CapeNature

ECOLOGICAL SURVEILLANCE, MONITORING & RESEARCH FRAMEWORK 2022-2026

Ecological Surveillance, Monitoring & Research Framework 2022 – 2026

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Abbreviations and Acronyms

Abbreviation	Explanation
BMP-s	Biodiversity Management Plan for Species
BRUV	Baited Remote Underwater Video
CoCT	City of Cape Town Municipality
COAE	Certificate of Adequate Enclosure
CPUE	Catch per unit effort
CREW	Custodians of Rare & Endangered Wildflowers
CWAC	Coordinated Waterbird Counts
DEA & DP	Western Cape Department of Environmental Affairs and Development Planning
DFFE	National Department of Forestry, Fisheries and Environment
DWS	Department of Water and Sanitation
EMP	Estuary Management Plan
EWT	Endangered Wildlife Trust
FPA	Fire Protection Association
GCFR	Greater Cape Floristic Region
GCTWF	Greater Cape Town Water Fund
IAP	Invasive Alien Plant
IAS	Invasive Alien Species
ICM	Integrated Catchment Management
IUCN	International Union for Conservation of Nature
MMP	Mouth Management Plan
MPA	Marine Protected Area
NMLS	National Marine Line Fish Survey
NBA	National Biodiversity Assessment
NDF	Non-detriment Finding reports by the Scientific Authority
NRM	Natural Resource Management
PA	Protected Area
PAMP	Protected Area Management Plan
PBSAP	Provincial Biodiversity Strategy & Action Plan
SAIAB	South African Institute for Aquatic Biodiversity
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks Board

SASS	South African Scoring System
SAEON	South African Environmental Observation Network
SATCT	South African Tortoise Conservation Trust
SOB	State of Biodiversity
SoCR	State of Conservation Report
TMNP	Table Mountain National Park
TNC	The Nature Conservancy
TPC	Threshold of potential concern
UNESCO	United Nations Educational, Scientific and Cultural Organization
WCBA	Western Cape Biodiversity Act, 2021 (Act 6 of 2021)
WWF-SA	Worldwide Fund for Nature – South Africa
WCP	Western Cape Province

Glossary of Definitions, Scientific and Technical Terms

Term	Explanation
Surveillance	Describing and recording data at one point in time. This differs from monitoring above which records data and its change over time.
Monitoring	The process of describing and recording changes in the state of biodiversity and ecosystems to support evidence-based decision making, reporting, and planning.
Research	The process of investigating systems and phenomena using the scientific method.

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1. Introduction

The Western Cape Province is characterised by the Greater Cape Floristic Region (GCFR) which is not only the smallest plant kingdom of the six floral kingdoms in the world, but it is the only plant kingdom that is found within the boundaries of only one country. The Western Cape terrestrial ecosystems represent 167 terrestrial ecosystems, 13 489 recorded plant species, of which 6 776 (50.2%) are endemic (CapeNature 2020). These endemic species also face high levels of threats that have led or may lead to loss of this unique biological diversity. CapeNature manages 16 reserve complexes comprising 659 792 hectares which includes 42 739.31 hectares of Marine Protected Area (CapeNature 2020). Many of the terrestrial protected areas comprise the Cape Floral Region Protected Areas World Heritage Site, inscribed by UNESCO and recognised internationally for its unique biodiversity.

According to the Western Cape Biodiversity Act, 2021 (Act 6 of 2021) (WCBA) CapeNature together with DEA&DP is responsible for nature conservation and the protection, management and sustainable use of biodiversity and ecosystems in the province.

One of CapeNature's responses to the rapid global decline in the conservation status of species and ecosystems, is to provide annual snapshots on the status of conservation in the Western Cape, highlighting achievements, challenges, impacts and urgent actions that contribute towards a detailed review in the State of Biodiversity Reports which are published on a five-yearly cycle. CapeNature monitors the status of representative habitats, species of plants and animals across the terrestrial, freshwater, estuarine, marine and coast ecosystems, CapeNature contributes to the development and maintenance of a comprehensive inventory of biodiversity in the Western Cape.

Monitoring and research focus on assessing the effectiveness of management interventions to apply strategic adaptive management which is a process that recognises the inherent uncertainties of dynamic and unpredictable ecosystems but tests these uncertainties, progressively improving management. The pillars of adaptive management are science, monitoring and management.

1.1. Purpose of plan

The purpose of the Ecological Surveillance, Monitoring & Research Framework is to provide the foundation for a biodiversity surveillance and monitoring system, in collaboration with its partners, that allows for provincial level reporting on key aspects of the State of Biodiversity to inform policies, support decision making and to guide research. This provincial information will be provided to support national and global reporting on the State of Biodiversity.

Key objectives of this plan are to ensure:

- CapeNature is aligned with South Africa's national and international monitoring and reporting commitments.
- All data underpinning the 5-yearly Western Cape State of Biodiversity and Annual State of Conservation Report, including any national and international indicators that CapeNature contribute to, are clear and the methods of data collection, quality control and analysis are clear and repeatable across the four CapeNature Landscapes.

- Key biodiversity research required in the province is identified to contribute to understanding of the functioning of ecosystem, the impact of threats and to measure the effectiveness of management actions/interventions.

2. Surveillance and Monitoring

To determine species distribution (extent of occurrence or area of occupancy) and/or persistence within an area, surveillance is appropriate and is useful for species conservation assessments such as the IUCN Red List. In this context the surveillance can be simply recording presence or absence with the evidence (positive identification) for the record. Surveillance also encompasses the use of appropriate methods, techniques, and technologies to determine the extent of an affected area following an impact or change.

CapeNature deploys multi-species surveillance techniques in the form of a “bioblitz” where an area is targeted to record a range of taxa by assembling several different taxon experts within a dedicated timeframe. Such surveillance data is easily incorporated in the entity’s Biodiversity Database which also incorporates valuable data from organised citizen science programmes such as iNaturalist and various Virtual Museums.

Monitoring is aimed at determining trends in population responses to the changes in the environment particularly where it is because of management action or inaction. This in the context of the adaptive management framework, makes appropriate, regular, and consistent monitoring an essential function. Monitoring is generally carried out over an extended period at appropriate intervals to gain to most effective data for interpretation to inform management actions and decisions. Typically, population numbers fluctuate seasonally, and recruitment can only be ascertained when a proportion of a population reach maturity, meaning that data has much variability and therefore needs to be statistically robust. There are also numerous reporting imperatives deriving from the National Environmental Management suite of legislation that rely on monitoring data to inform the provincial and national indicators.

Table 1 illustrates the types of essential questions asked to inform a management response in relation to the impact of change and the associated surveillance and monitoring requirements implemented.

Table 1: Essential questions to be answered by monitoring to inform management.

Key Questions	Surveillance and Monitoring requirements to produce data (results) for analyses.	Justification/explanation
What is the impact of the extent and frequency of fires in CapeNature-managed Protected Areas (PAs)? Are fires occurring at appropriate age, frequency, size, season and return interval to maintain biodiversity and ecosystem function? If not, modify fire regimes and fire preparedness accordingly.	• Surveillance: and mapped extent of fire. • Calculated area (ha) of fire. • Assessed veld age of area prior to fire.	Fire extent is a direct measure of impact and in conjunction with veld age and fire history can indicate whether the impact is positive or negative. It also has potential legal ramifications and thus is a critical character to know.
What it the impact of fires on biodiversity? Modify fire regimes and fire preparedness accordingly.	• Monitoring long-term #key species persistence, recruitment, and population trends in response to fire frequency: indicator species e.g., frogs and serotinous proteas (long-term frog monitoring, post-fire, and permanent plots). • Monitoring the extent and density of Invasive Alien Plants in response to fire frequency.	Certain species e.g., serotinous proteas have a direct response to fire and their presence and age structure and reproductive state are good indicators for measuring veld health in relation to fire.
What is the state of rivers in the Western Cape Province? Are rivers in the desired state (ecological condition A-F) and what are the threats that affect ecological condition? If ecological condition	• Measure ecological condition of rivers using relative abundance of river health-indicator aquatic invertebrates (South African Scoring System Monitoring)	Many aquatic invertebrates and indigenous fish species give a measure of river health as they respond to water quality (point source pollution and agricultural runoff). Other impacts include effect of Alien Invasive

