National Biodiversity Research & Evidence Strategy

(2015-2025)

Annual implementation plan: 2016-2017

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CONTENTS

1 INTRODUCTION

This is the first annual implementation plan of the National Biodiversity Research & Evidence Strategy (NBRES) 2015-2025 approved by the Minister in 2015.

The NBRES builds from the July 2015 the National Biodiversity Strategy and Action Plan (NBSAP) that set out the policy priorities for the sector in the form of six strategic objectives:

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

The scope of these objectives, and the depth of evidence that is required to meet them, is challenging. The NBRES 2015-2025 describes how decision-making and policy formulation in the biodiversity sector can be most effectively supported with robust evidence. As well as supporting the NBSAP strategic objectives, evidence is also needed to support a number of other sectoral priorities such as: improving efficiencies in government spending and delivery, managing environmental risks, adapting to climate change and strengthening links across Africa.

This annual implementation plan is part of a pilot process to synthesise those evidence needs in a single document and communicate them widely across the sector.

1.1 Purpose of the implementation plan

This implementation plan supports the NBRES. Its purpose is to outline the detail of what evidence is needed to answer key policy questions across the biodiversity sector in the short- to medium-term, and the foundational knowledge that is required over the medium- to long-term. Short-term is defined here as within the next year, medium-term within the next two to five- years, and long-term within the next six to ten years.

The biodiversity sector is very diverse with role players and stakeholders including national, provincial and municipal spheres; government entities such as the South African National Biodiversity Institute (SANBI), South African National Parks(SANParks), iSimangaliso Wetlands Park, university departments, non-government organisations, civil society, private sector, research and international organisations. All these organisations are able to contribute evidence in some way to support policy formulation, decision-making and implementation. The aim of this implementation plan is to synthesise and communicate the sector's broad understanding of what evidence will be needed in future, so that stakeholders are able to deliver that evidence, either individually or in partnership. This enables a more strategic approach to the evidence base for biodiversity and conservation policy, making the search for evidence more

transparent and ultimately ensuring that scarce resources are spent where they are most needed. While the NBRES document is intended to stay in place for ten years (to complement the NBSAP), the implementation plan will be updated annually to ensure that it remains current.

The strategy and implementation plan have been developed in a two-stage process. The initial stage set out the foundational and medium- to long-term needs for evidence following wide consultation across the sector, led mainly by the scientific community. The second stage focused on the evidence needed to answer specific policy questions in the short- and medium-term, led mainly by the policy community but involving all members of Working Group 1. The results of the two consultation processes have been synthesised to remove as much duplication as possible.

1.2 Communicating the implementation plan

This document will be communicated widely across the sector to stimulate discussions about the key questions that needs to be answered to make, implement and assess effective biodiversity and conservation policies. It will also help stimulate discussions about what the future priorities for evidence should be and who is best placed to resource the processes of collecting, assembling, interpreting and communicating the evidence to ensure it is used effectively.

In some cases the evidence may already exist but policymakers may be unaware of it. In these cases, the issues may still appear in the implementation plan as requiring evidence. The document will serve as a reminder to those who produce evidence to consider whether they have reached the right audiences, and what more they could do to communicate the evidence to those who need it. We anticipate that this issue will disappear over time as the process of monitoring and updating the implementation plan refines what it contains (see section 1.4).

1.3 Prioritising and resourcing the implementation plan

The success of the strategy will depend in large measure on the mobilisation of funds from various sources to ensure that core research and evidence programmes are adequately funded and that collectively evidence is also able to respond to short-term policy requirements.

The short-term needs for evidence identified in this implementation plan represent clear policy priorities for which there is a real and urgent need to answer specific questions. Medium-term evidence needs will help respond to anticipated future priorities, or help build up knowledge in key areas of strategic importance to biodiversity policy. Long-term evidence needs provide the essential underpinning knowledge for the sector. The categories inevitably overlap to an extent and within each one it may be necessary to prioritise further to ensure that scarce resources are allocated effectively.

This implementation plan attempts to cover all the sector's needs for evidence. There are many stakeholders and role players who could contribute evidence depending on their mandates and budgets. Some may wish to work in partnership with others to share resources most effectively. Deciding which evidence needs to prioritise, and who will fund the process of collecting that evidence, will therefore need to be done collaboratively. The Biofin project, which is a

collaboration between the National Treasury and DEA (under the auspices of United Nations Development Programme) supports the development of the NBSAP and will be able to support the resourcing process for this implementation plan – developing a comprehensive national resource mobilisation strategy to fill the finance gap for the biodiversity sector.

It is not only financial resources that are important. The NBRES cannot succeed without the skills and capacity needed to generate knowledge. Considerable human resources are needed to scope out, assemble, review, quality assure and interpret the evidence that is needed in this complex sector. At the same time, the urgent need to improve communication between researchers and users and to co-generate knowledge that addresses social needs means that the research community must represent the breadth of cultures and values in South Africa. A capacity assessment will help inform the development of a human capital strategy for the sector, and complement the assessment of the finance gap.

1.4 Monitoring and updating the implementation plan

This is a pilot process, linked to wider work within DEA to improve the use of evidence. It is likely that improvements will be needed in the coming years. These improvements will help ensure that all policy priorities and key decisions are well served with the best available evidence, and that the full range of stakeholders and role players are involved.

The Director, Science-Policy Interface in the Biodiversity & Conservation Branch of DEA is responsible for monitoring progress against this implementation plan and updating it to make sure that it responds to emerging priorities. This will be done on an annual basis and involve stakeholders from across the branch, department and sector. The revised annual implementation plan will be published at the beginning of each financial year.

Monitoring the implementation plan

At the end of Quarter 3 (December) of each year the Director, Science-Policy interface will ask sector stakeholders to identify which evidence needs set out in the annual implementation plan have been met and where that evidence is located. Three levels of response are anticipated:

- Within the Biodiversity and Conservation Branch in DEA, information will be gathered from Annual Performance Plans (APPs) and branch meetings
- Members of Working Group 1 will be required to respond
- Wider stakeholders (such as universities and Non-Government Organisations) will be invited to respond

The results will be summarised and presented as a database of existing evidence that all can use.

Updating the implementation plan

The implementation plan itself will be updated by asking the same groups of stakeholders three questions:

- which of the evidence needs in the current implementation plan can be removed because either they have been met or they are no longer relevant;
- which of the remaining evidence needs should be rescheduled as being more urgent (for example moved from ‘medium-term’ to ‘short’-term’);

- whether there are any new evidence needs that should be included (and if so, how urgent and important they are).

The updated implementation plan will then be produced as described above.

1.5 Limitations to this process and future improvement plans

This has been a pilot process with only limited resources. It is clear that it has not yet been able to cover all the sectoral needs for evidence, nor to fully rationalise them. Nor has it been able to involve all the stakeholders and role players. As the implementation plan is updated and refined, more people and organisations will be brought into discussions to ensure that all evidence needs for the sector are covered as far as possible within resource constraints.

In the coming year, for example, the updating process will:

- involve more members of Working Group 1 to ensure that all key institutions are able to contribute;
- involve more members of the IPBES structures to ensure that all key institutions are able to contribute;
- clarify what is driving the search for evidence across the sector, particularly the policy drivers which need evidence in the short- to medium-term;
- ensure that evidence requirements for reporting against Outcome 10 are included – in particular the evidence needed to ensure that the technical descriptions of the indicators are up to date;
- engage with ongoing work to improve information systems within DEA and across the sector.

2 OPERATIONAL IMPERATIVES

This chapter outlines the operational imperatives for the strategy and provides an overall framework for achieving the strategic objectives via this implementation plan.

2.1 Mobilising key institutions

Biodiversity research is undertaken, coordinated and funded by a number of different institutions, including components within the Department of Environmental Affairs (Oceans & Coasts, Environmental Programmes, Biodiversity & Conservation) and its entities (SANParks and SANBI), the Department of Science & Technology (DST), the National Research Foundation (NRF), science councils, national facilities (e.g. South African Environmental Observation Network (SAEON), South African Institute for Aquatic Biodiversity (SAIAB), universities, museums and provincial conservation agencies. The effective implementation of the research and evidence strategy depends on clarifying the respective roles of these institutions, obtaining institutional commitment, and providing coordination and support to improve delivery of relevant research and eliminate duplication between institutions. In addition, the DST/NRF has established mechanisms to promote research (e.g. South African Research Chairs Initiative (SARChi) Chairs and Centres of Excellence) and the implementation of the strategy will include jointly deciding on priorities and proposals to achieve the outcomes using these existing mechanisms.

2.2 Knowledge and Information systems

The entire value chain from Foundational Research through to knowledge exchange must be supported by an effective information system. The scope for such a system must include access to basic information on the taxonomy, distribution and classification of our biodiversity through to research results, assessments, models and tools and policy applications. There is ongoing work to share information in key areas, but it will be important to consider how to link different information systems together, where they have been developed (or may be developed in future) in isolation of one another

2.3 Evidence-policy interface

As set out in the DEA RD&E Framework, enhancing the evidence-policy interface is the foundation of enhancing an evidence-informed approach to decision making across the sector. DEA is putting in place a departmental improvement plan to strengthen and scale up the work it is currently doing to improve all relationships between evidence and policy. The NBRES and its Implementation Plan is part of this process.

3 SHORT- AND MEDIUM-TERM EVIDENCE NEEDS

3.1 Introduction

This section sets out what evidence is needed to respond to policy decisions that are likely to be taken in the short term (within 1 year) and medium term (within 2-5 years) to respond to NBSAP Strategic Outcomes 1-5 and other priorities such as extreme weather events.

A three-stage process was used to determine the short- to medium-term evidence needs. First, a survey was sent out to all members of Working Group 1. It asked them to:

- Identify up to five 'big issues' for which they required evidence
- Prioritise those issues
- For each issue, indicate up to five key questions for which evidence would be required

Members were asked to consolidate the responses for their Branch or organisation where possible. A total of 18 responses were received, with 75 separate issues identified.

Next, a workshop was held with DEA staff to consolidate the responses and clarify how they related to the NBSAP strategic outcomes and other priorities (such as the current drought, and goals from DEA's Strategic Plan). Finally, the outputs of the workshop were synthesised into a table and sent to the Branch for checking and re-prioritising. These are set out in Table A over the page, and expanded on in the rest of this chapter.

3.2 Short- and medium-term policy priorities

Overall, the following policy priorities were listed over short to medium term

- *Policy priorities for the next year*
    - Implementation plan for the revised Threatened or Protected Species (TOPS) regulations developed
    - The draft Biodiversity Management Plan (BMP) for the Cape Mountain Zebra published for public participation
    - BMP for one ecosystem published for implementation
    - National Biodiversity Offsets Policy submitted for approval
    - Implementation plan for the National Strategy and Action Plan for the Management of cycad developed
    - Climate Change adaptation plans for SA biomes implemented
    - Draft Integrated rhino management strategy developed (2016 – 2021)
    - Reviewed NBSAP implemented and monitored.
    - National Action Plan (NAP) to combat land degradation approved

- *Policy priorities for the next 2-5 years*
    - 5 legislative tools to ensure conservation and sustainable use of biodiversity developed and implemented
    - 5 tools to mitigate threats to biodiversity developed and implemented.

