Mapping Biodiversity Priorities

A practical approach
to spatial biodiversity assessment and prioritisation
to inform national policy, planning, decisions and action

Second edition 2024
Adds new support and guidance for:

Global Ecosystem Typology

RED LIST OF ECOSYSTEMS

IUCN RED LIST

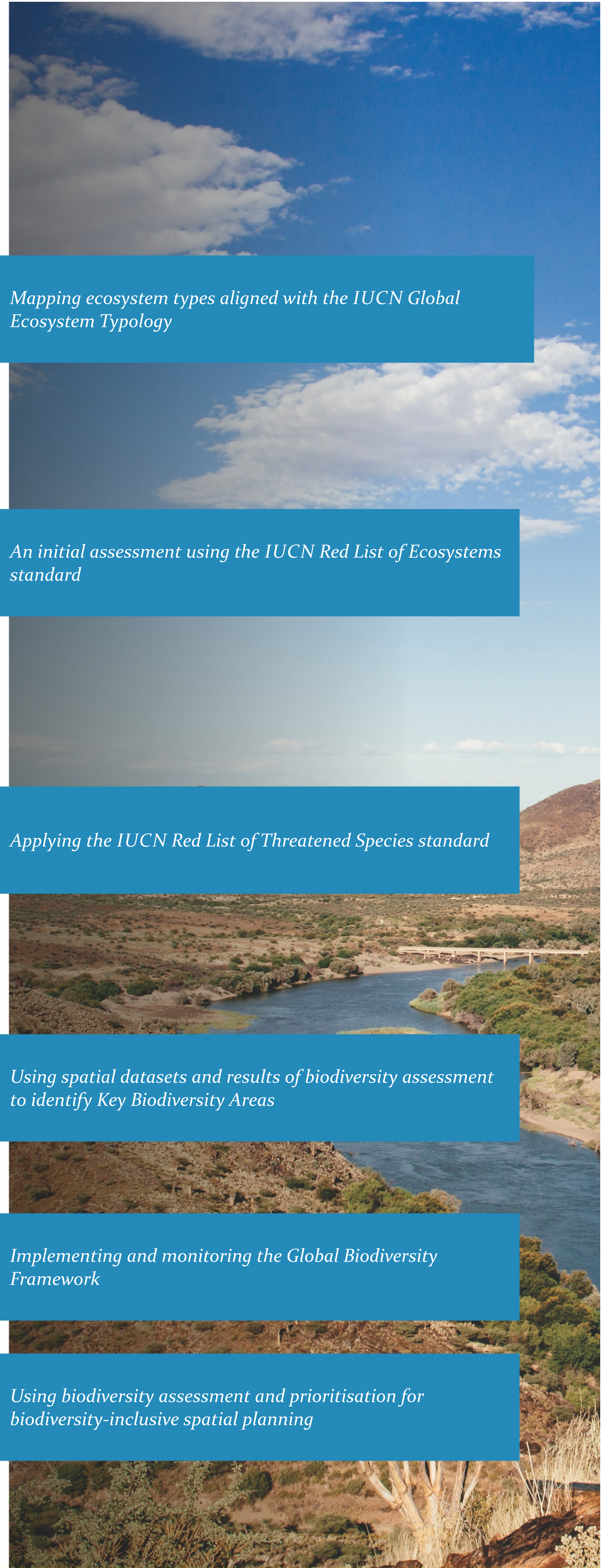
KBA KEY BIODIVERSITY AREAS

Kunming-Montreal GLOBAL BIODIVERSITY FRAMEWORK

SANBI Biodiversity for Life
South African National Biodiversity Institute

UN environment programme WCMC

Adds new support and guidance for:



Global Ecosystem Typology — *Mapping ecosystem types aligned with the IUCN Global Ecosystem Typology*

RED LIST OF ECOSYSTEMS — *An initial assessment using the IUCN Red List of Ecosystems standard*

IUCN RED LIST — *Applying the IUCN Red List of Threatened Species standard*

KBA KEY BIODIVERSITY AREAS — *Using spatial datasets and results of biodiversity assessment to identify Key Biodiversity Areas*

Kunming-Montreal GLOBAL BIODIVERSITY FRAMEWORK — *Implementing and monitoring the Global Biodiversity Framework*

Using biodiversity assessment and prioritisation for biodiversity-inclusive spatial planning

Mapping biodiversity priorities: a quick overview

A practical approach to spatial biodiversity assessment and prioritisation to inform national policy, planning, decisions and action.

Purpose

Spatial data and mapping can provide multiple benefits for biodiversity policy, planning, decisions and action at a national level. This document sets out a practical approach to spatial biodiversity assessment and prioritisation. It shows how it is possible to use a few foundational datasets to produce useful indicators of the state of biodiversity and maps that identify biodiversity priority areas. The products can be useful in a wide range of applications, from mainstreaming biodiversity to global reporting.

Key questions

Answering three key questions about biodiversity can be useful for a range of policy, planning, decisions and action:

1. What biodiversity does a country have and where is it?
2. What is the state of biodiversity across the landscape and seascape?
3. Where and how should a country act first to manage and conserve biodiversity?

Guiding principles

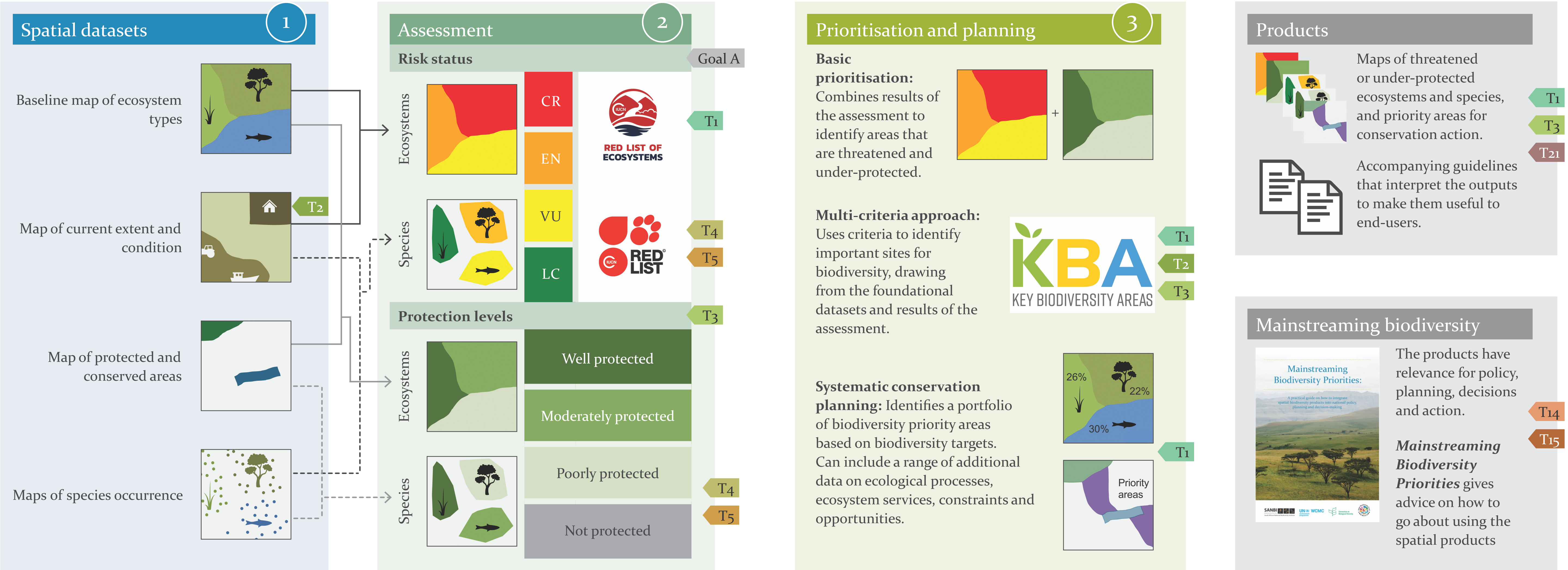
The approach is based on the principles of systematic conservation planning and augmented by several operating principles:

1. Aim to conserve a viable representative sample of every different type of biodiversity.
2. Aim to conserve key processes that allow biodiversity to persist over the long-term.
3. Set quantitative biodiversity targets to achieve representation and persistence.
4. Use the best available information to enable robust, defensible and credible results.
5. Use an adaptive approach: start simply and plan for iterative improvements.
6. Aim for consistency across terrestrial, freshwater and marine realms.
7. Keep the process simple, with clear and understandable outputs.
8. Make a clear link to implementation by remaining aware of the context.
9. Be inclusive and engage stakeholders at relevant stages.
10. Make the products freely and easily accessible for wide use.

Kunming-Montreal
GLOBAL BIODIVERSITY FRAMEWORK

Spatial biodiversity data and information can contribute to implementing and monitoring the goals and targets of the Global Biodiversity Framework, including:

Goal A	
Target 1	Target 5
Target 2	Target 14
Target 3	Target 15
Target 4	Target 21



Mapping Biodiversity Priorities

A practical approach
to spatial biodiversity assessment and prioritisation
to inform national policy, planning, decisions and action

Second edition 2024

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Foreword

The Kunming-Montreal Global Biodiversity Framework was adopted at the fifteenth meeting of the Conference of the Parties of the Convention on Biological Diversity (CBD) in December 2022. The Framework sets out an ambitious pathway to reach the global vision of a world living in harmony with nature by 2050. It consists of four goals for 2050 and 23 targets for 2030.

This second edition of the guide *Mapping Biodiversity Priorities: A practical approach to spatial biodiversity assessment and prioritisation to inform national policy, planning, decisions and action* has been revised and updated as a key resource for countries implementing and monitoring the Global Biodiversity Framework. The practical methods depicted allow spatial data to be better incorporated into national biodiversity policy, planning, decisions and action. In so doing, countries can improve their ability to implement and report on indicators for the goals and targets of the Global Biodiversity Framework. The approach presented in this guide results in the exact information needed to measure several of the indicators (***Section 1.1: Global Biodiversity Framework***).

Since the first edition of *Mapping Biodiversity Priorities* was published in 2016, the approach has been successfully applied in several African countries. Work in South Africa, Namibia, Mozambique and Malawi is continuing through the project titled *'Building biodiversity knowledge for action in Southern Africa: Spatial Biodiversity Assessment, Prioritization and Planning in South Africa, Namibia, Mozambique and Malawi'* (the 'SBAPP Regional Project') funded by the Agence Française de Développement (AFD) and the Fonds Français pour l'Environnement Mondial (FFEM). This second edition is funded through the SBAPP Regional Project, and AFD and FFEM are proud to present this new edition as part of their support to building capacity for implementation of the Global Biodiversity Framework.

The International Union for Conservation of Nature (IUCN) welcomes this second edition of *Mapping Biodiversity Priorities*, in which several IUCN standards and guidelines are used, showcasing the immense value of the international standards.

The CBD Secretariat also welcomes this second edition of *Mapping Biodiversity Priorities* due to its practical guidance for implementing and monitoring the Global Biodiversity Framework. The guide will be added as one of the 'relevant resources that can assist implementation' as part of the guidance notes for relevant targets for the Global Biodiversity Framework.[1]

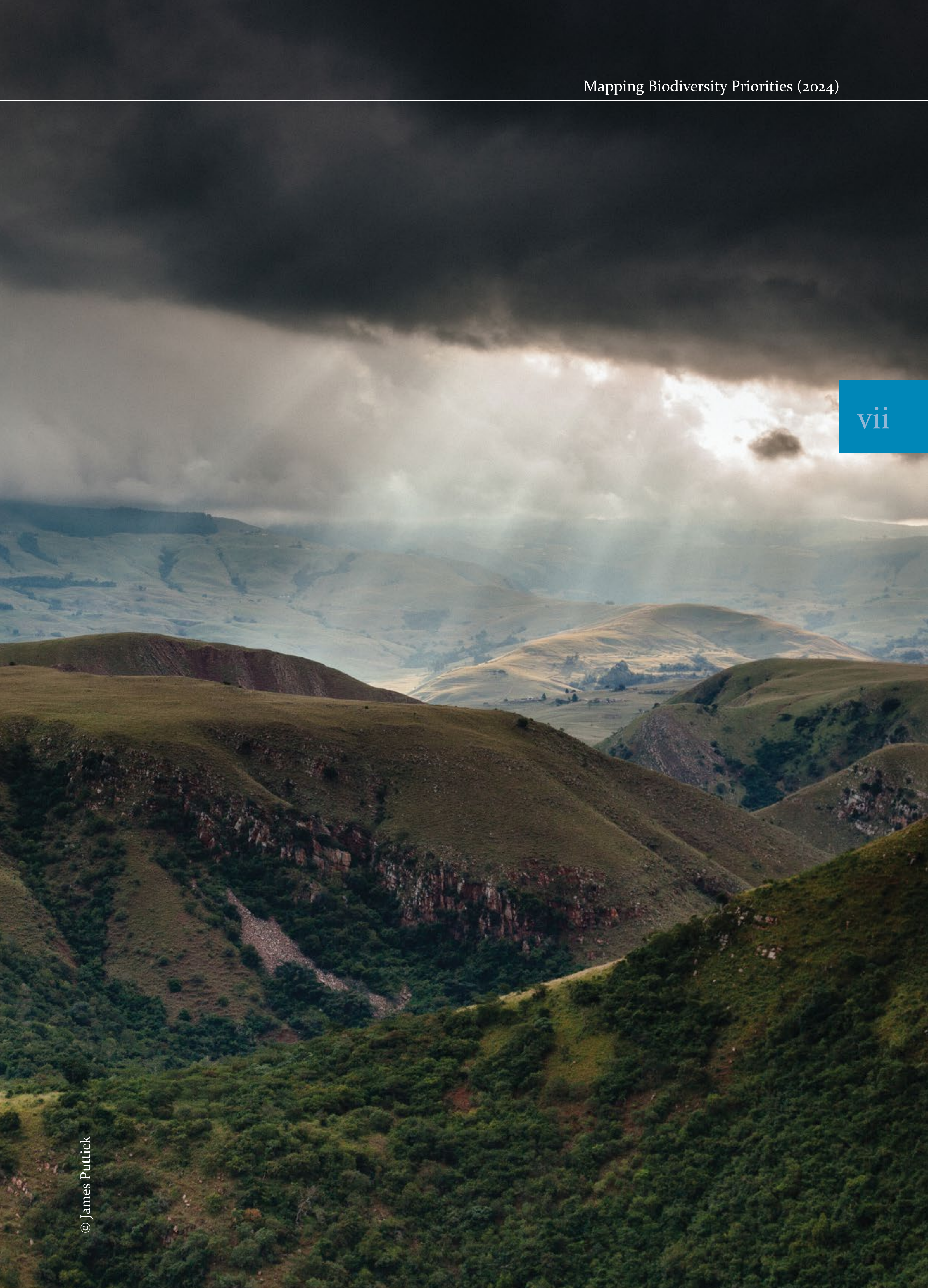
Dr Grethel Aguilar; Director General: International Union for the Conservation of Nature

Ms Astrid Schomaker; Executive Secretary: Convention on Biological Diversity

Mr Rémy Rioux; Chief Executive Officer: Agence Française de Développement

Ms Stéphanie Bouziges-Eschmann; Secretary General: Fonds Français pour l'Environnement Mondial

[1] *https://www.cbd.int/gbf/targets.*



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Preface

Spatial data and mapping can provide multiple benefits for policy, planning, decisions and action at a national level, such as determining the state of biodiversity in a country, identifying national priority areas, monitoring progress towards national and global targets, and communicating key biodiversity issues. It is also a good basis for mainstreaming biodiversity into other sectors.

The United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) is a global centre of excellence on biodiversity and nature's contribution to society and the economy. UNEP-WCMC works at the interface of science, policy, and practice to tackle the global crisis facing nature and support the transition to a sustainable future for people and the planet.

The South African National Biodiversity Institute (SANBI) has extensive experience in producing the National Biodiversity Assessment of South Africa, and with integrating the products of biodiversity assessment and prioritisation into national policy around spatial planning, environmental assessment, protected area expansion and more.

Discussions between UNEP-WCMC and SANBI initiated the joint development of this guide to distil and share the experience from South Africa's approach to spatial biodiversity assessment and prioritisation. In 2016, the first edition of *Mapping Biodiversity Priorities* was published to provide basic guidance on spatial biodiversity assessment and prioritisation at a national level. Since then, the approach has been successfully applied in several other African countries including Botswana, Ethiopia, Ghana, Malawi, Mozambique, Rwanda and Uganda. A follow up guide – *Mainstreaming Biodiversity Priorities* – was also developed to expand on how the products and results of the approach can be used in a wide range of applications.[2]

Several global developments in the biodiversity sector meant that it was important to update the guide. The second edition now includes information about the Global Biodiversity Framework, the IUCN Global Ecosystem Typology, the IUCN Red List of Ecosystems, the IUCN Red List of Threatened Species, and the identification of Key Biodiversity Areas. This ensures that the guide remains relevant and aligned with international frameworks so that it can help countries to implement the targets of the Global Biodiversity Framework and monitor progress towards their achievement.

SANBI
Biodiversity for Life
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[2] UNEP-WCMC & SANBI. 2022. Mainstreaming biodiversity priorities: A practical guide on how to integrate spatial biodiversity products into national policy, planning and decision-making. South African National Biodiversity Institute, Pretoria, South Africa. *http://hdl.handle.net/20.500.12143/8735*.

Executive summary

In almost any country, and in almost any policy context, there are certain fundamental questions that need to be answered to inform biodiversity policy, planning, decisions and action. Assessing biodiversity at a national level is a useful basis for answering these key questions, which include:

1. What biodiversity does a country have and where is it?
2. What is the state of biodiversity across the landscape and seascape?
3. Where and how should a country act first to manage and conserve biodiversity?

The Convention on Biological Diversity has increasingly recognised the benefits that spatial biodiversity information can have for effective policy-making and implementation. For example, spatial biodiversity assessment at a national level can help to monitor the state of biodiversity and identify geographic priority areas and actions to address urgent conservation needs. Spatial biodiversity assessment and prioritisation can contribute to a number of the goals, targets and indicators under the Kunming-Montreal Global Biodiversity Framework, including those relating to biodiversity-inclusive spatial planning (Target 1) and protected area expansion (Target 3), as well as restoration (Target 2), halting species extinction (Target 4), sustainable use (Target 5), mainstreaming biodiversity into other sectors (Target 14), business risks and impacts (Target 15) and accessibility of best available information for decisions (Target 21). The spatial products are useful to inform updates of National Biodiversity Strategy and Action Plans (NBSAPs) and support their implementation.

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This guide sets out a practical approach to spatial biodiversity assessment and prioritisation, which can be applied at the national level in any country. It is especially useful for countries that are both biodiversity rich and resource constrained, where difficult choices often have to be made about how and where to focus conservation action. This guide shows how even the most data-poor country can draw on available global data, with local expertise, as the basis for an initial spatial assessment and prioritisation that will yield useful results. The core intended audience is those involved in managing, conserving or reporting on biodiversity at a national level, including reporting on multi-lateral environmental agreements, although the approach has many other wider applications.

The approach presented here draws on the principles of systematic conservation planning to conduct a country-wide biodiversity assessment and prioritisation. Only four foundational datasets are required to use the approach. These are (1) a baseline map of ecosystem types, (2) a map of current extent and condition, (3) a map of protected and conserved areas, and (4) a set of species occurrence records. In most cases, these can be relatively easily generated, or drawn from global datasets and customised nationally. Combining these datasets in a few logical analyses will allow a biodiversity assessment and prioritisation to be carried out.

The assessment process produces maps and indicators of the state of biodiversity for both ecosystems and species. Risk status identifies which ecosystems and species are threatened. It is assessed using the globally accepted categories and criteria of the IUCN Red List of Ecosystems and the IUCN Red List of Threatened Species. Assessing protection levels provides useful information on which ecosystems and species are under-protected. Following on from assessment, prioritisation produces a set of biodiversity priority areas that should be the focus of conservation action. Sites of particular importance for biodiversity can be identified using the criteria of Key Biodiversity Areas, or through systematic conservation planning.

The products of this approach can feed easily into biodiversity policy, planning, decisions and action. Maps and indicators provide a wealth of information about where important biodiversity occurs, where it is most threatened and where to act first.

1. Introduction

This guide sets out a practical approach to spatial biodiversity assessment and prioritisation, which can be applied at the national level. It will provide useful information for any country, and is also applicable at sub-national and regional levels. The approach is especially useful for countries that are both biodiversity-rich and resource-constrained, where difficult choices often have to be made about how and where to focus conservation action.

In almost any context, **three key questions** are useful for informing conservation policy and action:

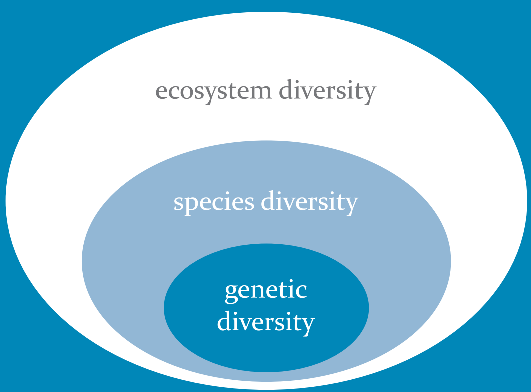
1 What *biodiversity*[3] does a country have and where is it?

2 What is the state of biodiversity across the landscape and seascape?

3 Where and how should a country act first to manage and conserve biodiversity?

What is biodiversity?

Biodiversity is the diversity of genes, species and ecosystems on Earth, and the ecological and evolutionary processes that maintain this diversity.



Spatial biodiversity assessment and prioritisation at a national level can answer these questions in a way that is useful for a range of different applications, such as biodiversity monitoring, state of the environment reporting and protected area expansion, as well as the integration of biodiversity objectives into the operations of other sectors.

1.1 Global Biodiversity Framework

Kunming-Montreal
GLOBAL BIODIVERSITY FRAMEWORK

The Kunming-Montreal Global Biodiversity Framework (GBF) was adopted in 2022. It sets the global biodiversity agenda for the next several decades. Biodiversity assessment and prioritisation is relevant to understanding, implementing and reporting on many of the targets of the GBF. In particular, it helps track progress toward achieving Goal A of protecting and restoring biodiversity. Each goal and

[3]Key terms are italicised at the first instance where a link to the definition may aid understanding. Definitions can be found in the Glossary at the end of the document.

target has a set of indicators, and the assessment and prioritisation approach in this guide results in the exact information needed to measure several of the indicators. The GBF goals and targets directly assisted by the approach in this guide are:

Goal A is about protecting and restoring ecosystems, and halting extinction of species. It envisions an increase in the natural area of ecosystems, and a reduction in the extinction rate and risk of species by 2050. Assessment and prioritisation provide a wealth of biodiversity information towards implementing and monitoring progress towards this goal.

Target 1 seeks to achieve integrated, biodiversity-inclusive spatial planning across all land and sea areas. Spatial assessment and prioritisation identify geographic areas that are important for biodiversity, which can easily be incorporated into integrated spatial planning. This will help to ensure that biodiversity is taken into account during decisions about land- and sea-use change.

Target 2 aims to have 30% of degraded ecosystems under effective restoration by 2030. Assessment and prioritisation can help to identify and prioritise degraded ecosystems, set restoration targets and monitor restoration success.

Target 3 envisions that areas of importance for biodiversity covering at least 30% of land, sea and freshwater are protected or conserved by 2030. The target specifies that the expansion of protected and conserved areas should be ecologically representative, which is one of the guiding principles of assessment and prioritisation (***Section 3: Guiding principles***). Assessment and prioritisation can identify areas that are priorities to contribute to a representative network of protected and conserved areas. The target also recognises the need to protect and conserve areas of particular importance for biodiversity – such as threatened ecosystems (***Section 5.2.1: Ecosystem risk status***) or habitat for threatened or range restricted species (***Section 5.3.1: Species extinction risk***) – and to ensure that networks of protected and conserved areas are well-connected and will maintain ecosystem function and services (***Section 6.3: Systematic conservation planning***).[4]

Target 4 calls for urgent management actions to halt human induced extinction of known threatened species and for the recovery and conservation of species, in particular threatened species. Assessment and prioritisation can help to identify threatened species and plan conservation actions.

Target 5 calls for sustainable use of biodiversity and specifically urges that an ecosystem approach is used. Assessment and prioritisation provide information that is essential to the sustainable management of ecosystems and species. Spatial planning can support sustainable use, especially in marine systems where protection supports fisheries sustainability.

Target 14 calls on parties to integrate biodiversity and its values into policies, regulations, planning, development processes, poverty reduction strategies, environmental impact assessments and national accounts. The products of assessment and prioritisation, particularly map products, are well-suited to mainstreaming biodiversity and can be a way of achieving this target. For further information about mainstreaming the products, see companion guide *Mainstreaming Biodiversity Priorities*.[5]

Target 15 aims to enable businesses to monitor, assess and disclose their risks, dependencies and impacts on biodiversity. Assessment and prioritisation can help businesses account for ecosystems and species during their development planning and operations. They can also help businesses, finance institutions and governments apply the mitigation hierarchy[6] to reduce negative impacts on biodiversity.

[4]Watson et al. 2023. Priorities for protected area expansion so nations can meet their Kunming-Montreal Global Biodiversity Framework commitments. Integrative Conservation, 2, 140–155. *https://doi.org/10.1002/inc3.24*.
[5]UNEP-WCMC & SANBI. 2022. Mainstreaming biodiversity priorities: A practical guide on how to integrate spatial biodiversity products into national policy, planning and decision-making. South African National Biodiversity Institute, Pretoria, South Africa. *http://hdl.handle.net/20.500.12143/8735*.
[6]Jones et al. 2022. Spatial analysis to inform the mitigation hierarchy. Conservation Science and Practice, 4(6), e12686. *https://doi.org/10.1111/csp2.12686*.