Key Questions	Surveillance and Monitoring requirements to produce data (results) for analyses.	Justification/explanation
does not meet desired state, then alter management or notify DEA&DP, Dept. Agriculture and DWS as required.	• Freshwater fish monitoring (fish community composition and presence and persistence of indigenous fish species).	Species, water abstraction, land use practices and indirectly also climate change). Desired ecological condition must be maintained or improve over time.
What is the state of wetlands in the Western Cape Province? If ecological condition does not meet desired state, then alter management or notify DEA & DP, Dept. Agriculture and DWS as required.	• Mapping and measuring the type and extents of wetlands. • Long-term wetland-indicator species (e.g., frogs) monitoring in relation to climate change, fire, and invasive alien species. • Measure ecological condition of rivers using relative abundance of river health-indicator aquatic invertebrates (South African Scoring System Monitoring (SASS)).	Wetlands are critical ecological infrastructure providing a range of invaluable ecosystem services. Monitoring the extent and representative species allow for identification of these special areas in the landscape to facilitate their conservation and to monitor changes in health over time.
What is the state of estuaries in the Western Cape Province? If condition thresholds are exceeded, then actively manage estuary mouth state.	• Mouth state (open/closed) of estuaries. • Estuary water quality monitoring to detect pollution • Waterbirds are used as an indicator of estuary health (Coordinated Waterbird Counts (CWCA)). • Fish species presence surveillance.	Estuaries are essential interfaces between freshwater and saltwater ecosystems that allow necessary ecological processes to occur e.g., fish breeding and movement of migratory species such as eels. Estuaries are affected water quality and flow regimes and whether and when they open to the sea which directly affects management decisions. The monitoring needs to inform the objectives of the Estuary Management

Key Questions	Surveillance and Monitoring requirements to produce data (results) for analyses.	Justification/explanation
		Plan (EMP) and Mouth Management Plan (MMP).
What is the state of coasts in the Western Cape Province? Manage priority dune systems to restore function when required.	• Fixed point photography of priority dune systems in coastal PAs and restoring where needed to maintain associated sand cycle (most have been artificially planted (often with IAPs) to stabilise dunes). – • Priority dune management and conservation projects where appropriate/needed (indicator is dune management project) • Estuary mouth management (open/closed) as part of the link to the coastline (sediment & nutrients) and the ocean (sediment and nutrients) – indicator is approved EMP and MMP. • Recording marine stranding (often the only way to obtain occurrence data for rare marine species).	The Western Cape coastline is made up of alternating sandy beaches and rocky shores. The interaction of sandy beaches with the associated dune systems and sand cycles forms a critical field within which coastal protected areas and estuaries exist. The monitoring of dune systems within coastal Protected areas forms an important part of ecosystem monitoring as well as management planning (roads are covered in moving sands). Major contributors to these sand cycles are the adjacent estuaries which provide sediment from the catchments. The management of these mouths, where appropriate, forms part of estuary and beach restoration. The decision support tool as well as the approval tool is the MMP.
State of Marine Protected Areas (MPA) managed by CapeNature. Quantify the value of MPAs relative to unprotected marine areas to set appropriate protection levels.	• Water temperature. • Bathymetry (once off if rocky area predominates)	Priority MPA monitoring fields were agreed upon at a national meeting held at South African Environmental Observation Network (SAEON) in 2008. The aim is to implement these

Key Questions	Surveillance and Monitoring requirements to produce data (results) for analyses.	Justification/explanation
	• Weather and climate (require appropriately placed weather stations). • Baited Remote Underwater Video (BRUV) (comparison of inside and outside MPAs). • Rocky Shores Invertebrate Community Structure (informs climate change and oil spill base line data). • National Marine Line Fish Survey (NMLS) (where angling is allowed – inside and outside MPAs). • Catch and release (covers near shore fish species often missed by BRUV) – compare inside and outside MPAs.	protocols in all MPAs managed by CapeNature over time. An evaluation of results over time will provide managers with the changes as well as conservation effectiveness of the MPA linked to the MPA Management Plan objectives.
What is the state of Threatened species? Quantify threat status to identify which species require active conservation action and measure success of conservation interventions.	• Population monitoring of select Threatened species to measure trends; baseline surveillance data to determine species persistence in the wild.	Knowing the extents of occurrence and occupancy is key information for formally assessing threat status. Even more useful is being able to track population change over time. This is only done for select Threatened species due to the very large numbers of Threatened species in the province. Changes in distribution and abundance can indicate the impact of threats and inform management actions to address

Key Questions	Surveillance and Monitoring requirements to produce data (results) for analyses.	Justification/explanation
		these (e.g., game off-takes, conservation translocations etc.).
What is the state of invasive alien species in the Western Cape Province (focused on CapeNature PAs)? Are we making progress to Invasive Alien Species (IAS) management goals (e.g. maintenance levels or eradication)?	Measure the distribution (mapping) and densities of invasive alien plants, Measure the presence (surveillance) and distribution of invasive alien animal distributions.	Invasive alien species are a major threat to the biodiversity and ecosystems of the Western Cape Province. Knowing where these species are and how dense their populations are is an ongoing management requirement.
What is the effect of IAS on biodiversity in CapeNature PAs?	Measure the effects on indigenous species (primarily plants using permanent vegetation plots).	There is a need to measure the effect of invasive alien species on indigenous species as this facilitates prioritisation and location of priority management activities. Monitoring and/or surveillance of new or emerging invasive species (mainly animal species) and their impacts is critical to inform management interventions such as Early Detection and Rapid Response.
What is the effect of IAS on ecosystem services (primarily water delivery) in CapeNature PAs?	Measure the effect of invasive alien species on stream reduction.	There is a need for better catchment-level quantification of stream flow reduction by invasive alien plants. This is needed to measure management effect and calibrate hydrological models for future predictions (and may

Key Questions	Surveillance and Monitoring requirements to produce data (results) for analyses.	Justification/explanation
		assist in estimating the contribution of CapeNature PAs to water delivery).
What is the effect of IAS management activities on biodiversity in CapeNature PAs?	Measure the effects of management on indigenous and invasive alien species (primarily plants using permanent vegetation plots) which measure species presence and abundance.	It is necessary to be able to quantify the intended and off-target effects of invasive alien management techniques on indigenous biodiversity. This allows for site-specific and species-specific best management practice. It is also crucial to measure the effectiveness of the control measures to see if they need to be adjusted or replaced to reach the management goals for invasive alien species. It also directly informs the remaining work to be planned and completed.
What is the impact of CapeNature operations on water availability (ground & surface water)?	Measure water usage on CapeNature Protected Areas (borehole monitoring, metered water use and surface water monitoring).	Water in the Western Cape Province is a scare and essential resource which needs to be protected and wisely utilised which requires regular measurement and must be compliant with legislation. CapeNature should lead by example in wise and sustainable water utilisation.
What is the degree and extent of climate change on CapeNature PAs?	Measure the long-term changes in climate by obtaining regular and good quality weather data.	Climate change is major but subtle threat to ecosystems and society. Monitoring the rate and extent of

Key Questions	Surveillance and Monitoring requirements to produce data (results) for analyses.	Justification/explanation
	Certain climate data can also be obtained through remote sensed environmental state data (reliant on partners to pursue this).	change over time will inform current and future responses to this threat (mitigation and adaptation).
Is CapeNature fulfilling its commitments to Biodiversity Management Plans for Species (BMP-s), Species Conservation Action and Biodiversity Management Plans for ecosystems (BMP-e) plans?	There are BMP-s specific indicators that need to be measured to assess the state of species or ecosystem as defined in the BMP-s.	There is a legislative mandate for compliance to BMP-s where CapeNature is a designated responsibility for certain actions.
Is CapeNature responding to management requirements as listed in Protected Area Management Plans (PAMPs)?	There are PAMP-specific indicators to assess state of species or ecosystems as defined in the PAMPs.	There is a legislative mandate for compliance to PAMPS for Protected Areas managed by CapeNature.
What are the impacts of tourism events on PAs?	Monitoring of ecological effects (e.g. erosion) during and after major tourism events.	Certain events may have ecological impacts and this needs to be measured to direct best practice for minimising and avoiding environmental impacts due to these events.
What are the impacts of resource harvesting projects on PAs?	Measure population changes to assess the impact of harvesting on the populations of affected species.	Harvesting has the potential to reach unsustainable or damaging levels and needs to be monitored for impacts.
What is the condition of CapeNature linear infrastructure?	Monitor erosion of road and other infrastructure to assess condition.	All infrastructure requires maintenance to prevent negative effects and to maintain functionality. Monitoring is

Key Questions	Surveillance and Monitoring requirements to produce data (results) for analyses.	Justification/explanation
	Monitor trails to combat erosion and keep trails functional for tourism and management.	required to plan this maintenance in response to the monitored state. There could be downstream sediment impacts.

2.3. CapeNature Prioritization Framework for Biodiversity Monitoring and Surveillance

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. For this reason, CapeNature developed the CapeNature Prioritization Framework for Biodiversity Monitoring and Surveillance that provides an objective and defensible tool to assist with the prioritization of monitoring and surveillance projects that CapeNature will prioritize for the 2022-2026 period.

This tool will be used to prioritize monitoring and surveillance of indigenous species, alien invasive species and ecosystem types. A three-tier decision-tree approach was developed and for each species/ecosystem type, three categories of criteria are scored: (a) Biological Criteria, (b) Relevance Criteria and (c) Feasibility Criteria.