Table A. SHORT- TO MEDIUM-TERM PRIORITIES FOR EVIDENCE: SUMMARY OF STRATEGIC OBJECTIVES AND DETAILED EVIDENCE NEEDS

NBSAP Strategic Objective and associated outcomes	Priorities to address the objective	Urgency of the evidence needs	
Strategic Objective 1: Management of biodiversity assets and their contribution to the economy, rural development, job creation and social wellbeing is enhanced		**Within 1 year**	**Within 2-5 yrs.**
1.1. Greater understanding of how to unlock the benefits of biodiversity assets is developed	Further research into threatened or protected species: • Relationship between demand management for trophy hunting and species conservation; • The impact of poaching, and sustainable use policies, on tourism; • Successes and risks of breeding rhinos in intensive systems; • Research to establish the success of breeding sungazers (giant girdled lizard) in captivity.		
	Determination of the current & future value of the indigenous biological resource: • Development of a provincial baseline of bioprospecting markets, potential markets and new product development; • Resource assessments of indigenous biodiversity used in the bioprospecting industry including impacts of bioprospecting businesses; • Development of a research agenda of untapped bioprospecting subsectors.		
	Increasing productivity in the biodiversity economy (*also addresses 'biodiversity is mainstreamed'*): • Understanding the links between the biodiversity economy and other sectors (agriculture, trade & industry); • Understanding and managing the risks associated with the biodiversity economy.		
1.2. Sustainability of biodiversity assets is understood	Balancing economic consumption of biodiversity assets with management of the biological resource: • Research on whether economic consumption of the natural resource contributes to biodiversity conservation or whether it leads to the unwise/illegal use of resources		
	Subsistence harvesting of natural resources (*also addresses 'biodiversity is mainstreamed' and 'people are mobilised'*): • Explore the decriminalisation of subsistence harvesting of natural resources; • Engage with local communities on conservation status of species and the benefits of protecting them; • Improve understanding of on carrying capacity (animals and people) of natural areas and the implications of the collection of food, raw materials, fresh water & medicinal resources for over-use.		
	Economic analysis of the use of environmental goods: • Supply response for wild harvesting and/or propagated indigenous biological resources, to determine appropriate price policy; • Sensitivity of Indigenous Biological Resources (IBR) consumption to income, to analyse the quantity of IBR likely to be required by the market; • Import demand function for major IBR consuming countries; relationship between supply and demand for IBR.		
	NEMPAA and land restitution *(also addresses 'investments in ecological infrastructure)*: • Evidence to develop an incentives programme for restituted land for continued conservation practices and compatible land use.		
1.3. The impact of policies and management actions is assessed	The impact of high level management interventions such as: • The impact on fish numbers and local communities of opening/closing a Marine Protected Area to certain activities; • The biodiversity, ecosystem and social impacts of removing alien species (possibly when planned according to ecological versus social criteria); • the impact of stopping / initiating culling;		

NBSAP Strategic Objective and associated outcomes	Priorities to address the objective	Urgency of the evidence needs	
	• the impact of allowing certain high intensity tourism activities.		
	The impact of climate change mitigation and adaptation strategies: • on people and organisations; • on monetary savings; • on energy/water consumption.		
	Incorporate new evidence into existing management plans: • promote new protected areas for Strategic Water Source areas and the last remaining free-flowing rivers; • Incorporate freshwater planning principles into the future design and expansion of national parks.		
1.4. Evidence is used to review specific biodiversity management plans	Evidence requirements for Biodiversity Management Plans for: • African lion • White rhino • Bearded vulture • Cycad		
Strategic Objective 2. Investments in ecological infrastructure enhance resilience and ensure benefits to society		**Within 1 year**	**Within 2-5 yrs.**
2.1. Interventions to mitigate biodiversity loss are evaluated	Assessment / evaluation of most effective interventions to mitigate biodiversity loss to • Pollution (stormwater runoff, solid waste, air quality, recycling) • Climate change • Habitat loss and fragmentation		
2.2. The economic benefits of biodiversity infrastructure and interventions are understood	Unlocking the benefits of biodiversity infrastructure: • Quantification of returns on investment and avoided cost from restoration of ecological infrastructure; • Assessment of the priority areas for investment in ecological infrastructure; • Analysis of the optimal institutional arrangement for ecosystem restoration work in SA; • Assessing the role of public and private investment in maintaining / enhancing ecological infrastructure; • Developing best practice models of EI investment; • Assessing the contribution of investments in ecological infrastructure to jobs and livelihoods		
	Cost-benefit analysis of environmental regulations and other policies • Externalities or unintended effects resulting from economic activity associated with the economic use of biodiversity • Assessing the role of the *Working for…* Programmes		
Strategic Objective 3. Biodiversity considerations are mainstreamed into policies, strategies and practices of a range of sectors		**Within 1 year**	**Within 2-5 yrs.**
3.1. Research into land use for long-term sustainability (in other sectors) is conducted	Determining the most appropriate land uses for long-term sustainability (*also addresses 'management of biodiversity assets'*): • Evaluating and quantifying the value of long-term ecosystem services and benefits vs. short term destructive or inappropriate practices (including biodiversity offsets) or developments (e.g. mining, sugar cane, aquaculture); • Evaluate agricultural subsidy schemes which lead to ecosystem degradation (e.g. sugar cane in water scarce areas, plantation forestry in key water producing areas) to develop incentives for maintaining ecosystems intact in these areas; • Identify key opportunities to develop linkages (connectivity) between natural areas by enabling appropriate land uses (including private and communal);		

NBSAP Strategic Objective and associated outcomes	Priorities to address the objective	Urgency of the evidence needs	
	• Management of United Nations Educational, Scientific and Cultural Organization (UNESCO) biosphere reserves and World Heritage Sites sustainably while achieving our mandate to benefit local communities: comparison with sites in other countries • Development of biodiversity offsets policy and minimum requirements for biodiversity consideration in land use planning • Engagement with stakeholders e.g. business and private sector on the integration of biodiversity into their sectoral practices		
3.2. Opportunities for main-streaming biodiversity considerations into other sectors are identified and understood	Identification of the extent to which other sectors are contributing to biodiversity loss and degradation		
	Identification of critical biodiversity areas including areas earmarked for National Protected Areas Expansion Strategy (NPAES) within the following sectors, particularly addressing the following issues: • Agriculture: genetically modified organisms (GMOs), biotech, synthetic biology, geo engineering • Energy: renewable energy, nuclear, non-renewables • Ocean economy: ocean fertilisation, aquaculture • Mining: a critical issue for biodiversity • Forestry: deforestation, plantations • Urban development: industry, housing, dams, land zoning, land reform • Water: investment in ecological infrastructure, storm water management • Business: green economy • Tourism: infrastructure, parks, no-go areas		
	Ecosystems that transcend boundaries • The extent (and causal mechanisms) to which dams built in neighbouring countries affect local ecosystems		
3.3. The extent and nature of cross-sectoral impacts on habitat loss and habitat fragmentation is understood	Where cross-sectoral impacts are likely, to what extent • Are representative habitats protected (fenced/proclaimed) • Are conserved habitats able to ensure sustainable continuation of ecological and evolutionary processes • Are development impacts on these habitats understood (Environmental Impact Assessments (EIAs)/Environmental Management Plans (EMPs)) • Are ecological corridors in place to compensate for fragmentation and are effective for a range of taxa • Are buffer zones in place to reduce development impacts • Can migration activities take place between green and blue nodes		
3.4. Pollinators and pollination associated with food production	Increase understanding of pollination in subsistence agriculture landscapes as well as large, commercial farming: • Consider the effects of new and emerging pesticides, herbicides • How the increasing frequency of extreme weather events may affect forage, nesting success and epidemiology of pollinators • Whether new agricultural and land redistribution policies influence the behaviour and choices made by farmers in a way that affects pollinators and/or their forage		
Strategic Objective 4. People are mobilised to adopt practices that sustain the long-term benefits of biodiversity		**Within 1 year**	**Within 2-5 yrs.**
4.1. Evidence on the impact of specific regulations is used to inform policy and management decisions	The impact of management decisions on the social behaviour of species *(see also 'effective knowledge foundations' in a separate table)* • Impact of dehorning rhinos on the social behaviour of black and white rhinos under various circumstances • Impact of dehorning rhinos on reduction of poaching		

NBSAP Strategic Objective and associated outcomes	Priorities to address the objective	Urgency of the evidence needs	
	• Impact of contraception (on the social behaviour of elephants) • Impact of uncoordinated killing of predators (in particular caracal and black-backed jackal) on the social and breeding behaviour of these species • Impact of trophy hunting on lion social dynamics (e.g. leading to the breakup of prides and higher mortality in the population as a whole as new male lions take over prides and kill cubs) • Impact of fencing on distribution patterns of smaller predator species		
	Evidence for genetic-level management • Genetic make-up of smaller antelope species (relates to the genetic distinctness / similarities of geographic separate populations of a species, and to the continuity of movement between these populations) • Genetic integrity of species likely to be subject to hybridization (particularly for black wildebeest and roan, as an indication of the 'healthy status' of the population as a whole) • Extent of colour variants in South Africa, and the threshold, for each of the affected species • Extent of inbreeding in captive lion breeding facilities		□
	Evidence for population management • Effect of climate change on the natural distribution of indigenous species • Population size of predators such as leopard, cheetah (linked to whether hunting permits could be issued for trophy purposes) • Re-assessment of the conservation status of wild and managed wild lions • Period required for captive-bred lions to fully adapt in extensive wildlife systems (establish territories, form prides, breed etc.) • Determine the contribution of captive-bred lions to the conservation of the species	□	
	Evidence on international trade issues • Information on the trade routes of lion bones, the value of the products along the value chain, and what happens to lion bones and products at the point of destination (mostly Asian countries)? • Availability in other African countries of lion bones through legitimate and illegitimate sources, origin of the sources (wild or captive-bred), and impact on regional wild lion populations across the ranges in Africa • Assessment of the ex situ tiger population in South Africa, the extent of consumptive and non-consumptive use	□	
	Risks related to the release of captive bred animals and alien species into extensive systems • Risks in terms of genetics and disease • Use of captive bred animals for commercial purposes		□
	Citizen and stakeholder engagement around regulatory mechanisms • Social impacts of regulatory instruments		□
4.2. Effective management strategies for selected invasive alien species are developed, implemented and assessed	Assessment of the economic value of managing and using invasive alien plants (IAPs) through various value chains (*also addresses 'investments in ecological infrastructure' and 'management of biodiversity assets')* • Understanding whether management (clearing) of invasive alien plants can be a self-sustaining economy: its costs and benefits • Assessing the extent and nature of IAPs (especially in the Western Cape Province): where is it most critical within CBAs to manage IAPs and how does IAP clearing contribute to improving ecosystems goods and services? • Assessing the economic potential of different IAP value chains (fuel, biochar, compound materials, energy generation) • Assessing how local communities can contribute to IAP clearing and the social & livelihood benefits that might result	□	
	Note: that there is a gap around invasive alien species in general: what evidence do we need for non-plant invasives?		

