP): An ecosystem type or species that has its full biodiversity target included in one or more protected areas.

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OTHER ANNEXURES

Each technical report listed has a number of annexures such as inventory reports, method explanations, and both spatial and non-spatial datasets, available at <http://nba.sanbi.org.za/>.

Three other independent annexures exist as supplementary material for NBA 2018:

- SANBI. 2019. *National Biodiversity Assessment 2018 Supplementary Material: Compendium of Benefits of Biodiversity*. South African National Biodiversity Institute, Pretoria.
- SANBI. 2019. *South Africa's National Biodiversity Assessment: Contextual and Operational Framework*. Released as supplementary material to the National Biodiversity Assessment 2018. South African National Biodiversity Institute, Pretoria.
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This synthesis report presents the summarised results of South Africa's NBA 2018, and is underpinned by seven technical reports. The NBA is led by the South African National Biodiversity Institute (SANBI), and is a collaborative effort from over 470 individuals from approximately 90 institutions. The NBA synthesises the best available science on South Africa's biodiversity to inform policy and decision making in a range of sectors, and contribute to national development priorities.

NBA 2018 follows on from the previous two assessments in 2004 and 2011, and is an important part of SANBI's mandate to monitor and report regularly on the status of the country's biodiversity, in terms of the National Environmental Management: Biodiversity Act (Act 10 of 2004).

NBA 2018 showcases findings for the headline indicators of threat status and protection level for both ecosystems and species, and presents these findings across the terrestrial, inland aquatic, estuarine and marine realms, as well as for the coast and South Africa's sub-Antarctic territory (Prince Edward and Marion Islands and associated waters). New analyses in NBA 2018 include an examination of potential ways to assess genetic diversity on a national scale, trend analyses for species threat status, and an assessment of land cover change in the terrestrial environment.

The NBA highlights the crucial role of biodiversity assets and ecological infrastructure in providing benefits to people that underpin social and economic development.

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