



CapeNature

**CapeNature Prioritization
Framework for Biodiversity
Monitoring and Surveillance**

CapeNature Prioritization Framework for Biodiversity Monitoring and Surveillance

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EXECUTIVE SUMMARY

Conservation management actions should ideally be informed by biodiversity monitoring and surveillance data, however both the collection of robust data and the ability to act upon it are resource constrained. Prioritization of monitoring and surveillance activities is thus necessary and towards this aim, CapeNature has developed a tool for objective prioritization of monitoring and surveillance of indigenous species, alien invasive species and ecosystem types. A three-tier decision-tree approach was developed. For each species/ecosystem type, three categories of criteria are scored: (a) Biological Criteria, (b) Relevance Criteria and (c) Feasibility Criteria. In Tier 1, the risk of not monitoring the survival of a species/ecosystem type is assessed by considering the interplay between Biological Criteria and Relevance Criteria. The outcome is used to decide if a lack of monitoring and surveillance would be detrimental or non-detrimental. In Tier 2, a combined Biological Score and Relevance Score is considered against a Feasibility Score, with the latter reflecting the capacity of CapeNature and/or the organization's partners to carry out monitoring and surveillance. If capacity is lacking, then other options to ensure that monitoring takes place are explored in Tier 3.

ACKNOWLEDGEMENTS

Jan Vlok (Botanical Ecologist Specialist, Regalis Environmental Services) is acknowledged for his contribution to the development of this framework by testing it on several plant species.

ACRONYMS

| | |
|-------|---|
| BC | Biological Criteria |
| BMP-S | Biodiversity Management Plan for Species |
| CITES | Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| FC | Feasibility Criteria |
| IAS | Invasive Alien species |
| IUCN | International Union for Conservation of Nature |
| M&S | Monitoring and Surveillance |
| MOU | Memorandum of Understanding |
| NBA | National Biodiversity Assessment |
| NDF | Non-detriment finding |
| NEMBA | National Environmental Management Biodiversity Act |
| PAMP | Protected Area Management Plans |
| RC | Relevance Criteria |
| RLE | Red List of Ecosystems |
| SANBI | South African National Biodiversity Institute |
| SOB | State of Biodiversity (CapeNature database) |
| SWSA | Strategic Water Source Area |
| WCP | Western Cape Province |
| WIMS | Water Information Management System |

DEFINITIONS

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| Conservation target (Conservation Measures Partnership, 2013) | Conservation targets are specific species or ecological systems/habitats that are chosen to represent and encompass the full suite of biodiversity in the project area for place-based conservation or the focus of a thematic program. They are the basis for setting goals, carrying out conservation actions, and measuring conservation effectiveness. |
| Ecosystem (SANBI, 2016) | An assemblage of living organisms, the interactions between them and their physical environment. Ecosystems can be delineated at a range of spatial scales. |
| Ecosystem protection level (SANBI, 2016) | Ecosystem protection level indicates how well represented an ecosystem type is in the protected area network. Ecosystem types are categorised as well protected, moderately protected, poorly protected, unprotected (<5% protection) or not protected at all, based on the proportion of the biodiversity target for each ecosystem type that is included in one or more protected areas. Not, protected, unprotected, poorly protected, and moderately protected ecosystem types are collectively referred to as under-protected ecosystems. |
| Ecosystem type (SANBI, 2016) | An ecosystem unit, or set of ecosystem units, that has been identified and delineated as part of a hierarchical classification system, based on biotic and/ or abiotic factors. Ecosystems of the same type are likely to share broadly similar ecological characteristics and functioning. For the purposes of this document, |

| | |
|---------------------------------|---|
| | the 2018 National Vegetation Map is used to represent the southern African ecosystem types. |
| Focal biodiversity surveys | Biodiversity surveys conducted in a particular place (typically under-sampled) to cover a range of taxonomic groups (also known as BioBlitzes). |
| Monitoring (CapeNature, 2022) | The process of describing and recording changes in the state of biodiversity and ecosystem types to support evidence-based decision making, reporting and planning. |
| Surveillance (CapeNature, 2022) | Describing and recording data at one point in time. This differs from monitoring above which records data and its change over time. |

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1. INTRODUCTION

Myers *et al.* (2000) identified the Cape Floristic Province, located primarily in the Western Cape Province (WCP), as one of 25 global biodiversity hotspots. These are areas that not only feature exceptional concentrations of endemic species but are also experiencing exceptional loss of habitat. Managing this wealth of biodiversity is challenging due to the very large number of threatened and endemic species and their scattered distribution in the province, the number of threatened ecosystem types and the acceleration of threats on both. To cope with this challenge, it is necessary to prioritize the collection of data on ecosystem types and species so that this data can be used to inform management decisions and conservation actions.

The aim of this document is to facilitate the objective and defensible prioritization of biodiversity Monitoring and Surveillance (M&S) by CapeNature in the WCP. Surveillance data is generally collected through ad hoc observations or focal biodiversity surveys and provides occurrence information which is useful for determining species persistence or changes in species distribution. Monitoring data is generally collected according to standardised biodiversity monitoring protocols and provides information on trends over time e.g., population trends, changes in community structure, or changes in ecosystem condition. Examples of other M&S prioritizations include the development of a strategic framework for biodiversity monitoring in national parks by South African National Parks (McGeoch *et al.* 2011), prioritization of species for monitoring in Table Mountain National Park (Rebelo *et al.* 2011), and an IUCN list of criteria for the selection of species and populations for monitoring genetic diversity (Hvilsom *et al.* 2022). Prioritization tools need not only apply to decisions relating the M&S, for example a multi-criteria decision model was developed for the prioritization of invasive alien plant control projects in the Western Cape (Forsyth *et al.* 2012).

The CapeNature prioritization framework is an adaptation of that used for making non-detriment findings (NDFs) for CITES Appendix II exports (<https://cites.org/sites/default/files/eng/cop/11/info/03.pdf>). The CITES approach rates the risk of utilization of a species to its survival and its ecosystem role, and this risk is assessed by considering the interplay of (1) species vulnerability and (2) the strength of the systems in place to manage that species. The CapeNature framework was initially developed to prioritize indigenous species but was later expanded to make provision for evaluating invasive alien species (IAS) and ecosystem types.

The CapeNature framework employs a three-tiered decision-tree approach (Figure 1).

- *Tier 1* - The prioritization tool rates the risk of not monitoring a species or ecosystem type (hereafter referred to as a conservation target) to the functional persistence of that conservation target and meeting legislative obligations. Risk is assessed by considering the interplay of (a) Biological Criteria (the ecological importance of the species/ecosystem type,

particularly in the Western Cape) and (b) Relevance Criteria (the robustness of the methodology and the extent to which the data informs management). This results in a finding that monitoring is important (not carrying out monitoring will be detrimental), or is not important (not carrying out monitoring will not be detrimental).

- *Tier 2* - For conservation targets for which monitoring is important, the capacity of CapeNature and/or the organization’s partners to carry out the required monitoring and surveillance is then assessed by means of Feasibility Criteria.
- *Tier 3* - If CapeNature capacity is lacking, then other options to ensure that M&S takes place are explored, e.g., through an agreement with a partner organization. If CapeNature capacity is available, then the value of the monitoring programme to date is evaluated and the programme adapted or improved as needed.

