# WESTERN CAPE
# 2023
# STATE OF BIODIVERSITY REPORT










Western Cape Government
FOR YOU

CapeNature

## ACKNOWLEDGEMENTS

CapeNature expresses its thanks to partners and collaborators for contributing to the development of the 2023 Western Cape State of Biodiversity Report.

CapeNature extends its special thanks to the South African National Biodiversity Institute and the South African National Parks for their support.


## SUGGESTED CITATION: ENTIRE REPORT

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Kogelberg Nature Reserve - King Protea (*Protea cynaroides*)
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## Acronyms

| | |
|---|---|
| ARC | Agricultural Research Council |
| BioSCape | Biodiversity Survey of the Cape |
| BOCMA | Breede-Olifants Catchment Management Agency |
| BRUV | Baited Remote Underwater Video |
| BSP | Biodiversity Spatial Plan |
| CAP | Conservation Action Priorities map |
| CBA | Critical Biodiversity Area |
| CBD | Convention on Biological Diversity |
| CIB | Centre for Invasion Biology |
| CITES | The Convention on International Trade in Endangered Species |
| COP | Conference of the Parties |
| CPUE | Catch Per Unit Effort |
| DEA&DP | Department of Environmental Affairs and Development Planning |
| DFFE | Department of Forestry, Fisheries, and the Environment; previously Department of Environmental Affairs (DEA) |
| DWS | Department of Water and Sanitation |
| EFZ | Estuarine Functional Zone |
| ENDR | Extended Natural Distribution Range |
| ESA | Ecological Support Areas |
| FBIS | Freshwater Biodiversity Information System |
| FTE | Fixed term Employee |
| GBF | Global Biodiversity Framework |
| GCFR | Greater Cape Floristic Region |
| GCTWF | Greater Cape Town Water Fund |
| IAP | Invasive Alien Plants |
| IPCC | The Intergovernmental Panel on Climate Change |
| IUCN | International Union for Conservation of Nature |
| NASA | National Aeronautics and Space Administration |
| NBA | National Biodiversity Assessment |
| NBF | National Biodiversity Framework |
| NBSAP | National Biodiversity Strategy and Action Plan |
| NDR | Natural Distribution Range |
| NEM: BA | National Environmental Management: Biodiversity Act |
| NEM: PAA | National Environmental Management: Protected Areas Act |
| NFEPA | National Freshwater Ecosystem Priority Areas |
| NGO | Non-Governmental Organisation |
| NMLS | National Marine Linefish System |
| NPAES | National Protected Area Expansion Strategy |
| NRM | Natural Resource Management |
| PA | Protected Area |
| RLE | IUCN Red List of Ecosystems |
| RLI | Red List Indices |
| SANBI | South African National Biodiversity Institute |
| SANLC | South African National Land Cover |
| SASS | South African Scoring System |
| SOB | State of Biodiversity |
| SWSA | Strategic Water Source Area |
| TNC | The Nature Conservancy |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNODC | United Nations Office on Drugs and Crime |
| WCCC | Western Cape Conservation Category |
| WCNCB | Western Cape Nature Conservation Board; trading as CapeNature |
| WCG | Western Cape Government |
| WCP | Western Cape Province |
| WCPAES | Western Cape Protected Area Expansion Strategy |
| WWF-SA | Worldwide Fund for Nature: South Africa |

CapeNature is proud to present the 2023 Western Cape State of Biodiversity Report which represents the status of priority conservation indicators on 31st of March 2023.

The outcomes of the 15th United Nations Biodiversity Conference of Parties to the Convention of Biological Diversity, which concluded in the landmark 2022 Kunming-Montreal Global Biodiversity Framework agreement has set the course to guide current and future global action for nature.

CapeNature is privileged to contribute to the South African perspective where the status of biodiversity in the Western Cape impacts the outcomes towards reporting on progress towards the targets of the framework.