Target 21 is about ensuring that data and information is available to decision-makers, practitioners and the public. Biodiversity assessment and prioritisation can become a regular, recognised way to share information about biodiversity in the form of indicators, map products and accompanying guidance.

Several other GBF targets are assisted indirectly through biodiversity assessment and prioritisation.

1.1.1 Reporting on indicators from the Global Biodiversity Framework

In preparing the foundational datasets and undertaking the assessment and prioritisation described in this guide, relevant information will be gathered to report on several of the indicators adopted as part of the monitoring framework of the Global Biodiversity Framework. Of the headline indicators, the approach provides the spatial data required to compile:

- Indicator A.1: Red List of Ecosystems
- Indicator A.2: Extent of natural ecosystems[7]
- Indicator A.3: Red List Index of Species
- Indicator 3.1: Coverage of protected areas and other effective area-based conservation measures

In addition, the approach presented here provides input data for the compilation of indicators B.1 (services provided by ecosystems) and 2.1 (area under restoration) which require spatial datasets on the extent of different ecosystem types. Mainstreaming the products of the approach may contribute to elements of indicator 1.1 on coverage of biodiversity-inclusive spatial plans.

Many of the further component and complementary indicators can also be drawn from the datasets developed using this approach. For example, several of the component and complementary indicators under Targets 5, 6, 9 and 10 use disaggregation of the Red List Index of Species (e.g. for pollinators, traded species, species used for food or medicine). The information on ecosystem extent and condition can assist with other component or complementary indicators such as the Ecosystem Intactness Index or the Ecosystem Integrity Index.

1.1.2 National Biodiversity Strategy and Action Plans

National Biodiversity Strategy and Action Plans (NBSAPs) are the principal instruments for countries to meet their obligations under the Convention on Biological Diversity. The Convention requires countries to prepare national biodiversity strategies (or equivalent instruments) and to ensure that these are taken up into the planning and activities of all sectors whose actions can have an impact (positive and negative) on biodiversity.[8] Previously, many countries included only limited spatial data in their NBSAPs, resulting in challenges with putting them into action and monitoring their progress. Spatial biodiversity assessment and prioritisation can strengthen an NBSAP by illustrating the current state of biodiversity in a country, identifying national priorities, and communicating key biodiversity issues. These data can provide baselines to track progress towards national and global targets, analyse trade-offs, measure policy impacts, and consider future scenarios.

1.2 Benefits of a systematic, spatial approach

Since biodiversity is not distributed evenly across the landscape or seascape, and neither are the pressures that act on it, it is important to have a

[7]The methodology for indicator A.2 is based on the System of Environmental-Economic Accounting (SEEA) Ecosystem Accounting, and requires the compilation of ecosystem extent accounts. These accounts require the same foundational datasets on extent of ecosystems that are used in spatial biodiversity assessment and prioritisation.

[8]*https://www.cbd.int/nbsap/*.

defensible and spatially explicit approach, based on the best available information, to assess the state of biodiversity and decide on priority areas for action. This is especially the case in mega-diverse countries that have many different ecosystems and species in need of conservation, and in those countries with limited resources that must be focused on the most urgent priorities. The approach is also beneficial in many other circumstances including data rich, well-resourced settings. Three key advantages of a systematic, *spatial* approach are discussed below.

All aspects of biodiversity are comprehensively included. Conservation efforts can be biased towards charismatic species, regions that happen to be well sampled, or the objectives of particular organisations. In contrast, the approach presented here aims to reduce such biases by using a systematic methodology that includes all terrestrial, freshwater and marine ecosystem types. Each ecosystem type is treated objectively, and is not given preference over other ecosystem types based on skewed or subjective information. Ecosystem types mapped across the entire landscape or seascape are used as a surrogate for biodiversity, which gives even un-described species across taxonomic groups a good probability of being conserved. The approach is then complemented by adding a subset of relevant and available species data. There is also a specific focus on safeguarding ecological processes at a range of spatial scales that are required for continued functioning and persistence of biodiversity over time.

Methods are pragmatic, flexible and can be applied widely and in an iterative way. The methods described here are flexible enough to be achievable even when data and resources are limited. The basic approach can be applied relatively simply and quickly when necessary, but can also be used as a basis for ongoing improvement and refinement that will yield increasingly sophisticated outputs in the subsequent iterations. It can be conducted at a broad spatial scale to determine national priorities, but also at finer scales for other applications, such as informing land-use planning at a more local level. The foundational datasets and methods are similar, and results of the analyses are thus comparable, across the terrestrial, freshwater and marine realms.

Products support a range of sustainable development applications. This approach can inform many different kinds of planning and decision-making in support of sustainable development. It implicitly considers conservation as part of a range of appropriate land uses and sea uses, and seeks to avoid conflict between conservation and other sectors, such as agriculture, forestry, mining and urban development. Among the useful outputs of a biodiversity assessment are a set of indicators of the state of biodiversity that are easily understandable by a wide audience. These can be used for monitoring and reporting at a national level. Similarly, maps of priority areas can be easily linked to explicit conservation actions, such as restoration or the expansion of protected areas. The foundational datasets and products of biodiversity assessment and prioritisation can be used for many other applications, such as the United Nations System of Environmental-Economic Accounting (SEEA) Ecosystem Accounting, reporting on several indicators for the Sustainable Development Goals and in applying the framework of the Task Force for Nature-Related Financial Disclosures. Using similar biodiversity information across all of these applications creates a cohesive national focus for biodiversity.

1.3 Purpose and structure of this guidance

Many countries may feel that, while a spatial biodiversity assessment and prioritisation would be valuable, it is largely out of reach due to limited biodiversity data and resources. However, it is possible to use available spatial data to conduct a national assessment of the status of biodiversity in a short space of time and with modest resources. Even a basic, initial biodiversity assessment can be a highly useful source of information at a national level. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), which performs regular global, thematic and regional assessments of biodiversity, ecosystem services and their interlinkages, also recommends that national assessments are undertaken.

This guide sets out a practical approach to conducting a spatial biodiversity assessment and prioritisation using a small number of key datasets. The approach is based on the well-known principles of *systematic conservation planning*, as well as several additional operational principles developed through practical application of the approach. The ten most important principles to keep in mind when applying the approach are discussed in ***Section 3: Guiding principles***. The small number of spatial datasets that form the basis for the approach are discussed in ***Section 4: Spatial datasets***.

The approach distinguishes between spatial biodiversity assessment and spatial biodiversity prioritisation in the following way:

Assessment addresses the question of the state of biodiversity within a country (key question 2). ***Section 5: Assessment*** shows how, by combining key datasets, and with limited additional analysis, it is possible to provide maps and indicators of the state of biodiversity. Assessment identifies the ecosystem types and species that are threatened and under-protected. Risk status is assessed using the globally accepted categories and criteria of the IUCN Red List of Ecosystems and the IUCN Red List of Threatened Species. An initial Red List of Ecosystems assessment for all ecosystem types can be easily achieved and can then be built on using more comprehensive data when feasible. Similarly, the Red List of Threatened Species can first be applied to an initial set of species and then expanded as data becomes available. Assessing protection levels provides additional important information for both ecosystems and species about how well they are protected in the current network of protected and conserved areas.

Prioritisation takes this information a step further, by helping to answer the question of where to focus conservation efforts (key question 3). ***Section 6: Prioritisation and planning*** covers several methods that can be used to identify important biodiversity areas, from basic prioritisation, through criteria-based approaches like Key Biodiversity Areas, to the more comprehensive methods of systematic conservation planning. These methods identify a set of national *biodiversity priority areas* that can inform where it is most strategic to act first.

By following the steps set out in these sections, it will be possible to develop a set of valuable products, as discussed in ***Section 7: Products***. These are typically in the form of maps and accompanying guidelines, which can inform policy, planning, decisions and action in the biodiversity sector, as well as in a range of other sectors that depend on or impact biodiversity. In ***Section 8: Enabling factors***, some institutional and other factors are discussed that will make the approach easier to conduct and implement.

The core intended audience for this guide are those in government agencies or other organisations who are involved in managing, conserving or reporting on biodiversity at national level, including those involved in revising or implementing NBSAPs and country reporting to the Convention on Biological Diversity. The guide has broader relevance to

anyone operating in a land, catchment or ocean management or spatial planning role, including conservation planners, protected area managers, researchers, and others involved in spatial planning in any context. The audience also includes policy- and decision-makers who require an information resource to aid understanding in this subject area. To reach this broad audience, the guide provides an overview of the approach through simple flow charts, and aims to provide sufficient technical detail in tables to assist readers who wish to implement the approach.

Case studies: A selection of case studies showcase how the methods can be applied in practice across a range of terrestrial, freshwater and marine realms in different regions. A sequence of South African examples shows how the country has extensively applied the methods over the past 20 years, accumulating practical experience of both the challenges that can be experienced as well as the ultimate versatility and value of the approach.[9]

Box 1:
Case study: Spatial biodiversity assessment in South Africa.

The National Spatial Biodiversity Assessment (NSBA),[10] completed in 2004, was South Africa's first attempt at a comprehensive assessment of the state of biodiversity spanning terrestrial, river, estuarine and marine ecosystems. The NSBA was conducted in less than a year, with very limited resources and only a small team of people. It used what data were available at the time, building on some excellent research, but also highlighting extensive data gaps. Nevertheless, it became one of the most widely used resources in the conservation sector in South Africa, informing the development of the country's first NBSAP, and prompting a range of important conservation actions.

Regular National Biodiversity Assessments (NBAs) have since become a core aspect of biodiversity policy, strategy and reporting in South Africa, and have been institutionalised as an ongoing responsibility of the South African National Biodiversity Institute (SANBI). The most recent version, the National Biodiversity Assessment 2018,[11] made significant progress in filling data gaps and refining the methodology. It continues to highlight conservation priorities in South Africa and guide biodiversity strategy for the country. The next National Biodiversity Assessment is due to be completed in 2025. More information on the NBA is available at *http://nba.sanbi.org.za/*.

[9]Botts et al. 2019. Practical actions for applied systematic conservation planning. Conservation Biology, 33(6), 1235–1246. *https://doi.org/10.1111/cobi.13321*.

[10]Driver et al. 2005. National Spatial Biodiversity Assessment 2004: priorities for biodiversity conservation in South Africa. Strelitzia 17. South African National Biodiversity Institute, Pretoria.

[11]SANBI. 2019. National Biodiversity Assessment 2018: The status of South Africa's ecosystems and biodiversity. Synthesis Report. South African National Biodiversity Institute, an entity of the Department of Environment, Forestry and Fisheries, Pretoria. *http://nba.sanbi.org.za/*.

2. Key questions

Regardless of the policy context or circumstances of a country, there are certain fundamental questions that, if answered, will provide a wealth of information for biodiversity-related policy, planning, decisions and action. Even greater value will be obtained by asking and answering these questions in a spatially explicit way. By doing so, conservation actions can be focussed on specific biodiversity priority areas, making the best use of limited resources and avoiding conflicts with other sectors in many cases. Almost any policy-relevant question about a country's biodiversity will be related to one of these key questions, and the approach presented here provides a way to answer them simply and effectively.

In this section, the three key questions are expanded to give examples of the sub-questions that may be explored within each one.

Key question 1: What biodiversity does a country have and where is it?

- **What different types of ecosystems exist in the country and where are they found?**
  - Which ecosystem types are widespread and which have a limited distribution?
- **What species of special concern occur in the country and where are they found?**
  - Where do nationally or locally endemic (or near-endemic) species occur?
  - Where do culturally, socially or ecologically important species occur (e.g. flagship species, keystone species or species utilised by people)?
- **Which ecological processes are important and where do they occur?**
  - What ecological processes are important for the persistence of ecosystems and species, and where do they occur?
  - What natural areas function as ecological infrastructure that provides valuable services to people and the economy?

Key question 2: What is the state of biodiversity across the landscape and seascape?

- **How much biodiversity is left and what condition is it in?**
  - Where do key pressures on biodiversity occur (e.g. land use change, climate change, unsustainable harvesting, excessive water abstraction, invasive alien species)?
  - Where have natural areas been converted to intensive land or sea uses?
  - What is the ecological condition of the remaining biodiversity?
  - Is biodiversity sufficiently functional and connected to allow persistence into the future?
- **How much of each ecosystem type and species is protected and is that enough?**
  - Where are existing protected and conserved areas located and do they include sufficient examples of all components of biodiversity?
- **How is the state of biodiversity changing over time?**
  - How are ecosystems and species responding to global changes?
  - Is the state of ecosystems and species improving or declining over time?
  - Are conservation or restoration efforts having a positive impact?

Key question 3: Where and how should a country act first to manage and conserve biodiversity?

- **How much of each ecosystem type, species or ecological process should remain in a *natural or near-natural* state to ensure persistence of biodiversity into the future?**
- **Which geographic areas are most important for conserving and managing biodiversity through a range of appropriate interventions?**
  - Where should efforts for avoiding loss of natural areas be focussed (e.g. through ensuring that these sites are taken into account in land-use planning and marine spatial planning)?
  - Where should protected or conserved areas be established or expanded?
  - Where should efforts for restoration of degraded ecosystems be focused (e.g. through the removal of invasive alien species or restoration of wetlands)?
  - Where should conservation efforts be focussed to support climate change adaptation?
- **Which sites need most urgent intervention?**
- **Where can scarce resources be used most strategically to get the best response?**
- **How can biodiversity be conserved while avoiding unnecessary conflict with other sectors?**
- **What other interventions are important for supporting place-based actions (e.g. policy, regulatory, social, research)?**

3. Guiding principles

In this section, ten guiding principles are discussed, which should be kept in mind during any spatial biodiversity assessment or prioritisation. Some are conceptual, and others relate to the process of undertaking assessment or prioritisation. Adhering to them is likely to improve the ease of conducting a national biodiversity assessment and prioritisation, and to enhance the utility of the outputs.

The **first three principles** follow the well-known principles of systematic conservation planning.[12] The next seven are additional principles that have been distilled from experience of applying this approach.[13]

1 **Aim to conserve a viable representative sample of every different type of biodiversity.** *Representation* is one of the two main goals of systematic conservation planning and is a fundamental basis for the approach described here. The purpose of representation is to conserve a viable sample of all species and all ecosystem types. It recognises that there has often been a historical bias in conservation that has either favoured charismatic species for conservation or placed protected areas mainly in those areas not wanted for other purposes. By aiming for full representation of all ecosystem types and species, the unique attributes, potential uses and intrinsic value of all biodiversity native to a country will be conserved.

2 **Aim to conserve key processes that allow biodiversity to persist over the long term.** *Persistence* is the second of two main goals of systematic conservation planning. It refers to the need to maintain ecological and evolutionary processes that enable ecosystems and species to persist over time. Rather than preserving a static state of biodiversity, this implies that the ongoing dynamic nature of ecosystems should be allowed to continue in the long term, to allow species to respond and adapt to changing environments. Consideration must be given to the quantity and configuration of biodiversity priority areas that will be needed to maintain ecosystem functioning. Addressing persistence may include making provision for ecological corridors that allow movement of species and enable connectivity in the landscape, or identifying refugia where biodiversity can persist in the face of climate change, amongst other factors. By planning for persistence, conservation actions taken today will still have benefits well into the future.

3 **Set quantitative *biodiversity targets* to achieve representation and persistence.** Biodiversity targets are quantitative measures used both to identify conservation priorities (through planning) as well as to evaluate the success or impact of conservation actions (through monitoring). Biodiversity targets refer to the amount of biodiversity that should be kept in a natural or near-natural state to meet the goals of representation and persistence. Biodiversity targets should be based on the best available information to ensure that they are defensible, and more importantly, to provide assurance that by achieving them, the desired conservation outcomes of representation and persistence will likewise be achieved. ***Section 6.3.1: Biodiversity targets*** contains more information.

[12] Margules & Pressey. 2000. Systematic conservation planning. Nature 405, 243–253. *http://www.nature.com/nature/journal/v405/n6783/full/405243a0.html.*

[13] Botts et al. 2019. Practical actions for applied systematic conservation planning. Conservation Biology, 33(6), 1235-1246. *https://doi.org/10.1111/cobi.13321.*

4 **Use the best available information to enable robust, defensible and credible results.** Throughout this approach, the best available data, information and knowledge should be used, and any limitations of the data carefully considered before it is included. Expert, traditional and local knowledge can be included where appropriate, and often plays a vital role at various stages in the process. It is important to check that any step taken makes ecological sense, rather than just following a set methodology. This requires involvement of ecologists who have first-hand knowledge of the country or region concerned. Each step should be carefully documented, including the data used and its limitations, methods applied, and any assumptions made during the process. This information should be made available in a technical report that accompanies the other outputs. This will allow other practitioners to understand, and potentially repeat, the methods. A robust process, based on best available information, will help to make certain that the results are credible, defensible and repeatable. With this basis, the spatial biodiversity assessment and prioritisation will be better able to stand up to any queries, especially when the products have been integrated into policy, planning, decisions and action.

5 **Use an adaptive approach: start simply and plan for iterative improvements**. The first time that this approach is applied in a country may well be basic due to data or capacity constraints. It is very useful to start simply, rather than awaiting optimal data and capacity to conduct a more sophisticated assessment at some future date. The first assessment or prioritisation is likely to be a valuable starting point, and can be built on in subsequent iterations as more data and capacity become available. Indeed, an initial assessment or prioritisation often helps to point to key data gaps, and to provide the impetus to fill them. It is necessary to be conscious of not revising the outputs too often or unnecessarily, especially if they are used to inform policy- and decision-making, as this can cause confusion or mistrust among users. It is thus important to find a balance between stability of the outputs on the one hand and iterative improvement on the other, and to ensure there is clear communication about which is the most appropriate version to use.

6 **Aim for consistency across terrestrial, freshwater and marine realms.** The approach described here is equally applicable across a wide range of ecosystems in different environments. The aim should be to keep the broad approach as similar as possible, so that the results are generally equivalent and comparable, while allowing for enough flexibility to deal with different types of data and different contexts. This allows for planning and decision-making to be inclusive and properly aligned across terrestrial, freshwater and marine realms. Ultimately, it may be possible to achieve a single integrated set of products that incorporates information across these realms, but a separate broadly consistent assessment or prioritisation for each realm can also be extremely useful.

7 **Keep the process simple, with clear and understandable outputs.** Biodiversity is complex, with many facets, ranging from genes to landscape- or seascape-scale ecological processes. However, allowing assessment or prioritisation to become overly complex does not enhance its utility or application. While remaining aware of the underlying complexity, it is important to aim to keep the assessment and prioritisation process, and more particularly the outputs, as straightforward as possible. This can be achieved by summarising results in a few indicators and a few maps, linked to clear messages, which will allow the products to be used most widely.

8 **Make a clear link to implementation by remaining aware of the context.** The implementation context, needs and opportunities should be considered throughout the process of assessment and prioritisation, from conceptualisation to dissemination of the final products. Requirements for implementation may tailor the questions that are asked, the data and methods used, and the type or structure of products that are produced. For this reason, it is important for those involved in the assessment or prioritisation process to be familiar with the implementation context and to understand how, and by whom, the products will be used, to ensure that they are fit for the purpose of implementation.

9 **Be inclusive and engage stakeholders at relevant stages.** Effective stakeholder participation in the assessment and prioritisation process is essential for the uptake and implementation of the results. As with any process that aims to involve stakeholders, it is beneficial to be inclusive from an early stage. However, it must also be understood that certain aspects of assessment and prioritisation are more appropriate to certain groups, and not all need to be involved in every aspect throughout the entire process. For

assessment, it may be appropriate to involve a smaller group of stakeholders who have the technical knowledge to apply the various categories and criteria of the Red List processes. While for prioritisation, broader stakeholder participation is important. Stakeholder participation should be strategic and well-structured to avoid unproductive interactions that might simply result in fatigue. Hence, the science community, practitioners, policymakers, indigenous people and local communities, and other stakeholders should be included at the most appropriate times, and not necessarily all at the same time. Similar to the technical nature of the assessment and prioritisation process, stakeholder engagement is an area that may require specialist skills (e.g. participatory workshop facilitation or negotiation skills) and innovative use of technology (e.g. online meetings and online tools to share draft reports or maps). Many excellent resources exist to guide the stakeholder participation process.

10 **Make the products freely and easily accessible for wide use.** Products of this approach are likely to include foundational data layers (which are often useful products in their own right), map products (the outputs of the analysis) and other accompanying products (such as technical reports, lists, implementation guides). See ***Section 7: Products***. All of these products should be made freely available from a well-known, credible and easily accessible online source. For scientific audiences, the information that should be made available includes input data and technical documentation on the methods used. For potential users of the data, the products and outputs should be provided in suitable formats that are easily accessible, to improve use and uptake. There are limited exceptions where data privacy may be important, such as for data on the locations of threatened species targeted by collectors.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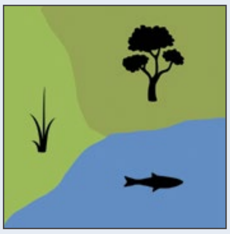
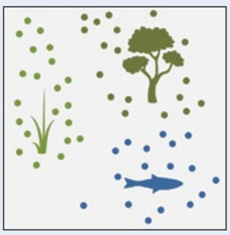
4. Spatial datasets

Four foundational datasets are required to complete a spatial biodiversity assessment and prioritisation at a national level (Table 1). The focus on only a few spatial datasets is a deliberate effort to maintain the simplicity of the approach, which is especially important for those countries that have limited data or resources. For those countries where it is challenging to gather the appropriate species data, it is still possible to conduct a useful assessment and prioritisation using only ecosystem-level data.

These datasets are not only important building blocks of the approach presented here, but are also useful products in their own right. They provide a wealth of information about what biodiversity is present within a country, its location and the major pressures that it faces.

Table 1: The four foundational datasets required for a spatial assessment or prioritisation of biodiversity.

	**Baseline map of ecosystem types** Ecosystem types are spatial units that are likely to share broadly similar ecological characteristics and functioning. The map represents diversity at an ecosystem level and is also a surrogate for a range of other biodiversity features. It should cover the entire area of the country that is being assessed and ideally show the historical extent of each ecosystem type or as close to that as possible.
	**Map of current extent and condition** A map of current extent and condition shows the current state of the landscape or seascape or as close to that as possible. It combines information on the impact of different pressures on ecosystems. The map is used to delineate the amount and location of natural areas that remain, and their condition compared to a reference condition of natural.
	**Map of protected and conserved areas** Protected areas are areas of land or sea that are formally protected by legal means. Conservation areas are conserved using other effective area-based conservation measures. The map of protected and conserved areas shows their locations and boundaries.
	**Maps of species occurrences** Species occurrence data are records of the places and times where species have been observed or collected. They are used to map species distributions, and generate parameters like the extent of occurrence or area of occupancy for species assessments. Ideally, species occurrence data should be spatially unbiased in its collection and comprehensive across a taxonomic group, but if this is not possible, collating all available data for each species is still useful.

The sections below examine the important characteristics of each of these spatial datasets, and provide guidance on how to source or generate them for a region or country. While it is always better to use national datasets, if these are not available then combining global datasets with expert and local knowledge can provide data of sufficient quality for an initial, basic assessment and prioritisation. This is preferable to having no spatial biodiversity information to inform policy, planning, decisions and action. An initial assessment and prioritisation can help to identify data gaps and plan for improvements in data quality over time, while still providing insights that can usefully inform conservation strategy in the meantime.

A pragmatic approach to ecosystem types

Ecosystem types evolve and change over time, for example, in response to climate change. Such ecosystem changes typically happen over much longer time scales than does planning. While acknowledging ecosystem change, mapping and classifying ecosystem types is a pragmatic way of grouping biodiversity to enable the assessing, managing and monitoring of the state of biodiversity in a country. The dynamic nature of ecosystems can be taken into account by including aspects of ecological processes and climate change in prioritisation, to maximise the ability of ecosystem types to evolve and adapt.

4.1 Baseline map of ecosystem types

An *ecosystem type* is a complex of organisms and their associated physical environment that share broadly similar ecological composition, structure and function. Using ecosystem types is a valuable approach, especially in situations where other biodiversity data may be limited or geographically biased. It is a way to bring in many complex aspects of biodiversity under the umbrella of ecosystem types that can be mapped systematically across a country. The map represents diversity at an ecosystem level and is also a surrogate for other *biodiversity features* that may otherwise be excluded from the analysis, such as assemblages of species typical of that ecosystem, unknown or poorly sampled species, habitat structure and ecological processes.

The baseline map of ecosystem types provides the fundamental unit of analysis for spatial biodiversity assessment and prioritisation. It is possible to build an initial version from a range of available datasets (Table 2), and early attempts can then be significantly refined and improved with iterative changes over time.

There are certain characteristics that are important in developing any map of ecosystem types:

Complete coverage of the country or region. The map of ecosystem types should cover the entire region or country being assessed. Complete coverage will mean that biodiversity is fairly represented across the country or region and no part of the land- or seascape is excluded from the analysis. Complete coverage can highlight pressures on overlooked areas that have not been the focus of previous research or conservation efforts. Complete coverage is also necessary for making meaningful comparisons, such as countrywide proportions of threatened or under-protected ecosystems.

Map the baseline extent of the ecosystem types. It is ideal to know the *historical extent* of ecosystem types, or as near to that as possible, as a baseline for assessing their current status and understanding changes. Establishing a historical baseline for the extent of an ecosystem type provides a stable measure against which to assess changes in extent. It allows for a more accurate and more systematic measure of indicators such as ecosystem protection level and ecosystem risk status. The historical extent should ideally be mapped to a pre-industrial baseline, before large-scale human modification of the landscape occurred. This is understandably difficult in some regions, where a decision will have to be made about an appropriate baseline date. In practice the baseline may be different for different ecosystem types depending on the availability of data. Accurate spatial delineation of historical boundaries of ecosystem types is not always possible, and it may be sufficient to estimate the historical extent of some ecosystem types, drawing on expert judgement.