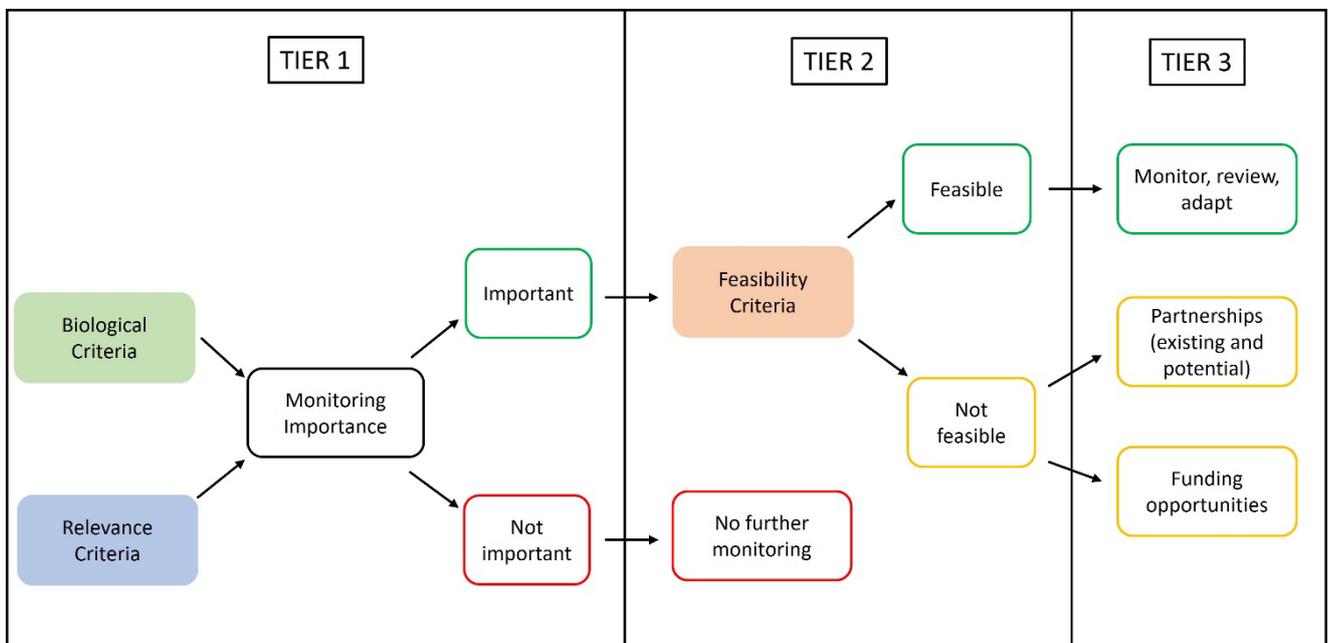


Figure 1 Three-tier decision-tree approach to biodiversity monitoring and surveillance prioritization.

2. SCORING SYSTEM

There is an accompanying MS Excel spreadsheet template (PrioritySpeciesMonitoring_Tool_MASTER.xlsx) that is used to calculate the scoring for each species or ecosystem type.

2.1 Importance (I)

For each conservation target, each criterion is scored: -1 (not applicable) or 1 to 5, 1 being least important and 5 being most important. Note that for some criteria, “not applicable” cannot be used.

For example, a score of -1 for the criteria “keystone species” is not possible because all species have an ecological role (no matter how small) in the ecosystem type they are part of.

2.2 Weighting (W)

For species, the Importance Score for each criterion is multiplied by a weighting according to its importance relative to all the other criteria. Weightings are: 0.8 (Desired, least important), 0.9 (Provincial Priority, medium importance) or 1 (Mandatory, high importance). These weightings are fixed and are the same for all conservation targets in that group (i.e., indigenous or alien species), thus they cannot be changed by the scorer of a target. For example, monitoring required in terms of a Biodiversity Management Plan for Species (BMP-S) for which CapeNature is the implementing authority is weighted 1, since this is an obligation in terms of national legislation. Once the ecosystem Biological Criteria have been finalized, the application of weightings to these should be considered. During the evaluation of the roll-out of this framework these weightings can be examined by conducting pair-wise comparisons of influence as shown in the Weight column in Table 1 below and adjusted according to requirements.

Table 1: Example of the classification and weighting of criteria according to their importance, and the impact of these weightings on scores.

| Class | Description | Weighting, pair-wise comparisons | Weighting, current |
|---------------------|--|----------------------------------|--------------------|
| Mandatory | There is a legal requirement to monitor these features | 1.0 | 1.0 |
| Provincial Priority | Provincially identified priority indicator species | 0.53 | 0.9 |
| Desired | Reporting priority for an external entity | 0.32 | 0.8 |

2.3 Confidence (C)

Importance scores are multiplied by a factor of 0.5, 0.75 or 1.0, depending on confidence in the information used to rate Importance (Table 2). For example, for Cape Mountain zebra confidence in a score of 1 for Criterion 1 (keystone species) is rated 0.75 because the score is based on a good understanding of the species and its habitat but not on empirical evidence.

Table 2: Factors used to adjust Importance Scores according to degree of confidence in the information used to rate importance.

| Class | Description | Confidence factor |
|-------|-------------|-------------------|
|-------|-------------|-------------------|

| | | |
|---------------------|---|------|
| High Confidence | There is empirical evidence to support scoring. | 1.0 |
| Moderate Confidence | There is a good experiential understanding of the focal value but there is limited to no empirical evidence. | 0.75 |
| Low Confidence | There is limited experiential understanding of the target (limited field observations/notes and anecdotes) and limited to no empirical evidence (or the data is > than 30 years old for example). The status is inferred based on secondary supporting information. | 0.5 |

2.4 Score (S)

For each conservation target, the final score (S) per criterion is calculated as $S=I*C*W$.

Criteria fall into two categories, Biological Criteria (BC) and Relevance Criteria (RC). Criteria that are not applicable to a particular conservation target, and are therefore scored -1, are excluded from these calculations.

For Biological Criteria, a total Biological Score between 0 and 1 is calculated as:

$$BS = \frac{\sum_{BC=1}^n S}{n*5} \quad \text{where } BS = \text{Biological Score, } BC = \text{Biological Criterion and } S = \text{Score.}$$

For Relevance Criteria, a total Relevance Score between 0 and 1 is calculated as:

$$RS = \frac{\sum_{RC=1}^n S}{n*5} \quad \text{where } RS = \text{Relevance Score, } RC = \text{Relevance Criterion and } S = \text{Score.}$$

For each conservation target, a graph is produced showing the relationship between Biological Score and Relevance Score (Figure 2). Monitoring and surveillance importance is rated as low, medium, or high.

A final summary statistic, the Priority Score, is calculated as the average of all BC and RC scores combined (range 0-1). The decision line for these graphs is an initial indication of monitoring priorities and is currently set to intersect the x- and y-axes at 0.5 but this can be adjusted as required. Once a large subset of conservation targets has been evaluated, the Priority Scores will be used to generate a shortlist of conservation targets for monitoring and surveillance.

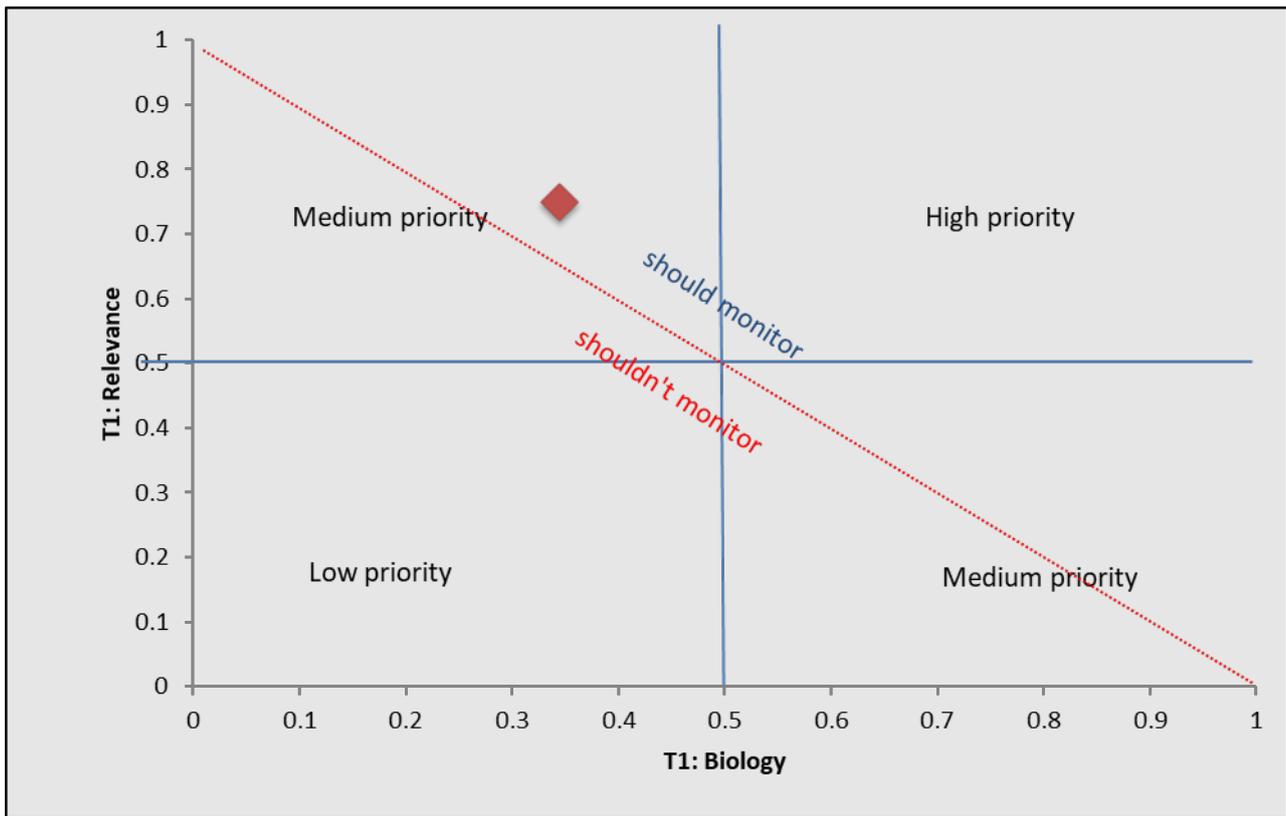


Figure 2: Monitoring priority for hypothetical Species X, represented as the relationship between the Biological Score and Relevance Score. In this example, the plotted point falls in the top left quadrant and above the red line, thus monitoring of Species X is medium priority although this is based more on relevance than vulnerability.