2.4. Monitoring methods

In addition to the relevance mentioned above monitoring needs to be:

- **robust and reliable** so that we can depend on these results for directing our responses;
- **repeatable** so that the results are comparable and so that trends are not due to spurious changes in methods over time; and
- **replicable** so that the same data will be recorded the same way. Minimising subjectivity assists in achieving this.

To achieve this consistency and quality, all monitoring projects require an ecological monitoring protocol which specifies the exact methods to be employed. These ecological monitoring protocols or standard operating guidelines are listed in Table 2 and can be accessed through one central biodiversity data share managed by Biodiversity Capabilities Conservation Innovation Team.

2.5. Analysis of monitoring results

All data collected must be analysed and written up in a Technical Report or scientific paper to provide meaningful information to inform strategic adaptive management and serve as a reference in the future. The type of analysis and timeframe will vary for the different monitoring programmes. Analysis can be at Landscape level such as Protected Area Management Plan viability assessments or by Biodiversity Capability staff for analysis across the province. Technical reports will inform the Annual State of Conservation Report and 5-yearly State of Biodiversity Report and State of the Coast Report, and various other national, provincial and CapeNature reporting; details of these are provided in Table 2.

CapeNature currently focusses on (the proportion of area in each post-fire age class, the proportion of the area that burns in summer over the past 15 years, the distribution of areas of all individual fires over the past 15 years, and the proportion of individual serotinous Proteaceae populations that have flowered for > 3 successive seasons, area occupied by each invasive alien plant species in four density categories.) There are however other TPCs that should be set including fire return interval as assessed over the past 30 years which although this is estimated where we can it is a challenging task. Currently CapeNature have limited measurement of species known to be sensitive to altered fire regimes (certain Proteaceae and frogs). We are not yet setting or measuring TPCs for area of infestations burnt in unplanned wildfires that cannot be

subjected to adequate follow-up control operations, the number of refugia for biological control agents, depth of topsoil lost or comparative vegetation diversity in fenced and unfenced plots.

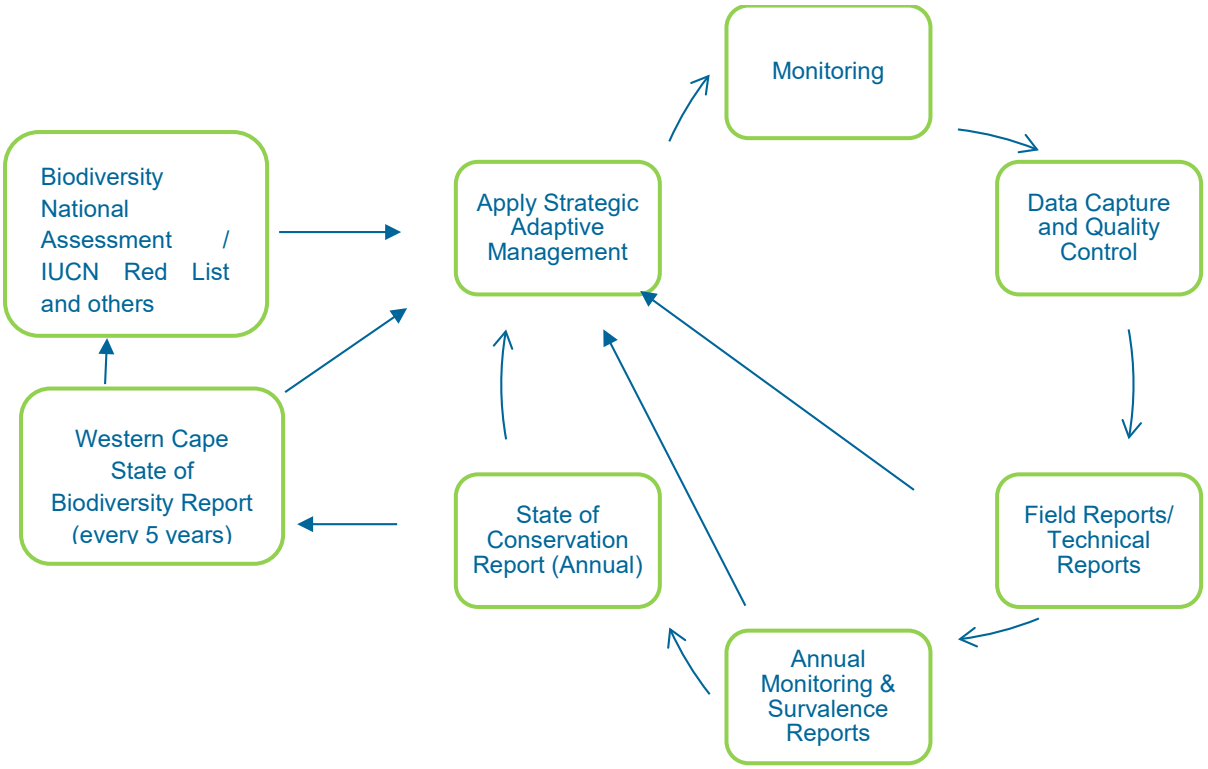

Figure 1: CapeNature flow of information from monitoring programmes

2.6. Data storage and extraction

All data collected by Landscape staff is processed in the Landscape. This will include the capture of data into the correct repository as outlined in the relevant ecological monitoring protocol. This information is then submitted from both on and off reserve Landscape staff to the Landscape Conservation Intelligence Team, where data is quality checked for correctness before sending to either the central internal or external partner databases.

It is critical that all data collected by external stakeholders on CapeNature managed protected areas, through partnership agreements or research permits (see Appendix 2 and 3), is provided to CapeNature in the required format through the relevant Landscape Conservation Intelligence Team. This must be clearly stipulated in partnership agreements and as a research permit condition and managed by the allocated responsible CapeNature staff member. The same would apply to CapeNature bursary holders who collect data on reserves and should be stipulated in the bursary conditions.

Verified and validated data is sent from the Landscape Conservation Intelligence Team to the various central CapeNature biodiversity databases, managed by the Biodiversity Capabilities:

Conservation Innovation Team. Further data quality checking is undertaken by the various ecologists, who use the data collected by Landscape staff and partners to compile various Technical Reports, that will inform the Annual State of Conservation Report and 5-yearly State of Biodiversity Report.

A complete list of biodiversity databases maintained by CapeNature (including national databases CapeNature contributes to) is included in Appendix 1.
Third parties may request access to CapeNature biodiversity data by completing a data sharing agreement administered by the Capability Manager: Conservation Innovation. The data sharing agreement conditions stipulate how data may and may not be used, and state that any associated outputs that have used CapeNature data must be shared with CapeNature.

2.7. Anticipated impacts and benefits of monitoring

The following key benefits of monitoring include:

- Obtaining an understanding of environmental state and change over time and the effectiveness of interventions.
- Providing motivation for funding and resources required for effective and efficient catchment to coast management.
- Planning and implementing responses to meet objectives and refine the strategic adaptive management process.
- Informing reports on the state of the environment such as the CapeNature State of Conservation Report, the CapeNature State of Biodiversity Report, the provincial State of the Environment Report and State of the Coast Report. This information is also aggregated at national level in reports such as the National Biodiversity Assessment and the National Status Report on Biological Invasions.

3. Research

Applied conservation research is typically a relatively slow and complex pursuit that involves multiple people often across several institutions. CapeNature is heavily dependent on research partners and collaborations with other conservation agencies and environmental NGOs. To ensure that there is effective communication of the research required by CapeNature there needs to be a regular platform on which these issues can be raised. Currently these include Cape Action for People and the Environment Invasive Alien Animal Working Group for invasive alien animals. CapeNature documents research needs on the CapeNature website for public access (https://www.capenature.co.za/research-requests). Research collaboration meetings should take place at least annually and preferably twice a year. The timing of these interactions is critical as new projects must fit with the academic calendar. New research requests need to be made before the end of October to allow student or post-graduate studies in the following year.

CapeNature research associates should actively engage in setting up and directing research needs with universities. Having memoranda of understanding with research partners and institutes facilitate this work and the sharing of data that is necessary and clarifies the conditions

that CapeNature and the research partners need to attach to these agreements. For these research projects to be successful it is important that an individual in CapeNature and the student's supervisor/s are responsible for the execution of the project. For all such projects a presentation to management/relevant sector of CapeNature is required upon conclusion of the research.

Key local research partners for CapeNature include the University of the Western Cape, University of Cape Town, Stellenbosch University, Cape Peninsula University of Technology, Nelson Mandela University, the Centre for Biological Invasions, Centre for Biological Control, South African National Biodiversity Institute, Department of Forestry Fisheries and Environment and the South African Institute for Aquatic Biodiversity. There are many other potential research partners, many of which are further afield or abroad and opportunities to engage should always be considered where practical.

There is a strong link between research and monitoring. Monitoring is often required to answer research questions and conversely research is often needed to find out how best to conduct monitoring. One of the ongoing research topics relevant to CapeNature is using new technologies to improve monitoring methods and their automation.