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Use ecologically meaningful units. Meaningful ecological units are essential if the results of assessment and prioritisation are to be effective in informing conservation policy, planning, decisions and action. The map of ecosystem types should reflect ecosystem composition, structure and function, which requires a range of data sources. Ideally, the map of ecosystem types should be supported by ground-truthed data on species composition where available. However, if field data are not available, a pragmatic initial map of ecosystem types can be constructed from remotely sensed data and biophysical data layers that are usually widely available (Table 2), in consultation with ecologists who know the area.

Improve integration across realms. Ideally, the map of ecosystem types should be continuous across the terrestrial, freshwater and marine realms. This enables integrated prioritisation across realms and all-in-one map products, and allows better incorporation of the important transitional ecosystems between realms. Exchanges that occur between realms, such as at the coast, estuaries or wetlands, are ecologically important and should not be disregarded during assessment and prioritisation. However, given the different data sources in each of the realms, such integration is not always achievable. In such cases, it is still extremely useful to create a separate map of ecosystem types for each realm, with the aim of improving alignment and edge-matching over time so that ultimately they can be integrated into a single map.

Provide a description of each ecosystem type. Each ecosystem type should be recognisable based on its abiotic (e.g. soils, climate) and biotic (dominant communities or species) characteristics. Developing a description helps to think through the uniqueness of the ecosystem type in the landscape or seascape, while recognising that some ecosystem types cross country borders. Initial descriptions can be brief outlines of the characteristics. These descriptions can be expanded over time as more information is gathered and discussions are held with neighbouring countries, to include additional aspects of the characteristic species and ecological processes of the ecosystem. A definition of the ecosystem type can guide conservation actions that are aligned with its unique characteristics. Submitting threatened ecosystems to global databases also calls for a description of the ecosystem type.

Establish a sensible classification with a nested hierarchy. Ecosystem types should be nested within broader categories, which are a useful level at which to summarise findings of assessment and prioritisation. It is useful to develop a basic hierarchical framework before mapping ecosystem types. The ecosystem functional groups of the IUCN Global Ecosystem Typology[14] can be a useful starting point, within which national ecosystem types can be nested and refined over time. A fully nested hierarchy enhances the utility of the map of ecosystem types, making it more appropriate as a basis for assessment and prioritisation at a range

[14]*https://global-ecosystems.org.*

of spatial scales. A national map and classification of ecosystem types that becomes well-established is an extremely valuable product in its own right that has a wide range of applications.

The **IUCN Global Ecosystem Typology** (GET) is a hierarchical classification for Earth's ecosystems. In its upper three levels, the GET defines ecosystems by their functional characteristics, while in its three lower levels, it is designed to distinguish ecosystems with different assemblages of species. It recognises five realms (level 1 of the typology): terrestrial, freshwater, marine, subterranean and atmospheric. Within the realms are nested biomes (level 2) and ecosystem functional groups (level 3). Ecosystem functional groups have been recommended for use across the ecosystem-related indicators for the Global Biodiversity Framework, and are the reference classification for ecosystem types in SEEA Ecosystem Accounting and the Red List of Ecosystems. The GET has been endorsed by the United Nations Statistical Commission as an international statistical classification.

The GET does not replace national ecosystem classifications or national ecosystem types. Rather, it provides a way of linking national ecosystem classifications to a consistent global system. Ideally, each national ecosystem type (typically identified at level 5 or 6 of the GET) should fall within one of the ecosystem functional groups (level 3) in the GET, which is a useful level for summarising measurement and indicators for ecosystems across countries. Countries can retain as much detail as is useful in their national maps and classifications while at the same time allowing for aggregation of ecosystem types to ecosystem functional groups. The identification of ecosystem types is intended to support biodiversity conservation, research, management and human well-being.

Sourcing or developing a baseline map of ecosystem types is slightly different across the terrestrial, freshwater and marine realms (Table 2). In the absence of more accurate national data, broad-scale global datasets or available biophysical data can be used as a basis for an initial map of ecosystem types. Even data-poor countries will be able to generate a useful initial version with little need for additional data collection. An initial national map is likely

to involve a combination of global datasets, available national data (even if partial or incomplete) and expert input. Rapidly advancing Earth observation technology, along with innovative artificial intelligence methods, can also support mapping. However, land cover classes in themselves are often not a suitable proxy for mapping ecologically meaningful natural ecosystem types.

Table 2: Sourcing or generating a baseline map of ecosystem types across the terrestrial, freshwater and marine realms.

Terrestrial	• Vegetation types can provide a way of mapping, classifying and describing terrestrial ecosystem types. • National vegetation maps are available for many countries as a result of botanical and agricultural research (sometimes called geobotanical maps). • Sometimes it may be necessary to bring together several sub-national vegetation maps and then work to fill in the gaps with other data. • In some cases, useful regional maps (e.g. for Africa) can be adapted to national level. • A basic map of terrestrial ecosystem types can also be generated using a combination of biophysical data layers such as soil types, elevation, geology and rainfall. • Additional sources of historical data can include old photos, botanical memoirs or paintings. • Expert, traditional and local knowledge can be used to assist in the classification and delineation of ecosystem types, for example by uncovering useful datasets or refining existing data.
Freshwater	• Basic datasets for developing a map of freshwater ecosystem types include maps of the river network and wetlands for a region or country. It is also useful to have a map of catchments. • Many countries have a map of their river network, at least of major rivers at a broad scale. • Maps of larger wetlands can often be extracted from a topographical map, vegetation or land cover data, if a national map of wetlands does not exist. • There are rapidly unfolding advances in the remote sensing detection of surface water, soil moisture and the 'signature' of vegetation that responds to the sustained presence of wet soils. • Wetland extent is often dynamic and seasonal, and therefore cannot be equated with the open water visible through remote sensing at a particular point in time. Field mapping is usually needed, along with modelling. • It is not always possible to map historical extent of wetlands, so it may be necessary to decide on a baseline year. • Where possible, freshwater ecosystem types can be categorised using hydrological, geomorphological or biological characteristics. • Finer scale classification can be achieved by including additional information such as flow variability, channel gradient and species composition. • Expert, traditional and local knowledge can be used to assist in the classification and delineation of ecosystem types, for example by uncovering useful datasets or refining existing data.
Marine	• Maps of marine ecosystem types can be created from a small set of globally available biophysical layers, including sediment and depth. • At the broadest level, marine environments can be divided into coastal, inshore and offshore. • Depth classes (coastal, inshore, shelf, shelf edge, upper bathyal, lower bathyal and abyss) can be used as a basis for further delineating marine ecosystem types. • Additional factors used to classify coastal or marine ecosystem types can include substrate (e.g. rocky shore or sandy beach), geology, wave exposure or biogeography. • It is also possible to map some coastal ecosystems from remote sensing imagery. • Expert, traditional and local knowledge can be used to assist in the classification and delineation of ecosystem types, for example by uncovering useful datasets or refining existing data.

4.2 Map of current extent and condition

The map of current extent and condition gives a current view of what is happening in the landscape or seascape, or as close to that as possible. It gathers a range of information about what has changed, or has not, since the baseline that is captured in the map of ecosystem types. The purpose of the map of current extent and condition is to determine the amount and location of natural areas that remain, and their condition in terms of how their composition, structure and function has been modified from a reference condition of natural. It combines information on the impact of different pressures on biodiversity (such as land use change, alteration of freshwater flows, unsustainable harvesting of resources, invasive alien species or climate change), and is a way of summarising the many pressures acting on ecosystems. Ideally, it is useful to work towards a time series of maps of current extent and condition at regular intervals with each version named clearly to indicate the timepoint.

Depending on how it is used for assessment and prioritisation, the information can be combined in various ways. At the most fundamental, it distinguishes between the parts of the landscape or seascape that are no longer natural and have been converted to anthropogenic ecosystem types and those that remain natural or semi-natural. This provides a measure of the remaining extent of natural ecosystem types, which provides information for Global Biodiversity Framework headline indicator A.2 Extent of natural ecosystems. It is also an important part of the assessment criteria for the Red List of Ecosystems (***Section 5.2.1: Ecosystem risk status***). In the terrestrial and freshwater realms and for coastal areas, the primary input to identifying areas that have been lost are the classes in land cover data that represent anthropogenic ecosystem types, such as urban, mining and cultivation. However, these can be supplemented by other data that may not be well represented in land cover, such as the transport network (roads, rail, harbours).

Once the areas that are no longer natural have been mapped, it is then also possible to define the differing degrees of *ecological condition* in the areas that remain natural or semi-natural. There are many appropriate ways to map ecological condition, and methods often differ across the terrestrial, freshwater and marine realms (Table 3). Ideally, more detail about ecological condition is better, so including several categories that show degrees of modification from natural (such as good, fair, poor) is helpful. Ecological condition can draw on additional data that captures causes of degradation, such as overgrazing in the terrestrial realm or heavy fishing pressure in the marine realm. Whichever method is chosen, the aim should be a simple classification of ecological condition into sensible and easily understood categories.

Table 3: Sourcing or generating a map of current extent and condition across the terrestrial, freshwater and marine realms.

Terrestrial	• The primary source of data for the map of current extent and condition in the terrestrial environment is land cover. • Land cover classes can in many cases be linked to degree of modification. • It may be possible to use a range of additional data sources to supplement land cover data (e.g. road data, aerial imagery, lights at night). • Additional data on specific sectors may be useful (e.g. data on the location of cultivated fields, plantation forestry and extractive industries are sometimes available).
Freshwater	• The extent of rivers is often measured in length and is generally constant. • Ideally, an assessment of the ecological condition of rivers requires data on a range of factors such as modifications to hydrology (the quantity, timing and velocity of flow in the river), water quality, in-stream habitat and riparian habitat. • If such information is not available, the ecological condition of rivers can be estimated by using land cover data to estimate the proportion of natural vegetation in the river catchment and

Table 3: Sourcing or generating a map of current extent and condition across the terrestrial, freshwater and marine realms (continued).

Freshwater (continued)	within a defined buffer along the river corridor. The higher the proportion of natural vegetation, the better the ecological condition of the river is likely to be. • Wetland condition can be assessed by using land cover data to estimate the proportion of natural vegetation in, and surrounding, the wetland. • Other proxies for pressures on freshwater ecosystems can be included where available, for example presence of dams or road crossings that fragment freshwater ecosystems. • The assessment of ecological condition of rivers and wetlands using proxies should be supplemented with expert and local knowledge whenever available.
Marine	• There is no equivalent to land cover in the marine environment, but data on pressures on marine ecosystems can be used as a proxy for ecological condition. • Pressures in the marine environment can include fishing, mining, shipping, waste water discharge, coastal development, mariculture and invasive species, amongst others. • Information on these pressures is sometimes available from the relevant industries or government departments. • These pressures need to be sensibly converted into a map of current extent and condition, for example, by applying a matrix that scores the impact of each pressure (extent and intensity) within each ecosystem type. • Whilst global maps of biodiversity in the marine realm are available, they are generally of coarse resolution and as such, caution should be applied if using them to infer ecological condition.

Anthropogenic ecosystem types and mapping the baseline for assessment

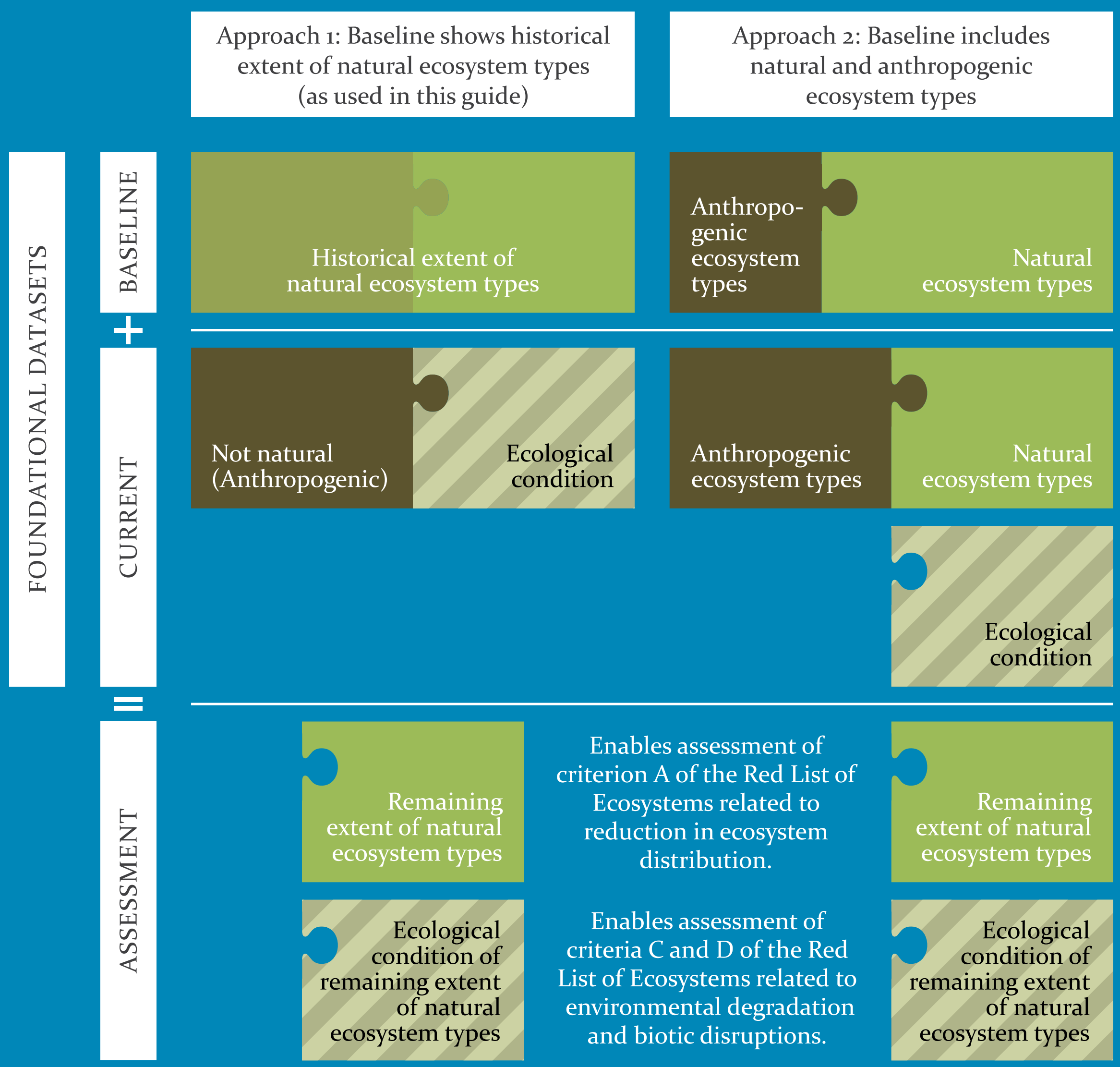
The IUCN Global Ecosystem Typology recognises anthropogenic ecosystem types as well as natural ecosystem types. Anthropogenic ecosystem types arise where human modification of natural ecosystems results in a completely new ecosystem type such as an urban area, cropland or dam. Human activity is the primary determinant of the properties in these ecosystem types, and they are maintained through human influence and management. They function very differently to the natural ecosystems that they replaced, and in general the ecosystem type they replaced will no longer be recognisably present. If it is not possible to map the historical extent of natural ecosystem types, then anthropogenic ecosystem types can be included in the baseline map of ecosystem types.

There are different ways to develop, combine and present the baseline map of ecosystem types and the map of current extent and condition. Countries may choose different approaches based on their context.

One approach is to map the historical extent of natural ecosystems across the whole country on one map. It is often possible to estimate the historical extent without necessarily having detailed maps or records from the past (***Section 4.1: Baseline map of ecosystem types***). Information on human land uses, pressures and other ecological condition information is combined in a second map that reflects the current state of the landscape or seascape (***Section 4.2: Map of current extent and condition***). Overlaying these maps provides the assessment (***Section 5.2: Steps for conducting an ecosystem assessment***). This is the method that is used in this guide.

Mapping the historical extent of natural ecosystems makes it possible to assess Criterion A3 of the IUCN Red List of Ecosystems (which relates to reduction in the extent of ecosystems over historical timeframes) for all ecosystem types in the country. This is a simple way to achieve an initial Red List of Ecosystems assessment. A baseline map of historical extent of ecosystem types also has benefits for meaningfully assessing protection levels. Setting percentage targets for protection based on less than the full historical extent of an ecosystem type might mean that the area required to meet protection targets gets smaller and smaller as more of the ecosystem is modified (***Section 6.3.1: Biodiversity targets***). An ecosystem type may then be inaccurately assessed as well protected when actually only a tiny fraction of its historical extent is protected. See Box 2: Developing a baseline map of ecosystem types for Rwanda.

For some countries, however, mapping the historical extent of natural ecosystem types is difficult as large portions of some ecosystem types have been converted to anthropogenic types and this conversion may have happened in the distant past. These countries often combine the extent of anthropogenic ecosystem types and natural ecosystem types at a specific point of time into a baseline map of ecosystem types that can be used for assessment. This is compared to a current map to show how the extent of ecosystem types has changed. Condition information is brought in to assess the condition of the remaining natural ecosystem types. The benefits of this approach are that the baseline map of ecosystem types (natural and anthropogenic) more closely resembles what people are familiar with on the ground. In this case, it is useful to estimate the historical extent numerically, even if it cannot be mapped, as a basis for setting protection targets.



Box 2:
Case study: Developing a baseline map of ecosystem types for Rwanda

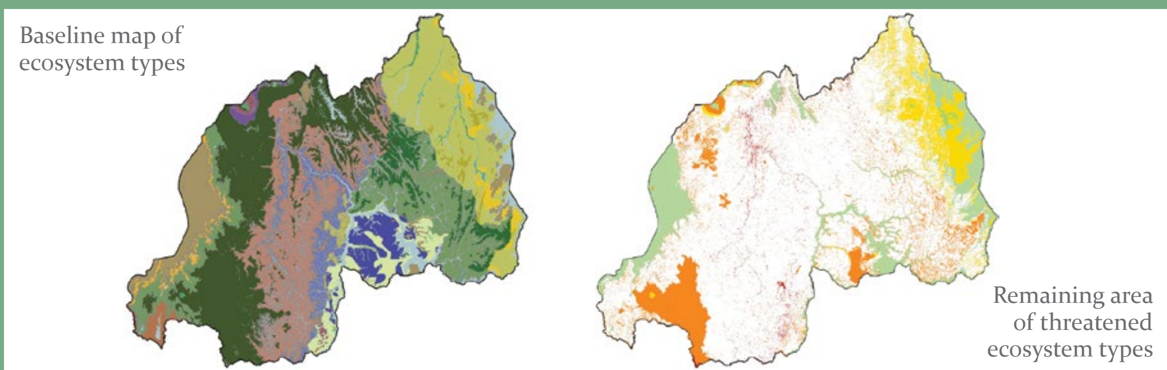
Often referred to as the land of a thousand hills, Rwanda boasts a landscape that is topographically diverse with five volcanoes, over 23 lakes and an elevation between 1 000 and 4 500masl. However, with more than 500 people per square kilometre,[15] much of the land has been converted to commercial and subsistence farming, housing and other intensive anthropogenic uses.[16]

In 2022, Rwanda undertook its first spatial biodiversity assessment. As a first step, partners needed to create a map of ecosystem types to form the baseline for the assessment. The limited ecosystem data, extensively transformed landscape and thinly spread expert knowledge posed a challenge to developing a map of the historical extent of natural ecosystem types. However, a map showing just the remaining distribution of natural ecosystem types would not have been useful in an assessment of biodiversity as it would not give an estimate of how much of each ecosystem type had been lost.

Therefore, efforts were made to collate all available data, drawing on local and international knowledge and experience. Local experts used a range of proxies based on their knowledge of what processes drive Rwandan ecosystems. Many useful datasets were eventually gathered, including regional vegetation maps, biophysical maps and several fine-scale local maps. With several rounds of review by experts, this data was used to build a map of the historical distribution of ecosystem types that was used as a baseline for an assessment of risk status and protection level for ecosystems.

Ecosystem types such as Wooded Savanna, which is Critically Endangered and not protected, were highlighted as priorities for conservation action. The assessment found that 71% of Rwanda's ecosystem types are threatened and nearly two thirds (64%) are not protected or poorly protected. It was only possible to calculate these statistics because a historical baseline extent was established for all ecosystem types.

Efforts have since been made to refine the map of ecosystem types as more ecologists have become involved in the process. A team was established with partners in national government so that the map and assessment can be included in future policy and planning.



[15]NISR. 2023. The Fifth Rwanda Population and Housing Census, Main Indicators Report, National Institute of Statistics of Rwanda.

[16]SANBI, CoEB and REMA. 2022. Rwanda Spatial Biodiversity Assessment 2022. University of Rwanda's Centre of Excellence in Biodiversity and Natural Resource Management, Rwanda Environment Management Authority and South African National Biodiversity Institute.

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4.3 Map of protected and conserved areas

Protected areas are areas of land or sea that are formally protected by legal means and managed mainly for biodiversity conservation. *Conserved areas* are areas that are conserved using other effective area-based conservation measures (OECMs). Conserved areas do not necessarily have a primary conservation objective, but are managed in ways that deliver positive and sustained outcomes for biodiversity.[17] The map of protected and conserved areas shows the location and boundaries of existing protected or conserved areas for the country or region. It is not always easy to obtain a complete map of protected and conserved areas for a country. Protected areas can be declared using a range of different legislation, such as environmental laws, forestry laws, marine regulations and more, at both sub-national and national levels of government, and often at different points in the history of the country. Nevertheless, most countries will be able

[17]'Protected and conserved areas' are used for simplicity, for a comprehensive discussion of terminology and definitions see Salafsky et al. 2024. A standard lexicon of terms for area-based conservation version 1.0. Conservation Biology, e14269. *https://doi.org/10.1111/cobi.14269*.

to gather the necessary information on their own protected and conserved areas. Global data can be accessed from the World Database on Protected Areas and the World Database on Other Effective Conservation Measures (*http://www.protectedplanet.net/*).

Since protected and conserved areas may vary in the degree of formal protection and the degree of management effectiveness, some decisions must usually be made about whether certain areas can be considered as effectively contributing to protecting biodiversity in the protection level assessments (***Section 5: Assessment***). In practice, management effectiveness is difficult to measure and there is often little information available about the management effectiveness of protected areas. The most pragmatic solution is to consider only those protected areas with secure, long-term status as contributing to meeting biodiversity targets. A classification such as the IUCN Protected Areas Management Categories can also be used, for example by considering only categories I – III. In the marine realm, consideration should be given to the different zones that are often used in marine protected areas (for example, no-take zones and zones where extractive use of marine resources is permitted), as it may be necessary to treat these differently in the assessment process.

4.4 Maps of species occurrence

It is not possible to include all species since many species are either too poorly known or still require taxonomic delineation. The first step is therefore to decide which species to include. To avoid bias towards charismatic species, all species within a taxonomic group should be assessed. Determining which taxonomic groups to select is based on availability of knowledge on the group, whether the taxonomy is stable and if there has been sufficient sampling effort to determine the distribution and habitat preference for each species. It is useful to select taxonomic groups that are representative of different realms (terrestrial, freshwater and marine).

When collating species data to use in assessment and prioritisation, it is best to focus on data that are already available from existing sources. This determines which species can be assessed now and which species need more field data collection. For example, it is unlikely that a country starting species assessments will have data for all invertebrate species, but they might have data for all mammal or bird species. Waiting to conduct field work to collect additional data can slow down the assessment process. It is better to use the data that are available, and strategically prioritise additional data collection over the longer term.

The most essential data for including species in assessment and prioritisation are accurate species occurrence records – records of the places and times where species have been observed or collected. Collating all the available occurrence records is the first step. Specimen records should be sourced from national museums, herbaria, universities and other collections. In some instances, collection institutions in other countries may host important data for specific taxonomic groups. The easiest way to establish if these are available is to check the Global Biodiversity Information Facility (GBIF). Published taxonomic revisions also often include useful lists of reference collections. Observation data from open online platforms (Table 4) can complement specimen information. Citizen science initiatives are notably expanding the availability of species data. However, extra precaution is needed when using records from these repositories or from GBIF, to ensure they are thoroughly vetted by relevant species experts for accuracy.

Species occurrence data can sometimes be geographically biased towards areas of high sampling intensity (such as areas that are accessible to people). This can give a skewed representation of species presence. Such biases would be more challenging if species data alone was being used to identify priorities. However, when used in combination with a map of ecosystem types (***Section 4.1: Baseline map of ecosystem types***), even incomplete species data can add important information to the analyses. To address biases in the long term, field inventories need to target areas where suitable habitats for species exist but have not yet been sampled. Where data are suspected to be highly biased, models of suitable habitat can replace the use of occurrence points. Models should be used with caution as they can over-represent actual occurrence of species.

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In addition to collating all suitable occurrence records, other useful data for species assessments include:

- **Population:** The current population size, past and current population trends, rate of past population decline. These data are usually available only for a limited subset of species that have been the focus of regular monitoring initiatives.
- **Habitat, ecology and life history:** Essential habitats, environmental requirements (e.g. water availability, soil types), generation length and other characteristics. These can be sourced from taxonomic revisions or field guides.
- **Relative abundance:** Not all species are equally abundant within suitable habitat, and it is important to consider this when setting biodiversity targets for species. Quantitative abundance data (such as density estimates) are ideal, but qualitative estimates of relative abundance can also be useful.
- **Direct pressures:** Past, ongoing and future or likely potential pressures. These data can sometimes be inferred from land-cover datasets for species impacted by land-use change, or gathered from literature or species experts.
- **Use and trade:** Data on hunting or collecting of the species, including sustainable use. This data can be gathered from literature, species experts, or databases that collate both legal and illegal use of species nationally.