2.5 Feasibility

For each conservation target, the feasibility of monitoring by CapeNature is assessed by scoring three Feasibility Criteria (FC). A Feasibility Score between 0 and 1 is then calculated as:

$$FS = \frac{\sum_{FC=1}^n S}{n*5} \text{ where } FS = \text{Feasibility Score, } FC = \text{Feasibility Criterion and } S = \text{Score.}$$

The Feasibility Score is then plotted against the Priority Score (Figure 3). Once a large subset of conservation targets has been evaluated, Priority Scores relative to Feasibility Scores will be used to generate the final list of conservation targets for M&S. As for Figure 3, the decision lines for these graphs are currently set to intersect the x- and y-axes at 0.5. These can be adjusted as required, depending on the length of the final list of conservation targets and the proportion of conservation targets to be monitored by CapeNature versus partners.

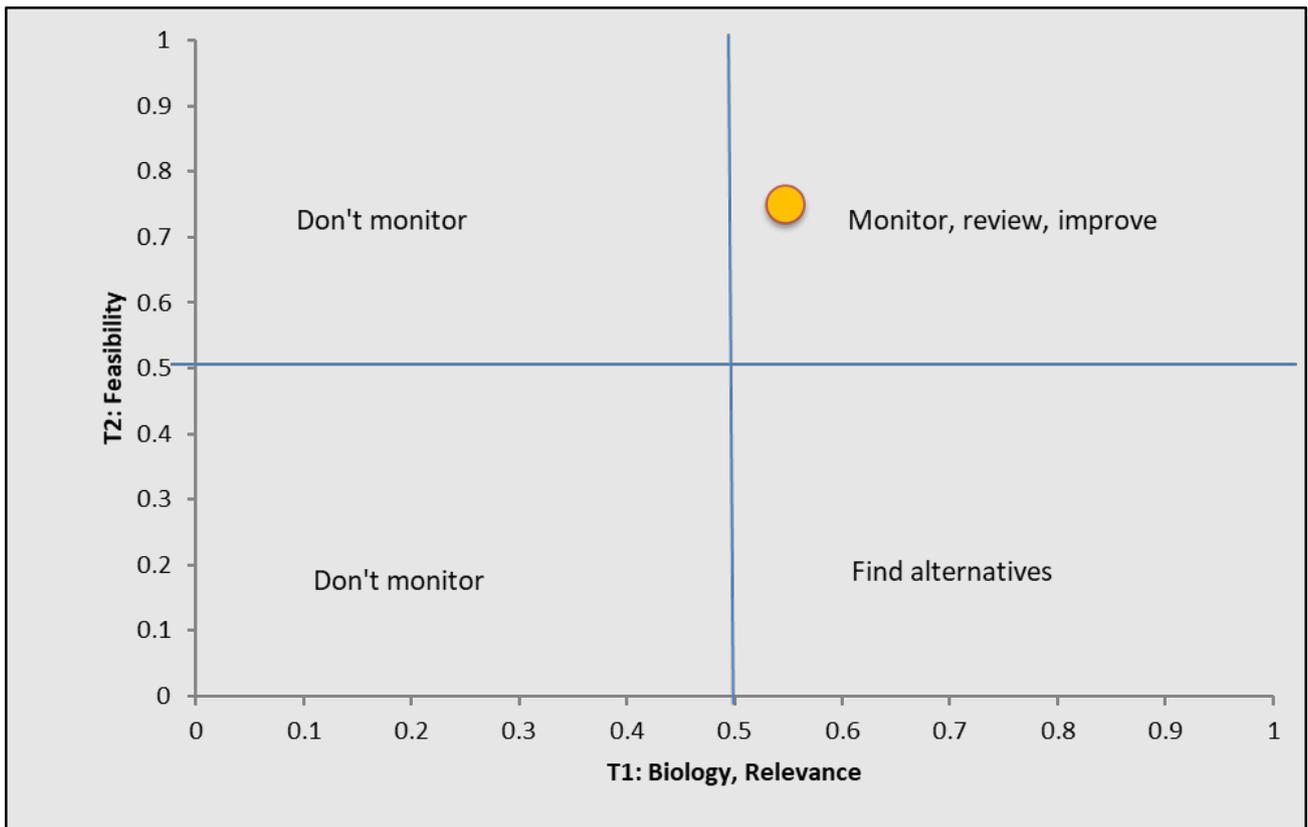


Figure 3: Relationship between monitoring importance and monitoring feasibility for hypothetical Species X. In this example, it is important to monitor the species and feasible to do it given the current resources. Monitoring of the species should thus continue and where relevant, existing protocols should be reviewed and improved.

2.6 Radar Chart

All criteria (Biology, Relevance and Feasibility) are plotted on a radar chart for easy visualization of the criteria (Figure 4).

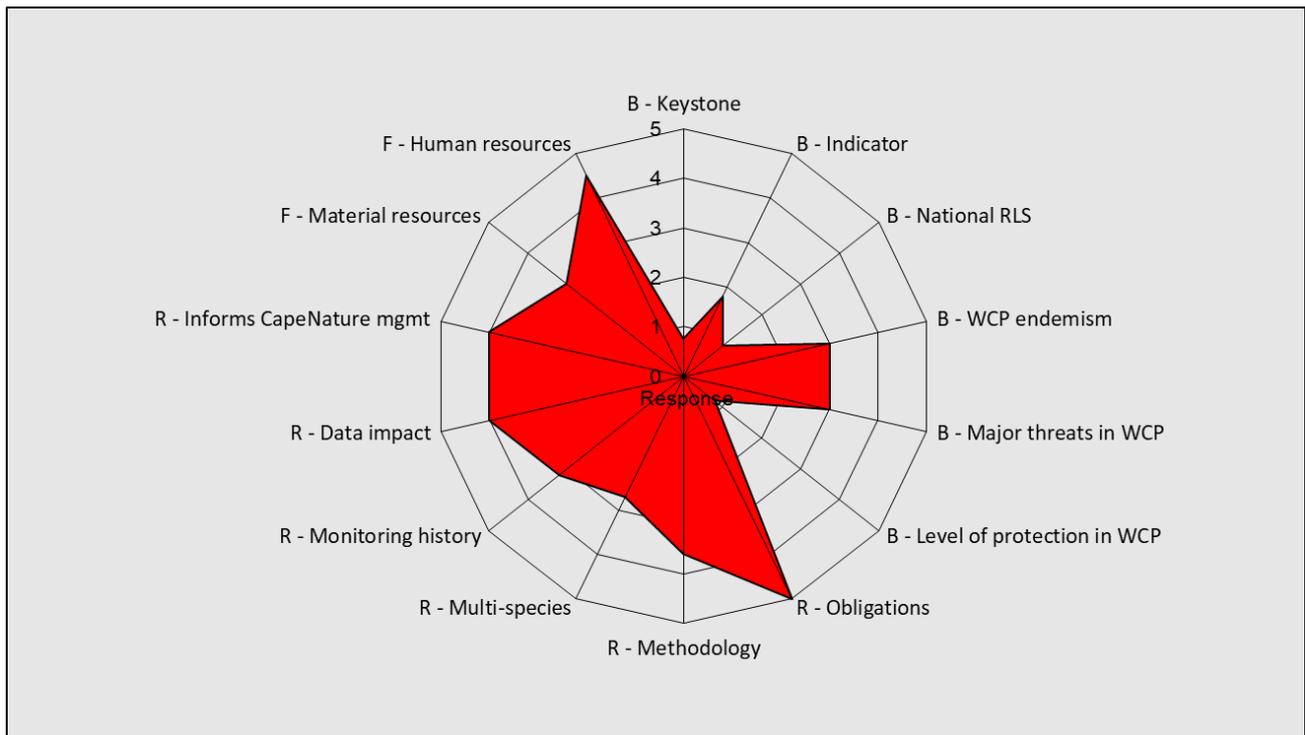


Figure 4: Radar chart for hypothetical Species X. Criteria fall into three categories: B=Biology, R=Relevance and F=Feasibility. This species scores highly on Feasibility and Relevance Criteria, especially in terms of legal obligations (data impact and informs management), but low on most Biological Criteria.