CapeNature endeavored to produce annual snapshots of the status of biodiversity in the Western Cape since 2020, through the publication of annual State of Conservation Reports, which are precursors to this more comprehensive State of Biodiversity Report, detailing the methods of assessments, results and highlighting the impacts and guide decision making.

**Dr Razeena Omar**
**Outgoing Chief Executive Officer**

## PURPOSE

The Western Cape Biodiversity Act, 6 of 2021 (WCBA) mandates CapeNature, the provincial authority responsible for nature conservation in the Western Cape, to report on the state of biodiversity in the province: CapeNature provides succinct annual State of Conservation Reports in addition to this more comprehensive State of Biodiversity Report.

The results of this report and of the 2023 Western Cape Biodiversity Spatial Plan (2023 WC BSP), are key informants for the National Biodiversity Assessments (NBAs, see SANBI 2019a), the Provincial Biodiversity Strategy and Action Plan (DEA&DP 2016), the National and Provincial Protected Area Expansion Strategies (Government of South Africa 2009, CapeNature 2021a), and Western Cape State of Environment Outlook Report (DEA&DP 2018). Collectively, these respond to South Africa's obligations to international conventions, e.g., the Convention on Biological Diversity (CBD) and the Global Biodiversity Framework (GBF), the Convention on Migratory Species, and the Ramsar Convention. This report also supports the requirement for an evidence-based approach to management and the policies that CapeNature develops as articulated in the National Biodiversity Research and Evidence Strategy 2015-2025 (DEA 2016).

Besides these requirements, monitoring and reporting on the state of biodiversity is an essential guide for the sustainable management of the environment of the Western Cape. This is especially the case in the context of climate change, biodiversity loss (Secretariat of the CBD 2020), ecosystem and species restoration and sustainability (resilience and adaptation). Regular reporting is necessary to monitor the success of management interventions and to adapt to the factors that drive the status of biodiversity. Regularly gathering and analyses of state of biodiversity evidence is essential for Strategic Adaptive Management, enabling management authorities to respond to change and continuously improve management or maintain status quo.

Reporting on the state of biodiversity at a provincial level date to 2002, with subsequent reports released in 2007, 2012 and 2017 (CapeNature 2007, 2012 and 2017b respectively). The 2023 Western Cape State of Biodiversity Report (2023 WC SOBR) builds on the 2017 CapeNature State of Biodiversity Report, the last report published in the series, and covers the period from April 2017 to March 2023.

## CONTEXT

Biological diversity is vital in sustaining all living systems, including all natural systems on which human life depends (Centre for Sustainable Systems 2022, UN Environment 2019). The Western Cape abounds with rich biodiversity and complex ecosystems, underpinning critical ecological infrastructure which provides essential ecosystem services to the people of the province: Healthy natural ecosystems are crucial for the survival of species and to sustain human livelihoods. Diversity within and between species is the currency of ecosystem diversity and ecological processes, which are in turn linked to the provision of ecosystem services such as pollination, soil health, water purification and food provision. In addition, biodiversity harbours aesthetic, recreational, cultural, and spiritual values essential for human wellbeing. The status of natural ecosystems is primarily impacted by loss of habitat, degradation, and climate change, globally (Skowno *et al.*, 2019b, CBD 2022) and is equally true for the Greater Cape Floristic Region, the world's smallest floristic region and a global biodiversity hotspot.

Climate change is a "Threat Multiplier" for ecosystems, human disaster, security and ultimately conflict (Huntjens & Nachbar 2015). As the planet experiences increased pressure from population growth, economic development, and a warming climate; species, habitats and ecosystems are stressed to the point where they may be drastically altered, moved, or may collapses. The climate projections for the Western Cape not only indicate a general warming trend, but also drying in many areas, with increased variability of rainfall (longer time periods between increasingly intense rainfall events) (DEA&DP 2023a, Beck *et al.* 2018). Drying is of particular concern in a province that is already water stressed. These broad projections raise the risk profile of the Western Cape, a province already vulnerable to drought, floods, and fire. In addition, the province has a coastline spanning approximately 900 km, leaving it vulnerable to climate change induced storm surges and sea level rise (DEA&DP 2023a). Being a winter rainfall area, the Western Cape is especially vulnerable to climate change compared to other provinces in the country that are summer rainfall areas. The vegetation and agricultural conditions are therefore largely unique to this province, resulting in a particular climate vulnerability (DEA&DP 2023a).