It is always preferable to collate species data from both global and national datasets. However, in data-poor and resource-limited countries, it is possible to download spatial data already compiled for existing Red List assessments as a starting point. It is important to be aware of the biases in these data. The current Red List of Threatened Species covers vertebrates and the terrestrial and freshwater realms better than invertebrate, plant, fungi and marine species.

Table 4: Possible sources of species occurrence data.

Species data	• Global Biodiversity Information Facility (GBIF): *https://www.gbif.org*. • National databases of specimen information digitised from museums and herbaria that may not yet be published to GBIF. • Open online databases, such as iNaturalist: *https://www.inaturalist.org*; BirdLasser: *https://www.birdlasser.com* or eBird: *https://ebird.org*. • Species inventory and monitoring data from conservation agencies and research institutions. • Global Red List of Threatened Species: *https://www.iucnredlist.org/*.

4.5 Combining the datasets for assessment, prioritisation and planning

The four spatial datasets described above are sufficient to conduct a biodiversity assessment and prioritisation. By combining these datasets through a few logical analyses, it is possible to achieve a robust assessment of the state of biodiversity and an indication of the priority areas where action should be focused first (Figure 1). Explanation of the methods for analysing these datasets, and details of the steps to be taken, are provided in ***Section 5: Assessment*** and ***Section 6: Prioritisation and planning***.

✓ Ticks indicate which datasets are required		Assessment				Prioritisation and planning
		Risk status		Protection level		
		Ecosystems	Species	Ecosystems	Species	
Spatial datasets	Baseline map of ecosystem types	✓		✓		✓
	Map of current extent and condition	✓	✓	✓		✓
	Map of protected and conserved areas			✓	✓	✓
	Maps of species occurrence		✓		✓	✓

Figure 1: Four foundational datasets can be combined to conduct a spatial biodiversity assessment and prioritisation.

4.6 Other datasets

The above four datasets present the minimum requirements to conduct a biodiversity assessment and prioritisation using the approach presented here. The datasets form the foundation for a range of further analyses that can be performed by drawing on additional data. Particularly during prioritisation, incorporating a wide range of additional data can be extremely useful and can improve the prioritisation outputs. Additional data may include data on *ecological processes*, *ecological infrastructure*, *ecosystem services*, climate change and a range of socio-economic data. Innovative methods for mapping these are quickly developing. Including additional socio-economic and ecological data in a prioritisation process will result in a more comprehensive and refined selection of priority areas. When available, these additional data should be included, always with due consideration for their possible limitations. Such additional spatial data may also have relevance for informing biodiversity strategy and actions, even if not used directly in the assessment or prioritisation.

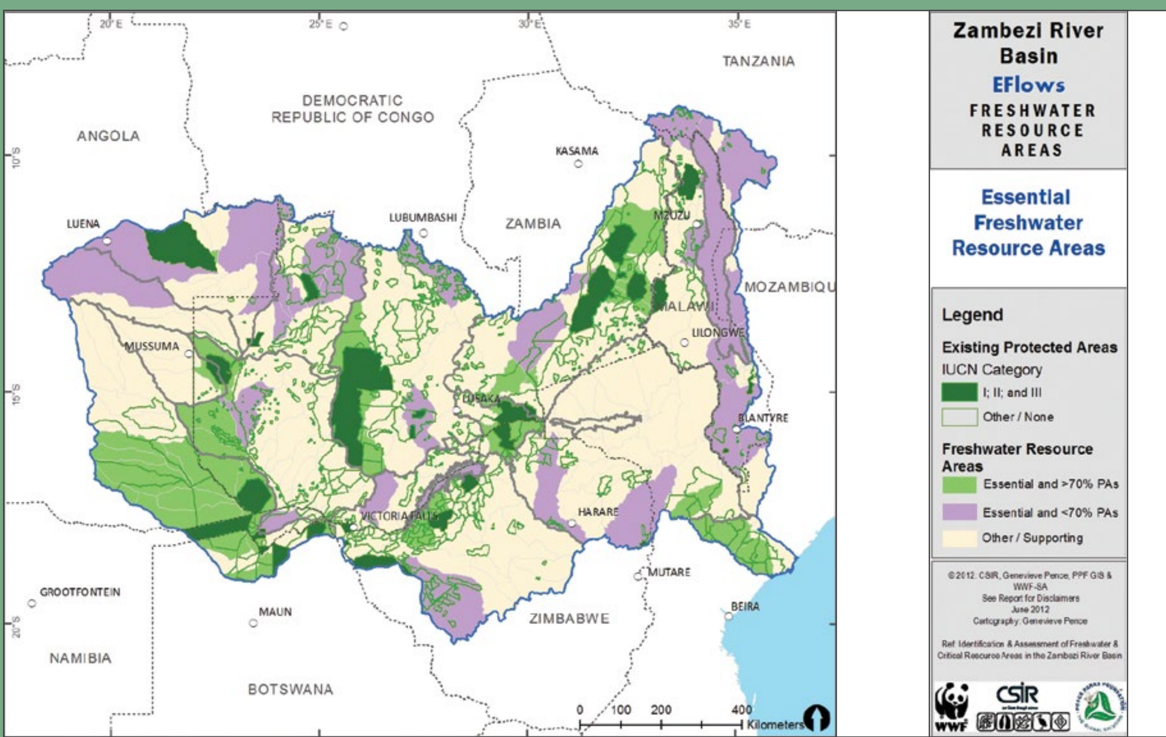
Box 3:
Case study: Additional data for prioritisation – the Zambezi Freshwater Resource Areas.

Maps showing the areas important for delivering ecosystem services to people are one of the many additional types of data that can be included at the prioritisation stage. The Zambezi Freshwater Resource Areas[18] is an example of a prioritisation that included biodiversity features as well as identifying areas important for providing freshwater ecosystem services in the Zambezi basin.

The Zambezi River Basin covers nearly two million square kilometres, spans eight countries, and is important for supplying a wealth of ecosystem services that meet the most basic needs of approximately 30 million people. These services range from flows essential for food security and hydropower production, to mitigating flood events and providing people with harvestable resources.

Maps of freshwater ecosystems for the basin were either sourced or generated from existing data: a watershed model was used to delineate 220 sub-catchments for the Zambezi basin, a rivers layer was derived from elevation data, and a wetlands layer was produced by merging five existing wetlands datasets. Large numbers of hydrological and physiographic characteristics were mapped to aid in the identification of Freshwater Resource Areas.

The Freshwater Resource Areas were then assessed based on their ability to supply hydrological services, their significance to local livelihoods and their biodiversity importance. The result is a map that shows a portfolio of Freshwater Resource Areas that are considered essential for meeting biodiversity targets in the Zambezi River Basin, and for sustaining key hydrological functions.



[18]Colvin et al. Zambezi Environmental Flows: Freshwater Resource Areas. Project number ZA1744, WWF-South Africa.

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5. Assessment

Spatial biodiversity assessment evaluates the state of biodiversity based on indicators of risk status and protection level for ecosystems and species (***Section 5.1: Indicators***). These indicators highlight which of the country's ecosystem types or species are most threatened, and which are in need of better protection. They combine a range of information on biodiversity pattern, major pressures and protected areas into a few easily understood categories. Assessments often present the only comprehensive analysis of the pressures on a country's biodiversity, with the ability to compare levels of risk between different ecosystem types, species and realms.

Assessment is centred on overlaying the spatial datasets to determine how ecosystem types and species spatially overlap with the map of current extent and condition, and the map of protected and conserved areas. This helps to give an indication of how much of each ecosystem type or species distribution remains intact and in good condition, and how much is protected.

The products of a biodiversity assessment are usually a set of maps displaying the categories for each of the indicators, highlighting the location and proportions of the most threatened and under-protected ecosystem types or species. The indicators can also be summarised on a bar graph and compared across realms or taxonomic groups. Ideally, maps and graphs should be accompanied by a user-friendly document explaining what the maps and graphs show and how they can be used. See ***Section 7: Products*** for more information on developing useful maps, graphs and accompanying material. The relatively simple information produced from a biodiversity assessment can inform a wide range of biodiversity policy, planning, decisions and action.

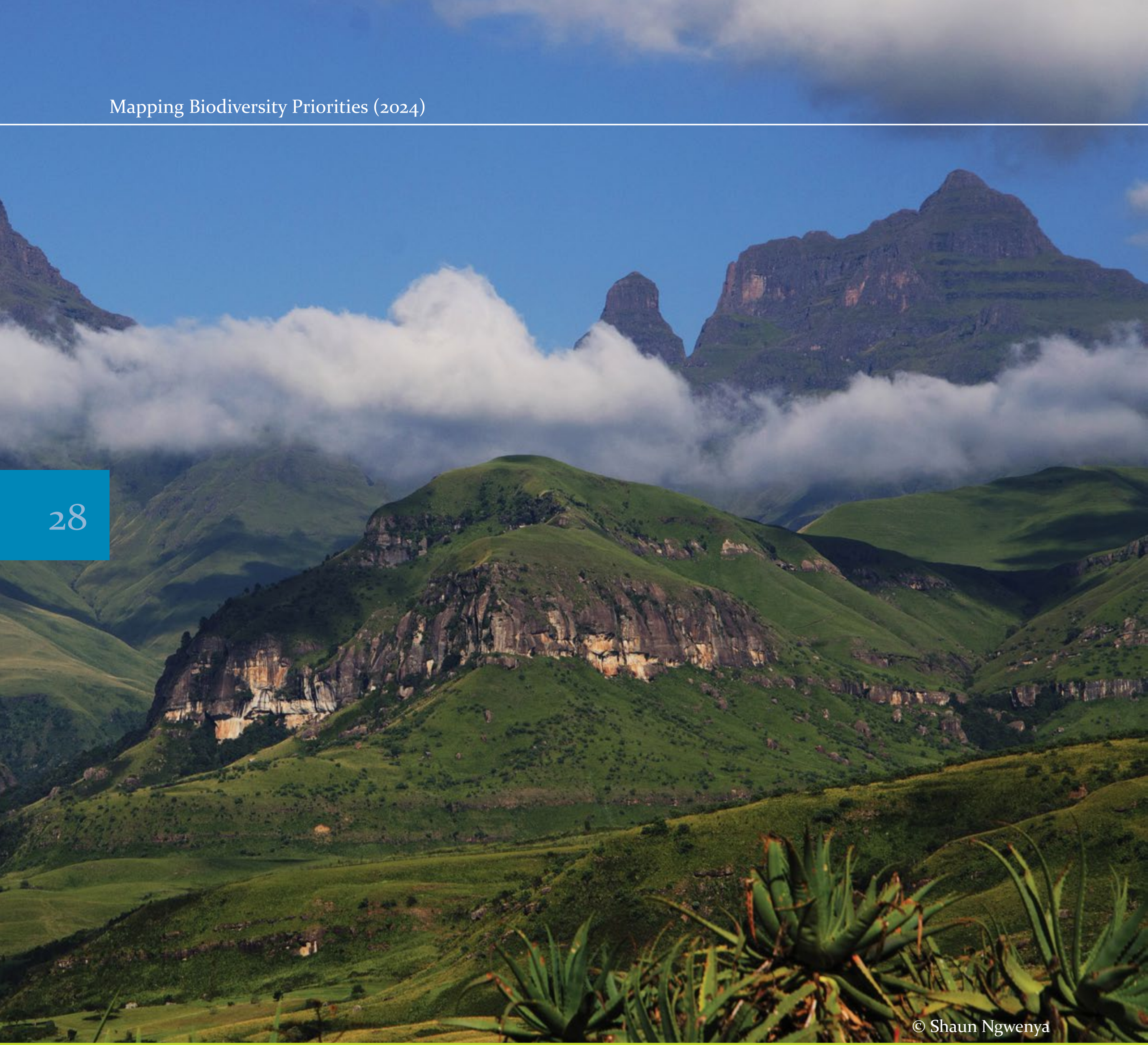
5.1 Indicators

The indicators that result from the assessment help to communicate information about the levels of risk and protection for ecosystems and species in an intuitive way to a broad, non-technical audience. The indicators can be reported using interrelated graphics and maps that can quickly convey the primary results (see ***Section 7: Products***). If the assessment is periodically updated using the same indicators, they can be used over time to monitor and report on trends in the state of biodiversity at a national level. The indicators contribute directly to several headline indicators of the Global Biodiversity Framework.

Risk status is an indicator of how threatened an ecosystem or species is, or in other words how close it is to collapse or extinction. Risk status for both ecosystems and species are based on the internationally accepted categories and criteria adopted by the IUCN through the Red List of Ecosystems[19] and the Red List of Threatened Species.[20] Ecosystem types or species are assigned to an escalating series of categories that describe the degree to which they are at risk – Vulnerable, Endangered and Critically

[19]IUCN. 2024. Guidelines for the application of IUCN Red List of Ecosystems Categories and Criteria, Version 2.0. IUCN, Gland, Switzerland. *https://portals.iucn.org/library/node/45794*.

[20]IUCN. 2012. IUCN Red List Categories and Criteria: Version 3.1. Second edition. International Union for Conservation of Nature, Gland, Switzerland and Cambridge, UK. *https://portals.iucn.org/library/node/10315*.



Endangered. These categories are widely known and easily understood. See ***Section 5.2.1: Ecosystem risk status*** and ***Section 5.3.1: Species extinction risk***.

Threatened ecosystems and species are a very useful guide for conservation action. It is clear that ecosystems or species that are endemic or near-endemic to a country and also threatened should receive particular conservation attention. In a few cases, the results of national and global assessments of risk may differ, for example, when a small portion of an ecosystem type or species population is nationally threatened and yet widespread and not threatened in other parts of the world. In such cases, a rational decision must be made about conservation action, which is best done on a case-by-case basis considering context-specific factors.

Protection level is an indicator of the extent to which ecosystems or species are adequately protected in the network of protected and conserved areas. This differs from a measure of the total area protected and conserved in a country in that it assigns a protection level category to each ecosystem type or species. The aim is to ensure that representative samples of all the ecosystem types and species are included within protected and conserved areas. Unlike risk status, there is currently no global standard for assessing protection levels of ecosystem types or species. See ***Section 5.2.2: Ecosystem protection level*** and ***Section 5.3.2: Species protection level***.

Box 4:
Case study: The results of the indicators from South Africa.

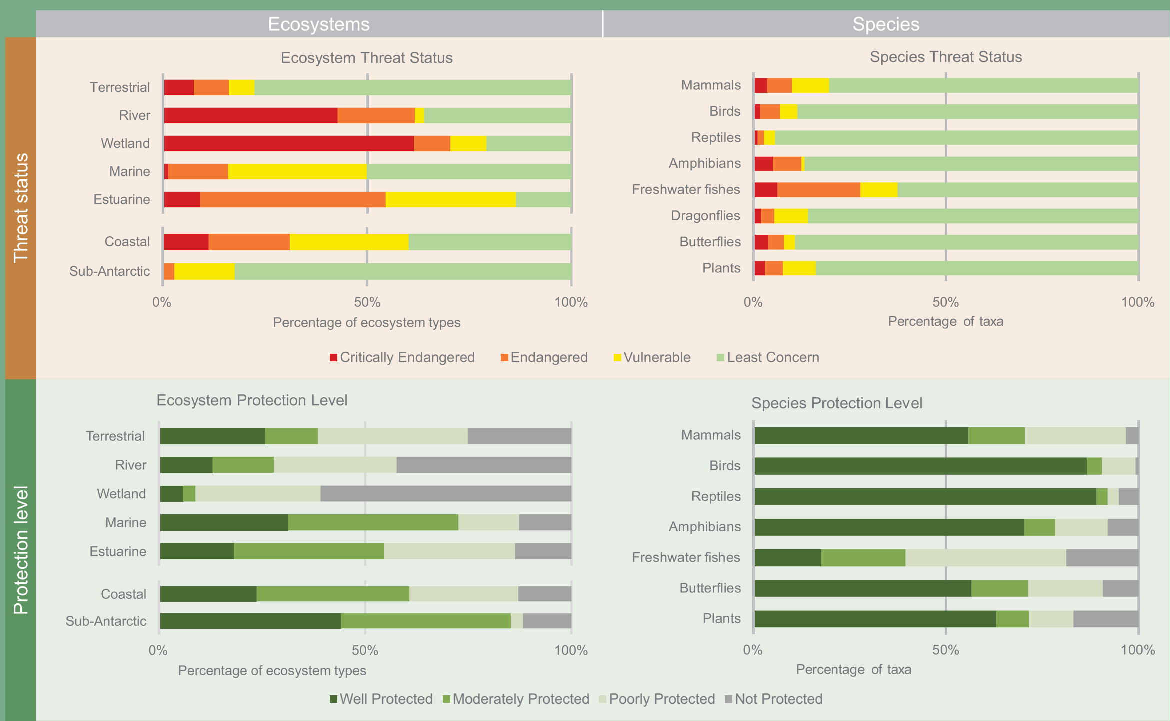
The third iteration of the National Biodiversity Assessment (NBA)[21] for South Africa was completed in 2018. It provided an assessment of the indicators for the terrestrial, freshwater, estuarine and marine ecosystems of the country.

Ecosystem threat status:[22] The assessment of ecosystem threat status in the NBA 2018 was based on application of the Red List of Ecosystems for all realms. It showed that almost half of the 1 021 ecosystem types assessed in South Africa were threatened. Estuaries and wetlands had the highest proportion of threatened ecosystem types.

Ecosystem protection level: The assessment of ecosystem protection level revealed that 31% of ecosystem types were Not Protected, with wetland and river ecosystem types having the lowest levels of protection overall.

Species threat status: All of South Africa's recorded plants, mammals, birds, reptiles, amphibians, freshwater fishes, butterflies and dragonflies, as well as selected marine and estuarine fishes and invertebrates, were assessed based on the Red List of Threatened Species. Of those assessed, 14% of plant species and 12% of animal species were found to be threatened.

Species protection level: The NBA 2018 was the first time that species protection level was assessed. It found that 63% of assessed plant and animal species were Well Protected. The taxonomic group with the highest proportion of under-protected species was the freshwater fishes.



[21] SANBI. 2019. National Biodiversity Assessment 2018: The status of South Africa's ecosystems and biodiversity. Synthesis Report. South African National Biodiversity Institute, an entity of the Department of Environment, Forestry and Fisheries, Pretoria. *http://nba.sanbi.org.za/*.

[22] The term threat status is generally used in South Africa rather than risk status since it has been accepted in policy and legislation.

5.2 Steps for conducting an ecosystem assessment

Calculating the indicators for ecosystems is possible using only the datasets described in ***Section 4: Spatial datasets***: a baseline map of ecosystem types, a map of current extent and condition, and a map of protected and conserved areas. These basic building blocks are combined by overlaying the maps and calculating proportions in relation to a series of thresholds. While some GIS capability is required, the methods are relatively straightforward and logical to understand and apply.

5.2.1 Ecosystem risk status

Ecosystem risk status is an indicator of the risk of ecosystem collapse. In other words, it provides information about how threatened an ecosystem is, or the degree to which it is still intact or alternatively losing vital aspects of its function, structure or composition. Ecosystem risk status is assessed by applying the categories and criteria of the Red List of Ecosystems. The **IUCN Red List of Ecosystems**[23] is a consistent global standard for ecosystem risk assessment to monitor the status of ecosystems. It is based on a set of five criteria that capture different spatial and functional impacts on ecosystems (Figure 2).[24] The first two criteria, A and B, deal with the extent or area of ecosystems, while Criteria C and D deal with ecological condition. The Red List of Ecosystems, using the Red List Index of Ecosystems, is an accepted headline indicator under the Global Biodiversity Framework to support the monitoring of Goal A and several targets.

Ideally, all five criteria would be assessed for each ecosystem type. In practice, there is often neither sufficient data nor capacity available to do so. It is possible to do an initial assessment that gives robust results by applying just one (or more) of the most accessible criteria for which spatial data are available. The spatial datasets developed for assessment and prioritisation (***Section 4: Spatial datasets***) can provide suitable data for several criteria. An initial assessment can be easier to undertake, and can also be done systematically for all ecosystem types across a country. Experience has shown that an initial assessment of ecosystem risk status can provide a simple but powerful indicator of the state of biodiversity. The initial assessment can be a basis for expanding to other criteria as capacity and data availability improve.

Criterion A is a good starting point. Sub-criterion A3 measures the long-term reduction in the

Figure 2: Categories and criteria for the IUCN Red List of Ecosystems, which is used to assess ecosystem risk status.[25]

[23] *https://iucnrle.org/*.
[24] IUCN. 2024. Guidelines for the application of IUCN Red List of Ecosystems Categories and Criteria, Version 2.0. IUCN, Gland, Switzerland. *https://portals.iucn.org/library/node/45794*.
[25] *https://iucnrle.org/documents_and_publications*.

geographic distribution of an ecosystem. It uses a nominal date of 1750 as a baseline, which can be assumed to be before large-scale industrialisation. Therefore, the map of ecosystem types based on historical extent is an appropriate dataset to use as a baseline for sub-criterion A3. The map of current extent and condition can then be used to identify how much of each ecosystem type has been lost (Figure 3). The proportion by which the distribution of an ecosystem type has been reduced is evaluated against the thresholds to assign a risk category for the ecosystem type (Table 5).

An assessment based on sub-criterion A3 can be done systematically for all ecosystem types across a whole country – when a map of the historical extent of ecosystem types is available as a baseline against which to assess reduction in ecosystem distribution (***Section 4.1: Baseline map of ecosystem types***). If historical extent is not available, sub-criteria A1 and A2 provide alternative timeframes to assess the reduction in ecosystem distribution.

The assessment based on criterion A can be supplemented with additional criteria (Figure 2) where information is available. Criterion B also focuses on spatial extent of ecosystems, but it assesses the current geographic extent in combination with the evaluation of ongoing spatial threats (e.g. forest conversion to agricultural lands) or functional threats (e.g. disruption of fire regimes). Then, depending on the data that went into the map of current extent and condition, it may provide additional information to also apply either criterion C related to environmental degradation or criterion D related to biotic disruptions. Cumulative pressure mapping has been used for a systematic assessment of ecosystem types in the marine realm.

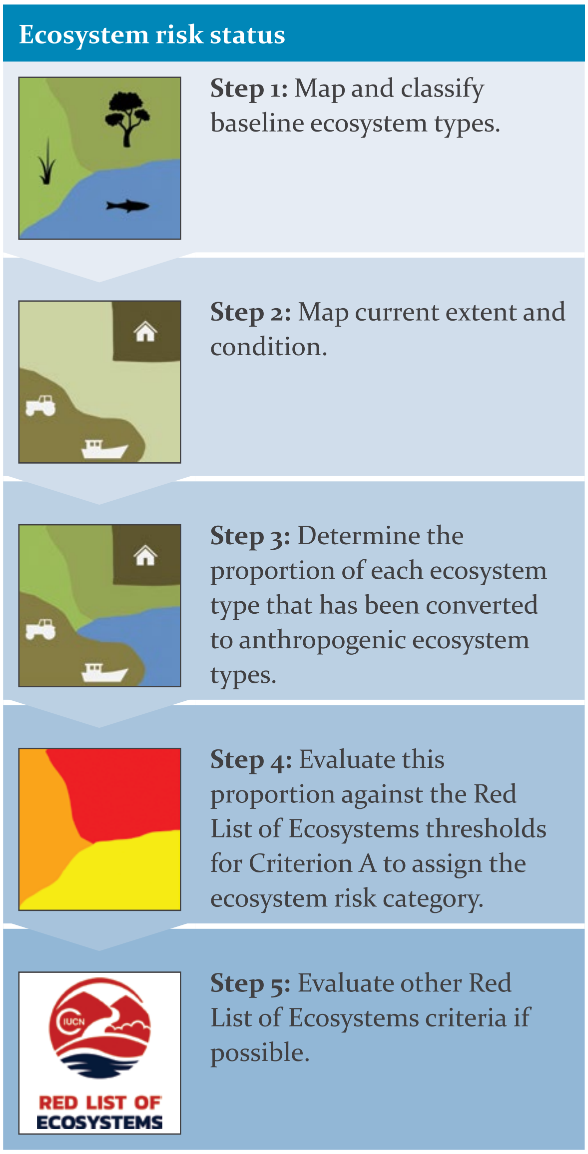


Figure 3: Steps for conducting an initial assessment of ecosystem risk using criterion A of the Red List of Ecosystems. See Table 7 for more detail on each step.

Table 5: Main categories and thresholds for an initial assessment of ecosystem risk using sub-criterion A3 of the Red List of Ecosystems.

Risk category		Description	Threshold for sub-criterion A3
Threatened	Critically Endangered (CR)	*Critically Endangered ecosystem types are considered to be at extremely high risk of collapse.* They have very little of their historical extent left in a natural or near-natural state. Most of the ecosystem type has been converted to anthropogenic ecosystem types. Critically Endangered ecosystem types are likely to have lost much of their natural structure and functioning, and species associated with the ecosystem may have been lost. Few patches of these ecosystem types remain in natural or near-natural condition. Any further reduction in area or deterioration in condition of the remaining intact fragments of these ecosystem types should be avoided, and the remaining intact examples should be the focus of urgent conservation action.	Reduction in geographic distribution of more than 90% since 1750.
Threatened	Endangered (EN)	*Endangered ecosystem types are considered to be at very high risk of collapse.* They are close to becoming Critically Endangered. Any further reduction in area or deterioration of condition in these ecosystem types should be avoided, and the remaining intact examples should be the focus of conservation action.	Reduction in geographic distribution of more than 70% since 1750.
Threatened	Vulnerable (VU)	*Vulnerable ecosystem types are considered to be at high risk of collapse.* Vulnerable ecosystem types still have much of their historical extent left in natural or near-natural condition, but have experienced reduction in area. These ecosystem types are likely to have lost some of their structure and functioning, and will be further compromised if area continues to reduce. Maps of biodiversity priority areas should guide planning, resource management and decision-making in these ecosystem types.	Reduction in geographic distribution of more than 50% since 1750.
	Least Concern (LC)	*An ecosystem is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widely distributed and relatively undegraded ecosystems are included in this category.* Ecosystem types that have experienced little or no reduction in area are classified as Least Concern. Maps of biodiversity priority areas should guide planning, resource management and decision-making in these ecosystem types.	