3. CRITERIA

The criteria defined for evaluating indigenous species, alien invasive species and ecosystem types are listed and described in Appendices 1, 2 and 3, respectively. Relevance and Feasibility Criteria are applicable to all three types of conservation targets to be evaluated, i.e., indigenous species, alien invasive species and ecosystem types. In addition, subsets of criteria relevant to specific types of conservation targets were developed to allow the evaluation of different types of targets as part of the same framework. Criteria thus speak to five aspects (Figure 5):

- (A) Vulnerability: Aspects of biology and ecology which influence the vulnerability of indigenous species or ecosystem types.
- (B) Relevance: Aspects of monitoring methodologies, legal obligations to monitor, data impact and data use.
- (C) Feasibility: Resource availability, both in terms of human resources and funding.
- (D) Invasiveness: National Environmental Management Biodiversity Act (NEMBA) listings, extralimital listing and emerging invasives, Environmental Impact Classification for Alien Taxa (EICAT).
- (E) Ecosystem types: Factors related to ecosystem threat status, ecosystem protection levels and ecosystem service importance.

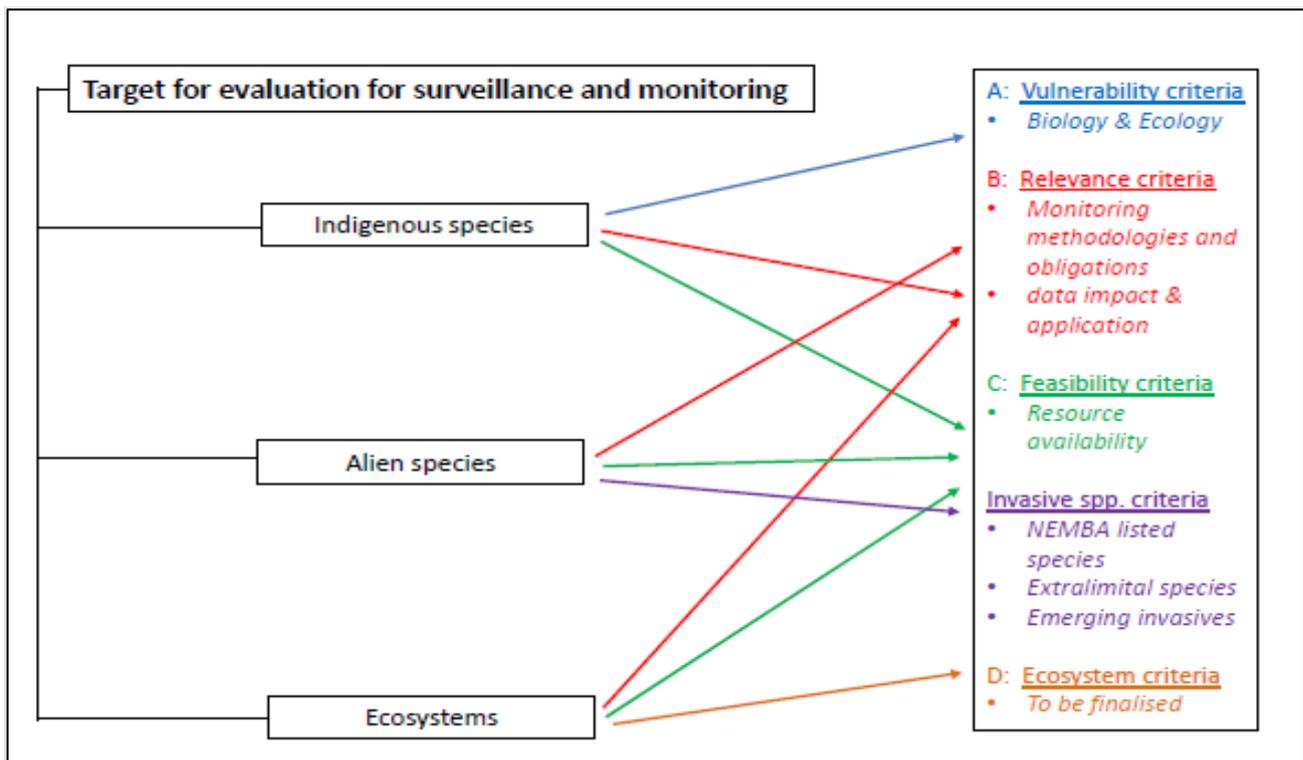


Figure 5: Diagram indicating which subsets of criteria are applicable to each type of conservation target.

4. IMPLEMENTATION

It is envisaged that M&S priorities will be re-evaluated by CapeNature's Biodiversity Capabilities and Landscape Intelligence Teams every 5 years in the year after the end of each State of Biodiversity Report cycle. Ad hoc changes can be made on an annual basis should there be sufficient scientific evidence to support the change and should the change formally be supported by the relevant Landscape Intelligence Team(s).

A starting point for the scoring of conservation targets should be those for which monitoring is specified in CapeNature's ecological monitoring schedules (eco-matrices) or Protected Area Management Plans (PAMPs). Eco-matrices are annual plans for each nature reserve for the implementation of biodiversity and heritage M&S projects. To this end, a combined list of species and ecosystem types across all eco-matrices and PAMPs should first be compiled before prioritization begins.

Once the eco-matrix and PAMP conservation targets have been evaluated, additional species/ecosystem types for inclusion can be sourced from other priority species lists, e.g., the CapeNature 2021 priority faunal species list or South African National Biodiversity Institute (SANBI's) Threatened Species List (SANBI, 2021; <http://biodiversityadvisor.sanbi.org/online-biodiversity->

[data/sensitive-species/](#)). Additionally, other sources of information can be consulted to add to the list of conservation targets to be evaluated, e.g., new research publications or expert knowledge.

In the next iteration of this framework, an ecosystem-centric rather than a species-centric/species-first approach to M&S prioritization could be considered. The rationale behind this is that species are transient, and that management should thus rather aim at preserving ecosystem resilience than conserving individual species or even species assemblages. In the context of the WCP where there is enormous biodiversity represented across a fragmented environment, both ecosystem and species prioritization are required. It will however make sense to start by prioritizing ecosystem types first, followed by prioritization of species which may not necessarily be captured in the ecosystem prioritization, and increasing the weighting of species scores where species monitoring, and surveillance data provides important information on priority ecosystem types.

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APPENDIX 1

CONSERVATION TARGET - INDIGENOUS SPECIES

The codes in brackets in the first column relate to the three types of criteria (B=Biological, R=Relevance, F=Feasibility), followed by a code indicating that the criteria for Indigenous Species are being used (IS), followed by the number of the particular criterion in the spreadsheet.

The “notes” column in the Excel spreadsheet is used to explain the rating of importance and confidence.

Common acronyms used in this section:

M&S: Monitoring & Surveillance

WCP: Western Cape Province

A. Biological Criteria¹

| Criterion | Definition and scoring |
|-------------------------------|---|
| 1. Keystone species (B-IS-1) | <p>A keystone species is an organism that plays a major role in the functioning and integrity of an ecosystem. Without its keystone species, the ecosystem type would be dramatically different or cease to exist altogether. Keystone species have low functional redundancy. The impacts on ecosystem function and integrity caused by its disappearance are expected/known to be severe. The degree to which these effects propagate through an ecosystem depends on the size and complexities of the food web of a particular ecosystem. Where these are not quantified by trophic web studies they can be estimated based on trophic position and biomass and published studies on ecological importance.</p> <p><u>Scoring</u> The effects of the disappearance of this species on the ecosystem type will be: 1 = No or negligible effects 2 = Affects adjacent trophic levels 3 = Affects adjacent and second order trophic levels 4 = Affects adjacent, secondary and tertiary trophic levels 5 = Affects the majority of trophic levels</p> |
| 2. Indicator species (B-IS-2) | <p>A species sensitive to environmental change and which can therefore provide a measure of the health of the ecosystem type (IUCN). Changes in this species' abundance and population status reflect changes in its associated ecosystem.</p> <p><u>Scoring</u> A change in persistence or abundance of this species reflects ecosystem health: 1 = does not indicate the health of any other species or ecosystem 2 = indicates the health of similar ecological function guild species</p> |

¹ Source for definitions: IUCN glossary of definitions, legal definitions as per NEMBA etc., Non-Detriment Finding (NDF) documents and online/printed biological dictionaries where appropriate.