4. Partnerships & Collaboration

Integrated catchment to coast management requires active management of the catchment and coastal landscapes and seascapes across all land and sea use types, ownerships, and management authorities. This necessitates a collaborative approach with a range of partners as the ecological drivers such as fire, rainfall, and the coastal ocean, atmosphere, land interphase, and the threats to these processes such as invasive alien species and Illegal, unreported, and unregulated fishing within the context of climate change. These factors pay no heed to boundaries and only a combined and integrated management approach will have any chance of success at the scale and speed that is required for effective catchment management.

A full list of formal partnerships relevant to the CapeNature Ecological Surveillance, Monitoring & Research Framework is included in Appendix 3.

5. Recommendations & Review

This framework requires review at least every five years by the Capability Manager Biodiversity Intelligence. A critical component of this implementation plan is that it is used in the compilation of the Protected Area Management Plans, Marine Protected Area Management Plans, Estuary Management Plans which will inform monitoring and research needs, including annual Eco-Matrix projects for each relevant operational component.

This review must take place annually by mid-February of each year.

6. Implementation Plan 2022-2026

The following summary of the key current monitoring actions are included in Table 2. These current monitoring and surveillance projects will be prioritised further by applying the CapeNature Prioritization Framework for Biodiversity Monitoring and Surveillance tool to refine the final allocated responsibilities for 2022-2026.

Table 2 Current Monitoring implementation action plan 2022

Objective	Monitoring actions & inputs required	Responsibility	Region/Complex/ PA	Frequency	Measurable Outputs	Monitoring Protocol	Enabling resources required	Constraints/ Obstacles	Measurable Outcomes
Assess whether the fire regime set in the PAMP supports CapeNature's biodiversity & ecosystem functioning objectives.	• Map and record all fires on/bordering CapeNature PAs and neighbouring Mountain Catchment Areas. • Capture data in Fire Database. • Conduct quality control. • Annual analysis of all fires. • Produce a report on the analysis of fire regime.	Capability Manager Biodiversity Intelligence; Landscape Managers; Landscape Unit Managers Conservation Managers Landscape Conservation Intelligence Team; Restoration Ecologist; GIS Scientist	All relevant PAs (where fire occurs)	Fire reports as fires occur. Analysis annual (June)	Individual fire report incl. spatial extent of fire. Eco-sensitive areas maps Pre-fire season maps Fire belts Hotspots (July)	Fire Monitoring Manual, 2006	Operational budget, Vehicles, Remote sensed imagery, Analytical capacity.	Spatial resolution of mapping; mapping unburnt/partially burnt areas within fire scars. Accessibility of remote drives.	Annual Fire Report State of Conservation Report State of Biodiversity report PA Complex fire regime analysis – as part of PAMP review process
Invasive alien plant species populations assessed against management goals set in the Invasive Species Monitoring, Control and Eradication Plans and PAMPs.	• Map and record distribution and densities of all invasive alien plant species on CapeNature Protected Areas according to CapeNature procedure. • Compile prioritization maps for the Protected Areas. • Update central data store. • Annual analysis of data for the SOCR. • Biennial analysis of data.	Capability Manager: Biodiversity Intelligence; Landscape Managers; Landscape Unit Managers; Conservation Managers; Landscape Conservation Intelligence Team; Restoration Ecologist; GIS Scientist	All PAs	Annual in time for Integrated Work Plan and Integrated Annual Plan of Operations processes. National reporting biennial	Annual IAP map compiled by GIS Specialist Annual IAP prioritisation compiled by GIS specialist (Aug) Biennial analysis for National Status Report compiled by the Restoration Ecologist (2021,2023, 2025 etc.)	Working for Water Project Operating Standards 2007. CapeNature protocol to be developed.	Operational budget, Vehicles; Remote sensed imagery	Inaccessibility of certain areas; Resolution of imagery time hungry data processing and analysis; Automated remote sensed detections systems not yet available; analytical capacity.	State of Conservation report National Status of Biological Invasions State of Biodiversity report National Biodiversity Assessment
Monitor the effectiveness of biological control as part of an integrated invasive alien plant control programme.	• Map the presence/absence (establishment) and spread of biological control agents on PAs. • Collection, Release and Monitoring data sheets. • Record the impact of biological control agents on invasive alien plants.	Capability Manager: Biodiversity Intelligence; Landscape Managers; Landscape Unit Managers	All relevant Protected Areas	Collection and release according to monitoring protocols.	Annual Technical Report compiled by the Restoration Ecologist	Mapping and Monitoring of Biological Control, 2016	Operational budget, Vehicles, Capacity.	Reliant on funding and expertise.	State of Biodiversity report

Objective	Monitoring actions & inputs required	Responsibility	Region/Complex/ PA	Frequency	Measurable Outputs	Monitoring Protocol	Enabling resources required	Constraints/ Obstacles	Measurable Outcomes
		Conservation Managers (on Reserve and Off Reserve), NRM Programme Managers; Conservation Intelligence Team, Restoration Ecologist; GIS Specialist		Determine establishment within 2-5 years after release.	Biennial analysis for National Status Report compiled by the Restoration Ecologist (years; year)	Implementation of Biological Control on Australian Acacia species, 2016 Implementation of Biological Control on Australian Hakea species, 2016 *Acacia and Hakea* biological control ID Booklets (dates) Stinkbean protocol (draft) - 2021			State of Conservation report National Status of Biological Invasions
The impact of invasive alien plant species is assessed to inform management interventions.	• Conduct vegetation community composition and species counts at control and treatment sites. • Conduct data analysis and provide management recommendations.	Capability Manager: Biodiversity Intelligence, Landscape Manager Central; Landscape Unit Managers, Landscape Central Conservation Intelligence Team; Restoration Ecologist; Flora Ecologist; **External: GCTWF**	Hottentots-Holland	Baseline at all sites then biennial; analysis every five years	Technical Report by Flora Ecologist, Landscape Ecologist & Restoration Ecologist, and research partners	CN and GCTWF terrestrial biodiversity protocol	Operational budget, Vehicles, Advanced plant identification skills; Quadrats, permanent marker poles	Reliant on external funding and expertise.	State of Conservation Report State of Biodiversity Report
Invasive alien animal species management goals have been assessed against the objectives in the Invasive Species Monitoring, Control and Eradication plans and PAMPs.	• Map and record all invasive alien animal species on CapeNature PAs and wherever possible off-reserve. • Update biodiversity database/CMSi.	Capability Manager: Biodiversity Intelligence; Landscape Managers; Landscape Unit Managers; Conservation Managers (on Reserve and Off Reserve); NRM Programme Managers; Conservation Intelligence Team; Restoration Ecologist; GIS Specialist	All PAs	Annually	Annual Technical Report compiled by the Restoration Ecologist. Biennial analysis for National Status Report compiled by the Restoration Ecologist (years; year)	PA Monitoring, Control and Eradication plans and PAMPs.	Operational budget, Vehicles, equipment: trap cameras, nets etc. animal identification skills.	Inaccessibility of certain areas.	State of Biodiversity report State of Conservation report National Status of Biological Invasions
	• Trapping data sheet completed. • Data captured by contractor in hunting spreadsheet. • Annual report from NRM appointed contractor.	*External Lead:* Advanced Environmental Corporation; NRM Special Projects *Internal:* Capability Manager: Biodiversity Intelligence; Landscape Manager West; Landscape Unit Manager Cederberg	Voelvlei NR and Kasteelberg NR	Annual	Annual Technical Report compiled by Conservation Intelligence Team	Feral Pig Management Plan Boland PAMP			State of Biodiversity report State of Conservation report