5.2.2 Ecosystem protection level

Ecosystem protection level is an indicator of the extent to which ecosystem types are protected in the current network of protected and conserved areas. Assessing ecosystem protection level involves overlaying the baseline map of ecosystem types with the map of protected and conserved areas to determine the level of protection for each ecosystem type (Figure 4). Ideally this should be done based on the historical extent of the ecosystem types.

Protection level is evaluated relative to a protection target that is a percentage of the historical extent of each ecosystem type. This protection target can be based on commitments towards protected area expansion, for example by using the 30% by 2030 target under the Global Biodiversity Framework (Target 3). It is also possible for this percentage to be based on biodiversity representation targets for ecosystem types (***Section 6.3.1: Biodiversity targets***). The proportion of each ecosystem type currently included in the network of protected and conserved areas is evaluated against a set of thresholds to determine whether it is adequately protected.

An example of protection level categories is a system with four categories that includes: well protected, moderately protected, poorly protected, or not protected (Table 6). Table 7 summarises the steps required to complete a spatial biodiversity assessment for ecosystems.

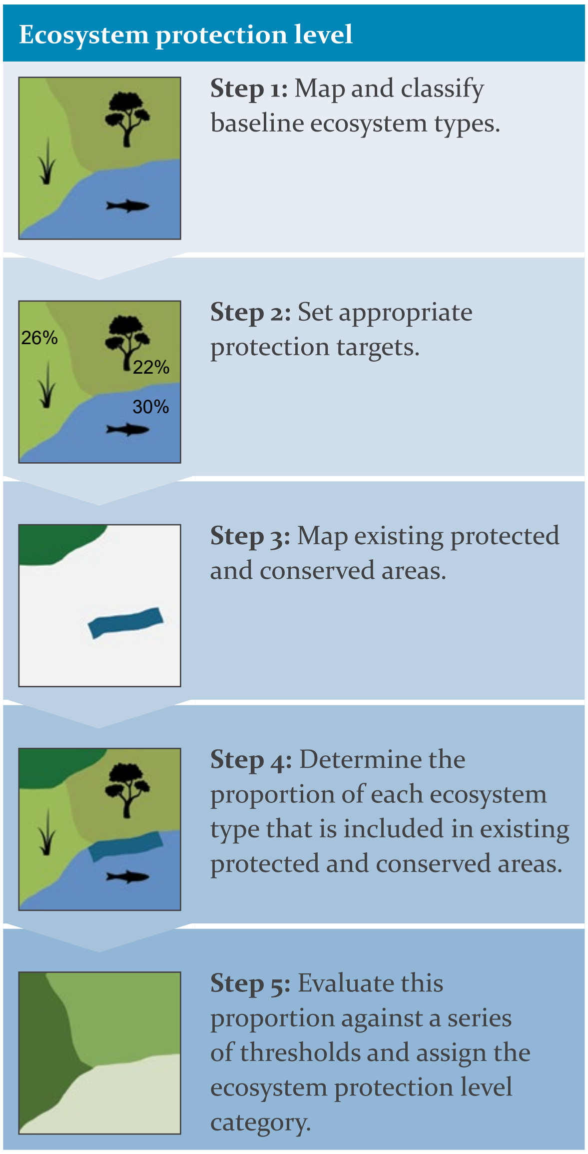


Figure 4: Steps for assessing protection level for each ecosystem type. See Table 7 for more detail on each step.

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Table 6: Suggested categories and thresholds for the assessment of ecosystem protection level.

	Protection level category	Description	Suggested threshold
Under protected	**Not protected**[26]	An ecosystem type for which no area, or only a very minimal area, is located within protected or conserved areas. These ecosystem types require significant additional protection.	Less than 5% of the protection target is located within protected or conserved areas. The use of 5% rather than 0% ensures that tiny GIS slivers do not give spurious results.
Under protected	**Poorly protected**	An ecosystem type for which a small area is located within protected or conserved areas, but much less than the area required to meet the target. Additional protection of these ecosystem types is required.	More than 5% but less than half of the protection target (50%) is located within protected or conserved areas.
Under protected	**Moderately protected**	An ecosystem type for which a moderate area is located within protected or conserved areas, but less than the area required to meet the target. Additional protection of these ecosystem types is required.	More than half (50%) but less than the full protection target is located within protected or conserved areas.
	Well protected	An ecosystem type for which an area equivalent to the full protection target is located within protected or conserved areas. These ecosystem types require no further protection to meet their protection targets. Areas within these ecosystem types may still be identified as priorities for protection for other reasons, such as considerations related to ecological processes or ecological infrastructure.	

[26] 'Protected' is used for brevity in these categories, but can be understood to mean 'protected and conserved'. It would also be possible to separate protection levels for protected and conserved areas.

Table 7: Methods and tasks for conducting a spatial biodiversity assessment of risk status and protection level for each ecosystem type within a country.

Steps	Tasks	Description and additional notes
Map and classify ecosystem types	Source or develop a baseline map of ecosystem types	• Information on how to source or generate a baseline map of ecosystem types can be found in ***Section 4.1: Baseline map of ecosystem types***. • The ability to map and classify ecosystems into different ecosystem types is essential to assess risk status and protection level, and to track changes over time. • Ecosystem types should ideally be mapped based on their historical extent, or alternatively to their extent at a chosen baseline date. • Ecosystem types are the unit of assessment for ecosystem risk assessment.
Map current extent and condition	Map current extent and condition	• Information on sourcing or generating a map of current extent and condition can be found in ***Section 4.2: Map of current extent and condition***. • A map of current extent and condition combines information on the impact of different pressures on ecosystems (such as land use change, alteration of freshwater flows, overharvesting of resources, invasive alien species or climate change). • In the marine realm, the map of current extent and condition is developed by mapping cumulative pressures. • The map of current extent and condition identifies which areas are no longer natural and have been converted to anthropogenic ecosystem types, as well as the ecological condition of the remaining natural or semi-natural areas. • Ecological condition can be classified into categories such as good, fair and poor condition compared to a reference condition of natural.
Assess ecosystem risk status	Apply criterion A of the Red List of Ecosystems	• Decide on which of the Red List of Ecosystems criteria will be applied. An initial assessment can be achieved using only criterion A. • Overlay the map of current extent and condition on the baseline map of ecosystem types in a GIS. The portions that have been converted to anthropogenic ecosystem types are extracted from the baseline map of ecosystem types to give the remaining extent of natural ecosystem types. • The reduction in ecosystem distribution is evaluated against the thresholds of sub-criterion A3 to assign a risk category for each ecosystem type (Table 5). These measure the reduction in the geographic distribution of an ecosystem since 1750. • If historical extent is not available, sub-criteria A1 and A2 provide alternative timeframes to assess the reduction in ecosystem distribution. • Assign an ecosystem risk category to each ecosystem type.

Table 7: Methods and tasks for conducting a spatial biodiversity assessment of risk status and protection level for each ecosystem type within a country (continued).

Steps	Tasks	Description and additional notes
Assess ecosystem risk status (continued)	Apply additional criteria if possible	• If more information is available to assess ecosystem types using other criteria, these can then be applied as per the IUCN categories and criteria (Figure 2). ▪ Criterion B relates to restricted distribution. Criterion B should only be applied to the full global extent of an ecosystem type. ▪ Criterion C relates to environmental degradation, and criterion D relates to biotic disruptions. Depending on the data that went into the map of current extent and condition (either biological or environmental) it may provide information to assess these criteria. Criterion A already covers the reduction in ecosystem distribution, so these additional criteria focus on the degree to which the remaining extent is modified or degraded. • The final risk category for an ecosystem type is the most severe across all assessed criteria. This means that applying additional criteria may confirm the risk category assigned using sub-criterion A3 or may result in a more severe risk category being assigned, but cannot result in a less severe risk category being assigned.
	Review and publish the assessments	• To be listed on the global Red List of Ecosystems database, an assessment is done for the entire global distribution of an ecosystem type. For ecosystem types that extend beyond a country's borders, a national assessment will still be useful, but may not be included on the global Red List of Ecosystems database. • Global submissions are made to the Red List of Ecosystems Unit for publication on the Red List of Ecosystems database: *https://assessments.iucnrle.org*.
Assess ecosystem protection level	Map existing protected and conserved areas	• Information on sourcing or generating a map of protected and conserved areas can be found in ***Section 4.3: Map of protected and conserved areas***. • Decide which types of protected and conserved areas should count towards meeting protection targets.
	Set protection targets and decide on protection level categories and thresholds	• Decide on a protection target against which to evaluate protection levels for each ecosystem type. • Protection targets should be set in relation to the historical extent of each ecosystem type, even if the historical extent of the ecosystem type has to be estimated rather than spatially delineated. • A flat target for all ecosystem types can be a pragmatic and strategic way to set targets. A protection target of 30% can be very useful to align with Target 3 of the Global Biodiversity Framework. • Decide on a set of categories for ecosystem protection level. • Decide on a threshold for each protection level category. • Suggested categories and thresholds for protection levels are given in Table 6.

Table 7: Methods and tasks for conducting a spatial biodiversity assessment of risk status and protection level for each ecosystem type within a country (continued).

Steps	Tasks	Description and additional notes

Assess ecosystem protection level (continued)	Evaluate protection level	• Overlay the map of protected and conserved areas on the baseline map of ecosystem types in a GIS.
		• Calculate the proportion of each ecosystem type that falls within the network of protected and conserved areas.
		  ▪ Areas within protected and conserved areas that have been intensively modified (for example, roads, dams, tourist resorts etc.) should be excluded from the calculation.
		  ▪ Rivers often form the boundaries for protected areas, and a decision on whether to consider these rivers protected or not will have to be made.
		• Compare the proportion of each ecosystem type that is protected to the protection target and associated thresholds.
		• Assign a protection level category to each ecosystem type.

Develop products	Develop products that present the outputs clearly	• Provide summaries of ecosystem risk status and ecosystem protection level for the realms assessed, highlighting the number or proportion of threatened and under-protected ecosystem types. • Develop simple maps and graphics that clearly display the assessment results. • Colours for ecosystem risk status and ecosystem protection level categories should match between maps and charts. • Colours for ecosystem risk categories are provided in the Red List of Ecosystem guidelines. • See ***Section 7: Products*** for more information and tips on presenting the results of the assessment. • See *Mainstreaming Biodiversity Priorities*[27] for more information on presenting, disseminating and applying the results of the assessment.

[27]UNEP-WCMC & SANBI. 2022. Mainstreaming biodiversity priorities: A practical guide on how to integrate spatial biodiversity products into national policy, planning and decision-making. South African National Biodiversity Institute, Pretoria, South Africa. *http://hdl.handle.net/20.500.12143/8735*.

Box 5:
Case study: Assessment and spatial prioritisation for the Arabian Peninsula.

In 2013, the approach presented here was applied to the entire Arabian Peninsula.[28] Encompassing eight countries, the peninsula is characterised by extensive desert habitats, which support limited numbers of species, but those that occur are often distinctive and endemic.

The project was delivered at three scales, locally for Abu Dhabi, nationally for the United Arab Emirates (UAE), and regionally for the whole Arabian Peninsula. This highlights the flexibility of the approach, which can be nested at different scales.

The project gathered data from a wide number of sources, including local government departments responsible for land-use planning, national environmental ministries, and local and global environmental organisations. Significant effort was expended to build an integrated ecosystem map from a range of existing national and international sources and expert inputs. Marine and terrestrial maps of ecosystem types were fully integrated into a single spatial dataset.

Ecological condition was inferred from spatial data on a range of pressures in the marine and terrestrial environments.

Results showed that inland terrestrial ecosystems in the Arabian Peninsula are generally not threatened, as expected for a desert environment. However, many coastal ecosystems are classified as Vulnerable and are poorly protected. Several marine ecosystems are Critically Endangered, especially coral reefs, mangroves and seagrass beds. Spatial prioritisation was done using MARXAN software and a range of additional data, including data on ecological processes, key species and other economic and planning factors. The prioritisation identified 35 Priority Focus Areas within which conservation actions should be focused.

The project outputs inform protected area expansion, land-use planning and environmental permitting. They assist with meeting national and global targets, and provide information for state of the environment reporting.

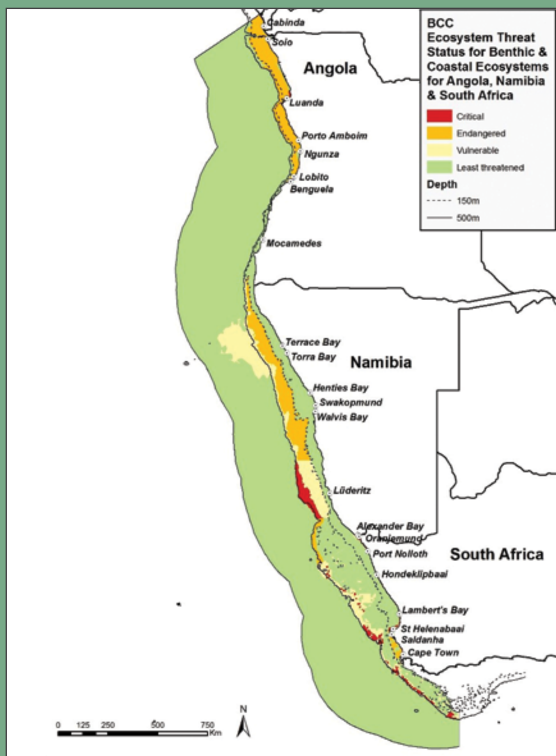
[28]AGEDI. 2013. Systematic Conservation Planning Assessments and Spatial Prioritizations for the Emirate of Abu Dhabi, the United Arab Emirates and the Arabian Peninsula. Abu Dhabi, UAE.

Box 6:
Case study: Spatial biodiversity assessment and prioritisation for the Benguela Current Large Marine Ecosystem.

The cold Benguela current flows northwards along the southwest African coastline, spanning the marine regions of South Africa, Namibia and Angola. The upwelling of nutrient rich water provides habitat for a wide diversity of fish species, migratory seabirds and marine mammals. The high ocean productivity of the ecosystems associated with the current is the basis for an economically important fisheries industry. Since the Benguela Current Large Marine Ecosystem (BCLME) spans three countries, there is a need for integrated management to ensure the protection of its unique ecosystems and sustainable use of its marine resources. In 2014, the Benguela Current Commission initiated a project to develop an integrated conservation plan for the area.[29] The project aimed to replicate and expand the spatial planning approach that had been undertaken for the South African portion of the BCLME to the waters of its neighbours in Namibia and Angola.

An important component of the project was to source and gather existing data for the region. Angola, in particular, had very little spatial data and much of the data for this country had to be derived from existing regional and global datasets. The classification of ecosystem types took into account depth, slope topography, bathymetry, geology, grain size, wave exposure, available biological and biophysical (remotely sensed) data to identify 134 marine biozones across the BCLME. The result was the first integrated map of ecosystem types for the region, which although still imperfect, is a significant improvement on what was previously available. This map of ecosystem types has significant value for ecology and biodiversity science. Similarly, existing data on pressures on the marine environment were collected and combined using a scoring method that had been applied in South Africa to develop a map of current extent and condition for the entire planning area.

Conducting a biodiversity assessment by combining the baseline map of ecosystem types and the map of current extent and condition resulted in 50 of the 134 ecosystem types being classified as threatened. The majority of the threatened ecosystems were coastal, particularly in Angola and South Africa, as well as shelf edges across the planning area that were associated with fishing. Protection levels varied across the three countries, with Namibia having the highest number of ecosystem types that are well protected in marine protected areas and Angola the lowest. The project went on to identify a suite of priority areas for conservation action, particularly for the expansion of Marine Protected Areas, and provided many spatial layers now being used to support Marine Spatial Planning in these countries.



[29]Kirkman et al. 2019. Using systematic conservation planning to support marine spatial planning and achieve marine protection targets in the transboundary Benguela ecosystem. Ocean and Coastal Management, 168, 117–129. *https://doi.org/10.1016/j.ocecoaman.2018.10.038.*

5.3 Steps for conducting a species assessment

It is possible to conduct many species assessments using only the datasets outlined in ***Section 4: Spatial datasets***, mainly the maps of species occurrence, spatial information on pressures that typically make up a map of current extent and condition, and a map of protected and conserved areas. However, not all data required for species assessment are necessarily spatial. Species assessment also involves consultation with taxonomic literature and *taxon* experts, to identify important life history traits and ecological responses of the species being assessed, as well as obtaining information on causes of decline that cannot be inferred from spatial data, such as utilisation, pollution, overgrazing by livestock, amongst others.

5.3.1 Species extinction risk

Species extinction risk is an indicator of the degree to which a species is at risk of extinction. Species extinction risk is assessed by applying the categories and criteria of the Red List of Threatened Species (Figure 5). **The IUCN Red List of Threatened Species** is a global standard for classifying species' risk of extinction. It is based on a set of five criteria that provide a consistent method for assessing the risk of species extinction. The Red List of Threatened Species is a basis for the Red List Index, an indicator that tracks the change in species' risk of extinction over time. It is a required indicator for Goal A and for several targets under the Global Biodiversity Framework.

Species need to be assessed against all five criteria (Figure 5). There are many online resources[30] and a comprehensive online training course[31] for Red List assessors that provide detailed information on applying the criteria. A species overall risk category is the most severe across all assessed criteria. For non-endemic species it is important that the IUCN regional criteria[32] are applied as only the proportion of the population of each species that occurs within the borders of the country is being assessed. Adjustments in the regional criteria take into account the influence of populations outside of the country.

For the assessment of species extinction risk, the different pressures are often considered separately, selecting those that are of relevance to the life history and ecology of the species in question. For example, a plant species may be particularly vulnerable to the spread of a certain invasive insect and an amphibian species may be susceptible to pressures happening upstream.

A: Population reduction
B: Restricted geographic range
C: Small population size and decline
D: Very small or restricted population
E: Quantitative risk analysis

CRITERIA

Extinct
Critically Endangered
Endangered
Vulnerable
Near Threatened
Least Concern

CATEGORIES

Figure 5: Categories and criteria for the IUCN Red List of Threatened Species.[33]

[30] *https://www.iucnredlist.org/resources.*
[31] IUCN Red List Assessor Training: *https://www.conservationtraining.org/course/index.php?categoryid=23.*
[32] Guideline for application of IUCN Red List criteria at regional and national levels: *https://portals.iucn.org/library/node/10336.*
[33] For the summary sheet of the criteria, see *https://www.iucnredlist.org/resources/summary-sheet.*

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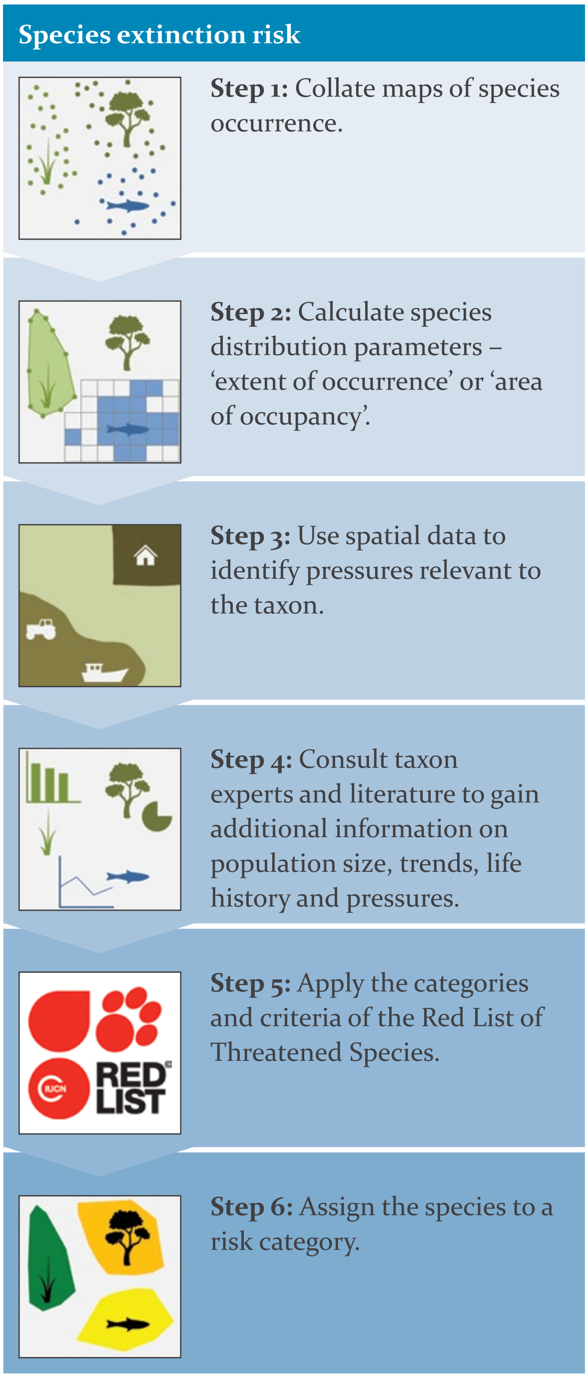

Figure 6: Basic steps for conducting an assessment of species extinction risk using the Red List of Threatened Species. See Table 10 for more detail on each step.

Table 8: Main categories for species extinction risk based on the Red List of Threatened Species.

	Risk category	Description
Threatened	**Critically Endangered (CR)**	*Critically Endangered species are considered to be at extremely high risk of extinction.* Any further loss of natural habitat for these species should be avoided, and the remaining healthy populations should be the focus of urgent conservation action, including recovery action called for in Target 4 of the Global Biodiversity Framework.
Threatened	**Endangered (EN)**	*Endangered species are considered to be at very high risk of extinction.* They are close to becoming Critically Endangered. Any further loss of natural habitat for these species should be avoided, and the remaining healthy populations should be the focus of conservation action.
Threatened	**Vulnerable (VU)**	*Vulnerable species are considered to be at high risk of extinction.* Vulnerable species may still have much of their distribution left in natural or near-natural condition, but are experiencing some threats. Maps of biodiversity priority areas should guide planning, resource management, and decision-making for these species.
	Least Concern (LC)	*A species is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widely distributed and relatively abundant species are included in this category.* Species that have experienced little or no habitat loss or population decline are generally Least Concern. Maps of biodiversity priority areas should guide planning, resource management, and decision-making for these species.

Box 7:
Case study: Mozambique's progress on the red listing of species.

Mozambique has been assessing species risk of extinction using the IUCN Red List of Threatened Species for over two decades, focusing primarily on flora. The country's first tentative Red List was produced in 2002.[34] In 2009, Mozambican flora experts joined the Southern African Plant Specialist Group under the IUCN Species Survival Commission (SSC), which works as a platform of experts to galvanise assessment of the risk of extinction for flora taxa. Building on the work of the plant experts, in 2011, Mozambique established a national Red List Initiative together with a national working group including flora and fauna taxonomic groups.

The Red List Initiative focused on endemic and near-endemic species of Mozambique. Building from data gathered under the Darwin and Pro-Natura initiatives, the plant experts aimed to assess at least 400 species. Alongside this target, an initiative was implemented to identify Key Biodiversity Areas (KBAs), through which the Red List national working group also hoped to assess all fauna species for which data was available. This enabled integration of Mozambican fauna experts into the IUCN-SSC working groups for freshwater fish, reptiles and amphibians.

Through the Red List Initiative, over 330 species of endemic and near-endemic plants and nearly 70 species of animals have been assessed so far.[35] Information resulting from plant assessments was used to identify 57 Important Plant Areas.[36] In addition, flora and fauna data was used to identify 29 Key Biodiversity Areas, having first established the National Coordination Group to oversee the work.

During this process, 15 areas were shortlisted as KBAs, but data was not sufficient to fulfil the KBA criteria requirements. These areas are now being targeted for fieldwork to gather additional data, and engage wider society through the use of iNaturalist, to inform future Red List assessments and KBA identification. New KBA proposals are underway, with more foreseen in the upcoming years. These outputs will inform species recovery programmes, as well as spatial prioritisation for expansion of protected and conserved areas, so that Mozambique achieves its commitments under the Convention on Biological Diversity.

5.3.2 Species protection level

Species protection level is an indicator of the extent to which species are sufficiently protected in the current protected and conserved area network. It is a recently developed indicator, introduced in South Africa's National Biodiversity Assessment 2018. It can be useful to plan practical actions to protect species under Target 3 of the Global Biodiversity Framework.[37]

Assessing species protection level involves setting biodiversity targets for species (***Section 6.3.1: Biodiversity targets***). Biodiversity targets for species are based on the Minimum Viable Populations and can be either the number of viable populations or

[34] Izidine & Bandeira. 2002. Mozambique. In: Golding, J.S., Ed., Southern African Plant Red Data Lists, SABONET, Pretoria.
[35] WCS, Governo de Moçambique, USAID. 2021b. Red List of threatened species, ecosystems, identification and mapping of Key Biodiversity Areas (KBAs) in Mozambique – Final report (vol. 1). *https://comboprogram.org/Portals/1/Documents/1622457927-2021_KBAs_Moz_vol_ii_Factsheets_EN.pdf?ver=F2plHBM5lZ2x3-c8UYc-MoA%3D%3D*.
[36] Darbyshire et al. 2023. The important plant areas of Mozambique. Royal Botanic Gardens, Kew.
[37] Von Staden et al. (in prep) Practical application of a species protection indicator to advance equitable species conservation.

the number of individuals needed for persistence. Targets are based on population variables because population size is directly correlated with extinction risk. It is acknowledged that detailed population data are not always available for all species. Where possible, counts of individuals for each protected or conserved area should ideally be used to measure progress towards the biodiversity target. In the absence of count data, alternative measures of abundance can be used. The two options are:

- Density estimates applied to area of suitable habitat within each protected or conserved area to infer numbers of individuals.
- The number of viable sub-populations within each protected or conserved area.