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| | <p>3 = indicates the health of multiple ecological function guild species 4 = gives a partial indication of the health of entire ecosystem 5 = indicates the health of entire ecosystem</p> |
| 3. National red list status (B-IS-3) | <p>The national red list status of a species refers to the threat status or risk of extinction of that species in South Africa. Threat status is determined by a red list assessment based on standardised IUCN criteria. Some species are rated as Data Deficient (DD), which can be further refined as Data Deficient - Insufficient Information (DDD) or Data Deficient - Taxonomically Problematic (DDT) and not enough is known about them to rate their threat status. Because of this uncertainty we employ the Precautionary Principle and these species are scored on par with Near Threatened species, i.e. the resources allocated to gathering data will be more than for Least Concern species but less than for Threatened species.</p> <p><u>Scoring</u> The national red list status of this species is: -1 = Not Evaluated 1 = Least Concern 2 = Near Threatened / Data Deficient 3 = Vulnerable 4 = Endangered 5= Critically Endangered / Critically Endangered, Possibly Extinct</p> |
| 4. Provincial endemism (B-IS-4) | <p>Endemism refers to a taxon being naturally restricted to a particular geographical area and not occurring anywhere else. Endemism is most often brought about by insularity (e.g. island ecosystems) and geographical barriers such as mountain ranges. Provincial endemism refers to the natural extent of distribution of a species across the South African provinces. In this document, provincial endemism is scored in terms of the occurrence of a species in the Western Cape Province (WCP).</p> <p><u>Scoring</u> In South Africa, this species occurs: 1 = marginally or as a vagrant in the WCP 2 = in the WCP and at least one other province, with significant distribution ranges in all 3 = mainly in the WCP and is marginal in neighbouring provinces (near-endemic to the WCP) 4 = only in the WCP but is relatively widespread in the province (endemic to the WCP) 5 = as a localized/range restricted WCP endemic or as a migratory species with important breeding colonies in the WCP</p> |
| 5. Major threats in the WCP (B-IS-5) | <p>This criterion rates the severity of direct and indirect threats to the species within the WCP, but the focus is on the major threats and their impact on the provincial population.</p> <p><u>Scoring</u> In the WCP, the major threats to the WCP population of this species: -1 = do not exist (e.g. for species that are marginal in the WCP) 1 = are causing no or negligible declines 2 = are causing or likely to cause population fluctuations 3 = are causing or likely to cause a relatively slow decline 4 = are causing or likely to cause a rapid decline that affects part of the population 5 = are causing or likely to cause a very rapid decline that affects most of the population</p> |

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| <p>6. Representation on protected areas (B-IS-6)</p> | <p>This criterion rates how well the species is represented on the formal protected area network of the WCP. General definitions are provided for each of the scores below. When they become available use Protection Levels for the WCP.</p> <p><u>Scoring</u> The South African population of this species is: 1 = well represented on protected areas inside and outside WCP (100 % of set conservation target met on protected areas) 2 = well represented on protected areas inside the WCP (50-99 % of set conservation target met on protected areas) 3 = moderately represented on protected areas inside the WCP (5-49% of set conservation target met on protected areas) 4 = poorly represented on protected areas inside the WCP (<5% of set conservation target met on protected areas) 5 = not represented on protected areas inside the WCP</p> |
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B. Relevance Criteria

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| <p>1. Obligations in terms of management results or outcomes (R-1)</p> | <p>This criterion speaks to the extent of CapeNature's obligation to implement those management actions which should be informed by M&S.</p> <p><u>Scoring</u> CapeNature's obligations to implement management actions based on M&S is: -1 = not applicable; there are no internal or external obligations 1 = an external recommendation that CapeNature agrees with in principle but has not agreed to implement, e.g. recommendation in a national red list account 2 = an internal reporting requirement but has no legal weight (e.g. CapeNature eco-matrix project to monitor Verreaux's eagle nests) 3 = an external reporting requirement that CapeNature has agreed to implement but that has no legal weight (e.g. actions specified in a Species Action Plan) 4 = an external reporting requirement that is audited and carries a legal obligation (e.g. actions listed in Protected Area Management Plan (PAMP) implementation frameworks and audited through the Management Effectiveness Tracking Tool (METT) process 5 = a gazetted or international reporting requirement (e.g. in terms of a BMP-S, an NDF, or other international agreement such as CITES or African-Eurasian Migratory Waterbird Agreement (AEWA))</p> |
| <p>2. Monitoring/ surveillance methodology (R-2)</p> | <p>This criterion speaks to the robustness of the methodology available for collecting information on this or similar species.</p> <p><u>Scoring</u> Data on this or similar species can be obtained through: 1 = ad hoc surveillance only (e.g. opportunistic State of Biodiversity database records) 2 = planned surveillance (e.g. targeted camera trapping surveys) 3 = monitoring, with the methodology described and tested by CapeNature 4 = monitoring, with the methodology described in a detailed monitoring protocol but not published and widely used outside of CapeNature 5 = monitoring, with the methodology described in a detailed monitoring protocol and published and widely used outside of CapeNature</p> |

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| <p>3. Multi-species monitoring (R-3)</p> | <p>Some species require very focused monitoring protocols that will only yield data for the species in question (e.g. Cape vulture monitoring), whereas other types of monitoring such as fish or frog surveys employ more general sampling methodology which will yield data on a range of species. Scoring of this criterion considers whether the method yields single- or multispecies information, with the latter providing insights into community composition and species richness, and the impacts of environmental change on these.</p> <p><u>Scoring</u> Monitoring or surveillance of this species will provide: 1 = data for only this species 2 = data for more than one species, presence/absence data only 3 = data for more than one species, population trend data 4 = data for taxonomic group, community composition data 5 = data for taxonomic group, population trend data, community composition</p> |
| <p>4. Monitoring history (R-4)</p> | <p>Long-term datasets are highly valuable in terms of population monitoring of species, especially in long-lived and/or slow maturing species which have low reproductive rates. Short-term datasets only give a “snapshot” of what is happening in a population and too few data points can make interpretation difficult or give an inaccurate picture of what is happening in a population. This in turn can lead to poor management decisions or the over or under commitment of resources to conservation actions.</p> <p><u>Scoring</u> The available CapeNature data: -1 = does not exist (there is no existing CapeNature data on this species). 1 = does not provide information on population or habitat condition trends 2 = provides short-term (<5 years) information on population or habitat condition trends 3 = provides medium-term (5-10 years) information on population or habitat condition trends but there are gaps in the data 4 = provides long-term (>10 years) information on population or habitat condition trends but there are significant gaps in the data 5 = provides medium-term (5-10 years) or long-term (>10 years) information on population or habitat condition trends and there are few or no gaps in the data</p> |
| <p>5. Data impact (R-5)</p> | <p>Data collection must first and foremost serve the purposes of CapeNature and feed into internal databases and contribute to internal conservation objectives such as PAMP deliverables. However, much of the data collected for internal management purposes also serves to meet higher level objectives (e.g. Red Listing) by contributing to larger datasets (e.g. South African Bird Atlas Project (SABAP2), the Global Biodiversity Information Facility (GBIF), Virtual Museums, South African Leopard Monitoring Programme).</p> <p><u>Scoring</u> As well as contributing to internal objectives, the data collected by CapeNature contributes to or has the potential to contribute to: 1 = only CapeNature database that is used at reserve level 2 = only a CapeNature database that is used at organizational level 3 = a provincial database 4 = a national database 5 = an international database</p> |
| <p>6. Informs CapeNature management (R-6)</p> | <p>Some types of monitoring or surveillance data are needed to inform management actions on- and/or off-reserve, e.g. data on game numbers may inform the off-take of game to reduce competition and grazing pressure or declines in threatened fish populations may inform the need for involvement with municipalities to address excessive water abstraction from rivers.</p> |