The Western Cape Climate Change Response Strategy (DEA&DP 2023a) highlights the fact that well-managed natural systems reduce climate vulnerability and improve resilience to climate change. A number of climate change response aligned programmes have been identified within the Western Cape Government with a key focus being on the advancement of the ecological resilience outcomes of the Provincial Biodiversity Strategy and Action Plan, through implementation of the Ecological Infrastructure Investment Framework, Biodiversity Spatial Plan and Protected Area Expansion Strategies in order to secure investment into natural capital and restoration our land and oceans.

At the basis of biodiversity conservation is knowledge and an understanding of what remains and what has been lost, what is at risk of being lost and what threats must be addressed to mitigate biodiversity loss. The information generated from knowledge and understanding informs progress toward the long-term goals for 2050 related to the 2050 Vision for Biodiversity of the United Nations CBD GBF. The 2022 Kunming-Montreal Global Biodiversity Framework includes four goals and 23 targets to be achieved by 2030 identified during the 15th Conference of Parties (COP) of the CBD.

### GOAL A – 2050 VISION FOR BIODIVERSITY

- *The integrity, connectivity and resilience of all ecosystems are maintained, enhanced, or restored, substantially increasing the area of natural ecosystems by 2050.*
- *Human induced extinction of known threatened species is halted, and by 2050, extinction rate and risk of all species are reduced tenfold, and the abundance of native wild species is increased to healthy and resilient levels.*
- *The genetic diversity within populations of wild and domesticated species, is maintained, safeguarding their adaptive potential.*

With these considerations in mind, the 15th COP to the UN CBD adopted the 23 targets of the "2022 Kunming-Montreal Global Biodiversity Framework". Targets 1 to 8 relate to reducing threats to biodiversity. The SOBR responds to inform progress against targets 2, 3, 4, 6 & 8.

#### Target 2

*Ensure that by 2030 at least 30 per cent of areas of degraded terrestrial, inland water, and coastal and marine ecosystems are under effective restoration, to enhance biodiversity and ecosystem functions and services, ecological integrity, and connectivity.*

#### Target 3

*Ensure and enable that by 2030 at least 30 per cent of terrestrial, inland water, and of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures, recognising indigenous and traditional territories, where applicable, and integrated into wider landscapes, seascapes and the ocean, while ensuring that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognising and respecting the rights of indigenous peoples and local communities including over their traditional territories.*

#### Target 4

*Ensure urgent management actions to halt human induced extinction of known threatened species and for the recovery and conservation of species, in particular threatened species, to significantly reduce extinction risk.*

**Target 6**

*Eliminate, minimize, reduce and or mitigate the impacts of invasive alien species on biodiversity and ecosystem services by identifying and managing pathways of the introduction of alien species, preventing the introduction and establishment of priority invasive alien species, reducing the rates of introduction and establishment of other known or potential invasive alien species by at least 50 percent, by 2030, eradicating or controlling invasive alien species especially in priority sites, such as islands.*

**Target 8**

*Minimize the impact of climate change and ocean acidification on biodiversity and increase its resilience through mitigation, adaptation, and disaster risk reduction actions, including through nature-based solution and/or ecosystem-based approaches, while minimizing negative and fostering positive impacts of climate action on biodiversity.*

## REPORT OUTLINE

The structure of this report has evolved to include new information on the taxonomic groups, ecosystems, provincial-level indicators, and reporting requirements. This aligns with the knowledge assessment of biodiversity and ecosystem services and their interlinkages recommended by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