The overall protection level is the total contribution from all protected and conserved areas where the species is found (Figure 7).

An example of protection level categories is a system with four categories that include well protected, moderately protected, poorly protected, or not protected (Table 9). A well protected species is one with sufficient viable populations within protected or conserved areas to ensure its long-term persistence.

Not all protected or conserved areas are effective at mitigating threats to all species. For example, a protected area may not be effective at protecting a freshwater species from pollution sources upstream of the protected area. A further component can be added to the assessment of species protection level to take into account the effectiveness of protected or conserved areas for the species in question. An adjustment factor can be included to take effectiveness (including elements of protected area design, ecological condition and management effectiveness) into account when assessing the contribution of each protected area to the biodiversity target of the particular species.

Table 10 sets out in more detail the steps required to complete a biodiversity assessment for species.

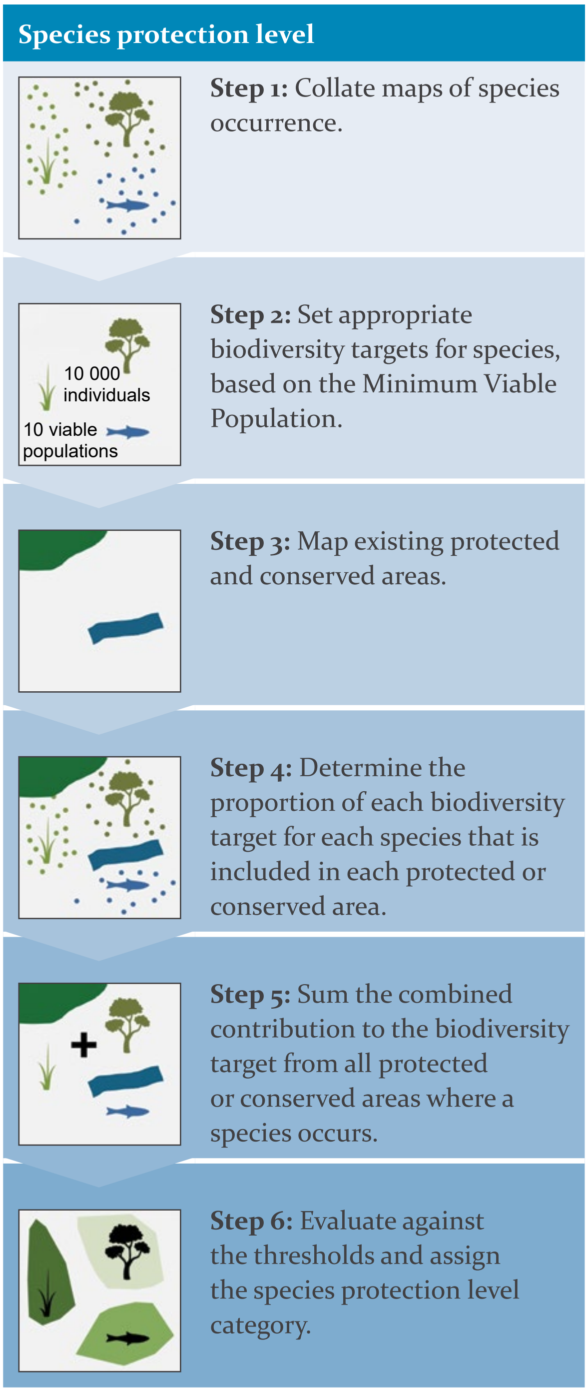

Figure 7: Steps for assessing protection level for each species. See Table 10 for more detail on each step.

Table 9: Suggested categories and thresholds for the assessment of species protection level.

Protection level category		Description	Suggested threshold
Under protected	**Not protected**	A species for which no, or a very limited population is located within protected or conserved areas. These species require significant additional protection.	Less than 5% of the target is located within protected or conserved areas.
Under protected	**Poorly protected**	A species for which a small population is located within protected or conserved areas, but much less than required to meet the biodiversity target. These species require additional protection.	More than 5%, but less than half of the target (50%) is located within protected or conserved areas.
Under protected	**Moderately protected**	A species for which a moderate population is located within protected or conserved areas, but less than required to meet the biodiversity target. These species require additional protection.	More than half (50%), but less than the full target is located within protected or conserved areas.
	Well protected	A species for which the full biodiversity target is met within protected or conserved areas. These species require no further formal protection to meet their targets. They may still be identified as priorities for protection for other reasons, such as considerations related to ecological processes or ecological infrastructure.	

Table 10: Methods and tasks for conducting a biodiversity assessment of risk status and protection level for species.

Steps	Tasks	Description and additional notes
Decide on the scope of the assessment	Decide which species to include	• Decide on which species to include, based on the availability of knowledge on taxonomic groups, whether the taxonomy is stable and if there has been sufficient sampling effort to determine the distribution and habitat preference for each species.[38] • The Red List of Threatened Species is conducted at the species level, rather than other taxonomic levels, so species are the unit of assessment. To conduct a global Red List assessment that is submitted to the IUCN Red List of Threatened Species, criteria must be applied to the entire global population of the species. However, for non-endemic species it is recommended to conduct national Red List assessments for the portion of the population within the country's borders and then apply the IUCN regional criteria.[33]

[38]Raimondo et al. 2023. Using Red List Indices to monitor extinction risk at national scales. Conservation Science and Practice, 5(1), p.e12854. *https://doi.org/10.1111/csp2.12854*.

Table 10: Methods and tasks for conducting a biodiversity assessment of risk status and protection level for species (continued).

Steps	Tasks	Description and additional notes
Decide on the scope of the assessment (continued)	Decide which species to include	• Further information on setting up Red List assessment programmes at the national level and how to submit assessments to the IUCN can be found in the guidance for setting up national Red List programmes.[39]
Collate maps of species occurrence	Source or develop maps of species occurrence	• Information on how to source or generate maps of species occurrence can be found in ***Section 4.4: Maps of species occurrence.*** • Aligning selection with taxonomic groups already assessed comprehensively on the Red List of Threatened Species helps promote consistency between national and global reporting and allows standardised comparisons between countries.[40] • The disaggregated Red List Index of Species is used for several Global Biodiversity Framework indicators (e.g. for pollinators, traded species, species used for food or medicine), so taxonomic groups that include these species should ideally be selected. • Search for and collate existing sources of specimen records or online observation records for the species to be assessed (see Table 4). • Species occurrence records that do not yet have good location data associated should be accurately georeferenced using GIS tools. • The records should also be verified by experts to identify any possible errors of identification or location.
	Consult taxon experts and literature	• Additional information on each species needs to be sourced from experts or literature, including: ▪ Population ▪ Habitat, ecology and life history ▪ Direct pressures ▪ Use and trade ▪ Abundance or density estimates in suitable habitat • Density estimates are not typically available for most species yet are highly useful for calculating protection level. Estimates of density should be gathered from taxon experts or collected via targeted field surveys. • Qualitative abundance estimates can also be useful in the absence of quantitative density estimates.

[39] National Red List Working Group of the IUCN Red List Scientific Committee. 2024. Guidelines for Establishing a National Red List Programme. Version 1.0. IUCN SSC, Gland. *https://doi.org/10.13140/RG.2.2.26717.01769*.

[40] Raimondo et al. 2023. Using Red List Indices to monitor extinction risk at national scales. Conservation Science and Practice, 5(1), p.e12854. *https://doi.org/10.1111/csp2.12854*.

Table 10: Methods and tasks for conducting a biodiversity assessment of risk status and protection level for species (continued).

Steps	Tasks	Description and additional notes
Collate maps of species occurrence (continued)	Calculate species distribution parameters	• The criteria of the Red List of Threatened Species require calculation of two parameters of species distribution from the occurrence records: ▪ Extent of occurrence (EOO) is the area within a boundary around all the occurrence points. It is a measure of the overall distribution of the species. ▪ Area of occupancy (AOO) is the area within the boundary of the EOO that is actually occupied by the species. It is a measure of the habitat used within the overall distribution. • There are resources available to help calculate EOO and AOO. For example, GeoCAT and the ArcMap EOO calculator tool available from the Red List of Threatened Species website *https://www.iucnredlist.org/resources/spatialtoolsanddata*.
Assess species extinction risk	Use spatial data to infer pressures	• Different species respond differently depending on their habitat and life history, so the pressures identified need to be relevant to the species being assessed. • The types of spatial data used to infer pressures on species are usually similar to the data that goes into the map of current extent and condition (***Section 4.2: Map of current extent and condition***) and can include land cover, aerial imagery, data on infrastructure like roads, or data from specific sectors like agriculture or mining.
	Consult taxon experts	• Available spatial data may not provide all the necessary information needed to conduct an assessment of species extinction risk. • Engaging with taxon experts is an integral part of assessing species extinction risk. • Taxon experts can help to identify pressures that are not easily observable from spatial data, such as unsustainable harvesting, pollution, overgrazing by livestock, loss of mutualisms, amongst others.
	Apply the categories and criteria	• Species must be assessed against all the criteria of the IUCN Red List of Threatened Species (Figure 5), including: ▪ A: Population reduction ▪ B: Restricted geographic range ▪ C: Small population size and decline ▪ D: Very small or restricted population ▪ E: Quantitative analysis • There are many online resources (*https://www.iucnredlist.org/resources*) and training courses for Red List assessors (*https://www.conservationtraining.org/course/index.php?categoryid=23*) that provide more information on applying the criteria.

Table 10: Methods and tasks for conducting a biodiversity assessment of risk status and protection level for species (continued).

Steps	Tasks	Description and additional notes
Assess species extinction risk (continued)	Review and publish the assessments	• Independent experts with knowledge on applying the IUCN Red List criteria provide an external review process once the assessment has been conducted. A review ensures the quality and consistency of the assessments, and correct application of the criteria. • Assessments of endemics should then be published to the IUCN Red List of Threatened Species to make them available to users and to contribute to global statistics on threatened species: *https://www.iucnredlist.org/*. • All assessments (endemic and non-endemic species) should also be published to national Red List online platforms and submitted to the global portal for national assessments: *https://www.nationalredlist.org/*.
Assess species protection level	Map existing protected and conserved areas	• Information on sourcing or generating a map of protected and conserved areas can be found in ***Section 4.3 Map of protected and conserved areas***. • Decide which types of protected and conserved areas should count towards meeting species persistence targets.
	Decide on protection level categories	• Decide on a set of categories for species protection level. • Decide on a threshold for each protection level category. • Suggested categories and thresholds for species protection levels are given in Table 9.
	Decide on biodiversity targets for species	• Decide on biodiversity targets for each species. These targets reflect what is required to support a Minimum Viable Population of each species. They can be expressed as a number of individuals or number of viable sub-populations. • There can be flexibility in the way that biodiversity targets are decided for species, depending on the ecology of the species, its abundance, and the amount and type of available data. • More information about setting biodiversity targets for species can be found in ***Section 6.3.1: Biodiversity targets***.
	Calculate population score for each protected and conserved area	• If the biodiversity target is number of individuals, then determine the population score for each protected or conserved area either by: ▪ Using sub-population count data from monitoring efforts, OR ▪ Estimating the number of individuals in a protected area based on the amount of suitable habitat multiplied by the species density within that habitat. • If the biodiversity target is a set number of viable sub-populations, then determine the number of viable sub-populations present in each protected or conserved area.

Table 10: Methods and tasks for conducting a biodiversity assessment of risk status and protection level for species (continued).

Steps	Tasks	Description and additional notes
Assess species protection level (continued)	Evaluate protection level	• Add up the population score from all the protected and conserved areas that the species is recorded in. • Divide the total population score by the biodiversity target for the species to get a proportion. • Compare the proportion to the protection level thresholds to assign a protection level category for the species.
	(Optional) Adjust for protected area effectiveness	• To adjust for the effectiveness of the protected area at protecting the species from pressures, an adjustment factor can be multiplied by the population score with the values of 1 if the protected area is effectively mitigating pressures, 0.5 if it is providing some effective protection, or 0.1 if the protected area is not helping to mitigate pressures. • The formula for calculating protection levels is thus: *[SUM protected area (population score x effectiveness factor)]/biodiversity target.*
Develop products	Develop products that present the outputs clearly	• Provide summaries of species extinction risk and species protection level in each of the terrestrial, freshwater and marine realms, highlighting the number of threatened and under-protected species. • Develop simple maps and graphics that clearly display the assessment results. • Colours for species extinction risk and species protection level categories should match between maps and charts. • Colours for species risk categories are provided in the IUCN guidelines. • See ***Section 7: Products*** for more information and tips on presenting the results of the assessment. • See the follow up guidance, *Mainstreaming Biodiversity Priorities*[41] for more information on presenting, disseminating and applying the results of the assessment.

[41] UNEP-WCMC & SANBI. 2022. Mainstreaming biodiversity priorities: A practical guide on how to integrate spatial biodiversity products into national policy, planning and decision-making. South African National Biodiversity Institute, Pretoria, South Africa. *http://hdl.handle.net/20.500.12143/8735*.

6. Prioritisation and planning

Spatial biodiversity prioritisation or planning identifies geographic areas, referred to as biodiversity priority areas, where it is most strategic to focus conservation action. Conservation resources are always limited and need to be directed towards the areas of high biodiversity importance and the most urgent conservation needs. Biodiversity priority areas are those parts of the landscape or seascape that are most important for conserving viable representative samples of ecosystems and species, for maintaining ecological processes, or as ecological infrastructure that provides ecosystem services. Prioritisation should preferably be undertaken only after a spatial biodiversity assessment has been conducted as described in ***Section 5: Assessment***, as it provides inputs into prioritisation.

> **!**
>
> ## Trade-offs between scope and scale
>
> National prioritisation, conducted at a broad spatial scale, can have useful applications such as identifying priorities for large new protected areas or for prioritising broad areas for increased conservation activities. However, this scale often does not provide detailed enough information for site-level decision-making (for example, to inform land-use decisions at the local level), which is likely to require mapping of biodiversity features and prioritisation at a finer spatial scale.

While assessment follows a relatively standard process, prioritisation methods can vary widely depending on the context and purpose. In the following sub-sections, details are provided on a simple prioritisation that builds directly on the outputs of the assessment, requiring no additional data and minimal extra work (***Section 6.1: Basic prioritisation***). A further option involves criteria-based approaches to identify areas of biodiversity importance, such as Key Biodiversity Areas (KBAs) (***Section 6.2: Criteria-based approaches***). Finally, systematic conservation planning is a comprehensive form of prioritisation (***Section 6.3: Systematic conservation planning***). It involves additional analysis, can be undertaken with varying degrees of complexity, and may involve additional data and resources.

Prioritisation can be used for a number of different purposes. Three of the most common are:

- Identifying priority areas where loss and degradation of biodiversity should be avoided, which

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can be integrated into biodiversity-inclusive spatial planning to inform decisions about land-use and sea-use across a range of sectors.

- Identifying priority areas for consolidating and expanding the network of protected and conserved areas.
- Identifying priority areas for restoring degraded ecosystems and ecological infrastructure that provides ecosystem services.

The exact methods of prioritisation may differ depending on the intended use of the maps (especially with regard to the spatial scale of application). Biodiversity priority areas identified for one purpose may not be appropriate for other uses. For example, development of a map intended to inform land-use planning and decision-making at the site scale would require data inputs and analyses at a fine spatial scale, while a map intended to inform broad priorities for conservation action could be based on broader scale inputs and analyses. For more information on the uses and applications of prioritisation, see *Mainstreaming Biodiversity Priorities*.[42]

6.1 Basic prioritisation

The outputs of spatial biodiversity assessment can be used as the basis for an initial identification of biodiversity priority areas. The most basic type of prioritisation can be achieved by simply combining the risk status and protection level from the biodiversity assessment (***Section 5: Assessment***). The remaining natural areas in those ecosystem types that have both high levels of risk and low levels of protection are clearly in need of urgent conservation action. Similarly, species that are both threatened and have low levels of protection should be

Box 8:
Case study: Protecting the 'Unlucky 13' marine ecosystem types in South Africa.

South Africa advanced the mapping, assessment and protection of marine ecosystems through iterative improvement of foundational maps. An offshore spatial prioritisation[43] initiated mapping of biodiversity, fisheries and other human use layers that facilitated significant advances in biodiversity assessment for the marine realm. It led to an assessment of ecosystem risk status and ecosystem protection level for all marine ecosystem types in South Africa as part of the National Biodiversity Assessment 2011. By combining the maps of these two indicators, it was possible to identify the 13 ecosystem types that were both Critically Endangered and Not Protected. These ecosystem types were called the 'Unlucky 13'. It was clear that urgent conservation action should be taken to limit pressures on these ecosystems, and to improve their level of protection. This messaging, together with the multi-realm perspective, highlighted the relatively poor offshore protection levels, which helped advance proposed new marine protected areas, including most of the 'Unlucky 13', into implementation. Since then, ecosystem mapping and assessment has improved[44] in alignment with the Global Ecosystem Typology and Red List of Ecosystems.

[42] UNEP-WCMC & SANBI. 2022. Mainstreaming biodiversity priorities: A practical guide on how to integrate spatial biodiversity products into national policy, planning and decision-making. South African National Biodiversity Institute, Pretoria, South Africa. *http://hdl.handle.net/20.500.12143/8735*.

[43] Sink et al. 2023. Integrated systematic planning and adaptive stakeholder process support a 10-fold increase in South Africa's Marine Protected Area estate. Conservation Letters, 16(4), p.e12954. *https://doi.org/10.1111/conl.12954*.

[44] Sink et al. 2023. Iterative mapping of marine ecosystems for spatial status assessment, prioritization, and decision support. Frontiers in Ecology and Evolution, 11, p.1108118. *https://doi.org/10.3389/fevo.2023.1108118*.

prioritised. In this way, the outputs of the assessment can provide a rudimentary set of priority areas and species that can be a powerful tool for informing action and decision-making (see Box 8 for an example).

6.2 Criteria-based approaches

Important areas for biodiversity can also be identified using criteria-based methods, such as **Key Biodiversity Areas (KBAs)**. They are identified using globally standardised criteria and thresholds established by the IUCN.[45] KBAs are sites contributing significantly to the global persistence of biodiversity. They represent the most important sites for biodiversity conservation worldwide (for ecosystems, species and genetic diversity), in terrestrial, freshwater and marine realms.

KBAs are site-based, which means that each KBA is a particular site that has been delineated with practical, manageable boundaries. Each site is given a unique name and is recorded on the World Database of KBAs with a description of the site, details of the biodiversity features present and the criteria that are met. Since KBAs follow a global standard, they are comparable across different countries. For this reason, they are often part of global reporting frameworks and may be used by international funding agencies to allocate grants. KBAs are included as complementary indicators for several of the targets of the Global Biodiversity Framework related to spatial planning, restoration and protected area expansion (Targets 1, 2, 3), and for the Sustainable Development Goals.

The process of identifying KBAs involves compiling data, applying the criteria and delineating sites (Figure 8). The datasets (***Section 4: Spatial datasets***) and the results of the assessment (***Section 5: Assessment***) provide much information that can directly feed into many of the KBA criteria (Table 11). The KBA identification process can be undertaken at different scales – from multiple taxa or ecosystems across a country, to a single site assessment for a single species. KBAs are sites of global importance, so only the full distributions of species and ecosystems, extending beyond national borders for non-endemics, must be used to correctly apply the KBA criteria. Importantly, the process of identifying areas that meet KBA criteria is a separate activity to delineating KBA boundaries.

Figure 8: The general process for identifying Key Biodiversity Areas.[46]

[45] IUCN. 2016. A Global Standard for the Identification of Key Biodiversity Areas, Version 1.0. First edition. International Union for Conservation of Nature, Gland.

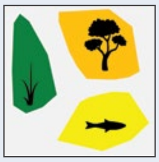
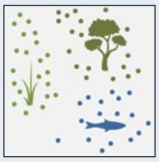
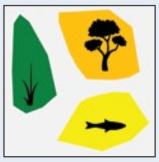
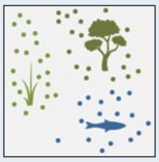
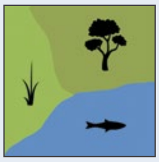
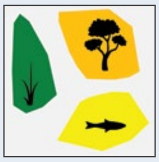
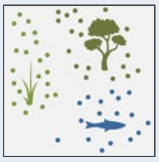
[46] KBA online training course hosted by The Nature Conservancy: *https://www.conservationtraining.org/course/index.php?categoryid=150*.

It is suggested that ecological boundaries – the boundaries of distribution maps for species and ecosystems – are used first to identify KBAs; and these are then refined to delineate manageable units, such as protected areas.

KBAs should ideally be proposed through the country's National Coordination Group for KBAs where it has been formally established, but can also be proposed by an individual or group of individuals where there is no formalised National Coordination Group. Proposed sites are reviewed before being included on the World Database of Key Biodiversity Areas.[47]

There are other types of criteria-based approaches that may be limited in taxonomic or geographic scope. In the marine realm, Ecologically or Biologically Significant Areas (EBSAs) are another criteria-based method to identify areas in the ocean that hold significant biodiversity, or features or processes that are unique, fragile, natural, threatened

Table 11: Information that can be sourced from the foundational datasets and assessment results for the identification of Key Biodiversity Areas.

KBA criteria		Input datasets
A1: Threatened species	 	Maps of occurrence for threatened species
A2: Threatened ecosystems		Map of threatened ecosystem types
B1: Individual geographically restricted species	 	Maps of occurrence for threatened species
B2: Co-occurring geographically restricted species		
B4: Geographically restricted ecosystem types		Map of ecosystem types
C: Ecological integrity		Map of current extent and condition
E: Irreplaceability	 	Maps of occurrence for threatened species

[47] *https://www.keybiodiversityareas.org.*

or important in the life history of key species. They are identified based on a set of seven criteria developed by the Convention on Biological Diversity. For specific taxa, there are also criteria-based approaches, such as Important Plant Areas (IPAs). The latest KBA standard aims to be a single approach that works across all taxonomic groups and natural realms, and therefore it is the standard used in global biodiversity reporting.

6.3 Systematic conservation planning

Basic prioritisation and criteria-based approaches can help to identify important areas for action. However, these methods cannot evaluate many aspects of biodiversity priority together, nor do they include other relevant information such as socio-economic factors. Target 1 of the Global Biodiversity Framework calls for all areas to be 'under participatory, integrated, and biodiversity inclusive spatial planning and/or effective management processes addressing land and sea use change',[48] with a headline indicator being the percentage of land and sea covered by biodiversity-inclusive spatial plans. Systematic conservation planning is a well-known scientific methodology for identifying geographic areas of biodiversity importance.[49] When systematic conservation planning outputs are integrated into multi-sectoral, participatory spatial planning processes, they contribute to achieving Target 1 of the Global Biodiversity Framework.

Systematic conservation planning emphasises the need to conserve viable representative samples of ecosystems and species (the principle of representation), as well as the ecological processes that allow them to persist over time (the principle of persistence; ***Section 3: Guiding principles***). The planning process identifies a portfolio of biodiversity priority areas that meet these principles. Systematic conservation planning can include a wide number of biodiversity features at the same time, including ecosystem types, species, ecological processes and others, with biodiversity representation and persistence targets set for each of these features.

The configuration of priority areas identified using this method is designed to be spatially efficient (i.e. to meet biodiversity targets in the smallest possible area). It also takes into account aspects such as connectivity in the landscape, to ensure well-functioning ecosystems that improve the likelihood of long-term persistence of biodiversity, including under climate change. It is possible to select a set of priority sites that avoid conflict with other sectors and land-uses or sea-uses, for example, by avoiding areas that have high agricultural or mining potential or that have been earmarked for expansion of settlements. Such conflict avoidance is not always possible, especially for ecosystem types that have very little of their historical extent remaining. The outputs of systematic conservation planning are geographically specific, as portions within ecosystem types and other fine-scale biodiversity features can be selected, rather than simply whole ecosystem types.

Systematic conservation planning usually makes use of specialised software that uses algorithms to consider a range of different options for achieving the biodiversity targets across the landscape or seascape (Figure 9). Methods for prioritisation can vary widely, depending on GIS capability, data availability, the purpose of the prioritisation and the context. The information provided here is intended to give a general overview of systematic conservation planning, rather than a comprehensive description of all the possible variations.

In the prioritisation process, sites in the best possible ecological condition are preferentially selected to meet the biodiversity targets because they are likely to best represent the ecosystem types or species concerned and to have the best chance of persisting into the future. Restoration of sites in fair

[48] *https://www.cbd.int/gbf/targets/1.*

[49] The term 'systematic conservation plan' may be interpreted as being only about spatial priorities for protected area expansion. However, systematic conservation plans can equally be used across the wider landscape or seascape to inform planning and decision-making.