NBSAP Strategic Objective and associated outcomes	Priorities to address the objective	Urgency of the evidence needs	
Strategic Objective 5. Conservation and management of biodiversity is improved through the development of an equitable and suitably skilled workforce		**Within 1 year**	**Within 2-5 yrs.**
5.1. A national assessment is conducted of the staff capacity and availability of resources to contribute adequately to sound, realistic and scientific decision making.	Assessment of: • Identification of skills required to support the envisaged work • Capacity in terms of skilled, experienced and appropriately qualified scientists • The availability of mentors in the scientific fraternity to capacitate scientists • Competencies of biodiversity graduates, and the extent to which academic institutions produce work ready graduates that can enter the work place • Assess uniformity of skill sets of graduates from different institutes • Whether the necessary skills are available in nature conservation organisations and incentives to retain staff are adequate • The extent and implications of budgetary shortfalls • The uniformity of salaries across the sector and the threat of losing skilled workers to higher paying institutions • The extent of training programmes available to enable the required skills and competencies	□	
Strategic Objective 6. Effective knowledge foundations, including indigenous knowledge and citizen science, support management, conservation, monitoring and sustainable use of biodiversity		**Within 1 year**	**Within 2-5 yrs.**
See separate table on medium- to long-term evidence needs. This is subdivided into the following outcomes, each of which may address more than one of the NBSAP Strategic Objectives: 6.1. Foundational information on South Africa's biodiversity, including information from indigenous knowledge, is available to enable planning and management of biodiversity and ecosystem services and to facilitate monitoring and evaluation of targets 6.2. Research and evidence are available, and tools and models are developed, to support planning and management to reduce the rate of loss of biodiversity and maintain the ecological infrastructure required to deliver goods and services 6.3. Knowledge of the contribution of biodiversity to economic development and human wellbeing provides specific and quantified evidence to make the case for biodiversity at a policy level, guide decision-making, and promote the mainstreaming of biodiversity in key economic sectors with a high impact on biodiversity *6.4.* Mechanisms are in place that provide a bridge between knowledge generation, policy formulation and decision making resulting in a relevant and accessible evidence base for environmental decision making			

3.3 Types of evidence

The detail of the evidence needs in the short- and medium-term are set out in Table A. There is a broad mix of qualitative and quantitative evidence from both the natural and social sciences. It is also possible to distinguish all four types of evidence that are set out in the National Biodiversity Research & Evidence Strategy and in DEA's Research, Development & Evidence Framework:

- **Statistical and administrative evidence**, such as data on populations of threatened or endangered species, the distribution of invasive plants, data on the areas suitable for investment in ecological infrastructure, and evidence that would form a baseline for the bioprospecting industry;
- **Evidence from research**, which forms the bulk of the evidence needs. This includes evidence on the supply response for wild harvesting, evidence of the demand for lion bones across Africa, and the impact of management decisions on the social behaviour of species;
- **Evidence from evaluations**, including the impact on fish numbers and local communities of opening/closing a Marine Protected Area to certain activities, cost-benefit analyses of environmental regulations, and evaluations of agricultural subsidy schemes which lead to ecosystem degradation to develop incentives for maintaining ecosystems intact in these areas
- **Citizen and stakeholder evidence**, and participatory and inclusive approaches to collecting evidence. This includes assessing the social and livelihood benefits that might result from clearing invasive alien plants, assessing the role of public and private investments in maintaining and enhancing ecological infrastructure, and evidence to help manage UNESCO biosphere reserves and World Heritage Sites sustainably while benefiting local communities.

3.3 Evidence underpinning the National Biodiversity Strategy and Action Plan Strategic Objectives

This section briefly summarises the detailed evidence needs presented in Table A.

Strategic Objective 1: Management of biodiversity assets and their contribution to the economy, rural development, job creation and social wellbeing is enhanced

This strategic objective suggests that the management of biodiversity assets needs to be improved so that they can contribute more substantially to the economy, rural development, job creation and social wellbeing. This also implies mainstreaming the management of such assets into relevant sectors such as trade and rural development. Strategic Objective 1 is supported by various associated outcomes, namely, greater understanding of how to unlock the benefits of biodiversity assets is developed, sustainability of biodiversity assets is understood, the impact of policy and management actions is assessed and evidence is used to review certain biodiversity management plans.

Four themes were identified for the evidence base for this outcome. The first, *greater understanding of how to unlock the benefits of biodiversity assets is developed,* requires further research into threatened or protected species, determining the current and future value of the indigenous biological resource, and increasing productivity in the biodiversity economy. This is complemented by *Sustainability of biodiversity assets is understood,* which can be achieved by

balancing the economic consumption of biodiversity assets with management of the biological resource, exploring the effects of subsistence harvesting of natural resources and understanding the economics of the use of environmental goods (such as understanding how demand for the indigenous biological resource responds to income). The management of restituted land to ensure continued conservation practice and compatible land use also emerged as an issue affecting the sustainability of biodiversity assets. A third theme that emerged was *The impact of policies and management actions is assessed,* including the environmental, economic and social impacts of opening and closing protected areas to certain activities, and the impact of climate change mitigation and adaptation strategies. A final theme is the need for evidence to help review biodiversity management plans for key species mentioned in DEA's Strategic plan such as the African lion, white rhino, bearded vulture and cycad.

Other strategic outcomes this evidence could contribute to include Objective 2 (*investments in ecological infrastructure),* Objective 3 (*biodiversity considerations are mainstreamed)* and Objective 4 (*people are mobilised*).

Evidence priorities for the coming year include:

- Determining the current and future value of the biological resource
- Increasing productivity in the biodiversity economy
- Economic analysis of the use of environmental goods
- Understanding the biodiversity implications of National Environmental Management: Protected Areas Act (NEMPAA) for restituted land
- Understanding the impacts of climate change mitigation and adaptation strategies

Strategic Objective 2. Investments in ecological infrastructure enhance resilience and ensure benefits to society

This strategic objective suggests that investments in ecological infrastructure, such as healthy mountain catchments, rivers and wetlands, are pivotal to enhancing the resilience of South Africa's ecosystems and communities, thereby ultimately also benefitting society. Strategic Objective 2 is supported by three associated outcomes, namely, interventions to mitigate biodiversity loss are evaluated and the economic benefits of biodiversity infrastructure and interventions are understood.

As noted in the NBSAP (page 3), "Ecological infrastructure are the naturally functioning ecosystems that deliver valuable ecosystem services to people, such as fresh water, climate regulation, soil formation and disaster risk reduction. These areas and other biodiversity assets offer significant opportunities to unlock the value of biodiversity and ecosystems in support of the country's development path." In terms of what evidence is required, a strong theme emerged about understanding the economic benefits of ecological infrastructure: assessing the priority areas to generate returns on investment, appraising the most appropriate funding models, and understanding the optimal institutional arrangements for restoring ecosystems and the calculation of returns on investments. As noted in the NBSAP, the evidence needed to address this topic is not simply about calculating returns, but about how investments in ecological infrastructure contribute to the wider economic goals of creating jobs and improving livelihoods.

Specific evidence needs include assessing the *Working for…* programmes (*Working for Water*, *Wetlands and Fire*) and assessing the most effective interventions to mitigate biodiversity loss to pollution (from stormwater runoff, solid waste, air quality or recycling).

In many cases these evidence needs are shared with other Objectives, specifically Objective 3 (*biodiversity considerations are mainstreamed)*.

Evidence priorities for the coming year include:

At least two priority catchments will be identified as part of the Global Environment Facility (GEF) 6 Project: Unlocking biodiversity benefits through development finance in critical catchments.

Strategic Objective 3. Biodiversity considerations are mainstreamed into policies, strategies and practices of a range of sectors

According to this strategic objective, biodiversity considerations should be integrated into the planning of various sectors. Examples include the economic sector (in terms of macro-economic trade, industrial and fiscal policy), the resource management sector (in terms of relevant policy and legislation), and the spatial development and planning sector. Strategic Objective 3 is supported by four associated outcomes, namely, research into land use for long-term sustainability (in other sectors) is conducted, opportunities for main-streaming biodiversity considerations into other sectors are identified and understood, the extent and nature of cross-sectoral impacts on habitat loss and habitat fragmentation is understood and pollinators and pollination associated with food production.

The NBSAP (page 41) notes that *"Opportunities exist particularly in the agriculture, water, land reform sectors, and at a local level in the municipal planning framework, including disaster risk reduction, for strengthening development through the integration of biodiversity considerations. Already foundations have been laid for integrating biodiversity considerations into the planning and regulatory frameworks of other sectors".* There are long-term, foundational needs for knowledge to address this Objective (see Table B), which will help integrated biodiversity considerations into the tools being implemented to support environmental decision-making for Strategic Integrated Projects, such as EIAs, Strategic Environmental Assessment (SEAs) and norms & standards. However, in the short to medium term, evidence requirements fell into three major themes.

The first is evidence around land use for long-term sustainability in other sectors. This might include: evaluating and quantifying the value of ecosystem services and benefits in extractive industries (such as mining, sugarcane and aquaculture), and specific incentive schemes such as agricultural subsidies, which can lead to ecosystem degradation. This evidence would help develop incentives to maintain ecosystems intact without adversely limiting production.

The second is evidence of the effects of cross-sectoral initiatives on habitat loss and fragmentation—where cross-sectoral impacts are likely, evidence is needed of the extent to which representative habitats are protected, development impacts are well understood, ecological corridors are in place to compensate for fragmentation and buffer zones are in place to reduce development impacts. Evidence for transboundary issues is also needed, such as the extent to which dams built in neighbouring countries affect local ecosystems.

A third and very specific short-term evidence need is around pollination, which is an Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES) priority and has particular resonance for the agricultural sector: not just for large-scale commercial farming, but for subsistence agricultural systems as well.

Evidence priorities for the coming year include:

- Understanding the effects of new and emerging pesticides and herbicides on pollinators
- Understanding how the ability of pollinators to forage, nest and reproduce successfully could be affected by extreme weather events
- Determining whether new agricultural and land redistribution policies influence the decisions farmers make in ways that affect pollinators and their forage

Strategic Objective 4. People are mobilised to adopt practices that sustain the long-term benefits of biodiversity

This strategic objective highlights the need for the South African public to become involved in practices that sustain the long-term benefits that biodiversity has to offer. A particularly important element here is the idea of creating partnerships between different role-players in South African society. Strategic Objective 4 is supported by two associated outcomes, namely, evidence on the impact of specific regulations is used to inform policy and management decisions and effective management strategies for selected invasive alien species are developed, implemented and assessed.