Chapters one to three account for the state of terrestrial, freshwater, and coastal ecosystems in the Western Cape. Changes in hydrological regime and poor water quality are the major pressures on biodiversity in inland aquatic, estuarine, coastal ecosystems and selected terrestrial ecosystems in the Western Cape (SANBI 2019b). For terrestrial ecosystems, habitat loss is largely accounted for by conversion of wild lands to agriculture, which now accounts for some 30% of land globally. This, combined with the known relationship between habitat area and species numbers could potentially mean that around 9 per cent of the world's estimated 5.9 million terrestrial species (> 500,000 species) have insufficient habitat for long-term survival, and are committed to extinction, many within decades, unless their habitats are restored (IPBES 2019).

Chapters four and five focus on the status of indigenous species and associated monitoring and surveillance. The diversity, endemism, and threat status of indigenous taxa in selected taxonomic groups in the Western Cape is described and changes to the conservation status of taxa since the publication of the 2017 State of Biodiversity Report are highlighted. The conservation status of taxa is tracked via the IUCN Red List of Threatened Species and South African Red Data Lists. Relevant data collected via monitoring and surveillance feed into the South African Red Data lists via the South African National Biodiversity Institute (SANBI).

Chapter six and seven focus on the status and threats of protected areas. A key aim of the Western Cape Protected Area Expansion Strategy (WCPAES) is to increase representation of threatened ecosystems as mitigation of the key threats facing protected areas and estuaries.

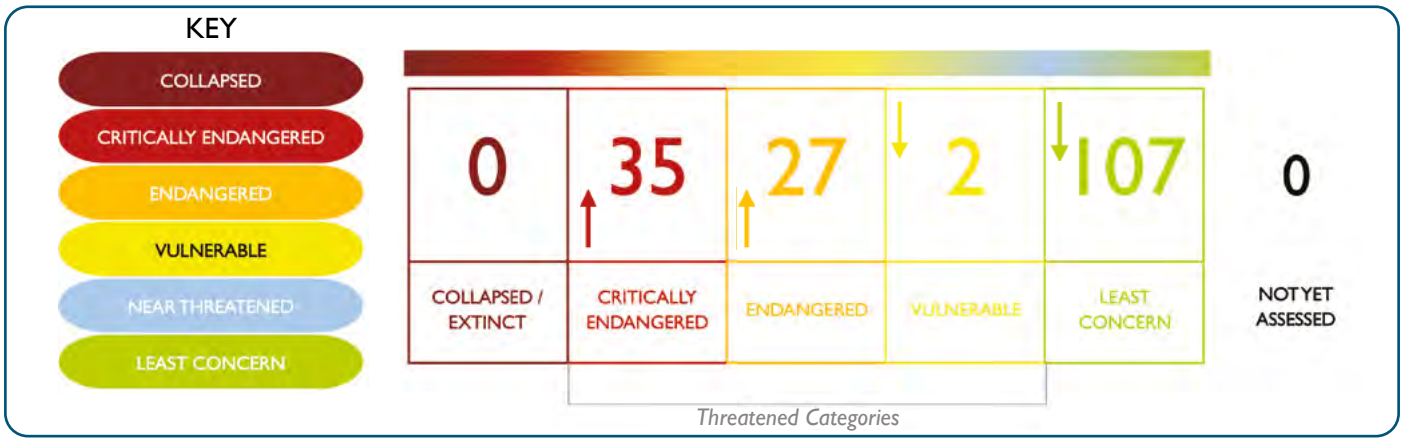
Chapter eight, nine and eleven highlight the status of the primary threats to biodiversity: habitat loss, biodiversity crime and invasive alien species.

Chapter ten reviews the effect of fire in protected areas as a key ecological driver of the Fynbos biome in view of ignitions, cause, frequency, and season.