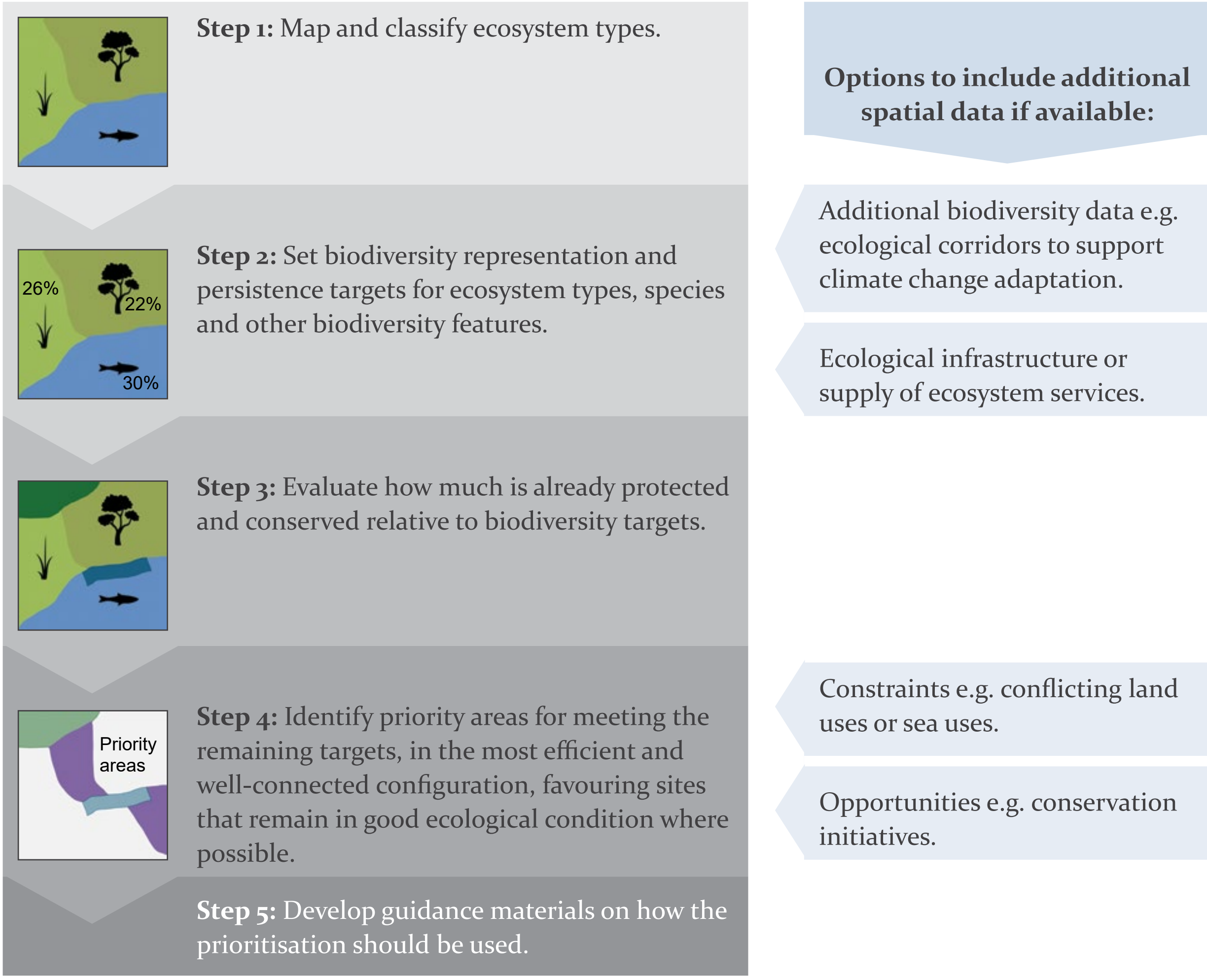


Figure 9: Steps for identifying biodiversity priority areas using systematic conservation planning. See Table 13 for more detail on each step.

or poor condition is often difficult and expensive, with no guarantee of success. Generally, only if the biodiversity target cannot be met in sites of good ecological condition, and if persistence of the biodiversity feature concerned is possible in a site that is in fair ecological condition, would sites in fair condition be selected as biodiversity priority areas. In rare circumstances, only if no better options exist and if the biodiversity feature concerned is still believed to be present, would a site in poor ecological condition be selected as a biodiversity priority area.

The initial 'raw' spatial output of a prioritisation process is often an irreplaceability or selection frequency map, showing the extent to which there are options for meeting biodiversity representation and persistence targets in different parts of the landscape or seascape. This initial spatial output must then be analysed further to select a portfolio of biodiversity priority areas, which can be shown on a map with a few simple legend categories. ***Section 7: Products*** gives more advice on creating user-friendly products with accompanying guidelines that provide explanation on how the maps should be used.

Depending on the purpose of the prioritisation, appropriate conservation objectives or actions should be identified for each of the priority areas. For example, an initial broad-scale prioritisation could guide where high-level strategic objectives in the NBSAP should be implemented. Broad-scale prioritisation at the national level can also be used to identify areas in which fine-scale prioritisation is needed, which could focus on areas of particular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biodiversity importance or areas where pressures on biodiversity are high. Priority areas from a systematic conservation plan can inform the consolidation and expansion of protected and conserved areas, and can be an essential input into biodiversity-inclusive spatial planning to inform decisions about land- and sea-use. They can also inform application of the mitigation hierarchy in environmental impact assessments, so that loss of biodiversity priority areas is avoided wherever possible.

6.3.1 Biodiversity targets

Systematic conservation planning relies on setting *biodiversity representation and persistence targets* for each biodiversity feature. These are the minimum proportion of each biodiversity feature that needs to be kept in a natural or near-natural state in the long term, to maintain viable representative samples of ecosystem types and species. These targets help to answer the question "How much is enough to ensure the long-term persistence of biodiversity?" and are usually expressed as a proportion of the historical extent of each ecosystem type or as an area required for a Minimum Viable Population of a species. Biodiversity representation and persistence targets are quantitative interpretations of the principles of representation and persistence.

Avoid the target trap !

The setting of biodiversity representation and persistence targets is still a developing science in many contexts, and can become the basis for contentious and time-consuming debate amongst scientists. It is better to use a pragmatic approach than to wait for perfect science or consensus on ecologically-based targets. Flat targets for ecosystem types can still provide useful results, and in practice, refining targets over time as the science improves does not usually dramatically affect the prioritisation outputs. See Table 12.

The term 'biodiversity targets' can be confusing as it is used for multiple purposes. Targets in the context of multilateral environmental agreements such as the Convention on Biological Diversity represent broad global and national commitments on various biodiversity-related themes. The overall targets contained within the Global Biodiversity Framework represent measurable global ambitions that are then used to guide the formulation of national targets in NBSAPs. These strategic global targets are set through negotiations and combine scientific inputs with socio-political and economic considerations. They differ from the biodiversity

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representation and persistence targets used in biodiversity prioritisation, which are based on an amount of biological or ecological attributes associated with the input features (ecosystems, species and processes).

There are, however, strong links between the biodiversity representation and persistence targets used in systematic conservation planning and the strategic goals and targets in the Global Biodiversity Framework. For example, the aim of the Global Biodiversity Framework to 'halt species extinction' can be achieved by setting biodiversity representation and persistence targets for species to ensure that the risk of species extinction is reduced.

Ideally, biodiversity representation and persistence targets should be based on ecological characteristics. However, scientific data are not always available to set such ecologically-based targets, especially in the freshwater and marine realms (Table 12). In the absence of more detailed scientific knowledge, a flat target (such as 30%) of each ecosystem type is pragmatic or can be adjusted to account for richness, rarity or ecosystem services.

Protected area targets are targets for the expansion of protected and conserved areas, and are usually linked to a particular timeframe and updated periodically. Internationally, the Global Biodiversity Framework sets a target for 30% of land, waters and seas to be protected by 2030 (Target 3). A country may choose to set protected area targets for its ecosystem types that are equivalent to their biodiversity representation and persistence targets, but may set short- to medium-term protected area targets that are less than the biodiversity representation and persistence targets.

All targets should ideally be set against the historical extent of ecosystem types, to avoid the situation where a proportional target will gradually reduce in actual area as more of the natural ecosystem type is modified. In cases where the historical extent of a natural ecosystem type has not been mapped, and the baseline map of ecosystem types is known to delineate less than the historical extent, it can be useful to make an estimate of the size of the historical extent even if it is not possible to delineate it.

There are many further considerations for the setting of biodiversity representation and persistence targets and the setting of targets for the expansion of protected and conserved areas (Table 12).

Table 12: Methods for determining biodiversity representation and persistence targets for ecosystem types and species.

Ecosystem types	• Biodiversity representation and persistence targets can be set based on ecological characteristics, with higher targets for ecosystems with greater diversity, rarity or ecosystem services.[50] • In both the terrestrial and marine realms, there are a number of proposed methods for determining representation targets based on ecological characteristics, including species-area curves, species occupancy models, extrapolated biodiversity samples, fisheries thresholds, or estimates of detection probability of species. • If insufficient data are available to develop targets based on ecological characteristics, a flat percentage target can be used, such as 30% of the historical extent of each ecosystem type. Flat percentage targets can be adjusted upwards or downwards for rare or common types, or combined with minimum area rules (e.g. not less than 10 000ha). • An option is to use fixed percentage targets based on political goals, such as the 30% of land, waters and seas to be protected by 2030 of Target 3 of the Global Biodiversity Framework. These targets will then align with global frameworks and political commitments. Such targets may be easier to justify to policymakers, although they may result in less efficient solutions. • Further approaches used for estimating persistence targets include graph theory, percolation theory, or landscape connectivity analysis. Ecosystem representation and persistence targets are often different, with persistence targets usually requiring larger extents of ecosystems compared to representation targets for the same ecosystem. • It remains critical to ensure that for every ecosystem type a justifiable biodiversity target is set to ensure the long-term representation and persistence of that ecosystem type.
Species	• Biodiversity persistence targets for species are based on Minimum Viable Populations, because population size is better correlated with extinction risk than area. • Setting biodiversity targets for species depends on the type of available species data and what is known about the species.[51] • For well-known and extensively researched species, such as large mammals and birds, there is usually information available in the literature to determine a biodiversity target based on the Minimum Viable Population. • The Minimum Viable Population is the smallest number of individuals that will be able to continue to survive and reproduce in the wild. It takes into account a range of factors such as reproduction rate, generation time, genetic diversity, habitat requirements and species interactions. • For species that do not have enough information to estimate the Minimum Viable Population, such as reptiles or fishes, a target of 10 000 mature individuals or 10 viable sub-populations can be used. • The target of 10 000 individuals is based on the Red List of Threatened Species threshold for listing a species as threatened under Criterion C, and is considered a precautionary number for most species.[52] Minimum Viable Populations estimated through population viability analyses tend to be smaller. • For species where population size is difficult to estimate, for example due to population fluctuations or where their density is difficult to estimate yet known to be high (such as invertebrates), a target of 10 viable sub-populations can be used. Viability of populations in these cases is usually determined by taxon experts in the absence of quantitative data. • For assessment, targets are expressed as a number of individuals or number of sub-populations. For systematic conservation planning, this target is usually translated into an area required to represent and maintain this population.

[50]Harris & Holness. 2023. A practical approach to setting heuristic marine biodiversity targets for systematic conservation planning. Biological Conservation, 286, 110218. *https://doi.org/10.1016/j.biocon.2023.110218*.
[51]Pfab et al. 2011. Application of the IUCN Red Listing system to setting species targets for conservation planning purposes. Biodiversity and Conservation, 20(5), 1001–1012. *https://doi.org/10.1007/s10531-011-0009-0*.
[52]IUCN. 2012. IUCN Red List Categories and Criteria: Version 3.1. Second edition. IUCN, Gland and Cambridge. *https://portals.iucn.org/library/node/10315*.

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6.3.2 Steps for conducting systematic conservation planning

The amount of data involved, and the computational complexities of evaluating different configurations of priority areas, means that prioritisation is generally conducted with the aid of specialised software. The most frequently used software programmes are *C-Plan*, *MARXAN*, *Zonation* and the *prioritizR* package for R. Use of such software does require additional technical skill and computing capacity relative to undertaking a biodiversity assessment. Table 13 gives the steps and tasks required to complete a prioritisation.

> **!**
>
> **Spatial skills and ecological knowledge**
>
> Both ecological knowledge and advanced spatial skills are required for systematic conservation planning. Some of the specialist software required for systematic conservation planning is highly technical and requires a steep learning curve. In many countries, there are few people who have both the technical skills and the necessary knowledge of ecology to make full use of such software. Any person conducting the systematic conservation planning should either have an understanding of the ecology of the area or work closely with ecologists who do.

It is possible to conduct a software-based prioritisation using only the four datasets described in ***Section 4: Spatial datasets***. Outputs of even a simple prioritisation such as this will be valuable to identify priorities for national policy, planning, decisions and action. Refinements to the prioritisation can be made as additional data become available or as methods and capacity improve. There is a whole suite of different options for improving and refining the analysis based on additional data. Some of these data may include:

- Additional spatial data on biodiversity features
  - Areas supporting ecological processes and climate change adaptation, such as ecological corridors
  - Areas important for providing ecosystem services
- Additional spatial socio-economic data
  - Opportunities, such as existing conservation initiatives
  - Constraints, such as areas with high potential for other land-uses or sea-uses like mining, fishing or agriculture or earmarked for future urban or infrastructure expansion

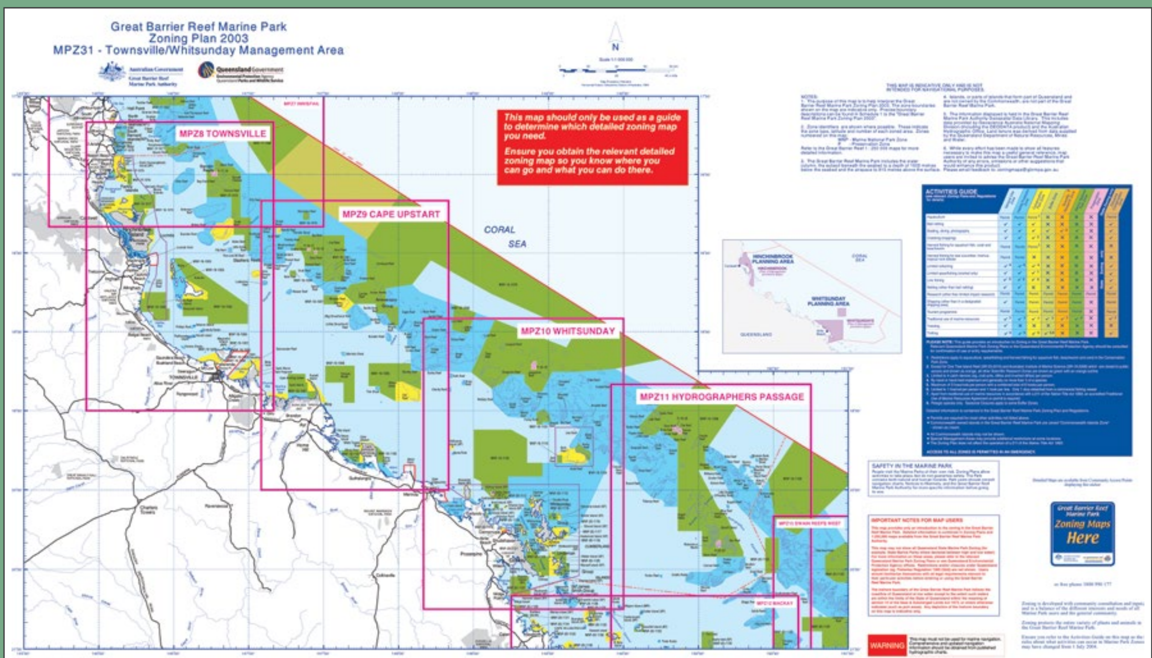
Box 9:
Case study: Origins of MARXAN for spatial conservation planning – the Great Barrier Reef zoning plan.

The Great Barrier Reef is the largest coral reef ecosystem in the world, and a recognised World Heritage Site. It extends for 2 300 km along the eastern coastline of Australia and contains 3 000 individual reefs, as well as a range of other marine habitats. The first area was proclaimed in 1983, and through progressive additions, the Great Barrier Reef Marine Park now covers 344 400 km^2. The whole of the Marine Park is a Marine Protected Area (MPA), but there are different zones of use within the Park.

It was realised in the early 2000s that the zoning was inadequate for protection of biodiversity. Zones needed to be more representative, with the goal of including at least 20% of all bioregions within the highest-level no-take zones. The Representative Areas Program conducted the re-zoning, which was completed in 2003.[53]

More than 40 datasets were combined to develop the baseline map of ecosystem types for the reef, resulting in 70 defined 'bioregions' – these served as ecosystem types. The MARXAN software, originally developed to conduct this prioritisation for the Great Barrier Reef, has since become one of the standard software options for such analyses worldwide. MARXAN was used to identify priority areas for meeting the biodiversity targets, which were then subject to additional stakeholder input before eight zones were finalised.

The zoning maps have been made widely available in easily understood formats, accompanied by guidelines that clearly interpret which activities are allowed or restricted in each zone.[54] In addition, a major research programme has been established to monitor the effects of the re-zoning.



[53]Lewis et al. 2003. Use of spatial analysis and GIS techniques to re-zone the Great Barrier Reef Marine Park. Coastal GIS workshop, July 7 – 8, 2003, Wollongong, Australia.

[54]Figure shows an example of an overview map. Full Zoning Maps for the Great Barrier Reef Marine Park are available at *https://www2.gbrmpa.gov.au/access/zoning/zoning-maps*.

Table 13: Methods and tasks for conducting systematic conservation planning to identify a portfolio of biodiversity priority areas across a country.

Steps	Tasks	Description and additional notes
Map and classify ecosystem types	Source or develop a map of ecosystem types	• Start with a map of ecosystem types, as for assessment. • Information on how to source or generate a map of ecosystem types can be found in ***Section 4.1 Baseline map of ecosystem types***.
Map species occurrence	Gather relevant species data	• Decide which species are most important to include, based on clear and defensible criteria. Recommended species are those listed as threatened, as well as other range restricted, endemic species and species of cultural or socio-economic significance. • Information on how to source or generate maps of species occurrence can be found in ***Section 4.4: Maps of species occurrence.***
Map other biodiversity features e.g. ecological processes	Include other assessment and prioritisation results	• Outputs of risk status and protection level assessments can be included, such as threatened ecosystem types or species. • Outputs of other criterion-based approaches, such as Key Biodiversity Areas, could be included.[55]
	Map relevant ecological processes and ecological infrastructure	• Map key areas for ecological processes and climate change adaptation where available, such as: ▪ Ecological corridors and upland-lowland gradients that provide for connectivity in the landscape ▪ Riparian corridors, wetlands and groundwater recharge areas ▪ Key migration routes for species ▪ Large or well-connected patches of natural or near-natural habitat, especially in landscapes that are highly fragmented (e.g. identifying the largest remaining patches of natural ecosystem types or habitats) ▪ Important areas for supporting species of special concern (such as breeding areas or movement corridors, if not already included in the species data) • Identify ecological infrastructure i.e. naturally functioning ecosystems that provide ecosystem services that benefit people or the economy. For example, areas important for water supply, wetlands important for flood regulation, coastal dunes or mangroves important for natural hazard prevention etc.
Set biodiversity targets	Set biodiversity targets for representation and persistence	• Biodiversity representation and persistence targets must be set for any biodiversity features included, such as ecosystems, species or ecological process features. • Information on setting biodiversity targets can be found in ***Section 6.3.1: Biodiversity targets***.

[55] Plumptre et al. 2024. The strengths and complementarity of Systematic Conservation Planning and Key Biodiversity Area approaches for spatial planning. Conservation Biology.

Table 13: Methods and tasks for conducting systematic conservation planning to identify a portfolio of biodiversity priority areas across a country (continued).

Steps	Tasks	Description and additional notes
Set biodiversity targets (continued)	Set biodiversity targets for representation and persistence	• Care needs to be taken to set appropriate targets for features representing ecological processes. For example, it may be necessary to include the full extent of a key corridor (i.e. to set a target of 100% for this feature) but it may be possible to retain sufficient ecological functioning by including only a proportion of a floodplain system (e.g. to set a target of 50% of this feature).
Consider current extent and condition	Map current extent and condition, and consider the minimum ecological condition required	• Information on sourcing or generating a map of current extent and condition can be found in ***Section 4.2: Map of current extent and condition***. • For each set of biodiversity features, decide on the minimum ecological condition required for them to contribute effectively to meeting biodiversity targets. • This may differ depending on the type of biodiversity feature (e.g. ploughed areas may have no further value for meeting targets for terrestrial ecosystem types, but may still contribute to meeting some ecological process targets e.g. as part of a corridor that allows for movement of some species). • Overlay the map of current extent and condition on each map of biodiversity features (e.g. ecosystem types, species and ecological processes), and remove the parts of each biodiversity feature that are not in at least the minimum required ecological condition.
Determine planning units	Decide on planning units to be used and delineate planning units	• There are many valid approaches for delineating planning units. For example, they can be: ▪ Regular geometric units such as a grid of pixels or hexagons ▪ Ecological units such as sub-catchments ▪ Land management units such as property boundaries • Creating ecologically sensible planning units may require including the entire extent of an ecosystem as a planning unit in cases where it would not make sense to select only part of that ecosystem for conservation or restoration, for example, the entire across-shore extent of intertidal habitats. • Consider the relationship between the size of the planning units and the resolution of the biodiversity feature data. For example: ▪ Planning units should not dwarf the smallest biodiversity feature ▪ Planning units should not be falsely small relative to the resolution of the biodiversity features • If the units are irregularly sized, avoid large ranges of different sizes, and avoid extremely large planning units. The size of the planning units should be broadly similar as software can preferentially select certain size units which can bias the results. • Protected and conserved areas can be treated as single planning units in their own right, or can be subdivided by the planning units used in the rest of the land- or seascape.

Table 13: Methods and tasks for conducting systematic conservation planning to identify a portfolio of biodiversity priority areas across a country (continued).

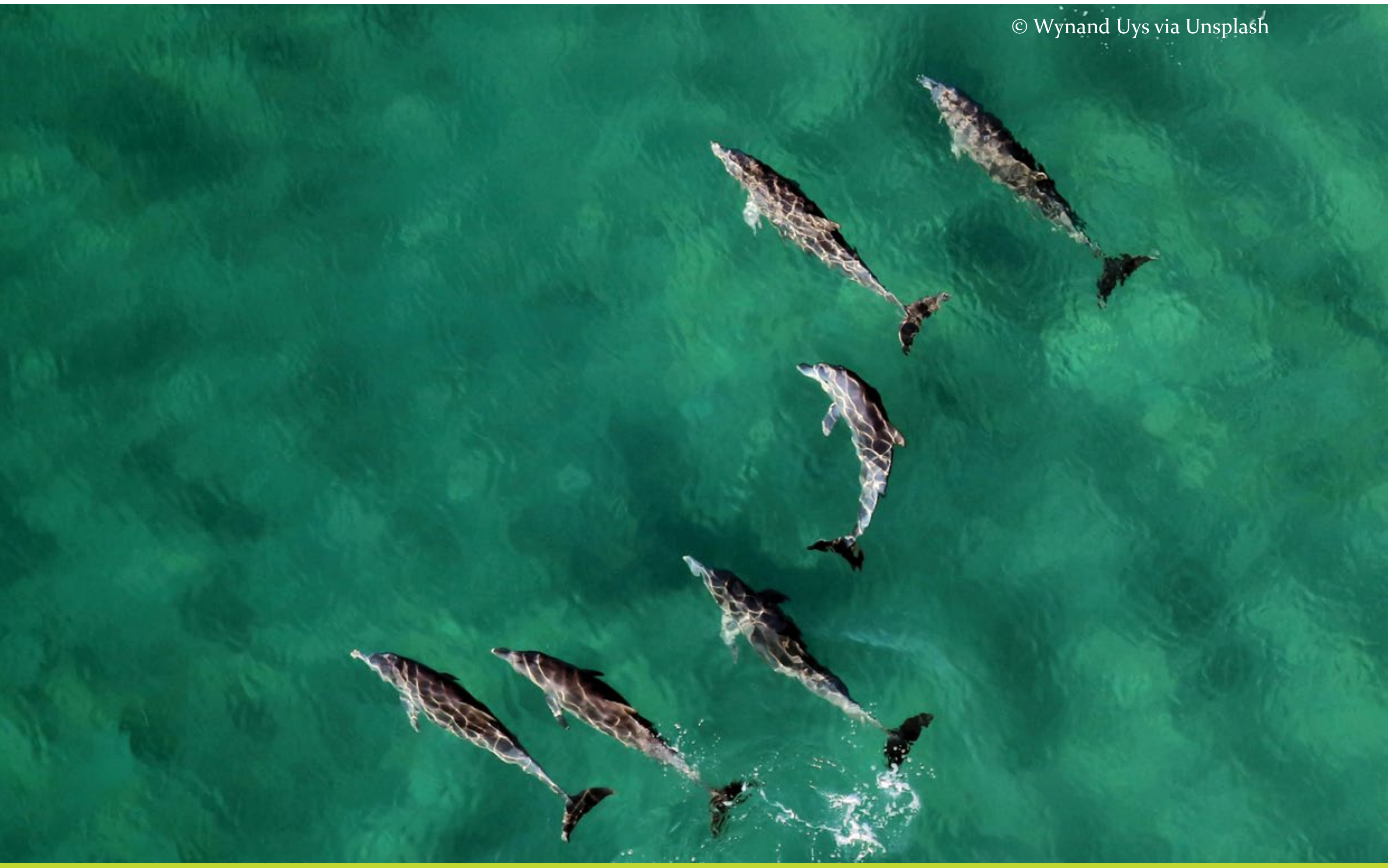
Steps	Tasks	Description and additional notes
Develop a matrix of planning units and features	Create a site-by-features matrix	• For each planning unit, determine how much of each biodiversity feature occurs in that planning unit in at least the minimum required ecological condition for that feature (e.g. how many hectares in good ecological condition of a particular ecosystem type occur in each planning unit). • Typically, this is done within a GIS or spatial planning software linked to a GIS.
	Identify protected planning units	• Identify which planning units fall within the existing protected and conserved areas. • Remember that decisions will have to be made as to which types of protected and conserved areas should count towards meeting biodiversity targets (***Section 4.3: Map of protected and conserved areas***).
Evaluate how much is already protected relative to targets	Evaluate how much is already protected relative to targets	• For each biodiversity feature, compare how much is already protected with the biodiversity target for that feature, i.e. determine what proportion of the target has been met in the existing network of protected and conserved areas. • This is similar to the protection level assessment discussed in ***Section 5: Assessment*** and provides very valuable information on which biodiversity features are not sufficiently represented in protected and conserved areas. This is often called a gap analysis. • It can be a useful way to draw attention to networks of protected and conserved areas that have become excessively focused on particular aspects of biodiversity (such as charismatic species), and are consequently neglecting other important features (such as an overlooked terrestrial or offshore ecosystem type).
Specify 'costs' for inclusion of planning units	Develop the cost variable	• A key aspect of systematic conservation planning is that it attempts to identify an efficient network of sites that meet targets at the lowest cost and in least conflict with other land-uses and activities. • 'Costs' are a concept in systematic conservation planning that refers to constraints that are taken into account in the process of identifying biodiversity priority areas. Costs do not always refer to financial costs, and other factors (such as other land uses) can also be used to set the 'cost' of a planning unit. • The cost variable used in systematic conservation planning often exerts a large impact on a planning outcome. Therefore, as much attention should be paid to developing the cost variable as the biodiversity information. • The simplest approach is to minimise the area selected to form part of the portfolio of biodiversity priority areas. Areas are assigned to each planning unit, and it is assumed that the cost of a planning unit increases with area. • The cost of a planning unit will affect its selection in the prioritisation process.