The short- to medium-term evidence needs identified under this Objective fell into two themes: regulatory research needs, and management of invasive species. Both have close links with Objective 1 (*management of biodiversity assets*) and provide evidence to inform the development of regulation, which influences how people can be mobilised to conserve biodiversity. What is needed covers very specific issues such as the impact of management decisions (e.g. dehorning rhino) on the social behaviour of species, genetic research to inform permitting and policy decisions, evidence for population management (such as issues related to the release of captive-bred lions into extensive wildlife systems) and evidence for international trade in commodities such as lion bones. Other evidence required to support regulatory decisions includes an understanding of the risks of releasing captive bred animals into extensive systems, and consideration of whether to cull hybrids to maintain the purity of species, or to use them for back-breeding to improve the genetic integrity of indigenous populations (for example, hybrids between Southern and Western roan). Citizen and stakeholder engagement around regulatory mechanisms is important to understand the breadth of the potential social and economic impacts of regulations.

Management of alien invasive species is increasingly seen as a potential economic activity. Evidence is needed on whether the management of invasive alien plants could be a self-sustaining economy, how it contributes to improving ecosystems goods and services in the province, what sorts of value chains could be created that would bring economic benefit, and the social and livelihood benefits that might result from clearing invasive alien plants. For the Western Cape Province this is an urgent requirement.

Evidence priorities for the coming year include:

- Understanding the impact of management decisions (e.g. dehorning rhino) on the social behaviour of species
- Collecting evidence on the international trade in products from endangered species (such as lion bones)
- Assessing the potential economic value of invasive alien plants through various value chains.

Strategic Objective 5. Conservation and management of biodiversity is improved through the development of an equitable and suitably skilled workforce

This strategic objective speaks to the need to develop scarce skills amongst all population groups in order to be able to better conserve and manage the country's biodiversity. Skilled staff needs to be developed and retained both in terms of biodiversity management and science. Strategic Objective 5 is supported by one associated outcome, namely, a national assessment is conducted of the staff capacity and availability of resources to contribute adequately to sound, realistic and scientific decision making.

Several respondents identified the urgent need for a national capacity assessment in the area of biodiversity and conservation. This would cover the skills and capacity of organisations conducting scientific research, as well as skills and capacity in government and nature conservation organisations. Assessing the ability of universities to turn out work-ready graduates in the field of biodiversity was considered, as well as the extent of training programmes to enable the necessary skills and competencies. Stakeholders indicated that this should be a priority for the coming year.

Strategic Objective 6. Effective knowledge foundations, including indigenous knowledge and citizen science, support management, conservation, monitoring and sustainable use of biodiversity

See the next section on medium- to long-term evidence needs.

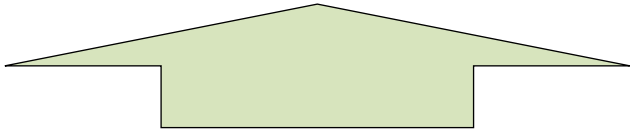
4 FOUNDATIONAL AND LONG-TERM EVIDENCE NEEDS

4.1 Introduction

The achievement of all the strategic outcomes set out in the NBSAP depend to some extent on having access to foundational information on biodiversity that is regularly updated and validated. This includes the knowledge required to understand the components of biodiversity and their spatial distribution, but goes beyond taxonomy and surveys of species, although there are gaps in taxonomy that require urgent attention. In all of our engagements with stakeholders, participants have identified other forms of vital foundational information on which they depend for further research, such as land cover data, monitoring and surveillance data, environmental data, description and classification of ecosystems. These needs must be addressed as part of the research strategy.

These are set out in Table B over the page, and expanded on in the rest of this chapter. The diagram below shows how they relate to each other and to the overarching goal of providing robust evidence to inform decision-making.

Robust evidence for policy and decision making relating to the management of South Africa's biodiversity and its benefits to the economy, society and human wellbeing



STRATEGIC EVIDENCE OBJECTIVES:

MEDIUM- AND LONG-TERM EVIDENCE

Mechanisms are in place that provide a bridge between knowledge generation, policy formulation and decision making resulting in a relevant and accessible evidence base for environmental decision making

Knowledge of the contribution of biodiversity to economic development and human wellbeing provides specific and quantified evidence to make the case for biodiversity and promote the mainstreaming of biodiversity in key economic sectors

Knowledge and evidence is available, and tools and models are developed, to support planning and management to reduce the loss of biodiversity and maintain the ecological infrastructure required to deliver goods and services

Foundational information on South Africa's biodiversity is available to enable planning and management of biodiversity and ecosystem services and to facilitate monitoring and evaluation of targets.

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Table B: MEDIUM- TO LONG-TERM PRIORITIES FOR EVIDENCE: SUMMARY OF EVIDENCE OBJECTIVES AND DETAILED EVIDENCE NEEDS

This table sets out the foundational needs for evidence in the sector. In many cases these will need to be built and maintained over time, as long-term datasets or evidence that needs to be regularly updated.

Strategic Evidence Objective	Urgency of the evidence need		Priorities to address the objective
	2-5 years	6-10 years	
Objective 1. Foundational information on South Africa's biodiversity, including information from indigenous knowledge, is available to enable planning and management of biodiversity and ecosystem services and to facilitate monitoring and evaluation of targets.			
2.1. A coordinated programme for taxonomy is designed and implemented that results in usable products such as checklists, identification tools, and revisions of major groups (which provide accurate descriptions and classifications of taxa with associated information about distribution) to facilitate other research that builds on this foundation.	□		• A national monitoring system for biodiversity is developed and carefully prioritized to ensure adequate commitment and resources. • A national strategy is in place to identify priorities for taxonomic research • Coordinated research programmes are established and funded to address taxonomic priorities and to develop and apply tools to support taxonomy and identifications (e.g. barcoding) • Distribution maps are available for key taxonomic groups including population maps for predators such as leopard and cheetah • The spatial extent of different ecosystems is mapped and accessible to different user groups • Classification systems have been developed and published for all terrestrial and aquatic ecosystems, including wetlands • A national framework for monitoring biodiversity at the ecosystem level is developed and funded to allow systematic monitoring of ecosystem health • Regularly updated land cover data are available to support ecosystem assessments. • An up-to-date repository of indigenous and local knowledge systems for key biodiversity assets is developed and maintained • Citizen science contributions are mobilised to increase resources for monitoring.
2.2. The spatial distribution of key components of biodiversity, including invasive alien species, is recorded and mapped.	□	□	
2.3. A national ecosystem classification system is in place that incorporates terrestrial and aquatic ecosystems.	□	□	
2.4. A national system for monitoring ecosystem health is designed and implemented.	□	□	
2.5. A National system for monitoring the status and trends of target species is designed and implemented	□	□	
2.6. A programme is in place for recording and communicating indigenous knowledge about management and conservation of biodiversity assets		□	
Objective 2. Knowledge and evidence are available, and tools and models are developed, to support planning and management to reduce the rate of loss of biodiversity and maintain the ecological infrastructure required to deliver goods and services			
2.1. Research on spatial planning supports the evidence based achievement of targets for protected areas and leads to better planning for climate change impacts and the maintenance of ecological infrastructure as well as improved planning in the marine environment.	□		• Assess the effects of climate change on the natural distribution of all indigenous species, to help identification of sensitive species that can serve as indicators • Biodiversity plans are in place for marine and freshwater ecosystems including wetlands. • Improved information systems are in place to support planning. • Promote research that provides a sound basis for maintaining accountability and measuring
2.2. The knowledge base for reducing the loss of			

Strategic Evidence Objective	Urgency of the evidence need		Priorities to address the objective
	2-5 years	6-10 years	
biodiversity in landscapes and seascapes, through better management of protected areas and the identification of biodiversity compatible production practices, is significantly improved.			performance on the part of agencies responsible for managing complex natural systems. • Strengthen research on the protected area network to understand its efficiency for different species • Promote the incorporation of freshwater planning principles in the future design and expansion of national parks • Preparation of action plans that set out the work required for each species and habitat. • Assess landscape connectivity and buffering of sensitive areas to ensure representativeness of the conservation network in the face of climate change • Promote interdisciplinary research on biological invasions, species in use, and sustainable use of goods and services to overcome difficulties in implementation of policies and regulations. • Continue and strengthen support for the effective management of invasive species including research on the most effective way to achieve social (e.g. job creation) and environmental objectives. • Strengthen research on the wildlife economy including exploring opportunities for biodiversity friendly harvest alternatives and linking aspects of the wildlife economy with climate change adaptation and livelihoods programmes. • Assess the impact of genetically modified organisms relative to other impacts on biodiversity. • Promote interdisciplinary research programmes that integrate social, economic and ecological questions to increase our capacity to deal with key issues such as climate change, invasive species and illegal or non-sustainable harvesting of wildlife. • Develop appropriate indicators to monitor the performance of agencies engaged in conservation actions to avoid simplistic quantitative measures and support meaningful biodiversity outcomes through adaptive management. • Development of an ecosystem integrity index • Development of headline biodiversity indicators across realms (e.g. freshwater, marine, terrestrial, estuarine) • Assessment of the future role of big data in monitoring biodiversity in future • Research into the risks of release of captive bred animals and alien species into extensive systems • Research into the effects of land degradation and restoration activities on biodiversity and the provision of ecosystem services • Forecasting the likely impact of future climate-related events (e.g. drought) on biodiversity and management options
2.3. Ongoing support for research on biological invasions leads to a better understanding of the invasion process, an improved knowledge base for managing established and novel invasive species and assessing risks, and the evidence base required to support regulations.			
2.4. Improved understanding of the ecological basis for the provision of ecological goods and services as well as the ecological, social and economic dynamics affecting the long term provision of services.			
2.5. Understanding the ecological and socioeconomic aspects of the wildlife economy, including carrying capacity (people and wildlife), species in use, bioprospecting, species' responses to harvesting, implications of different management systems, development of appropriate models of sustainable use, and monitoring of target species, supports a sustainable wildlife economy.			
2.6. Research, monitoring and modelling of the impacts of global climate change provide evidence to manage the risks and reduce the vulnerability of biodiversity to climate change and to manage ecosystems in a way that strengthens people's capability to adapt to climate change.			
2.7. Identification of key indicators to guide monitoring efforts			
2.8. Research on biodiversity considerations for other sectors (agriculture, mining, urban planning) provides evidence for more effective management of biological resources			
Objective 3. Knowledge of the contribution of biodiversity to economic development and human wellbeing provides specific and quantified evidence to make the case for biodiversity at a policy level, guide decision making, and promote the mainstreaming of biodiversity in key economic sectors with a high impact on biodiversity.			
3.1. The valuation of biodiversity and ecosystem services using standardised methods provides evidence for the value of biodiversity to economic development and of			• Assessment of the economic contribution to biodiversity conservation and management made by other sectors