Annexure One lists scientific and semi-scientific, authored, or co-authored publications, contributions to chapters in books and reports, and presentations given at conferences, symposia, and forums, by CapeNature employees.

Annexure Two lists CapeNature's formal partnerships.

The Western Cape is home to the Greater Cape Floristic Region (GCFR), comprising of the Core Cape Subregion and Extra Cape Subregion (Manning & Goldblatt 2012; Snijman 2013). The GCFR contains both the Fynbos and Succulent Karoo Biomes which collectively cover just over 67% of the province. Four additional biomes are also represented within the province, namely the Nama-Karoo, Albany Thicket, Azonal Vegetation, and Forest Biomes (specifically Afro-temperate Forests). Collectively, these six biomes are made up of 171 terrestrial ecosystems which are defined in the Western Cape Biodiversity Act, 2021 (Act No. 6 of 2021) as "*a dynamic complex of animal, plant and microorganism communities and their non-living environment interacting as a functional unit, which may be terrestrial, coastal, inland aquatic, estuarine or marine, or a combination thereof*". In the context of this chapter, terrestrial ecosystems are defined as **vegetation types** and the two terms are used interchangeably.




## 1.1 METHODS

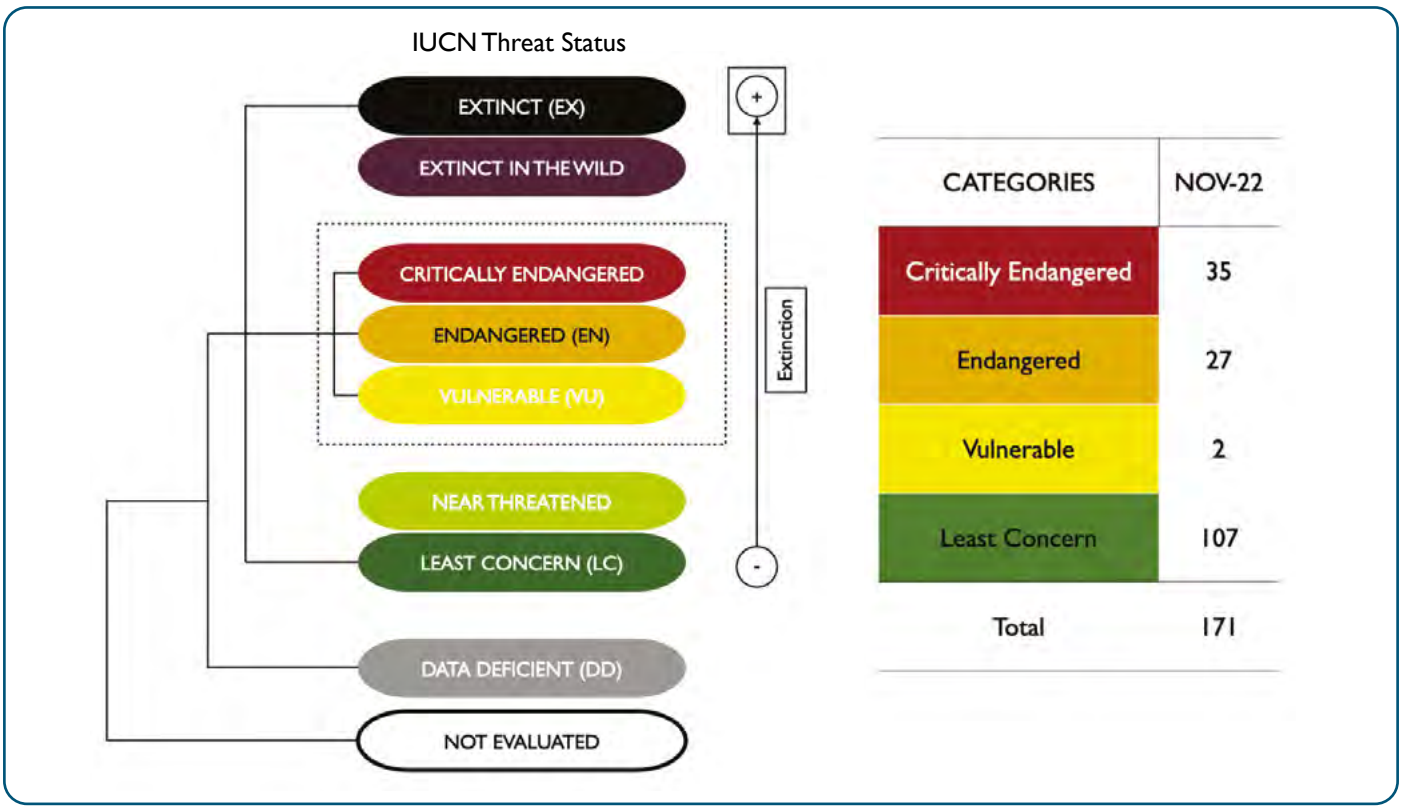
Terrestrial ecosystems face many pressures including loss of habitat, alien invasive species, unsustainable natural resource use, inappropriate development, and the impacts of climate change. To better understand and quantify the degree these impacts have on ecosystems, South Africa implements a national list of threatened ecosystems as a national indicator of ecosystem conservation status. The threat status of terrestrial ecosystems was nationally assessed for the first time in 2004 (Botts *et al.* 2020). In that same year, it became mandatory that this list of threatened ecosystems is updated at least every five years (National Environmental Management Biodiversity Act (NEM:BA) (Act No. 10 of 2004). The first legislated list of threatened ecosystems was subsequently published in 2011(Skowno & Monyeki 2021). In 2018, South Africa adopted the IUCN Red List of Ecosystems (RLE) approach, which is a framework for assessing the risks and threats to ecosystems, as per the IUCN Red List of Species (Table 1.1). Vegetation units, as described by Mucina and Rutherford (2006), defined the terrestrial ecosystem types assessed in accordance with the RLE. Criteria A and B (criteria linked to spatial configuration and remaining extent of ecosystems) of the RLE framework were applied and incorporated in the 2018 National Biodiversity Assessment (NBA). It was acknowledged that vegetation types are consistent units that represent biodiversity at an appropriate scale for use in the RLE (Botts *et al.* 2020). An updated list, making use of the best available information, was subsequently developed between 2016 and 2021 (2022 Ecosystem Status - Biodiversity BGIS (sanbi.org)).