Objective	Monitoring actions & inputs required	Responsibility	Region/Complex/ PA	Frequency	Measurable Outputs	Monitoring Protocol	Enabling resources required	Constraints/ Obstacles	Measurable Outcomes
		Conservation Managers; Landscape Conservation Intelligence Team West, Restoration Ecologist; NRM Programme Manager West							National Status of Biological Invasions
	• European Rabbits monitoring of success of eradication	Capability Manager: Biodiversity Intelligence Capabilities; Landscape Manager West; Landscape Unit Manager Peninsula Conservation Manager; Landscape Conservation Intelligence Team West, Restoration Ecologist; NRM Programme Manager West; Marine and Coasts Specialist West	Dassen Island		Annual Technical Report compiled by Restoration Ecologist	Draft Dassen Island IAS Eradication & Control plan and site-specific monitoring protocol (to be developed).			State of Biodiversity report State of Conservation report National Status of Biological Invasions National Biodiversity Assessment
	• Carp offtake (catch per unit effort) • Conduct water quality monitoring at Groenvlei. • Submit water samples to DWS lab for analysis. • Capture data in Groenvlei water quality monitoring database • Compile annual report on findings.	External: SAIAB and Invasive Fish Species Management Non-profit Organisation Capability Manager: Biodiversity Intelligence; Landscape Manager East; Landscape Unit Manager Garden Route; Conservation Manager Goukamma; Landscape Conservation Intelligence Team East; Fauna Ecologist; NRM Programme Manager East;	Goukamma NR: Groenvlei	Annual Monthly Monthly or quarterly (still to be determined) Annual	Annual Technical Report compiled by Fauna Ecologist: East. Annual water quality tracking report compiled by Landscape Intelligence Team	Groenvlei carp population control site specific protocol, 2020	Operational budget Vehicles, water access vehicles, sampling equipment	Budget constraints for water quality chemical analysis	PAMP viability assessment
The impact of fire on biodiversity is assessed using serotinous Proteaceae as an indicator species to inform management actions.	• Conduct post-fire and permanent *Protea* monitoring to determine recruitment and survival and establish fire return intervals. • Plant numbers; Parent to seedling ratio; survival • Produce report on the analysis of the fire regime and Protea monitoring data with management recommendations.	Capability Manager: Biodiversity Intelligence; Landscape Managers; Landscape Unit Managers; Conservation Managers; Landscape Conservation Intelligence Team, Fauna Ecologist; Flora Ecologist, GIS Specialist	All Fynbos PAs	Post-fire based on fires and permanent plot data annually once plot is 3 years old (viability assessment).	Annual for monitoring once plots are 3 years old. PA assessments (3-yearly cycle) compiled by the Landscape Conservation Intelligence Team	Post-fire regeneration monitoring method, 2010 Permanent protea monitoring method, 2010	Operational budget, Vehicles, Proteaceae identification skills, analytic skills, field training, technical skills.	Data quality	Annual Fire Report (those PAs in that 3-year cycle, all every five years); To set TPCs in PAMP viability analysis. State of Biodiversity report

Objective	Monitoring actions & inputs required	Responsibility	Region/Complex/ PA	Frequency	Measurable Outputs	Monitoring Protocol	Enabling resources required	Constraints/ Obstacles	Measurable Outcomes
									State of Conservation report
The impacts of fire and climate change on ecosystems is assessed, using frog populations as an indicator, and informs mitigating actions.	Long-term frog population monitoring at four sites: Monitor amphibian species communities to determine species presence and population estimations. Conduct data analysis and provide management recommendations	Capability Manager: Biodiversity Intelligence Fauna Ecologist; Restoration Ecologist;	Landdroskop, Swartboskloof, Veepos & Caledon Klein Swartberg	Site-dependent: From 2-6 times a year.	Population size estimates, annual technical report	Micro Frog Monitoring Programme, 1991 Northern Moss Frog Monitoring Programme, 2006	Operational budget; 4x4 Vehicles; Frog identification skills; Microphones; multichannel sound recorder	Specialist field skills; analytical time & skills.	State of Biodiversity Report State of Conservation Report To set TPCs in PAMPS
National Freshwater Ecosystem Priority Area (NFEPA) rivers are assessed and inform management interventions.	• Conduct SASS 5 Surveys, • Capture data into database, • Conduct annual analysis of the data. • Produce a report with management recommendations.	Capability Manager: Biodiversity Intelligence; Freshwater Ecologist; Landscape Managers; Landscape Unit Managers; Conservation Managers; Landscape Conservation Intelligence Team	Seven permanent sites, per relevant PAMP	Seasonal	SASS 5 invertebrate score data capture in Freshwater Biodiversity Information system database by SASS accredited person, currently Freshwater Ecologist Technical Report per PA compiled by the Freshwater Ecologist.	SASS 5 Monitoring protocol, 2002	Operational budget; 4x4 Vehicles, freshwater invertebrate identification skills; SASS equipment, SASS 5 accreditation.	Limited accredited capacity, currently only one person in CapeNature.	State of Biodiversity Report State of Conservation report
Population trends of threatened species and the state of NFEPA fish sanctuaries are assessed and inform management recommendations. **Freshwater fish: *Pseudobarbus burchelli*** ***Sedercypris erubescens***	• Assess the state of NFEPA fish sanctuaries, to assess the state of threatened fish populations • Complete risk assessment to identify extent of alien fish invasion in priority rivers. • Compile and implement reserve specific alien invasive fish management actions as part of the Invasive Alien Species Monitoring, Control and Eradication plans.	Capability Manager: Biodiversity Intelligence; Fauna Ecologist; **External partner SAIAB**	Cederberg Complex, Groot Winterhoek Complex, Langeberg Complex and supporting river habitats.	Annual	Population size estimates. Relative abundance. Condition of fish sanctuaries Technical report compiled by Fauna Ecologist	Ecological monitoring protocol Twee River Redfin *Sedercypris erubescens,* 2020	Operational budget, Vehicles, freshwater fish identification skills; fish nets, waders		State of Biodiversity Report State of Conservation report IUCN Red List & Protection Level Assessments; Species Conservation Plans

Objective	Monitoring actions & inputs required	Responsibility	Region/Complex/ PA	Frequency	Measurable Outputs	Monitoring Protocol	Enabling resources required	Constraints/ Obstacles	Measurable Outcomes
Selected threatened flora (too many to list here, see PAMPs for details) are monitored to determine population trends and whether management actions are required.	Plant population counts. Population size estimates and trends.	Capability Manager: Biodiversity Intelligence; Flora Ecologist; Landscape Managers; Landscape Unit Managers; Conservation Managers; Landscape Conservation Intelligence Team **External: CREW**	All relevant PAs	As specified in ecological monitoring protocols	Technical report compiled by Flora Ecologist	Ecological Monitoring Protocol for Event Monitoring on Protected Area roads, jeep tracks and trails, 2013	Operational budget, Vehicles, plant identification skills	Vacancies	State of Biodiversity report State of Conservation report IUCN Red List & Protection Level Assessments
Threatened mammal species are monitored to determine population trends and whether management actions are required		Capability Manager: Biodiversity Intelligence; Fauna Ecologist; Landscape Managers; Landscape Unit Managers; Conservation Managers (on and off reserve); Landscape Conservation Intelligence Team			Technical report compiled by Fauna Ecologist				State of Biodiversity Report State of Conservation Report IUCN Red List & Protection Level Assessments
Leopard	• Surveillance	As above	WCP	Annual		Camera trap SOG	Camera traps	Budget for camera traps	NDF reports
	• Individual counts at select sites	**External: Cape Leopard Trust, Landmark Foundation, Panthera.**		Annual	Distribution, density, population trends	CLT Leopard monitoring best-practice guidelines_			As above
Riverine rabbit	• Surveillance	As above	WCP	Annual		Camera trap SOG	Camera traps	Budget for camera traps	State of Biodiversity Report State of Conservation Report
	• Surveillance	External: EWT	WCP	Annual	Spatial distribution model	EWT riverine rabbit camera trap guidelines		Funding	IUCN Red List & Protection Level Assessments
Bontebok	• Coordinated Game Population and Distribution Assessments • On-reserve: game counts (vehicle and aerial)	As above	On-reserve: De Hoop	On-reserve: monthly vehicle counts, triannual aerial counts.	Technical report compiled by Fauna Ecologist	Coordinated Game Population and Distribution Assessments on	Aerial surveys	Budget for aerial surveys	Bontebok BMP-s report

Objective	Monitoring actions & inputs required	Responsibility	Region/Complex/ PA	Frequency	Measurable Outputs	Monitoring Protocol	Enabling resources required	Constraints/ Obstacles	Measurable Outcomes
	• Population estimates					Nature Reserves Protocol, 2014			
	• Off-reserve: COAE certificates		Off-reserve: WCP	Off-reserve: 3-yearly COAE inspections		Standard Operating Guideline: Inspections for Certificate of Adequate Enclosure and Fencing			
Cape Mountain Zebra	On-reserve: • Individual identification; counts. • Photo-id file, • habitat utilization, • herd dynamics, • population trend, • breeding success Off-reserve: • Counts • Genetic monitoring	As above **External: SANBI**	WCP - All PAs and private properties with CMZ	On-reserve: Monthly ground counts, tri-annual aerial surveys Off-reserve: Tri-annual COAE inspections Opportunistic	On-reserve: Off-reserve: Population trend Genetic: Hybridization, genetic diversity. Technical report compiled by Fauna Ecologist	Ecological Monitoring: Cape Mountain Zebra Monitoring Protocol, 2021 Site specific-Ecological Monitoring Protocol: Cape Mountain Zebra Monitoring De Hoop Nature Reserve, 2021 Draft Gamkaberg CMZ monitoring protocol,2021 SOP for Collection of Biological Samples of Cape Mountain Zebra, 2021	Vehicles and personnel for ground counts; aerial counts Annual updates for private properties Sites for genetic mixing of the three CMZ stocks	Budget for camera traps, and handheld cameras and binoculars for reserve staff. Budget for aerial censuses. Personnel for off-reserve annual updates. Budget, personnel for genetic mixing programmes and associated monitoring.	Cape Mountain Zebra BMP-s – NDF reports
Population estimates for all antelope (in addition to Bontebok)	• Game counts on and off reserve	As above	WCP: All PAs and private properties with game/antelope (ecotypical species to be covered by surveillance)	Monthly or annually or every 3 years for certificate of adequate enclosure (site-dependent)	Technical report compiled by Fauna Ecologist	Coordinated Game Population and Distribution Assessments on Nature Reserves Protocol, 2014	Reserve-specific protocols	Existing protocol not suited to rugged reserves with limited road networks. Reserve budgets.	NDF reports
The impact of game species on vegetation is measured to inform management actions.	• Long-term ex-closure plots	**External: Frans Radloff, CPUT**	De Hoop NR	Annual	Response of vegetation to herbivory and fire.				De Hoop PAMP
Threatened amphibian species are monitored to assess population trends and whether management actions are needed:	• Population size estimates at long-term frog monitoring sites. • Population estimates based on breeding behaviour (primarily advertisement calls)	Capability Manager: Biodiversity Intelligence; Fauna Ecologist; Landscape Managers; Landscape Unit Managers;	Caledon Klein Swartberg & Groot Winterhoek	Biannual	Technical Report compiled by Fauna Ecologist	Northern Moss Frog Monitoring Programme, 2006	Operational budget, Vehicles, Frog identification skills, Microphones,	Specialist field skills; analytical time & skills.	State of Biodiversity; report