Strategic Evidence Objective	Urgency of the evidence need		Priorities to address the objective
	2-5 years	6-10 years	
the relative contributions of biodiversity to different economic sectors.			• Quantify the income generation potential of biodiversity and conduct an overall cost-benefit analysis of the push to make conservation areas 'pay their own way'; clarify alternative models for improving the biodiversity conservation in conservation areas • Develop and test models for equitable sharing of benefits arising from the utilisation of the indigenous biological resource • Quantify the economic value of carbon sequestration via biodiversity assets (e.g. spekboom, indigenous hardwoods) • Develop and undertake a strategic set of studies aimed at supporting biodiversity mainstreaming into other sectors, including both monetary and non-monetary forms of valuation. • Develop and test non-monetary forms of valuation with different stakeholder groups. • Implement the local version of The Economics of Ecosystems and Biodiversity (TEEB) • Complete the ProEcoServe project to identify further research needs. • Strengthen capacity in social sciences to support mainstreaming including: effective use of indigenous knowledge, ecological economics, and studies relating to changing behaviour in target sectors • Promote research on the social and economic costs and benefits of invasive species control and the rehabilitation of ecosystems (wetlands). • Promote research on the contribution of biodiversity to job creation. • Promote research on the opportunities for sustainable use of biological resources in conservation areas and benefits of protected areas to a range of stakeholders • Promote research on the development of a national land zonation strategy that enables long-term sustainability of biological resources • Promote research on South Africa's performance in management of protected areas (including UNESCO biosphere reserves and World Heritage Sites) in relation to other countries • Develop case studies of the changing nature of the relationship between conservation and society, and the contribution conservation practices can make to social justice • Map ecosystem services in national parks to understand the relationship between protection of biodiversity and provision of ecosystem services
3.2. Clarification of the contribution of carbon sequestration projects using biodiversity assets provides evidence for the contribution of biodiversity to the national objective of carbon reduction			
3.3. Knowledge of the contribution of biodiversity and ecosystem services to job creation, livelihoods and poverty reduction, as well as human health and wellbeing, provides evidence to support policies and actions that maintain biodiversity.			
3.4. Improved knowledge of the inputs from biodiversity to specific economic sectors is available to strengthen mainstreaming in these sectors (e.g. agriculture, water, energy, tourism).			
3.5. Improved understanding of the social dynamics associated with achieving behaviour change in social-ecological systems provides a basis for more successful mainstreaming.			
3.6. Improved understanding of the current and future value of the indigenous biological resource promotes effective policies for sustainable growth in the biodiversity economy			
Objective 4. Mechanisms are in place that provide a bridge between knowledge generation, policy formulation and decision making resulting in a relevant and accessible evidence base for environmental decision making.			
1.1. The carrying out of regular scientific assessments that focus on priority areas for decision making and that assess contested areas of knowledge from different perspectives provide policy and decision makers with accessible and useable knowledge.			• Identify and activate a list of priority biodiversity assessments to deal with issues of most importance to policy/ decision makers, especially for issues where the evidence is contested. • Review existing forums for science-policy interface to see how they can be strengthened or expanded to deal with key issues and to strengthen the co-creation of knowledge. • Research the relationship between people and protected areas • Develop communications activities with local communities and schools on the social-ecological systems, benefits of biodiversity and stewardship of protected areas
1.2. Forums and other forms of communication are maintained and established for the exchange of ideas between communities of researchers and			

Strategic Evidence Objective	Urgency of the evidence need		Priorities to address the objective
	2-5 years	6-10 years	
policy/decision makers, the development of relevant research programmes and the interpretation of research results.			• Explore and develop opportunities for the co-management of research funding to strengthen the interaction and feedback between research, policy and implementation. • Strengthen Information management systems in order to make existing scientific knowledge available to policy/decision makers. • Provision of enabling services to ensure that existing data on biodiversity are readily accessible, up-to-date, and maintain information on long-term trends. • Promote research on decision support systems and developing the capacity to apply statistical tools to support decision making.
1.3. An adaptive management approach to funding is adopted that enables research and policy/decision making communities to adapt funding priorities based on feedback from existing research programmes.	□		
1.4. A Biodiversity Management Information system is in place that provides easy access to relevant knowledge and information	□		
1.5. Ensure evidence is available to develop national reports to key international conventions such as the Convention on Migratory Species (CMS) and agreement on the conservation of African Eurasian Migratory Waterbirds (AEWA)	□	□	

4.2 Foundational information on South Africa's biodiversity

Strategic objective: Foundational information on South Africa's biodiversity, including information from indigenous knowledge, is available to enable planning and management of biodiversity and ecosystem services and to facilitate monitoring and evaluation of targets.

4.2.1. Taxonomy

Accurate species-level information, and an understanding of the relationships between species, is a fundamental building block for many aspects of biodiversity knowledge generation and decision making. Taxonomic research is therefore an important component of the Biodiversity R&E strategy. However, we know that the discipline of taxonomy is in decline globally and very few countries have sufficient resources to invest in comprehensive taxonomic assessments of all their species. This is particularly true in a species-rich country such as South Africa and our challenge is to mobilise and enable taxonomy and the associated biosystematics research so that it serves the broader needs of biodiversity management and the realisation of benefits to society. Based on the needs identified for other strategic objectives, the taxonomic expertise should at least be able to provide taxonomic information for the following taxa.

- Groups with high levels of endemism and many range restricted species
- Groups with high potential for introduction and invasion
- Harvested groups for food, medicine and trade
- Groups that will be useful in monitoring impacts of global change
- Groups that are important in major ecosystem processes

It is also important that our investment in taxonomy results in usable products such as checklists and revisions of major groups to facilitate other research that builds on this foundation. Phylogenetic research is a powerful tool for understanding relationships but the increase in phylogenetic research appears to have coincided with a decrease in taxonomic revisions. Support for phylogenetic research as part of this strategy needs to focus on projects that address the priorities of the overall strategy.

If we are going to use our limited taxonomic expertise wisely, we also need to develop and adopt technologies that facilitate the identification of priority groups and the development of mechanisms to identify specimens in bulk ecological / monitoring samples. The development and application of DNA barcodes, electronic keys, virtual museums and information networks that enable identification need to be supported and there should be increased co-ordination to ensure wise use of resources and avoid duplication of work

4.2.2 Spatial distribution of biodiversity

In addition to classifying biodiversity, there is a key need to define the spatial patterns of biodiversity, to map the bio-geographic patterns for different components of biodiversity including invasive alien species, and to understand how these may be changing. Improved spatial data are needed to plan for protected areas and to assess their effectiveness in meeting biodiversity protection and resource management objectives. At the species level, it is

particularly important that we have accurate maps for threatened species as well as local endemics with restricted distribution ranges as these species are most likely to be sensitive to habitat loss.

Given the high number of threatened and endemic species in South Africa, mapping the distribution of even these species will be a demanding task, requiring extensive fieldwork. An important question is therefore to what extent we can use certain taxonomic groups (e.g. plants, birds, butterflies) as surrogates of total biodiversity and to what extent life forms or functional groups (e.g. pollinators or parasitoids for insects) can be used to gain an overall understanding of changes in biodiversity.

The task of obtaining distribution data can also benefit substantially from the contributions of civil society. We have a good history of developing citizen science survey and monitoring projects, including atlas projects for birds, reptiles, frogs, butterflies, proteas, and spiders, as well as reef monitoring and plant monitoring projects. These initiatives need to be supported and new projects should be developed that can harness citizen science collaboration from divers, fishers, bird watchers, and people interested in nature. A national fish atlas was identified as a priority in the 2004 National Spatial Biodiversity Assessment and the need for atlases of threatened, indicator species, key resources and species that can contribute to current research efforts remains a priority. In order to support these projects and their value to biodiversity management, we must have the statistical tools and expertise to analyse and interpret the data. Statistical/mathematical ecology is a scarce skill and needs to be strengthened (see under 4.3).

4.2.3. Ecosystem classification

The NBA highlighted the importance of mapping and classifying ecosystems as an essential foundation for monitoring, assessing and managing biodiversity. Ecosystem classification also provides a foundation for upscaling empirical data on ecosystem services and human well-being to the landscape level, using scientifically-based rules connected to functional ecosystem types. South Africa has some of the best ecosystem mapping and classification in the world, with a long history of vegetation mapping and more recent progress in the aquatic environments. This work amounts to an emerging national ecosystem classification system, which is an important step towards setting and achieving biodiversity targets for different ecosystem types, following the model based on vegetation types in the terrestrial environment. Research that leads to a national system of ecosystem classification must be prioritised.

While South Africa has a relatively well-advanced and widely accepted map of vegetation types (serving as terrestrial ecosystem classification), maps of river and wetland ecosystem types (serving as freshwater ecosystem classification) are less advanced. So too are maps of estuarine, coastal and offshore marine habitat types (which serve as marine and coastal ecosystem classification). A strong focus should be given to generating aquatic ecosystem type maps that are as advanced and widely accepted as the vegetation type map. This will include obtaining scientific and policy consensus on ecosystem types in terms of their spatial distribution, ecosystem type names, and descriptions of each ecosystem type (e.g. physical characteristics, dominant species, characteristic species). The lack of such ecosystem classification maps prevents the listing of threatened ecosystem types for rivers, wetlands, estuarine and marine ecosystems. It also hinders interpretation of ecosystem service research at a landscape scale, which is particularly problematic given the important role freshwater, estuarine and marine ecosystems play in this regard.

4.2.4. Monitoring the Condition of Ecosystems

In addition to a national system of ecosystem classification, the National Biodiversity Assessment (NBA) highlighted the need for regularly updated, countrywide data on the condition of ecosystems. Without good data on ecological condition, it is not possible to assess ecosystem threat status or to provide meaningful statistics on the status of biodiversity. Nor is it possible to interpret the effect that ecological condition may have on the delivery of ecosystem services and hence on human well-being. The Department of Water Affairs' system of Present Ecological State categories provides the basis for ecological condition assessment for rivers, wetlands and estuaries. The possibility of applying this type of approach in the terrestrial and marine environments should be explored. Research that explores the use of long term *in-situ* monitoring to calibrate the assessment of habitat condition will be important to understand complex changes in ecosystems and to interpret the effects of these changes on ecosystem function. Expert driven assessments of ecological condition, such as those generally provided by the Present Ecological State approach, are helpful, but empirical monitoring is essential for reliable assessment of trends over time. Monitoring of ecosystem health, especially for aquatic ecosystems (rivers, wetlands, estuaries and marine) ideally requires site-based monitoring of cumulative effects in conjunction with reliable data on pressures (e.g. land use, water abstraction, point pollution sources, harvesting rates).

One of the priorities for assessing ecological condition in terrestrial ecosystems is the need for regularly updated maps of land cover for the country. The lack of adequate land cover data diminishes our ability to undertake ecosystem assessments, produce a national map of degradation in the terrestrial environment, quantify the modification in freshwater flow to the coast on a watershed scale, and evaluate the impacts of climate change. The absence of land cover data has been repeatedly identified as a constraint and needs to be urgently addressed. There also needs to be compatibility between regularly updated land cover maps, so that trends over time can be detected and measured.