Table 13: Methods and tasks for conducting systematic conservation planning to identify a portfolio of biodiversity priority areas across a country (continued).

Steps	Tasks	Description and additional notes
Specify 'costs' for inclusion of planning units (continued)	Minimising conflict with other land-uses and activities	• Identify possible constraints – these are factors that should be avoided when selecting priority sites, such as high-potential agricultural land, key areas for fisheries, high-potential mining areas, or areas earmarked for urban expansion. • If possible, gather spatial data on these constraints. • The constraint layers are then used to increase the cost of certain planning units. • Ecological condition can also be used as a cost factor to help prioritise best condition area, by increasing costs of planning units that are not in good ecological condition.
	Maximising synergies with compatible land-uses and activities	• Identify possible opportunities – these are factors that should be sought out when selecting priority sites, for example, existing conservation initiatives. • If areas that are important for delivering ecosystem services have not already been included as features, it may be useful to include them as factors that reduce the cost of planning units. • The opportunity layers are used to reduce the cost of planning units.
Identify priority sites in the best possible ecological condition for achieving remaining targets, in the most efficient and effective configuration	Select planning units for priority sites	• Use suitable software to identify the planning units required to meet biodiversity targets in a way that is efficient, spatially coherent (e.g. that is arranged in a spatially connected manner that allows ecological processes to operate) and limits costs. • Various software programmes exist to do this, typically using spatial optimisation algorithms. • Be careful to follow available best practice guidelines for the software being used, as some of the software needs to be carefully calibrated to ensure sensible results. • Conflict with other sectors and land-uses can be avoided in instances where there are alternative options for meeting targets. This is not always possible, especially for ecosystem types that have very little of their historical extent remaining and for which all that remains is important for meeting biodiversity targets. • Often the initial output of the spatial analysis is an irreplaceability or selection frequency map, which summarises the degree to which options exist in the landscape or seascape for meeting biodiversity targets. This usually requires further interpretation, since it is not a product that will be intuitively understood by a non-technical audience. • Based on the irreplaceability analysis, select a portfolio of priority areas and evaluate it to ensure that targets are met for all biodiversity features. • Where targets are not met, carefully identify why this is the case – it may be necessary to include additional sites in poorer condition to meet targets where insufficient habitat in good condition is available.

Table 13: Methods and tasks for conducting systematic conservation planning to identify a portfolio of biodiversity priority areas across a country (continued).

Steps	Tasks	Description and additional notes
Develop guidance materials on how the prioritisation should be used	Identify appropriate conservation actions for priority sites	• Consider the range of conservation actions or interventions that may be applied to specific priority areas, bearing in mind the biodiversity features in, and pressures on, those areas. • These actions may include: ▪ Expanding the network of protected and conserved areas ▪ Influencing planning, authorisation and permitting processes, such as land-use zoning, environmental impact assessments or water use licensing ▪ Rehabilitating or restoring degraded features, e.g. priority wetlands or catchments
	Consider how products should best be displayed	• Think about how to display the spatial outputs in an understandable way, typically a portfolio of priority areas divided into a small number of categories. • Pay attention to legend categories, colours and terminology to aid easy understanding. • Think about what accompanying products should be developed e.g. technical reports, metadata, guidelines, implementation manuals, posters, interactive maps and online GIS. • See ***Section 7: Products***, for more information and tips on how to produce professional and insightful products.



Box 10:
Case study: Biodiversity priority areas and priority actions in South Africa.

South Africa has well-established capacity for conducting spatial prioritisation and producing systematic conservation plans. As a result, a number of different prioritisation processes have been conducted, resulting in a suite of areas identified as priorities for different purposes. Some examples of prioritisation exercises include:

- *Critical Biodiversity Areas:* All provinces in South Africa, and the full marine territory, have developed spatial biodiversity plans. These plans identify Critical Biodiversity Areas, which are areas required to meet biodiversity representation and persistence targets for ecosystems, species and ecological processes. These 'CBA Maps' have been taken up into law and policy for integrated spatial planning and environmental impact assessments. The map shown here is South Africa's national map of Protected Areas, Critical Biodiversity Areas and Ecological Support Areas – amalgamated from all the provincial and marine biodiversity plans.
- *National Protected Area Expansion Strategy (NPAES):* South Africa's first NPAES was developed in 2008, with the goal of achieving expansion of the protected area network. The NPAES draws on the outcomes of spatial biodiversity assessment and prioritisation to identify geographic focus areas for the expansion of protected areas. The NPAES is updated periodically to reflect changes to the protected area network and progress towards protected area targets.
- *National Freshwater Ecosystem Priority Areas (NFEPA):* A three-year multi-partner project that concluded in 2011, and is being updated, the NFEPA project gathered large amounts of data to identify priority areas within the freshwater environment. The resultant Freshwater Ecosystem Priority Areas (FEPAs) are rivers and wetlands required to meet biodiversity targets for freshwater ecosystems across the country.

7. Products

Conducting spatial biodiversity assessment and prioritisation at a national level generates a number of outputs and maps, with much technical and scientific information embedded therein. While documenting the technical outputs is important for scientific transparency, these outputs often need to be interpreted and displayed with care to communicate to a wider audience. An important final step for assessment and prioritisation should be a conscious focus on creating well-designed products that will be used to inform non-technical stakeholders, such as policy- and decision-makers, managers and the public. It is important to allocate substantial time and sufficient resources for this. For more information about presenting the results, see *Mainstreaming Biodiversity Priorities*.[56]

Some of the products that could be produced include:

Maps

- Ecosystem types
- Species occurrences
- Current extent and condition
- Protected and conserved areas
- Ecosystem risk status
- Ecosystem protection level
- Biodiversity priority areas to inform planning and decision-making by a range of sectors
- Protected area expansion priorities

Metrics and indicators

- Red List of Ecosystems
- Red List of Threatened Species
- Red List Index of Ecosystems
- Red List Index of Species
- Extent of natural ecosystems
- Coverage of protected and conserved areas
- Additional information towards the calculation of many other indicators

Datasets

- Spatial data files
- Metadata for spatial datasets
- Spreadsheets

Lists

- Threatened ecosystems
- Threatened species
- Under-protected ecosystems
- Under-protected species
- National priority areas and actions
- Data gaps and research needs

Reports

- Papers in the scientific literature
- Technical reports
- Guidelines or manuals for using the maps
- Summary report for policymakers

Through experience with communicating the results of spatial biodiversity assessment and prioritisation at national and sub-national level, several lessons and principles have emerged on how to structure these products most effectively:

Interpret the outputs for easy understanding by a wide general audience. Most stakeholders are not interested in reading technical reports, but prefer a simple summary of the most important findings. A short, diagram-rich, summary report, which clearly describes what the maps and other

[56]UNEP-WCMC & SANBI. 2022. Mainstreaming biodiversity priorities: A practical guide on how to integrate spatial biodiversity products into national policy, planning and decision-making. South African National Biodiversity Institute, Pretoria, South Africa. *http://hdl.handle.net/20.500.12143/8735*.

products mean and what they can be used for, will often be the most widely read resource. Interpretation of the outputs is necessary to not only improve understanding and encourage wider use, but also to avoid misuse. The summary report should distil the scientific findings into a few, easily understandable and well-explained messages that can be used to inform biodiversity policy, as well as contribute to uptake by other sectors and broader audiences.

Keep the message simple, with a few clear points. While acknowledging ecological complexity and scientific rigour, each map product should have a single clear message. Decide on as few indicators as possible, and think carefully about the simplest ways to report on these. The summary report should extract a limited set of key messages that are supported by simple and intuitive maps or statistics. Avoid overcomplicating the message by providing too many alternative options or too much detail. For example, rather than trying to explain the multiple options associated with an irreplaceability map, it should be interpreted into a single set of priority sites before being presented as a map product. The choice of appropriate terminology, and limited use of technical jargon, will make the products more comprehensible.

Play close attention to colour and design of map products. Maps are often the primary products of assessment or prioritisation and can convey a great deal of information in a concise and compelling format. The ecologists who conduct the assessment and prioritisation often do not have the graphic design or cartography skills to produce professional and well-designed products. The value of professional presentation should not be underestimated as it can improve understanding of the results and vastly encourage uptake. Colour is an important part of this, and careful choice of colour can help to highlight certain messages, such as using red to indicate only highly threatened ecosystems. Colours set by international standards should be used as far as possible. Legend categories and terms require careful consideration and should be as self-explanatory and intuitive as possible. Aspects of cartographic design may include adding features that help users orientate themselves on the map, and a shaded relief that makes the map look more realistic. Effort should be made to ensure a consistent design style that will generate a recognisable 'look-and-feel' across the various products. It can be useful to test draft design concepts, especially for maps, with a set of users.

Create a separate technical report to give evidence of scientific methods. Since the assessment or prioritisation is based on scientific methods, it is necessary for scientific credibility and robustness to provide a technical report that will allow others to query or repeat the methods. Paper(s) published in the scientific literature may also be appropriate for methods and results. It is crucial for the scientists involved in the assessment or prioritisation to receive recognition through these technical reports or papers having clear instructions on how to cite the work and an acknowledgement of all contributors. While most of the stakeholders will not read the technical report or papers, they should nevertheless be made available to the scientific community and to anyone else who wishes to understand the underlying science. If the analysis was not integrated across realms, it may be more realistic to produce separate technical reports or papers for the differing methods taken across the terrestrial, freshwater and marine realms. The datasets used as inputs and produced through the analysis should also be made available where appropriate, with strict data management protocols. Datasets should always be accompanied by the necessary metadata describing how they were generated, who the developer was, and what format they are in.

Promote easy access to the products, such as through an online repository. Products should be made available from a central and easily accessible source, ideally curated by a credible national entity that is seen as a source of biodiversity information. Access should preferably be through an online repository that allows downloads of reports, high-resolution pictures of maps, and spatial data in a range of appropriate formats to allow wide usage. For example, maps could be provided as printed posters, downloadable pictures, and in popular GIS formats. Having a single reference point helps users to know where to access final, legitimate products and prevents confusion from distributing multiple versions or revisions (particularly of maps). Sharing products over more accessible platforms such as online citizen science portals and mobile maps accompanied by video tutorials can also build capacity and encourage data sharing back to map curators. A clear system of numbering or identifying different versions will help clarify which is the latest version. Web traffic and numbers of downloads can give an indication of products accessed, and enable this to be monitored over time.

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Provide capacity-building and ongoing support to encourage implementation. Plans should be put in place to roll out the products to the user community. Limited capacity, especially within government departments, can mean that despite the best efforts at producing useable products, their purpose is poorly understood and they are simply overlooked by potential users. Release of the products should ideally be accompanied by information sessions, training and capacity development to promote their full intended use. Innovative use of learning materials, such as wall posters of important maps or webinars that can be watched at a user's convenience, can aid instruction. Further, it is vital to provide ongoing assistance to users with interpretation and application of map products and the accompanying guidelines. Once-off training or information sessions are almost always insufficient to ensure uptake. Measuring uptake and the use of spatial biodiversity mapping, assessment and prioritisation products can be extremely difficult, and thinking through how to evaluate uptake may be useful during the first rollout of the products. For example, surveys and literature reviews could enhance the understanding of how the products are being used, to supplement the quantitative measures of web traffic and numbers of downloads.[57]

[57]UNEP-WCMC & SANBI. 2022. Mainstreaming biodiversity priorities: A practical guide on how to integrate spatial biodiversity products into national policy, planning and decision-making. South African National Biodiversity Institute, Pretoria, South Africa. *http://hdl.handle.net/20.500.12143/8735.*

8. Enabling factors

Several important enabling factors greatly enhance a country's ability to conduct a spatial biodiversity assessment and prioritisation as described in this guide. These factors also improve the likelihood that the results will be taken up into policy, planning, decisions and action at a national level. Some enabling factors are:

An agency that can play a coordination role. Establishing or identifying a clear organising agency helps to ensure responsibility for coordinating the assessment and prioritisation project, disseminating the products, and advising on their uptake into conservation strategies and policies. Ideally, the organising agency should be a public sector department or conservation agency that is mandated to conduct national biodiversity assessment or monitoring. However, it is possible for a non-governmental organisation to play this role, especially if it works in collaboration with government departments or structures. An organising or champion agency of this type need not be directly involved in conducting the technical aspects of the approach, but should be able to play the role of facilitator and project coordinator. The agency should be in a position to add credibility and policy influence, if possible, to take responsibility for the outputs and to be a credible, single source for their dissemination. It is beneficial to have the role of project coordinator as a core part of someone's job description, allowing enough time for the necessary management and administration.

Establishing a strong community of practice that promotes peer learning and sharing. Good communication amongst a group of practitioners implementing this approach within a country is important for peer-to-peer learning and consensus building. Regular forums, learning exchanges and other opportunities to build communication channels and solid working relationships can help to improve the technical and scientific methods used, as well as the ways in which the outputs are presented and communicated. Strong communities of practice provide a sounding board for innovation and a peer review mechanism, allowing those working in this field to gain a feeling of peer endorsement and support. Communities of practice also provide a platform for the development of human capacity and a common place of learning for new practitioners. This contributes to the continuity between projects, adaptive learning, and iterative improvement. The coordinating agency mentioned above can play a key role in convening such a community of practice, for example through an annual forum or other meetings, events or working groups.

Making clear links to government priorities and processes, to inform national policy. Assessment and prioritisation should ideally be demand driven, arising from the needs of government. The process should be aligned with international obligations, national government mandates, legislation, national priorities, and existing national processes and structures. The national scope of the analysis means that the appropriate 'owner' of the process and products is usually national government. The relevant government department will help to ensure that the outputs are appropriate for informing national biodiversity policy as well as mainstreaming biodiversity into other sectors. In some cases, external service providers, non-governmental organisations or academic research organisations can conduct the process of spatial biodiversity assessment and prioritisation. While this may help to address limited government capacity to run the process, it should not mean that products are imposed upon government without an understanding of government priorities or processes. See *Mainstreaming Biodiversity Priorities* for more information.

9. Conclusion

Perhaps the most valuable aspect of the approach presented in this guide lies in the intuitive understanding and wide range of information that can be conveyed in a few maps. Maps give geographic meaning to a biodiversity assessment, and provide focus areas that can be prioritised in the real world. They are able to communicate important messages about pressures on the natural environment and conservation imperatives to a range of relevant stakeholders.

The maps that are developed can be harnessed for a wide range of related uses. Spatial biodiversity assessment and prioritisation can be used to strengthen environmental decision-making and land-use or sea-use planning, and to mainstream biodiversity concerns into national development plans and plans of other sectors. They can also encourage additional strategic research to fill knowledge gaps that are uncovered during the course of the assessment.

Most significantly, the approach presented here can contribute to the implementation and monitoring of targets of the Global Biodiversity Framework. Robust spatial information can help countries to plan and implement strategic conservation actions that are effective at a national level. Countries will also be better able to report and monitor the effectiveness of their conservation actions over the long-term. The approach directly contributes information to several of the indicators adopted by the Global Biodiversity Framework.

Importantly, such spatial information is within reach of capacity- and resource-constrained countries. This guide shows how even a data-poor country can draw from global data as the basis for an initial assessment and prioritisation that will yield useful results. By conducting a national biodiversity assessment and prioritisation in the manner outlined here, countries stand to discover a wealth of information about what biodiversity they have, where it is, its state, and where and how they could best act to manage and conserve it.

10. Glossary

Assessment: An assessment of the state of biodiversity, at the ecosystem, species or genetic level. The output of a biodiversity assessment could include risk status and protection levels for ecosystems and species.

Biodiversity: 'Biological diversity' means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.[58]

Biodiversity feature: An element of biodiversity that is included as an input layer in a systematic conservation plan and for which it is possible to set a quantitative biodiversity target. A biodiversity feature could be, for example, an ecosystem type, species, special habitat or ecological corridor. A map of ecosystem types can often be used as a surrogate for a range of other biodiversity features.

Biodiversity priority area: Area of the landscape or seascape that is important for conserving representative samples of ecosystems and species, for maintaining ecological processes, or for the provision of ecosystem services. They are usually identified using systematic conservation planning principles and methods. These areas are likely to be the most urgent focus for conservation action.

Biodiversity representation and persistence target: (sometimes shortened to biodiversity target) A quantitative target for an ecosystem type, species or ecological process that sets the minimum amount needed to ensure the representation and persistence of biodiversity, used in systematic conservation planning. This could be expressed, for example, in hectares of an ecosystem type or number of viable populations of a species.

Conserved area: An area of land or sea not formally protected in terms of legislation but managed for biodiversity conservation. Also see Protected area.

Ecological condition: The degree to which the composition, structure and function of an area or biodiversity feature has been modified from a reference condition of natural. Mapping ecological condition can be a way of summarising the many pressures acting on ecosystems.

Ecological infrastructure: Naturally functioning ecosystems that provide valuable services to people and the economy, such as healthy mountain catchments, rivers, wetlands, coastal dunes and corridors of natural habitat.

Ecological processes: The biological actions and interactions that link organisms and their environment, both at a local scale and at the landscape or seascape scale. These processes are important for the maintenance and persistence of biodiversity over time.

Ecosystem protection level: An indicator of the extent to which different ecosystem types are adequately protected in the existing network of protected and conserved areas. Ecosystems can be categorised into different levels of protection, for example, well protected, moderately protected, poorly protected or not protected.

Ecosystem services: The contributions of ecosystems to human well-being. The benefits that people obtain from ecosystems include provisioning services (such as food and water),

[58] Article 2 of the Convention on Biological Diversity.

regulating services (such as flood control and water purification), and cultural services (such as recreational benefits).

Ecosystem risk status: An indicator of the risk of collapse for an ecosystem type. In other words, the degree to which an ecosystem is still natural or near-natural, or alternatively losing vital aspects of its structure, function or composition. Ecosystems can be classified into risk categories, such as Critically Endangered, Endangered, Vulnerable and Least Concern. Ecosystem risk status is assessed using the criteria of the IUCN Red List of Ecosystems.

Ecosystem type: A complex of organisms and their associated physical environment that share broadly similar ecological composition, structure and function. An ecosystem type is identified and delineated as part of a hierarchical classification system, based on biotic and abiotic factors. Factors used to map and classify ecosystems differ across the terrestrial, freshwater and marine realms.

Historical extent: The mapped extent (geographic distribution) of an ecosystem type prior to major human modification of the landscape or seascape.

Key Biodiversity Area: Site contributing significantly to the global persistence of biodiversity.[59]

National Biodiversity Strategy and Action Plan (NBSAP): The principal instrument for implementing the Convention on Biological Diversity (CBD) at the national level. Countries are required to prepare a national biodiversity strategy (or equivalent instrument) and to ensure that this strategy is mainstreamed into the planning and activities of all those sectors whose activities can have an impact (positive and negative) on biodiversity. Ideally, a country's NBSAP should be informed by spatial biodiversity assessment and prioritisation.

Natural or near-natural: An ecological condition of natural or largely natural with few modifications resulting from human activity, such that ecosystem composition, structure and function are still intact or largely intact. Also see Ecological condition.

Persistence: The principle of persistence is one of the two main goals of systematic conservation planning. Persistence refers to the need to maintain ecological and evolutionary processes that enable ecosystems and species to persist over time. In identifying biodiversity priority areas, consideration must be given to the quantity and configuration of areas that will be needed to maintain ecosystem functioning in the long term.

Prioritisation and planning: The identification of a portfolio of geographic areas or sites that are of high importance for protecting, conserving, managing and/or restoring biodiversity. There are a range of options to conduct prioritisation and planning, from very basic methods, to criteria-based approaches, to the most comprehensive, which uses the well-known scientific method of systematic conservation planning to identify a set of efficiently configured priority areas that achieve the goals of representation and persistence.

Protected area: An area of land or sea that is formally protected in terms of legislation and managed mainly for biodiversity conservation. Also see Conserved areas.

Representation: The principle of representation is one of the two main goals of systematic conservation planning. The aim of representation is to conserve a viable sample of all species and all ecosystem types, and to avoid bias towards only certain species or ecosystem types.

Spatial: In this context, spatial refers to geographical location. Spatial information can be presented on a map.

Species extinction risk: An indicator of the risk of extinction for a species. Species can be classified into risk categories, such as Critically Endangered, Endangered, Vulnerable and Least Concern. Species extinction risk is assessed using the criteria of the IUCN Red List of Threatened Species.

[59]IUCN. 2016. A Global Standard for the Identification of Key Biodiversity Areas, Version 1.0 . First edition. Gland, Switzerland. *https://portals.iucn.org/library/node/46259*.

Species protection level: An indicator of the extent to which species are protected in the existing network of protected and conserved areas. Species can be categorised into different levels of protection, for example, well protected, moderately protected, poorly protected or not protected.

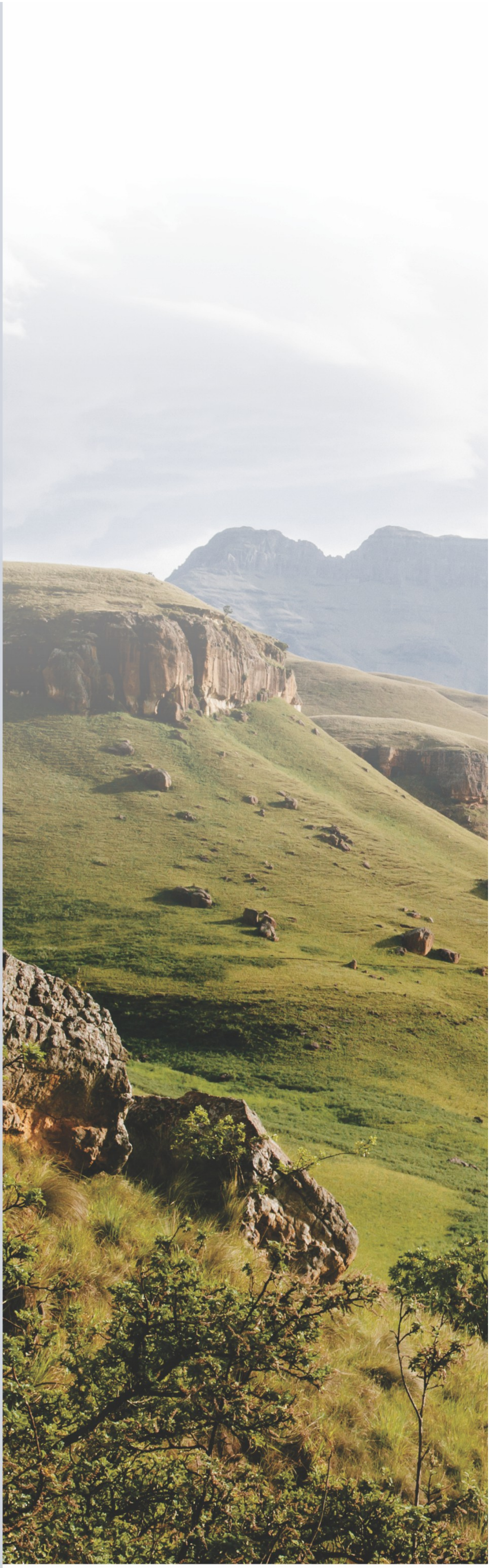
Systematic conservation planning: A scientific method for identifying geographic areas of biodiversity importance, emphasising the need to conserve representative samples of ecosystems and species (the principle of representation), as well as the ecological processes that allow them to persist over time (the principle of persistence). The configuration of priority areas is designed to be spatially efficient (i.e. to meet biodiversity targets in the smallest possible area), to take into account aspects such as connectivity, and to avoid conflict with other sectors where possible.

Taxon: A taxonomic group of any rank, such as a species, family or class. Taxonomy is the science of naming, describing and classifying organisms and includes all plants, animals and microorganisms of the world. If a taxonomic group includes sub-species or varieties, it is good practice to use the word 'taxa' as long as it is explained for non-scientific audiences. If a group only contains species, then the use of the word 'species' is recommended.

Mapping Biodiversity Priorities sets out a practical approach to spatial biodiversity assessment and prioritisation, which can be applied at the national level in any country. It shows a sequential process for biodiversity assessment, prioritisation and planning, based on a few foundational spatial datasets. These datasets can be combined to produce useful indicators of the state of biodiversity and maps that identify biodiversity priority areas. Assessment reveals the state of biodiversity for both ecosystems and species, using the indicators of risk status and protection level. Following on from assessment, prioritisation and planning identifies the most important areas that should be the focus of conservation action.

The guide will be useful to those involved in managing, conserving or reporting on biodiversity at a national level, including reporting on multi-lateral environmental agreements. The products can feed easily into biodiversity policy, planning, decisions and action. Maps and indicators provide a wealth of information about where important biodiversity occurs, where it is most threatened and where to act first.

The second edition now shows how the approach can help countries to implement the targets of the Kunming-Montreal Global Biodiversity Framework and monitor progress towards their achievement. It includes new guidance on the Global Ecosystem Typology, IUCN Red List of Ecosystems, IUCN Red List of Threatened Species, and the identification of Key Biodiversity Areas.



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