Objective	Monitoring actions & inputs required	Responsibility	Region/Complex/ PA	Frequency	Measurable Outputs	Monitoring Protocol	Enabling resources required	Constraints/ Obstacles	Measurable Outcomes
Arthroleptella rugosa *A. subvoce*	• Population estimates • Breeding site distribution • Data in frog population database • Annual technical report.	Conservation Managers (on and off reserve); Landscape Conservation Intelligence Team					multichannel sound recorder		State of Conservation report IUCN Red List & Protection Level Assessments Species Conservation Plan
External Monitoring:									
Western Leopard Toad	• Adult counts, road mortality counts.	**Western Leopard Toad Conservation Committee, CoCT, SANParks**	Cape Town, Agulhas	Annual	Data collected in iNaturalist project (SANBI)	Draft western Leopard Toad BMP-s			State of Biodiversity; report State of Conservation report IUCN Red List & Protection Level Assessments
Table Mountain Ghost Frog	• Tadpole counts	**CoCT** **SANParks**	TMNP	Biannual	EWT and SANParks.	EWT Draft monitoring plan			
Microfrog	• Population estimates	**CoCT** **SANParks**	Cape Town, Overstrand, Agulhas	Annual	CapeNature Frog Population Database	Micro Frog Monitoring Program 2007			
Cape Platanna	• Population estimates	**CoCT** **SANParks**	Cape Town, Overstrand, Agulhas	Annual	To be developed.	To be developed.			
Contribute to a southern African database (distribution and relative abundance of bird species), towards red-listing, establishing Important Bird and Biodiversity Areas, detecting change, and informing EIAs.	Surveys can be dedicated SABAP2 surveys or can be done in combination with focal biodiversity surveys. *The full protocol or the ad hoc protocol can be followed, depending on capacity and resources and on how much of a pentad is occupied by a reserve.*	Field rangers	All reserves currently doing SABAP2 or BIRP surveys.	From once a month to once a year, depending on capacity and resources.	No. of SABAP2 cards submitted per reserve / per year.	SABAP2 protocol (http://sabap2.birdmap.africa/media/document#pgcontent)	Training in bird identification skills. Binoculars	No-one in-house with time to provide training. Costs of external training by a service provider.	Results feed into PAMPs.
Threatened bird species are monitored to assess population trends and whether management actions are needed.		Capability Manager: Biodiversity Intelligence, Landscape Managers; Landscape Unit Managers, Landscape Conservation Intelligence Team							State of Biodiversity Report State of Conservation Report IUCN Red List & Protection Level Assessments

Objective	Monitoring actions & inputs required	Responsibility	Region/Complex/ PA	Frequency	Measurable Outputs	Monitoring Protocol	Enabling resources required	Constraints/ Obstacles	Measurable Outcomes
Cape Vulture	• Population size estimates; breeding pairs and reproductive output; • Data in Vulture database • Annual technical report.	Including Fauna Ecologist LCI ET, On reserve officer	De Hoop NR	Monthly from April to January	Annual technical Report compiled by Fauna Ecologist	Cape Vulture Monitoring Protocol, 2021 Multi-species Action Plan to Conserve African-Eurasian Vultures -Bonn Convention	Operational budget, Vehicles, specialist observation training.	Staff turnover	IUCN Vulture Specialist Group
African Penguin	• Breeding census, breeding success, chick condition, moult counts, mortality & predation	Including Marine & Coastal Ecologist; Marine & Coast Specialists	Dyer Island Dassen Island Stony Point	As per species protocols	Annual Technical Report compiled by the Marine & Coastal Ecologist	Draft national African Penguin protocols	Operational budget, Vehicles, boats, specialist observation training.	Training on Earthwatch database. Data analysis capacity.	African Penguin BMP-s (DFFE);
Roseate Tern	• Breeding census, mortality & predation		Dyer Island			Draft Coastal Seabird Population Census Protocol		Central data storage	Oceans & Coasts collate national population counts and trends.
Damara Tern			De Mond			Site Specific-Ecological Monitoring Protocol: Damara Tern Breeding Success De Mond Nature Reserve, 2020			
Bank Cormorant			Dyer Island Dassen Island			Ecological Monitoring Protocol: Coastal Seabird Population Census			
Threatened reptile species are monitored to assess population trends and whether management actions are required: Geometric Tortoise	• Individual counts in select populations to determine population estimates & trends and individual survival. • Compile an analysis protocol	Capability Manager: Biodiversity Intelligence, Fauna Ecologist; Landscape Managers; Landscape Unit Managers, Landscape Conservation Intelligence Team; Landscape South Conservation Intelligence Manager (detection dog)	Voelvlei Briers-Louw Onderplaas – done in conjunction with SATCT Elandsberg	Annual	Technical Report compiled by Fauna Ecologist	Draft Geometric Tortoise Monitoring Protocol	Operational budget, Vehicles, conservation detection dogs and training; marking skills	Technical expertise and central data storage	State of Biodiversity Report State of Conservation Report IUCN Red List & Protection Level Assessments
Threatened invertebrate species are monitored to assess population trends and whether management actions are required:	• Population counts, host ant nest and host plant *Indigofera erecta* distribution.	Capability Manager: Biodiversity Intelligence, Landscape Manager East; Garden Route Landscape Unit Manager, Garden Route Landscape	Brenton Blue NR	Annual	Technical Report compiled by BBT submitted to CN.	Brenton Blue Butterfly Special Nature Reserve Environmental	Access to the PA, butterfly, and ant identification skills.	Staff training	State of Biodiversity report

Objective	Monitoring actions & inputs required	Responsibility	Region/Complex/ PA	Frequency	Measurable Outputs	Monitoring Protocol	Enabling resources required	Constraints/ Obstacles	Measurable Outcomes
Brenton Blue Butterfly		Conservation Intelligence Team **External: Brenton Blue Trust**				Management Plan, 2008			State of conservation report Brenton Blue Butterfly Special Nature Reserve Environmental Management Plan IUCN Red List & Protection Level Assessments
Waterbird counts are conducted to determine population trends and whether management actions are required.	• Counts of adult birds, • breeding birds and chicks; • Count all waterbirds at select waterbodies • Submitted to National CWAC database.	Capability Manager: Biodiversity Intelligence, Marine & Coast Ecologist; Landscape Managers; Landscape Unit Managers, Landscape Conservation Intelligence Team; Senior Manager: Marine and Coasts; Marine & Coast Specialists		Biannual (Jan + Jul) minimum Quarterly (Jan, Apr, Jul + Oct) preferable Biannual	Technical Report per PA compiled by Landscape Intelligence Team Technical Report compiled by Marine & Coast Ecologist	CWAC protocol, 1999	Operational budget, Vehicles, Spotting scopes, bird identification skills.	Bird identification, counting skills.	State of Biodiversity report State of conservation report IUCN Red List & Protection Level Assessments DFFE report in terms of the AEWA agreement and Bonn Convention.
		Conservation Manager/Officer	Olifants River Mouth, Jakkalsvlei, Wadrif Saltpan, Verlorenvlei, Rocherpan						
		External: BirdLife Overberg	De Hoop						
		External: Volunteers	Berg River Estuary						
		External: SANParks and Volunteers	Langebaan Lagoon	Biannual (Jan + Jul) minimum					
Priority sea birds are monitored to assess population trends and whether management actions are required. Cape Gannet Cape Cormorant Kelp Gull Hartlaub's Gull	• Breeding census, mortality & predation	Capability Manager: Biodiversity Intelligence, Marine & Coast Ecologist; Landscape Managers; Landscape Unit Managers, Landscape Conservation Intelligence Team; Senior Manager: Marine and Coasts; Marine & Coast Specialists	De Mond Stony Point Bird Island Dyer Island Dassen Islands Rocherpan MPA Ganzekraal	Annual (breeding season)	Population size estimates; breeding indicators; data to DFFE. Annual technical report.	Ecological Monitoring Protocol: Coastal Seabird Population Census	Operational budget, Vehicles, Spotting scopes, bird identification skills.	Bird Identification, counting skills, resources. Central data storage	Bonn Convention on Migratory species, Ramsar Reports DFFE return data flow (via e-mail) State of Biodiversity Report