4.2.5. Monitoring at the species and genetic level

Our understanding of biodiversity also needs to be strengthened through monitoring of species. It is not possible or necessary to monitor everything but we need to understand changes in priority groups that provide information on the status of our biodiversity as well as responses to particular pressures (e.g. land use and climate change). As part of our commitments to Aichi targets and national regulations we need information on trends in threatened species, invasive species, as well as species that are in trade. In addition, we need to a system to identify and monitor appropriate indicator species. Red Lists of threatened species provide informative snapshots of threatened status and a Red List Index (change in Red List over time) has been identified as an indicator of the status of species (e.g. for the Millennium Development Goals). However, the Red Listing process does not detect change very quickly so more dedicated monitoring and research is required to fill this gap and to gain an understanding of how status changes in relation to different threats and conservation actions.

4.3 Knowledge for managing biodiversity and responding to change

Strategic objective: Research and evidence are available, and tools and models are developed, to support planning and management to reduce the rate of loss of biodiversity and maintain the ecological infrastructure required to deliver goods and services

Over the past half century, the management of our biodiversity has been driven by several different objectives. Initially, the focus was mostly on the conservation of our large terrestrial vertebrates, especially the big charismatic species. During the 1980's the emphasis shifted to a more holistic view of biodiversity so that areas were secured and managed to ensure the survival of a wide range of species and habitats. More recently, scientists and managers have been further challenged to consider management options that aim to secure the long term provision of ecological goods and services as a key contribution to human wellbeing, particularly since the publication of the Millennium Ecosystem Assessment in 2004. The core message is that the earth is an integrated system in which the degradation of our natural ecosystems affects human wellbeing through the loss of ecological goods and services for health, food, safety, water and energy.

At the same time, there has been a significant shift in ecological thinking from one of stable or successional environments to a realisation that ecological systems are more dynamic and may often be responding to global drivers of change. These shifts in biodiversity management objectives and our aspiration to live sustainably, which has been framed as "living within the planet's ecological boundaries" by the Future Earth Consortium, means that we need a new approach to knowledge generation that supports adaptive management and decision making.

The Biodiversity Act relies on an understanding of species and ecosystem level dynamics to support various regulations, including the management of alien and invasive species and the ecological impact of genetically modified organisms. In situations where we are not sure how ecological systems will respond or we need to meet multiple objectives (e.g. conservation and provision of ecosystem services), it may not be possible to provide unequivocal evidence that supports a particular course of action. This means that smart policies need to be developed (e.g. to balance the costs and benefits of certain alien species that are both useful and invasive) and risk management becomes an important factor in policy development. This, too, introduces a new way of thinking about the management of biodiversity and requires the development of new knowledge and decision support tools.

4.3.1. Spatial planning to maintain biodiversity and ecological infrastructure

South Africa has been at the forefront in the development and application of conservation planning tools. Our scientists were among the first to develop and test systematic spatial planning tools and these tools and methods are now widely used at national, provincial and even municipal levels. The planning community is also well organised and SANBI hosts an annual planning forum that brings together practitioners and stakeholders. This has contributed to the effectiveness of biodiversity management in South Africa. Yet, spatial planning is an ongoing activity that needs to be responsive to changes in social, economic, and ecological systems. New economic opportunities can present novel challenges (e.g. fracking in the Karoo), changes in scientific understanding can alter the criteria for planning (e.g. the emergence of the concept of ecosystem services), new technologies are developed that need to be applied, and shifting or competing social interests can affect planning (e.g. the Aichi 2010 targets for landscapes and seascapes are considerably higher than those that we have achieved so far). This means that continued investment in research to support biodiversity planning is required.

South Africa has identified objectives for terrestrial and marine protected areas and has also committed to the Aichi targets, of which Target 11 specifies that by 2020 at least 17% of terrestrial and inland water areas and 10% of coastal and marine areas will be conserved through a network of protected areas. Research and planning is required to ensure that the achievement of these spatial targets provides the greatest benefit for the protection of biodiversity. As part of reporting on targets, we will need evidence to verify the achievement of spatial targets and determine the effectiveness of the protected area network for achieving biodiversity and resource management objectives.

In the Environmental Sector Outlook, the planning for climate change received a red light indicating that there were gaps in knowledge required to respond to changes in ecosystems and shifts in the distribution of species. Essentially planning for climate change addresses two different questions. First, how are different components of biodiversity likely to move or persist in different ecosystems and how do we plan to accommodate these changes so that we retain effective protected areas? And, second, how does biodiversity enable our human societies to adapt to the impacts of climate change and how do we incorporate this knowledge into spatial planning? Responding to climate change is expected to have significant and potentially costly implications for land use decisions so we need good evidence and well substantiated design parameters to inform planning decisions.

We have been developing the concept of ecological infrastructure to define those parts of our natural ecosystems that are essential for the flow of ecosystem services and the achievement of our national development objectives. Research is required to strengthen the conceptual framework for ecological infrastructure and to identify optimal design features for maintaining process areas that are intended to deliver either individual services or bundles of services. A better understanding of the spatial dimension of ecological goods and services is required to support planning and action. Both adaptation to climate change and identification of ecological infrastructure require stakeholder input, and therefore need to be supported by social science research.

4.3.2. Reducing the loss of biodiversity in landscapes and seascapes through habitat management and appropriate use

The ongoing loss our biodiversity has been flagged as an area of concern in the Environmental Sector Outlook and has been identified as one of the areas where evidence is required in the Environment R, D& E framework. The key factors that contribute to biodiversity loss are well known and have been highlighted in the Millennium Ecosystem Assessment, the NBA and other assessments. Habitat loss and transformation, biological invasions, over harvesting, nutrient enrichment, and global climate change have all been identified as key drivers of biodiversity loss. For the purposes of this strategy, biological invasions (section 4.2.3), over harvesting (section 4.2.4), and climate change (section 4.2.5) are dealt with separately because they have specific regulatory and policy inputs. The main focus of this section is therefore on reducing loss due to habitat management, habitat destruction and the transformation of terrestrial and aquatic environments.

The retention of biodiversity in protected areas is a key component of South Africa's overall biodiversity strategy. This implies that the management of biodiversity within our protected areas will be done in such a way that it provides the best outcomes for biodiversity. Achieving biodiversity objectives within contained areas, with multiple objectives (e.g. tourism and conservation), and often constrained by social or economic factors (e.g. risk of fire, ethical responses to culling) requires an adaptive approach to protected area management where management interventions can be debated, tested and evaluated. This approach needs to be supported by appropriate research across various spatial and temporal scales.

Although habitat loss and transformation have been clearly identified as key issues for biodiversity management, we still have inadequate knowledge for managing transformed ecosystems, engaging with production sectors to reduce negative impacts, or supporting regulation and enforcement. In many cases, research on key impacts (e.g. terrestrial habitat fragmentation) has been patchy without providing a coherent body of knowledge that can support policy development and decision making. We don't know the critical thresholds for connectivity or the minimum area required to maintain biodiversity and ecosystem functioning in different ecosystems. Research on connectivity has focused mainly on terrestrial ecosystems but connectivity is also important in marine environments and needs to be included in research programmes.

Biodiversity friendly production and extraction practices are essential for both terrestrial and aquatic ecosystems. We need a better understanding of the impacts of existing and emerging pressures on different ecosystems (e.g. cultivation, overgrazing, farming methods, desalination plants, freshwater flow reductions) and what sorts of use are compatible with biodiversity objectives through the reduction or mitigation of negative impacts. Examples in the terrestrial environment would include appropriate farming and mining practices whereas in the marine environment research on innovative ways to mitigate mining, petroleum and mariculture impacts need to be addressed.

4.3.3. Biological Invasions

Invasion of our ecosystems by alien species is one of the major factors affecting our biodiversity and the delivery of important ecological services. The current policy framework for invasions recognises that there are more than 9000 alien species in the country but that they don't all need to be controlled. The policy adopts a risk management approach where regulation and resources for control or eradication are invested in those species with existing impacts or with a high risk of becoming invasive. At a basic level, this means that we need to understand the processes leading to naturalisation and invasion and the factors that transform some species from benign alien species with little or no impact to ones that spread and change ecological functions. This includes understanding pathways of introduction and dissemination of alien species, the genetics of invading populations, and the capacity to predict invasiveness.

The Biodiversity Act and the Conservation of Agricultural Resources Act (CARA) provide a framework and regulations for invasive species with a focus on assessing risk, restricting activities that enhance the spread or impact of alien species, and managing listed invasive species. These components all require evidence to support enforcement and research to improve implementation. Risk assessment is a relatively new area of work and skills and capacity need to be developed. The listing of species requires evidence to show that species are invasive and are impacting on biodiversity or ecosystem services, or at least to support any assessment of these potential risks. In addition, our policy framework acknowledges that some invasive species have value to South African society, e.g. for timber, aquaculture and the pet trade, so the knowledge base must include social research on perceptions and benefits to be able to inform regulations and decision making that strive for a balance between the benefits of particular invasive species and their impacts on broader society.

We understand certain types of impacts of invasive species quite well, especially invasive plants (e.g. impacts on water resources and fire regimes); such information has already informed major interventions for managing selected plant species through the *Working for Water* programme. Nevertheless, further research is required to examine all dimensions of impacts of key invasive species in all taxonomic groups and across all biomes. Better understanding of how to deal effectively with the growing impact of invasive species is urgently needed. Managing existing invasions is costly and both the cost and effectiveness

of management programmes depends on the strategy adopted and the methods of control. Research needs to support both the development of strategies and methods to increase effectiveness as well as the implementation of control programmes.

- The need for better spatial plans to support the management of invasive species was identified in section 4.2.1. However, it needs to be emphasized that spatial planning, including further development of tools to aid objective and systematic spatial allocation of funding, is a priority in order to develop effective regional strategies that optimise the use of resources for maximum impact. Comprehensive strategic plans for the management of key invasive species (or groups of species) are required.
- Good maps of the current distribution of invasive species are crucial for the strategic allocation of resources to manage invasive species. Distribution mapping is included in the 'foundations' section (4.1) but mapping invasive species is a challenging and expensive task. Research directed at yielding more efficient and accurate mapping of invasive stands (with the capacity for regular updating and rapid dissemination of information) should be supported.
- Further research is also required on the impact of clearing operations and to determine when active rehabilitation is required (most programs assume that areas cleared of invasive species will self-repair). Research should seek to determine key thresholds that define appropriate interventions for addressing restoration.
- Given the major cost of dealing with established invasive species, there is an urgent need to develop methods to detect and identify "emerging" invaders (species in the very early stages of the invasion process). 'Emerging' invasive species pose particular challenges for control and regulation and require focused research on the best methods for detection, evaluating the risks of spread, and the potential for eradication.
- The control of invasive species is often justified on the basis of ecosystem service benefits, such as improved water flow in mountain catchments. More research on the benefits of clearing invasive species is required to motivate for resources and to prioritise those control programmes that provide the greatest benefits.
- Some of the most widespread and damaging invasive species have commercial of other benefits in some contexts, while causing major impacts and costs in others. Research is required to ensure that objective cost: benefit analyses and other tools are applied to inform policy for such conflicts of interest.