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| | <p><u>Scoring</u> Monitoring or surveillance of this species informs or has the potential to inform management decisions: 1 = not at all; no management is needed 2 = not at all; management decisions can be based on expert knowledge and will not be improved by M&S 3 = to a limited extent; management decisions can be based on expert knowledge but will be improved by M&S 4 = to a large extent; important management decisions must be based on M&S 5 = completely; critical management decisions must be based on M&S</p> |
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C. Feasibility Criteria

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| 7. Material resources (F-1) | <p>Scoring of this criterion considers the availability and lifespan of budget and material resources to cover the costs of monitoring (e.g. equipment, vehicles, kms).</p> <p><u>Scoring</u> Budget and material resources for M&S 1 = are not currently available and there are no obvious funding opportunities 2 = are not currently available but there are potential opportunities for future funding 3 = are currently available for the short-term (1-2 years) 4 = are currently available for the medium-term (3-5 years) 5 = are currently available for the long-term (>5 years)</p> |
| 8. Human resources (F-2) | <p>In order for monitoring to be effective, CapeNature needs to have trained staff or have specialists in place to provide training or to undertake the monitoring themselves. There must not only be capacity to collect data, but also to provide support for data collection and to analyse and interpret data.</p> <p><u>Scoring</u> In CapeNature, there are 1 = no staff available to carry out monitoring 2 = untrained staff available to carry out monitoring 3 = limited trained staff available to carry out monitoring 4 = sufficient trained staff available to carry out monitoring 5 = sufficient trained staff available and there are specialists to provide support or analyse and interpret data</p> |
| 9. Partner resources (F-3) | <p>It might be possible to overcome lack of resources for monitoring within CapeNature through the involvement of capable and committed partners. Partner involvement is scored on the strength of the type of partnership, the scale of data collection and post-collection involvement.</p> <p><u>Scoring</u> To assist with monitoring this species, CapeNature: -1 = has no partner 1 = has an unofficial partner (no MOU) who collects some data 2 = has an unofficial partner (no MOU) who collects and analyses the data 3 = has an MOU with a partner who collects some data 4 = has an MOU with a partner who collects and analyses some data 5 = has an MOU with a partner who collects and analyses all data and provides recommendations for CapeNature.</p> |

APPENDIX 2

CONSERVATION TARGET - ALIEN INVASIVE SPECIES

The codes in brackets in the first column relate to the three types of criteria (B=Biological, R=Relevance, F=Feasibility), followed by a code indicating that the criteria for Alien Species are being used (AS), followed by the number of the particular criterion in the spreadsheet.

The “notes” column in the Excel spreadsheet is used to explain the rating of importance and confidence.

Common acronyms:

M&S: Monitoring & Surveillance

WCP: Western Cape Province

A. Biological Criteria

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| <p>1. Level of impact (B-AS-1)</p> | <p>The level of impact of an invasive species is based on the IUCN Environmental Impact Classification for Alien Taxa (EICAT) Categories and Criteria. While taxa should be assessed at individual species level, species can be grouped if they are closely related (i.e. same genus) and have a similar level of impact. <i>(Refer to Addendum A for impact mechanisms for scoring invasive species).</i></p> <p><u>Scoring</u> The impact of this species is of:</p> <ul style="list-style-type: none"> 1 = minimal: causes negligible levels of impacts, but no reduction in performance of individuals in the native biota. 2 = minor: has minor impacts when it causes reductions in the performance of individuals in the native biota, but no declines in native population sizes, and has no impacts that would cause it to be classified in a higher impact category. 3 = moderate: causes declines in the population size of at least one native taxon but has not been observed to lead to the local extinction of a native taxon. 4 = major: causes community changes through the local or sub-population extinction (or presumed extinction) of at least one native taxon, that would be naturally reversible if the alien taxon was no longer present. Its impacts do not lead to naturally irreversible local population, sub-population or global taxon extinctions. 5 = massive: causes naturally irreversible community changes through local, sub-population or global extinction (or presumed extinction) of at least one native taxon. |
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B. Relevance Criteria

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| <p>1. Obligations in terms of management results or outcomes (R-1)</p> | <p>This criterion speaks to the extent of CapeNature’s obligation to implement those management actions which should be informed by M&E.</p> <p><u>Scoring</u> CapeNature’s obligations to implement management actions based on M&E is: -1 = not applicable; there are no internal or external obligations 1 = an external recommendation that CapeNature agrees with in principle but has not agreed to implement, e.g. recommendation in a national red list account 2 = an internal reporting requirement but has no legal weight (e.g. CapeNature eco-matrix project to monitor Verreux’s eagle nests) 3 = an external reporting requirement that CapeNature has agreed to implement but that has no legal weight (e.g. actions specified in a Species Action Plan) 4 = an external reporting requirement that is audited and carries a legal obligation (e.g. actions listed in Protected Area Management Plan (PAMP) implementation frameworks and audited through the Management Effectiveness Tracking Tool (METT) process 5 = a gazetted or international reporting requirement (e.g. in terms of a BMP-S, an NDF, or other international agreement such as CITES or African-Eurasian Migratory Waterbird Agreement (AEWA))</p> |
| <p>2. Monitoring/ surveillance methodology (R-2)</p> | <p>This criterion speaks to the robustness of the methodology available for collecting information on this or similar species.</p> <p><u>Scoring</u> Data on this or similar species can be obtained through: 1 = ad hoc surveillance only (e.g. opportunistic SOB records) 2 = planned surveillance (e.g. targeted camera trapping surveys) 3 = monitoring, with the methodology described and tested by CapeNature 4 = monitoring, with the methodology described in a detailed monitoring protocol but not published and widely used outside of CapeNature 5 = monitoring, with the methodology described in a detailed monitoring protocol and published and widely used outside of CapeNature</p> |
| <p>3. Multi-species monitoring (R-3)</p> | <p>Some species require very focused monitoring protocols that will only yield data for the species in question (e.g. Cape vulture monitoring), whereas other types of monitoring such as fish or frog surveys employ more general sampling methodology which will yield data on a range of species. Scoring of this criterion considers whether the method yields single- or multispecies information, with the latter providing insights into community composition and species richness, and the impacts of environmental change on these.</p> <p><u>Scoring</u> Monitoring or surveillance of this species will provide: 1 = data for only this species 2 = data for more than one species, presence/absence data only 3 = data for more than one species, population trend data 4 = data for taxonomic group, community composition data 5 = data for taxonomic group, population trend data, community composition</p> |
| <p>4. Monitoring history (R-4)</p> | <p>Long-term datasets are highly valuable in terms of population monitoring of species, especially in long-lived and/or slow maturing species which have low reproductive rates. Short-term datasets only give a “snapshot” of what is happening in a population and too few data points can make interpretation difficult or give an inaccurate picture of what is happening in a population. This in turn can lead to poor management decisions or the over or under commitment of resources to conservation actions.</p> <p><u>Scoring</u> The available CapeNature data:</p> |

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| | <p>-1 = does not exist (there is no existing CapeNature data on this species). 1 = does not provide information on population or habitat condition trends 2 = provides short-term (<5 years) information on population or habitat condition trends 3 = provides medium-term (5-10 years) information on population or habitat condition trends but there are gaps in the data 4 = provides long-term (>10 years) information on population or habitat condition trends but there are significant gaps in the data 5 = provides medium-term (5-10 years) or long-term (>10 years) information on population or habitat condition trends and there are few or no gaps in the data</p> |
| 5. Data impact (R-5) | <p>The scale of the data impact is relevant for the prioritization of the monitoring. Data collection must first and foremost serve the purposes of CapeNature and feed into internal databases and contribute to internal conservation objectives such as PAMP deliverables. However, much of the data collected for internal management purposes also serves to meet higher level objectives (e.g. Red Listing) by contributing to larger datasets (e.g. South African Bird Atlas Project (SABAP2), the Global Biodiversity Information Facility (GBIF), Virtual Museums, South African Leopard Monitoring Programme).</p> <p><u>Scoring</u> As well as contributing to internal objectives, the data collected by CapeNature contributes to or has the potential to contribute to: 1 = only CapeNature database that is used at reserve level 2 = only a CapeNature database that is used at organizational level 3 = a provincial database 4 = a national database 5 = an international database</p> |
| 6. Informs CapeNature management (R-6) | <p>Some types of monitoring or surveillance data are needed to inform management actions on- and/or off-reserve, e.g. data on game numbers may inform the off-take of game to reduce competition and grazing pressure or declines in threatened fish populations may inform the need for involvement with municipalities to address excessive water abstraction from rivers.</p> <p><u>Scoring</u> Monitoring or surveillance of this species informs or has the potential to inform management decisions: 1 = not at all; no management is needed 2 = not at all; management decisions can be based on expert knowledge and will not be improved by M&S 3 = to a limited extent; management decisions can be based on expert knowledge but will be improved by M&S 4 = to a large extent; important management decisions must be based on M&S 5 = completely; critical management decisions must be based on M&S</p> |