Objective	Monitoring actions & inputs required	Responsibility	Region/Complex/ PA	Frequency	Measurable Outputs	Monitoring Protocol	Enabling resources required	Constraints/ Obstacles	Measurable Outcomes
Swift tern Caspian Tern White-breasted Cormorant Great White Pelican Leach's Storm Petrel Crowned Cormorant									IUCN Red List status updates
Fish diversity and abundance inside and outside the MPAs are assessed to inform management actions.	• Baited Remote Underwater Video Analysis • Species presence & abundance indices; data meant to go to SAIAB.	Capability Manager: Biodiversity Intelligence, Marine & Coast Ecologist; Landscape Managers; Landscape Unit Managers, Landscape Conservation Intelligence Team, Senior Manager: Marine and Coasts; Marine & Coast Specialists	Stilbaai - deprecated Goukamma Robberg De Hoop	Baseline for 2 years then once every 5 years	Technical Report compiled by Ecologist Marine & Coasts	BRUV protocol Ecological Monitoring Protocol: Baited Remote Underwater Video Analysis, 2020	Operational budget, Vehicles, boats, diving equipment, BRUV equipment, develop new partnerships	Data storage challenges, data processing constraints - too slow for annual analysis. Stilbaai to restart 5-year monitoring.	State of Biodiversity Report; State of Conservation Report
		External: WWF-SA	Betty's Bay						
		External: Dyer by DICT	Dyer Island						
Fishing pressure on fish and bait species in the Western Cape MPAs are assessed to inform management actions.	• National Marine Line Fish System • Species presence, numbers caught.	Capability Manager: Biodiversity Intelligence, Marine & Coast Ecologist; Landscape Managers; Landscape Unit Managers, Landscape Conservation Intelligence Team; Senior Manager: Marine and Coasts; Marine & Coast Specialists	Betty's Bay Walker Bay Geelkrans Goukamma Robberg Rocherpan De Mond	Monthly (but to provide meaningful data, should be weekly)	Technical Report to be compiled by the Ecologist Marine & Coasts	NMLS protocol Ecological Monitoring Protocol: The National Marine Line Fish System, 2013	Vehicles, rangers, fish identification skills, EMI appointment. Still in Excel format on PAs.	EMI appointments, Data storage, frequency, and timing of patrols. Betty's Bay & Walker Bay to start.	State of Biodiversity Report State of Conservation Report
The efficacy of CapeNature MPAs in protecting in shore line fish species are assessed to inform management actions, and fish population dynamics are recorded.	• Fish Catch Per Unit Effort Species presence, numbers caught, sizes • Annual technical report • Data in CN CPUE database	Capability Manager: Biodiversity Intelligence, Marine & Coast Ecologist; Landscape Managers; Landscape Unit Managers, Landscape Conservation Intelligence Team; Senior Manager: Marine and Coasts; Marine & Coast Specialists; Conservation Manager	Goukamma	Annual	Technical Report to be compiled by the Ecologist Marine & Coasts	CPUE protocol Ecological Monitoring Protocol: Fish catch and release (including tag and release) in MPAs, 2020	Operational budget, Vehicles, rangers, rods, fishing tackle, sufficient reliable volunteer anglers,	Important to get going properly. Labour & resource heavy.	State of Biodiversity Report State of Conservation Report

Objective	Monitoring actions & inputs required	Responsibility	Region/Complex/ PA	Frequency	Measurable Outputs	Monitoring Protocol	Enabling resources required	Constraints/ Obstacles	Measurable Outcomes
		External: DFFE	De Hoop						National Biodiversity Assessment
Rocky shore monitoring is conducted to assess the health of the ecosystem and identify management actions.	• Rocky Shore Monitoring • Species presence, sizes, and densities	Ganzekraal sites have been set up. No monitoring currently conducted.	Betty's Bay Ganzekraal De Hoop Goukamma Robberg	Biannual (seasonal)	Technical Report to be compiled by the Ecologist Marine & Coasts	Ecological Monitoring Protocol: Rocky shore monitoring- density measurements and photographic line transects, 2001	Operational budget, Vehicles, rangers, permanent sample sites and markers, quadrats, marine invertebrate identification skills	No capacity, expensive start-up costs, time consuming (approximately 4 consecutive days). Focus on MPAs and possible partners	State of Biodiversity Report State of Conservation Report National Biodiversity Assessment
Changes in water quality and estuary condition is monitored and documented to create a long-term, baseline database on water quality in estuaries.	• Conduct monthly monitoring on Salinity, pH, oxygen, temperature, conductivity. • Quarterly report to estuary Forum Data to DWS.	Capability Manager: Biodiversity Intelligence, Marine & Coast Ecologist; Landscape Managers; Landscape Unit Managers, Landscape Conservation Intelligence Team; Senior Manager: Marine and Coasts; Marine & Coast Specialists; Conservation Manager	Berg Estuary Bot Estuary Klein Estuary Heuningnes Estuary Goukou Estuary Goukamma Estuary Keurbooms/Bitou Estuary	Monthly	Quarterly reports per estuary compiled by LM1 assisted by Marine & Coast Specialists Annual report per estuary assisted by Marine & Coast Specialists Annual Technical report to be compiled by Ecologist Marine & Coasts	Estuary Water Quality SOG, 2020 Ecological Monitoring Protocol: Water Quality Monitoring in Estuaries, 2017	Operational budget, Vehicles, rangers, boats, probes,	Capacity, equipment	State of Biodiversity Report State of Conservation Report National Biodiversity Assessment
		External: SA Shark Conservancy	Bot Estuary will assist in future						
		External: DICT	Uilkraal Estuary						
		External: West Coast District Municipality	Verlorenvlei Estuary Olifants River Estuary						
Assess indicator species of coastal and marine health	• Carry out appropriate monitoring at designated sites. (See identification of indicator species as research need below)	Landscape Manager (L2 & L1); Conservation Manager (On Reserve); Specialist Manager Marine and Coasts Operations; Landscape Conservation Intelligence Manager; Marine Ecologist; Senior Manager Marine and Coasts Operations.	All coastal PAs	Annual	Annual coastal and marine indicator species monitoring report developed reflecting state of indicator species and ecosystem. Data included into the Western Cape State of Conservation Report and National Biodiversity Assessment. Data reflected in quarterly and annual DFFE Marine Protected Area reports.	Appropriate monitoring protocols to be developed?			Effective conservation management rating in Marine Protected Area reports.

Objective	Monitoring actions & inputs required	Responsibility	Region/Complex/ PA	Frequency	Measurable Outputs	Monitoring Protocol	Enabling resources required	Constraints/ Obstacles	Measurable Outcomes
Ground and surface water utilisation on CapeNature protected areas are determined and monitored to preserve the ecological reserve/flow.	• Measure water usage relative to ecological reserve/flow. • Monitor water abstraction quantity and water quality of CapeNature boreholes Protected Areas where abstraction is taking place according to CapeNature monitoring protocol. • Flow velocity using handheld transparent velocity rod (to be bought). • Meters to be installed (CN water use requirement)	Capability Manager: Biodiversity Intelligence, Freshwater Ecologist; Landscape Managers; Landscape Unit Managers, Landscape Conservation Intelligence Team; Conservation Managers	All relevant PAs	Monthly or quarterly (tbc)	Flow velocity using handheld transparent velocity rod (to be bought).	Ground water monitoring protocol. Site specific river flow monitoring protocol, GCTWF aquatic protocol	Operation budget, vehicles, field rangers, equipment, sampling expertise	Capacity, equipment still lacking.	State of Conservation Reports State of Biodiversity Report PAMPs
Species distribution data is obtained to inform IUCN assessments (presence/absence surveillance).	• Base-line surveillance through targeted bioblitzes.	Capability Manager: Biodiversity Intelligence, Ecologists (as required); Landscape Managers; Landscape Unit Managers, Landscape Conservation Intelligence Team; Marine & Coast Specialists; Conservation Managers	As per schedule	At least every five years or as set in PAMPs	Bioblitz summary report data captured in database, technical report;	Baseline Manual, 2010	Operational budget, Vehicles, Specialist identification skills, overnight accommodation/camping,	Time	State of Biodiversity Report State of Conservation Report IUCN Red List & Protection Level Assessments PAMP
The impacts of tourism events are determined and used to inform the reserve specific carrying capacity (type, number, and frequency).	• Measure erosion on trails according to the CapeNature protocol.	Environmental Control Officer of company that hosts the event Conservation Manager (on reserve)	Per relevant event	Per event	Monitoring report with management recommendations and/or interventions. Infrastructure use monitoring datasheets and database.	Ecological Monitoring Protocol for Event Monitoring on Protected Area roads, jeep tracks and trails, 2013	Operational budget, Vehicles, Equipment such as radios, GPS, cameras, measuring wheel and tape, measuring pole, stakes, and fixed-point markers. GIS skills.	Capacity, resources.	Technical reports on each event that is monitored.
The impacts of disasters and unplanned events are determined and monitored to inform mitigation measures.	• Monitor biodiversity impacts caused by disasters/unplanned events.	LCIM/Ecologists and other depending on nature and location of event	All	Per event	Indicators will need to be determined after the event as this will depend on the nature of the event	Monitoring protocols to be developed once disaster/unplanned event has occurred. Use existing protocols where appropriate e.g. oil spills.	Operational budget, Vehicles	Capacity, resources, expertise	Technical reports on each disaster that is monitored.