Novel organisms include species that have been subjected to genetic modification and public concern is especially focused on transgenic organisms where novel genes have been introduced into a target species (e.g. maize). South Africa has adopted this technology within a risk assessment framework in which GMO's are strictly regulated and are subjected to a risk assessment prior to release into the environment. The environmental sector is included in the risk assessment process and we need evidence to support inputs regarding risks to biodiversity. In addition, SANBI is mandated to monitor and report on any impacts of GMOs after their release into the environment and research is required to support this function. Given the anticipated increase in GM applications, and the rapid development of synthetic biology, research that identifies generic issues (e.g. impacts of gene flow), develops suitable techniques for monitoring, and evaluates the impacts of novel organisms within a broader context of biodiversity conservation should be prioritised.

4.3.4. Ensuring the long term provision of ecological goods and services

Our Government is committed to development goals and the National Development Plan outlines a series of development objectives. There is increasing recognition that our development objectives cannot be achieved if environmental degradation results in the loss of biodiversity and important environmental services. The Millennium Ecosystem Assessment (MA) defined these services simply as the benefits that people derive from ecosystems and can include such benefits as flows of clean water, maintenance of species used for medicine, provision of pollination for crops, and resilience to outbreaks of pests and diseases. The MA noted that people's dependence or impacts on ecosystem processes are unsustainable in more than 60% of ecosystems so that there are real risks to human wellbeing and development.

South Africa is also committed to overcoming desertification through actions that support the UN Convention to Combat Desertification (UNCCD). Desertification and degradation can be viewed as a loss of ecosystem services so there is a strong link between an understanding of ecological goods and services and efforts to combat desertification.

Although the concept of ecosystem services is now well established the knowledge required to underpin policy and actions is still rudimentary and requires integrated research on social–ecological systems. To ensure the long term provision of ecosystem services, we need to know the ecological limits to the flows of particular ecosystem services, how a change in ecosystem state influences the flow of services, and whether different services respond independently to a change in state so that an attempt to maximise one service may lead to decline in another. At the same time, our intention to provide a sustainable flow of services is dependent on how benefit flows will be allocated and regulated, who decides which services take precedence, and which ecosystem states should be maintained to deliver those services. This means that we need research to understand the social dynamics affecting distribution and governance of ecosystem services including asymmetries in power and economic status among potential users and the tradeoffs between different management objectives (e.g. poverty alleviation or biodiversity conservation). Of particular relevance to this strategy is the need for research on the link between biodiversity and the delivery of ecosystem services and on governance systems that promote biodiversity objectives.

Linked to the delivery of ecosystem services is the understanding that healthy functioning ecosystems provide the 'ecological infrastructure' for the provision of these services. This is an emerging concept that requires further conceptual development and research to support policy and implementation. We currently know relatively little about what ecological infrastructure is required to secure particular services. There is also an intention to restore degraded ecological infrastructure to secure the provision of ecosystem services. Restoration is costly and such programmes need to be supported by research that can identify priorities for restoration and test the outcomes of different restoration methods and strategies.

Provision of freshwater is one of the most important ecosystem services in South Africa and freshwater ecosystems harbour and support substantial biodiversity with both intrinsic value and functional importance for other services (e.g. fishing). Despite their importance, our rivers, wetlands and estuaries have been classified as some of the most threatened ecosystems in the country, and are under increasing pressure from agricultural cultivation, urban development, mining, dam construction, water abstraction, and poor grazing management that disrupt water flows, increase sediments, and pollute water bodies. We urgently need to improve our understanding of freshwater ecosystems in order to manage impacts on these systems, including a proper understanding of possible negative impacts of large-scale groundwater abstraction on the ecological health of rivers and other wetlands.

Wetlands are impacted by what happens in surrounding habitats, eutrophication, alteration of water regimes and transformation. Our limited knowledge indicates that they contain unique elements of biodiversity, support key ecosystem services and play a crucial role in supporting terrestrial biodiversity but there are very few explicit measures of any of these. Even in the absence of evidence, the *Working for Wetlands* programme has begun a programme for rehabilitating wetlands and this programme needs to be informed by research that identifies priorities in terms of both water provision and biodiversity benefits and that shows the improvements derived from rehabilitation.

4.3.5. Using species sustainably

A wide range of our living resources are used for food, medicine, energy, horticulture, crafts and recreation. The main research focus for sustainable harvest of living resources has been on fisheries and other marine species, due to the scale and economic contribution of these resources. Research to support sustainable management of these resources needs to be maintained and strengthened to address resources where there is inadequate knowledge to support sustainable use. In recent years, reports on trade in wild medicinal species and game animals indicate that the economic and social benefits of this trade are substantial and, in some aspects, as great as fisheries. Yet there has been very little research to verify their value or to establish a knowledge base for managing these species to ensure sustainability. An additional challenge for all aspects of wild harvest is the need to understand the social and economic dynamics that influence sustainable use (in both traditional and commercial systems), including the drivers of illicit trade in commodities such as abalone, lobster, rhino horn, ivory, cycads, succulents, and reptiles. We desperately need a better understanding of positive and negative feedbacks that preserve or destabilize a specific sustainable state, and how science, policy, enforcement and other inputs can influence these feedbacks.

Research on sustainable use needs to provide evidence for several components of the Biodiversity Act. Our TOPS and Convention on International Trade in Endangered Species (CITES) regulations list species that are threatened predominantly by unsustainable harvest levels or translocation associated with trade, and one of the intentions of the Bioprospecting Access and Benefit-Sharing (BABS) regulations is to manage the impact of bioprospecting on wild populations. Knowledge of population status, an understanding of species' responses to harvesting or other forms of use, and the risks associated with wildlife translocation are required to facilitate decisions regarding sustainable use. Scientific support for enforcement is also required through technologies such as barcoding, genetic fingerprinting, satellite tracking and forensic tools.

Development of models and simple but adequate monitoring protocols are required to support evidence based assessments of sustainable use. This field is likely to require detailed demographic analysis of target populations of plants or animals.

Our wildlife trade happens within the broader context of land use decision making and it is almost impossible to assess harvest impacts without a better understanding of the interactions between different types of land use and the factors driving wildlife trade. Understanding alternatives to wildlife trade and working together with communities to understand needs and customs should form part of this research. South Africa differs from many other African countries in that almost all larger wildlife species occur within fenced and managed areas, ranging from large national protected areas to small game enclosures. Trying to manage harvest as if from a single free ranging population is an unhelpful anachronism. There is an urgent need for research that supports better policy development and decision making regarding wildlife trade by providing critical analysis of how different wildlife management systems, including consumptive and non-consumptive use, contribute to improved biodiversity and the conservation of species of special concern.

4.3.6. Responding to Climate Change

Global climate change will influence species distribution and abundance and will transform ecosystems through changes in species composition and relative abundance as well as ecological processes (e.g. fire). This means that our efforts to reduce the loss of biodiversity need to consider the impacts of climate change. The spatial planning required to mitigate some of the negative impacts was outlined in Section 4.2.1 but we need a far better understanding of how biodiversity will respond to climate change in order to plan and manage effectively.

- Where is climate change expected to have the greatest impact on biodiversity and what tools do we use to monitor trends in these vulnerable ecosystems?
- How are large scale processes such as fire and bush encroachment being influenced by global climate change and how should we respond in terms of managing biodiversity? These questions may be particularly relevant in large protected areas where managers will need a robust evidence base to guide their management decisions.
- How do organisms respond to climate change and are there predictable patterns in terms of resilience, migration, or rapid adaptation to changing climate? In order to understand the requirements for mitigation and adaptation to climate change, we need to understand whether organisms can move across different landscapes as well as the potential rate of evolution in vulnerable ecosystems. This means that we need to move beyond climate envelope modelling towards a more mechanistic understanding and engage in experimental tests of responses under different conditions.

In addition to the impacts that climate change will have on biodiversity, our government acknowledges that healthy ecosystems are critical for our own adaptation to the unavoidable impacts that climate change will have on human health and wellbeing. The national policy framework aims to build and sustain social, economic and environmental resilience as part of an adaptation response strategy. The management of risk and the reduction of vulnerability needs to be informed by research and assessment of different responses to climate change and their implications for the economy and livelihoods, as well as better knowledge regarding how we can manage biodiversity and ecosystem services to enhance adaptation by South Africa's people. Some of the key questions relating to the link between biodiversity and ecosystem based adaptation to climate change are as follows.

- How can planning and management of priority marine, coastal and terrestrial ecosystems contribute to climate change resilience?
- Which ecosystem services are critical for climate change adaption?
- What level of ecosystem integrity is required to enable ecosystems to adapt naturally to climate change and how can this be factored into adaptation strategies?
- Which adaptation strategies will deliver multiple benefits across several sectors (for example, benefits for the safety of human settlements as well as benefits for agriculture and natural ecosystems)?
- Is it possible and desirable to establish novel ecosystems for species that may lose their historic habitat entirely due to climate change and what are the associated impacts of these novel ecosystems?

4.4. Making the Case for Biodiversity

Strategic objective: Knowledge of the contribution of biodiversity to economic development and human wellbeing provides specific and quantified evidence to make the case for biodiversity at a policy level, guide decision-making, and promote the mainstreaming of biodiversity in key economic sectors with a high impact on biodiversity

Our biodiversity is a national asset that should contribute significantly to economic development and job creation. Yet, we have insufficient evidence of the value of biodiversity and its contribution to economic development and human wellbeing to influence national policy and the allocation of public sector resources. At a finer scale, we lack information on the relative costs and benefits associated with the gains and losses of biodiversity in different ecosystems that would strengthen market transactions and mainstreaming of biodiversity in different sectors.

4.4.1. Valuation

There have been various estimations of the total value of our South African biodiversity, ranging from R27 billion to R94 billion per annum. These estimates are inherently variable because they consider different items in the basket of goods and services that are included in the valuation. There is some justification for assigning value to biodiversity based on an agreed set of variables. A national study on valuing ecosystems and biodiversity has been initiated, building on the recent global study on TEEB.

Given the problems with compiling total economic valuations and their limited scope for driving behaviour change, more tangible results may be achieved through targeted assessments of the value (both direct and indirect) of specific ecosystems services aimed at particular sectors. Appropriate thematic areas are: food security; the wildlife economy; ecological infrastructure for water provision; ecological infrastructure in risk and disaster management and climate change adaptation; and protected areas. The assessments should include assessments of job creation, contribution to livelihoods and wellbeing and the real contribution to the Gross Domestic Product (GDP). At the same time, research is needed to determine which types of assessment result in positive behaviour change and which are likely to lead to further exploitation of biodiversity due to the values assigned to particular goods and services.