C: Feasibility Criteria

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|--------------------------|---|
| Material resources (F-1) | <p>Scoring of this criterion considers the availability and lifespan of budget and material resources to cover the costs of monitoring (e.g. equipment, vehicles, kms).</p> <p><u>Scoring</u> Budget and material resources for M&S: 1 = are not currently available and there are no obvious funding opportunities</p> |
|--------------------------|---|

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| | <p>2 = are not currently available but there are potential opportunities for future funding</p> <p>3 = are currently available for the short-term (1-2 years)</p> <p>4 = are currently available for the medium-term (3-5 years)</p> <p>5 = are currently available for the long-term (>5 years)</p> |
| Human resources (F-2) | <p>For monitoring to be effective, CapeNature needs to have trained staff or have specialists in place to provide training or to undertake the monitoring themselves. There must not only be capacity to collect data, but also to provide support for data collection and to analyse and interpret data.</p> <p>Scoring</p> <p>In CapeNature, there are:</p> <ul style="list-style-type: none"> 1 = no staff available to carry out monitoring 2 = untrained staff available to carry out monitoring 3 = limited trained staff available to carry out monitoring 4 = sufficient trained staff available to carry out monitoring 5 = sufficient trained staff available and there are specialists to provide support or analyse and interpret data |
| Partner resources (F-3) | <p>It might be possible to overcome lack of resources for monitoring within CapeNature through the involvement of capable and committed partners. Partner involvement is scored on the strength of the type of partnership, the scale of data collection and post-collection involvement.</p> <p>Scoring</p> <p>To assist with monitoring this species, CapeNature:</p> <ul style="list-style-type: none"> -1 = has no partner 1 = has an unofficial partner (no MOU) who collects some data 2 = has an unofficial partner (no MOU) who collects and analyses the data 3 = has an MOU with a partner who collects some data 4 = has an MOU with a partner who collects and analyses some data 5 = has an MOU with a partner who collects and analyses all data and provides recommendations for CapeNature |

APPENDIX 3

CONSERVATION TARGET: ECOSYSTEM TYPES

The codes in brackets in the first column relate to the three types of criteria (B=Biological, R=Relevance, F=Feasibility), followed by a code indicating that the criteria for Ecosystems are being used (E), followed by the number of the particular criterion in the spreadsheet.

The “notes” column in the spreadsheet is used to explain the rating of importance and confidence.

Common acronyms:

MOU: Memorandum of Understanding

M&S: Monitoring & Surveillance

NBA: National Biodiversity Assessment

RLE: Red List of Ecosystems

SWSA: Strategic Water Source Area

WCP: Western Cape Province

WIMS: Water Information Management System

A. Biological Criteria

| Criterion | Definition and scoring |
|-----------------------------------|--|
| 1. Key ecological drivers (B-E-1) | <p>Key ecological drivers (e.g. fire, soil nutrients, herbivory) are factors which maintain ecosystem function, pattern and structure. For example, fire is a key driver in Fynbos ecosystems and animal disturbance is a key driver in Succulent Karoo ecosystems. Drivers per Western Cape ecosystem are listed in de Villiers <i>et al.</i> 2016¹. Monitoring that measures the effects of all relevant drivers are to be prioritized - this is currently a very simple numerical scale given that we do not know all the drivers and their relative rankings for each ecosystem type yet. Once this is known this criterion can be re-scaled to represent the full suite of key drivers.</p> <p><u>Scoring</u> Monitoring of this ecosystem type provides information on the key ecological driver(s) that is: 1 = does not measure ecosystem drivers 2 = measures a single ecosystem driver 3 = measures two ecosystem drivers</p> |

¹ De Villiers C, Holmes P, Rebelo T, Helme N, Brown DE, Clark B, Milton S, Dean WR, Brownlie S, Snaddon K, Day L, Ollis D, Job N, Dorse C, Wood J, Harrison J, Palmer G, Cadman M, Maree K, Manuel J, Holness S, Ralston S & Driver A. 2016. Fynbos Forum ecosystem guidelines for environmental assessment in the Western Cape. In Fynbos Forum, c/o Botanical Society of South Africa: Conservation Unit, Kirstenbosch, Cape Town.

| | |
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| | <p>4 = measures three ecosystem drivers 5 = measures more than three ecosystem drivers</p> |
| 2. Ecosystem service importance (B-E-9) | <p>Ecosystem service importance - broadscale (district or provincial, a national reporting mechanism exists). e.g. % of ecosystem type in a SWSA. Link to resource utilization, fine scale, e.g. marine fish. (socio-economics).</p> <p><u>Scoring</u> 1 = provides ecosystem services in a very localised area of influence; typically, <200m) 2 = provides ecosystem services at a localised scale (<1km sphere of influence) 3 = provides ecosystem services at a small regional scale (<10km sphere of influence) 4 = provides ecosystem services at a regional or provincial scale e.g. provincial SWSA 5 = provides ecosystems services at a nationally significant scale e.g. SWSA</p> |
| 3. Red List of Ecosystems (RLE) status (B-E-3) | <p>South Africa is currently in the process of migrating from its own Threatened Ecosystem criteria (used to inform the 2011 gazetted Threatened Ecosystems) and that of the IUCN RLE criteria (last updated in 2021). Whilst the latter List is expected to replace the 2011 gazetted list, it has still to be adopted and gazetted. Following precautionary principles and the need to recognise the best available information, for the purposes of this assessment an ecosystem is assigned the higher status when comparing the findings of the two Threatened Ecosystem lists i.e., if the 2011 status is on an ecosystem is VU but the 2021 assessment reflects a CR status, the ecosystem is considered to have a CR status.</p> <p><u>Scoring</u> The national red list status of this ecosystem type is: -1 = Not Evaluated 1 = Least Concern 2 = Near Threatened 3 = Vulnerable 4 = Endangered 5 = Critically Endangered</p> |
| 4. Provincial endemism (B-E-4) | <p>Currently, this criterion can only be applied to terrestrial ecosystems through the RLE process, through which ecosystem endemism is reflected by the percentage coverage in the WCP.</p> <p><u>Scoring</u> According to the RLE spreadsheet, the WCP coverage by this ecosystem type is: -1 = not applicable 1 = < 20 % in the WCP 2 = >20 and <=40 % in the WCP 3 = >40 and <=60 % in the WCP 4 = > 60 % and <80 % in the WCP 5 = >80 % in the WCP</p> |
| 5. Rate of ecosystem loss/degradation/or fragmentation in the WCP (B-E-5) | <p>This ranking system is based on the Ecosystem Area Index which measures the rate of decline of an ecosystem type area towards ecosystem collapse (given a value of '0'). This index is a mean of the proportion of ecosystem area remaining over a given timeframe relative to its historic area and taking an ecosystem-specific collapse threshold into account (Rowland <i>et al.</i> 2020). The Index scores of all ecosystems are then ranked based on their relative score according to the classes listed below.</p> <p><u>Scoring</u> 1 = the recorded degree of change of the ecosystem falls within the majority distribution (1<=50%) of all analysed ecosystem types over the predetermined time period</p> |

| | |
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| | <p>2= the ecosystem falls within the slightly smaller distribution reflecting a higher degree of change (50<=80%) of all analysed ecosystem types over the predetermined time period</p> <p>3 = the ecosystem falls within the within the moderately more impacted degree of change distribution range (80<=95%) of all analysed ecosystem types over the predetermined time period</p> <p>4 = the ecosystem falls within the within a significantly more impacted degree of change distribution range (95<=98%) of all analysed ecosystem types over the predetermined time period</p> <p>5= the recorded degree of change of the ecosystem falls within the top 2% (98<=100%) of ecosystems experiencing the greatest degree of change over the analysed time period</p> |
| 6. Representation on protected areas (B-E-6) | <p>This criterion rates how well the ecosystem type is represented on the formal protected area network of the WCP. For terrestrial ecosystem types, the CapeNature Ecosystem Calculator can be used for scoring. For marine/estuarine ecosystem types, the national assessments will be utilised.</p> <p><u>Scoring</u> The South African population of this species is:</p> <p>1 = well represented on protected areas inside and outside WCP (100 % of set conservation target met on protected areas)</p> <p>2 = well represented on protected areas inside the WCP (50-99 % of set conservation target met on protected areas)</p> <p>3 = moderately represented on protected areas inside the WCP (5-49 % of set conservation target met on protected areas)</p> <p>4 = poorly represented on protected areas inside the WCP (< 5 % of set conservation target met on protected areas)</p> <p>5 = not represented on protected areas inside the WCP</p> |