Table 3. Research implementation action plan for 2022-2026.

Objectives	Research actions/topics	Responsibility	Time frame	Measurable Indicators	Constraints/obstacles
The CapeNature research requests webpage is updated.	E-mail main research partners to alert them to the updates	Capability Manager: Biodiversity Intelligence	Annually by end October as new projects become necessary	Updated web page content	Post vacant.
Provide support key research projects:					
Invasive alien species are prioritised for control based on their negative impact on biodiversity or water resources.	Map and assess where managing IAS will have the greatest positive impact on biodiversity.	Restoration Ecologist	2022-2024	Map of biodiversity priorities for IAP management	Reliance on external contract for expertise.
The management of widespread and expanding invasive alien species is improved.	Investigate novel methods, including herbicides and biocontrol, for improving control efficiency of invasive alien trees, **especially pines**.	Restoration Ecologist	2022-2023	Updated or new SOPs	Reliant on regulatory approval (slow).
Develop a suite of indicator species to indicate vegetation health for lowlands systems such as renosterveld and strandveld.	Identify appropriately sensitive indicator species	Flora Ecologist	2022-2025	New SOPs	Botanical expertise.
Areas are quantified and prioritised for management action.	Develop improved methods of remote mapping of invasive alien plant species. Includes use of drone imagery	Capability Manager: Biodiversity Intelligence	2022-2026	Improved, automated map of invasive alien plant species.	Reliant on new systems being embedded in responsible
Fire management is focussed and defensible.	Conduct research to set clear thresholds of potential concern for fire management (set new TPCs where they have not been set and evaluate existing TPCs)	Capability Manager: Integrated Catchment	2022-2025	TPCs set per PA or PA cluster (in PAMPs)	Data quality
CapeNature's management is valued in support of providing essential ecosystem services to the province.	Quantify the water delivery ecosystem service delivered by CapeNature.	External contract (no in-house expertise)		Estimates of mean annual runoff per PA.	Budget
Quantify and map loss of natural habitat and priority conservation areas to regularly update and direct conservation planning.	Develop a semi-automated natural area and CBA loss measurement system.	External contract (no in-house expertise). Some of this work already underway. DEA&DP		National land cover classification	Budget
Fish diversity and abundance inside and outside MPAs are assessed to inform management actions.	Conduct baseline BRUV surveys in MPAs that without this information	Capability Manager: Biodiversity Intelligence	2022-2026	Reef fish species assemblage, abundance, and distribution	Large amounts of data produced and budget constraints
There is recovery of line fish stocks post rezonation to no-take MPA.	Conduct catch per unit effort research at Robberg MPA pre and post closure	Capability Manager: Biodiversity Intelligence	2022-2026	Species assemblage, size, and distribution of Line fish at Robberg MPA	Requires a team of volunteer anglers
Ensure that key indicator species are identified for monitoring effective coastal PA management	Engage with DFFE, DEA&DP and partners to identify key indicator species	Landscape Manager, Landscape Unit Manager; Conservation Manager (On Reserve); Landscape Conservation Intelligence Manager; Marine Ecologist; Senior Manager Marine and Coasts Operations.	2022-2026	Indicator species identified and appropriate monitoring protocols implemented	

References

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Appendix 1: List of CapeNature managed biodiversity databases 2021-22

Dataset	Responsibility
Aliens (IAP density, wall to wall mapping)	GIS Specialist
Fire Database	GIS Specialist
State of Biodiversity (Distribution/presence data)	Technologist: Biodiversity Databases
State of Biodiversity (Population monitoring data)	Technologist: Biodiversity Databases
Biocontrol Monitoring	Technologist: Biodiversity Databases
Game on Reserves Register	Technologist: Biodiversity Databases
Geometric Tortoise, African Penguin, Cape Mountain Zebra and Cape Vulture monitoring	Technologist: Biodiversity Databases
Corporate GIS database	GIS Technician
Invertebrate SASS	Freshwater Ecologist
Permanent Protea plot monitoring	Technologist: Biodiversity Databases
Post-fire Protea monitoring	Technologist: Biodiversity Databases
Western Cape Game Distribution Database	Technologist: Biodiversity Databases
Seabird Predation and Mortality database V2	Technologist: Biodiversity Databases
Vulture Monitoring	Team Leader: Ecology
Waterbirds Count data (CWAC)	Team Leader: Ecology
Damage Causing Animals	Biodiversity Conservation Specialist

Appendix 2: Complete list of Research permits issued by CapeNature (1 April 2021 - 29 March 2022).

Permit type	Number
Enter in a nature reserve for scientific purposes	15
Pluck flora protected and unprotected for research purposes	42
Hunt with prohibited hunting method of wild animals – research purposes	77
Grand Total	134

Appendix 3: List of Formal Research Partners (on 31 March 2022)

Name of MoU/MoA	Signatories to the MoU/MoA (names of org/company)	Value of the MoU/MoA	Start & end dates of the MoU/MoA	Deliverables of the MoU/MoA (very briefly)
University of Free State	CapeNature & University of Free State	None	5/06/2017 - 2022 (5 years)	To Research, Monitor, Training and Capacity Building Project agreement.
Nelson Mandela Metropolitan University (NMMU)	CapeNature & NMMU	Each party bears their own cost	12/06/2017 - 2022 (5 years)	To ensure that diving operations are conducted within the legal framework of OHS Act and Diving Regulations
South African Shark Conservancy	CapeNature & South African Shark Conservancy	None	8/05/2017 - 2022 (5 years)	Has certain skills capacity and research facilities such as specialized expertise to do certain research and offer training in marine science and marine monitoring.
University of the Western Cape	CapeNature & University of the Western Cape	None	25/03/2020 - 24/03/2025	MOU about the establishment of a collaborative relationship in areas of research, training and capacity building in institutional collaboration and interchange of scientific knowledge
DEA: Oceans & Coasts	CapeNature & DEA: Oceans & Coasts	R2 840 000 P/A	20/11/2017 – 29/11/2022	Management of MPAs and Islands
University of the Western Cape	CapeNature & University of the Western Cape	None	18/10/2019 – 17/10/2024	Establishment of a collaborative relationship in areas of research, training and capacity building in institutional collaboration and interchange of scientific knowledge
The Nature Conservancy of South Africa	CapeNature & The Nature Conservancy of South Africa	Funded by TNC	8/07/2020 – 7/07/2022	Invasive alien clearing, funded and managed by The Nature Conservancy (TNC) on CapeNature managed land.
World Wide Fund for Nature South Africa (WWF-SA)	WWF-SA & CapeNature	Funded by WWF	20/07/2020 – 19/07/2022	Invasive vegetation clearing on CapeNature-managed land
The Cape Leopard Trust	CapeNature & The Cape Leopard Trust	None	07/09/2020 – 06/09/2023	Concerning a coordinated approach to predator research, predator management and environmental conservation and education in the Western Cape Province

Name of MoU/MoA	Signatories to the MoU/MoA (names of org/company)	Value of the MoU/MoA	Start & end dates of the MoU/MoA	Deliverables of the MoU/MoA (very briefly)
DSI-NRF Centre of Excellence for Invasive Biology, Stellenbosch University	CapeNature & DSI-NRF Centre of Excellence for Invasive Biology, Stellenbosch University	None	01/04/2021 – 31/03/2023	Research on invasive alien species, their control, and their impacts on biodiversity.
Metos SA (Pty) Ltd	Metos SA (Pty) Ltd & CapeNature	None	08/03/2022 – 07/03/2027	Environmental Monitoring, Data Exchange, cooperation in areas of technology use, transfer and development and collaborate on projects. Installation & Maintenance of Automatic Weather Stations on CapeNature protected areas.