The Global Environmental Facility has invested in a Project on Ecosystem Services (ProEcoServ) to develop innovative and practical approaches to mainstream the value of ecosystem services into national development programmes. South Africa is one of five pilot countries involved, with the CSIR leading the South African component in partnership with DEA and SANBI. This critical work needs to be built upon.

We also need a greater understanding of the values of key sectors with a strong reliance on biodiversity. For example we have estimates for the value of our fisheries, wild medicinal plants and game industry, totalling >R10 billion per annum and employing >300 000 people, but these estimates are based on different valuation methods so they are difficult to use as evidence to support policy reviews or the allocation of resources. We need valuations for these sectors using comparable methods so that the relative contributions of biodiversity to different economic activities can be appreciated and supported.

4.4.2. Evidence of Societal Benefits and Job Creation

Job creation and poverty alleviation are key deliverables for the National Development Plan. Our existing knowledge suggests that the integrated management of natural resources has the potential to make a much greater contribution to job creation and poverty alleviation. Yet here again we need more evidence to show how the management of biodiversity can make a serious contribution to job creation and poverty alleviation. Where are the jobs and how many can be attributed to biodiversity. South Africa's *Working for Water* and *Working for Wetlands* programmes have been lauded internationally for implementing job creation through the restoration of ecosystem services and the potential to create more jobs for maintaining ecological infrastructure needs to be investigated. In order to support these Natural Resource Management (NRM) jobs, we need evidence that these jobs create real benefits for society not only through financial benefits but also in relation to identity, skills, capacity building, changing social relations and social cohesion. At the same time, we need research that examines how we can maximise the social benefits from NRM- Expanded Public Works Programme (EPWP) and other social development programmes while achieving objectives relating to maintaining ecological infrastructure. In addition to jobs linked to the EPWP, we need research done on job creation across the biodiversity sector, both those directly linked to biodiversity (e.g. conservation staff) as well as those with indirect links (e.g. tourism jobs created as a result of nearby protected areas, and film industry jobs linked to natural areas).

The evidence for societal benefits needs to be strengthened. Many of the benefits derived from biodiversity cannot be measured in monetary terms and several important ecosystem services are not easy to valuate. For example, investing in wetland restoration may improve water quality by a particular factor that then influences the health and quality of life of people who are reliant on the river for their water. Simplifying this to a monetary value is difficult and misses the point that the provision of goods and services is far more important, than a simple monetary value. As a result, more research is required to understand the benefits of biodiversity and to identify which societal benefits are most likely to lead to behaviour change.

4.4.3. Support for Mainstreaming

The concept of mainstreaming relies on the principle that other sectors (e.g. mining, tourism and agriculture) will acknowledge their dependence on and responsibility for biodiversity and incorporate biodiversity considerations in their normal business. This can be facilitated by research that provides information on the contribution of biodiversity to particular sectors. In cases where benefits to particular sectors are associated with the condition of ecosystems, evidence of the relative contribution of ecosystems in different states would benefit transactions and potentially contribute to mainstreaming.

4.5. Bridging into Policy and Decision Making

Strategic objective: Mechanisms are in place that provide a bridge between knowledge generation, policy formulation and decision making resulting in a relevant and accessible evidence base for environmental decision making

Despite demand for evidence based policy and decision making and a willingness by government to adopt an evidence based approach, there are obstacles to achieving this objective in the context of the Biodiversity R & E strategy. This results in frustration on both sides of the knowledge continuum where policy and decision makers feel that researchers don't take their needs seriously whereas researchers feel that the knowledge they have generated has little impact on policy and action.

The relationship between knowledge generation and policy and decision making must be improved, including feedback on the actual outcomes of policies and decisions. Given the proliferation of environmental legislation, it is critical that regulations designed to achieve biodiversity benefits - for example TOPS and AIS - are subjected to periodic assessment. In applying such regulations to complex systems there are likely to be unintended consequences that necessitate revision and updating of the regulations and this can only be achieved through more effective dialogue between researchers and policy makers.

The gap between research and policy/ decision making is not unique to the biodiversity sector and is also mirrored in the breakdown between research and industry where there has been considerable analysis of the best ways to improve knowledge exchange. These analyses recognise that knowledge exchange is a highly complex process that often fails due to particular properties of the knowledge being exchanged, the specific context in which the knowledge is developed and transferred, the language used to convey information, and factors that influence the ability of organisations/institutions to use externally generated knowledge. Some of the solutions to these challenges include the use of intermediaries (people or processes) to transfer knowledge between researchers and users, the co-creation of knowledge by academics and practitioners, joint participation in learning organisations, and the selective use of funding. We need to identify good practices for the enhancement of knowledge exchange that will meet the needs of the biodiversity sector.

In the biodiversity context, we do have some systems that have worked in some contexts and these could be explored as the basis for an emerging set of practices for knowledge exchange. These comprise scientific assessments, dedicated forums for knowledge exchange and the co-creation of knowledge, and co-managed funding sources that enable an adaptive approach to research funding. We also need to explore the use of social media in knowledge exchange.

Knowledge and Evidence Needs

4.5.2. Assessments

Assessments can play an important role as a bridge between research and policy/ decision making as has been illustrated through the Millennium Ecosystem Assessment at the international level and the National Biodiversity Assessment within South Africa. Assessments are more than simply syntheses or reviews of accumulated knowledge because they filter available information through a lens of policy needs or specific criteria. They can also incorporate different value judgements on the interpretation of primary data (evidence) and thereby provide a mechanism to deal with contested evidence. This is an important

consideration because data can be used to support conflicting viewpoints as experienced in fields such as education and climate change and these conflicting viewpoints need to be dealt with in order to provide a way forward for policy and decision makers. As an example, the National Elephant Assessment analysed and assessed information on elephant management from different perspectives as part of a process to inform contested decisions regarding the need to control elephant populations in South Africa. There is considerable scope for us to use assessments as a tool to identify crucial evidence and to make research outputs useful and accessible to policy and decision makers. The initiation of the IPBES will provide impetus to the assessment process and we need to build on this process to address national and regional priorities.

Assessments should be considered at different levels. We already have structures in place for regular assessments of the status of species and ecosystems as well as the assessment of sustainable use of species in trade. Specific processes will need to be put in place for other assessments dealing with specific issues.

4.5.3. Forums for Co-creating Knowledge

Knowledge exchange does not just happen, it needs to be facilitated and managed. Even policy briefs have been criticised for creating knowledge among recipients that was different to what was intended. Greater success is expected when the recipient can make sense of the information through an active process of knowledge generation so that the co-creation of knowledge is regarded as a more effective mechanism for knowledge exchange. During the 1980's a concerted effort was made to bring scientists and managers together through the biome-based research programmes in South Africa and several of these forums still provide a place for discussion and learning (e.g. the Fynbos Forum, Arid Zone Forum). These sorts of structures need to be replicated in a way that addresses the key areas for interaction and that also engages national policy and decision makers (e.g. the Biodiversity Planning Forum), not just as recipients of knowledge but as participants in the framing of questions and the creation of relevant knowledge. There are other mechanisms that can be equally effective, e.g. the Scientific Authority established in terms of the Biodiversity Act provides a formal structure for assessing science relating to wildlife trade and threatened species and advising Government on appropriate policy and action. The important point is to establish either informal or formal systems to facilitate dialogue and interaction and to make sure that relevant scientists and policy/decision makers participate in these forums. As shared in the environment sector R,D&E framework, policy-makers, researchers and other stakeholders need to work more closely together by means of established, regular and trusting interaction and dialogue. The evidence based development of a new policy for elephant management is one of the successful interventions the sector implemented in response to these frustrations (Box 1).

Box 1: Towards a new elephant management policy for South Africa 1995 – 2008 (SANParks 2008)

This SANParks publication is a synthesis of the processes followed and outcomes achieved over the last 12 years in addressing elephant management at Kruger National Park. Key interventions were conducted demonstrating the implementation of science-policy practice. Firstly, the interactions between the elephant management policy, its context, the stakeholders, their issues and concerns, suggested management options, and their potential implications were mapped. Secondly the role players were identified. Among others, scientists were identified as both stakeholders in the debate and providers of knowledge informing value-based decision-making in consultative processes during policy review. The process further recognised that decisions about environmental problems involve both knowledge and values, and it is not only scientists who have knowledge. A participatory management philosophy recognised that "everybody has a piece of the wisdom" we need. Not only do stakeholders have a right to be involved in decisions which affect them, their involvement can lead to policies and decisions that are wiser, fairer, more efficient and more competent.

It was recognised that an effective consultative policy review approach rests on principles including that:

- All views and perspectives count. Solutions are developed through discussions with all stakeholders.
- Science provides information. Science alone cannot provide the answers.
- Management must be adapted to the context of the problem, considering interrelated problems and externalities.
- Decision-making must be discursive and deliberative. Participants engage in open, honest and respectful discussion aimed at mutual learning and understanding others' perspectives. Avoid unproductive, yet common, tactics such as lobbying authorities about a particular point of view, polling opinions across stakeholder sectors without due recognition of proportional representation, and debating to win the argument rather than listening to understand it.
- Understand the past but build the future.

The development of this policy occurred in three phases. Beginning in 1996, it involved extensive consultation with stakeholders from all walks of life and included a range of events, forums, media, round table and opportunities for participation, culminating in the publication of National Norms and Standards for Elephant Management in February 2008.

4.5.4. Promoting an Adaptive Framework for Research Funding

Most universities and even government research institutes encourage curiosity driven research. This has been a powerful source of innovation and knowledge generation but it has also meant that research often does not address important societal priorities nor does it provide sufficient evidence to support policy development or decision making. When surveyed[1], university researchers ranked (in order) the reasons for choosing research topics as (1) curiosity, (2) access to funding, and (3) institutional strategy. In most cases, institutional strategy was regarded as a very weak driver of research direction. Funding remains a major driver of research direction and, if applied smartly can direct the curiosity of good researchers towards questions that are relevant to policy and decision making, while allowing space for novel ideas. A critical element is that funding needs to be constantly evaluated to ensure that the resulting research does address priorities for policy and decision making. The co-management of research funding by research managers and end users can provide an adaptive management approach where the impact of research is regularly evaluated. This sort of model has been applied in the context of funding for the management of invasive species through the DEA-NRM programmes and can be evaluated as a possible model for other funding.

[1] A survey was sent to ca. 100 researchers at institutions across South Africa from which 59 responses were obtained.

5 CONCLUSION

The environment sector continues its efforts to promote evidence informed policy making and implementation through initiatives such as the structured prioritisation of policy relevant evidence needs that are communicated to stakeholders who use or generate evidence. This Implementation Plan outlines the annual imperatives towards achieving the priorities of the NBRES 2015-2025. The Implementation Plan outlines the operational imperatives, short and medium term evidence needs, as well as foundational and long-term evidence needs. As a pilot approach, it is hoped that overtime there will be more and more refinements to the approach and content including bringing more relevant biodiversity multi-stakeholders on board.

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