B. Relevance Criteria

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|---|---|
| 1. Obligations in terms of management results or outcomes (R-1) | <p>This criterion speaks to the extent of CapeNature's obligation to implement those management actions which should be informed by M&S.</p> <p><u>Scoring</u> CapeNature's obligations to implement management actions based on M&S is:</p> <p>-1 = not applicable; there are no internal or external obligations</p> <p>1 = an internal reporting requirement but has no legal obligation</p> <p>2 = an external recommendation that CapeNature agrees with in principle but has not yet implemented, e.g. NBA or RLE recommendation</p> <p>3 = an external reporting requirement that CapeNature has agreed to implement but that has no legal obligation</p> <p>4 = an external reporting requirement that is audited and carries a legal obligation (e.g. actions listed in Protected Area Management Plan (PAMP) implementation frameworks and audited through the Management Effectiveness Tracking Tool (METT) process</p> <p>5 = a gazetted or international reporting requirement (e.g. in terms of a BMP-Ecosystem, Bioregional Plan or international agreement)</p> |
| 2. Monitoring/ surveillance methodology (R-2) | <p>This criterion speaks to the robustness of the methodology available for collecting information on this or similar ecosystem type.</p> <p><u>Scoring</u> Data on this or similar species can be obtained through:</p> <p>1 = ad hoc surveillance only</p> <p>2 = planned surveillance</p> <p>3 = monitoring, with the methodology described and tested by CapeNature</p> |

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| | <p>4 = monitoring, with the methodology described in a detailed monitoring protocol but not published and widely used outside of CapeNature</p> <p>5 = monitoring, with the methodology described in a detailed monitoring protocol and published and widely used outside of CapeNature</p> |
| 3. Monitoring history (R-3) | <p>Long-term datasets are highly valuable in terms of ecosystem monitoring. Short-term datasets only give a “snapshot” of what is happening in a population and too few data points can make interpretation difficult or give an inaccurate picture of changes in ecosystem condition. This in turn can lead to poor management decisions or the over or under commitment of resources to conservation actions. Examples of longer-term monitoring programmes are the CapeNature River Health, CapeNature Protea Plot, Radloff De Hoop Game Exclusion, UCT RePhoto and UCT Palynology projects.</p> <p><u>Scoring</u> The available CapeNature data: -1 = does not exist (there is no existing CapeNature data on this ecosystem type) 1 = does not provide information on ecosystem condition trends 2 = provides short-term (<5 years) information on ecosystem condition trends 3 = provides medium-term (5-10 years) information on ecosystem condition trends but there are gaps in the data 4 = provides long-term (>10 years) information on ecosystem condition trends but there are significant gaps in the data 5= provides medium-term (5-10 years) or long-term (>10 years) information on ecosystem condition trends and there are few or no gaps in the data</p> |
| 4. Data impact (R-4) | <p>The scale of the data impact is relevant for the prioritization of the monitoring. Data collection must first and foremost serve the purposes of CapeNature and feed into internal databases and contribute to internal conservation objectives such as PAMP deliverables. However, much of the data collected for internal management purposes also serves to meet higher level objectives by contributing to larger datasets, e.g. NBA, RLE, National Land Cover, National Strategic Water Source Areas and WIMS.</p> <p><u>Scoring</u> As well as contributing to internal objectives, the data collected by CapeNature contributes to or has the potential to contribute to: 1 = only CapeNature database that is used at reserve level 2 = only a CapeNature database that is used at organizational level 3 = a provincial database 4 = a national database 5 = an international database</p> |
| 5. Informs CapeNature management (R-5) | <p>Some types of monitoring or surveillance data are needed to inform management actions on- and/or off-reserve, e.g. data on river health may inform the need to address abstraction upstream.</p> <p><u>Scoring</u> Monitoring or surveillance of this ecosystem type informs or has the potential to inform management decisions: 1 = not at all; no management is needed 2 = not at all; management decisions can be based on expert knowledge and will not be improved by M&S 3 = to a limited extent; management decisions can be based on expert knowledge but will be improved by M&S 4 = to a large extent; important management decisions must be based on M&S 5 = completely; critical management decisions must be based on M&S</p> |

C. Feasibility Criteria

| | |
|---------------------------------|--|
| <p>Material resources (F-1)</p> | <p>Scoring of this criterion considers the availability and lifespan of budget and material resources to cover the costs of monitoring (e.g. equipment, vehicles, kms).</p> <p><u>Scoring</u> Budget and material resources for M&S: 1 = are not currently available and there are no obvious funding opportunities 2 = are not currently available but there are potential opportunities for future funding 3 = are currently available for the short-term (1-2 years) 4 = are currently available for the medium-term (3-5 years) 5 = are currently available for the long-term (>5 years)</p> |
| <p>Human resources (F-2)</p> | <p>For monitoring to be effective, CapeNature needs to have trained staff or have specialists in place to provide training or to undertake the monitoring themselves. There must not only be capacity to collect data, but also to provide support for data collection and to analyse and interpret data.</p> <p><u>Scoring</u> In CapeNature, there are 1 = no staff available to carry out monitoring 2 = untrained staff available to carry out monitoring 3 = limited trained staff available to carry out monitoring 4 = sufficient trained staff available to carry out monitoring 5 = sufficient trained staff available and there are specialists to provide support or analyse and interpret data</p> |
| <p>Partner resources (F-3)</p> | <p>It might be possible to overcome lack of resources for monitoring within CapeNature through the involvement of capable and committed partners. Partner involvement is scored on the strength of the type of partnership, the scale of data collection and post-collection involvement.</p> <p><u>Scoring</u> To assist with monitoring this ecosystem type, CapeNature: -1 = has no partner 1 = has an unofficial partner (no MOU) who collects some data 2 = has an unofficial partner (no MOU) who collects and analyses the data 3 = has an MOU with a partner who collects some data 4 = has an MOU with a partner who collects and analyses some data 5 = has an MOU with a partner who collects and analyses all data and provides recommendations for CapeNature.</p> |

ADDENDUM A: IMPACT MECHANISMS FOR SCORING INVASIVE SPECIES

1. *Competition* – the alien taxon competes with native taxa for resources (e.g. food, water, space), leading to deleterious impact on native taxa.
2. *Predation* – the alien taxon preys on native taxa, leading to deleterious impact on native taxa.
3. *Hybridisation* – the alien taxon hybridises with native taxa, leading to deleterious impact on native taxa.
4. *Transmission of disease* – the alien taxon transmits diseases to native taxa, leading to deleterious impact on native taxa.
5. *Parasitism* – the alien taxon parasitises native taxa, leading to deleterious impact on native taxa.
6. *Poisoning/toxicity* – the alien taxon is toxic, or allergenic by ingestion, inhalation or contact, or allelopathic to plants, leading to deleterious impact on native taxa.
7. *Bio-fouling or other direct physical disturbance* – the accumulation of individuals of the alien taxon on the surface of a native taxon (i.e. biofouling), or other direct physical disturbances not involved in a trophic interaction (e.g. trampling, rubbing, etc.) leads to deleterious impact on native taxa.
8. *Grazing/herbivory/browsing* – grazing, herbivory or browsing by the alien taxon leads to deleterious impact on native taxa.
9. *Chemical impact on ecosystem type* – the alien taxon causes changes to the chemical characteristics of the native environment (e.g. pH; nutrient and/or water cycling), leading to deleterious impact on native taxa.
10. *Physical impact on ecosystem type* – the alien taxon causes changes to the physical characteristics of the native environment (e.g. disturbance or light regimes), leading to deleterious impact on native taxa.
11. *Structural impact on ecosystem type* – the alien taxon causes changes to the habitat structure (e.g. changes in architecture or complexity), leading to deleterious impact on native taxa.
12. *Indirect impacts through interactions with other species* – the alien taxon interacts with other native or alien taxa (e.g. through any mechanism, including pollination, seed dispersal, apparent competition, mesopredator release), facilitating indirect deleterious impact on native species.