This core assessment was supplemented with additional assessments of selected ecosystem types based on additional data on ecosystem extent and condition, of which habitat loss and degradation were of particular importance in the case of the Western Cape (Skowno & Monyeki 2021). CapeNature provided additional data on selected ecosystems in support of changes to the original draft RLE List resulting in the determination of the final ecosystem status list.

## 1.2 RESULTS

The revised national list of ecosystems that are threatened and in need of protection was published in terms of NEMBA on 18 November 2022 (Republic of South Africa 2022). The Red List of Threatened Ecosystems 2022 (Government Gazette No: 47526) formally replaced the 2011 list. There are 171 terrestrial ecosystems in the Western Cape of which 64 are listed as threatened (Table 1.1; Figure 1.1). South Africa has 51 Critically Endangered terrestrial ecosystems and 35 of these form part of the fynbos biome, a majority of which are located in the Western Cape (Figure 1.1).

Table 1.1. IUCN RLE Threat Status of the Western Cape Terrestrial Ecosystems (Republic of South Africa 2022).




| CATEGORIES | NOV-22 |
|---|---|
| Critically Endangered | 35 |
| Endangered | 27 |
| Vulnerable | 2 |
| Least Concern | 107 |
| Total | 171 |

The Western Cape Protected Area Estate ensures the partial protection of 151 terrestrial ecosystems.

*Gladiolus quadrangulus*
© CapeNature

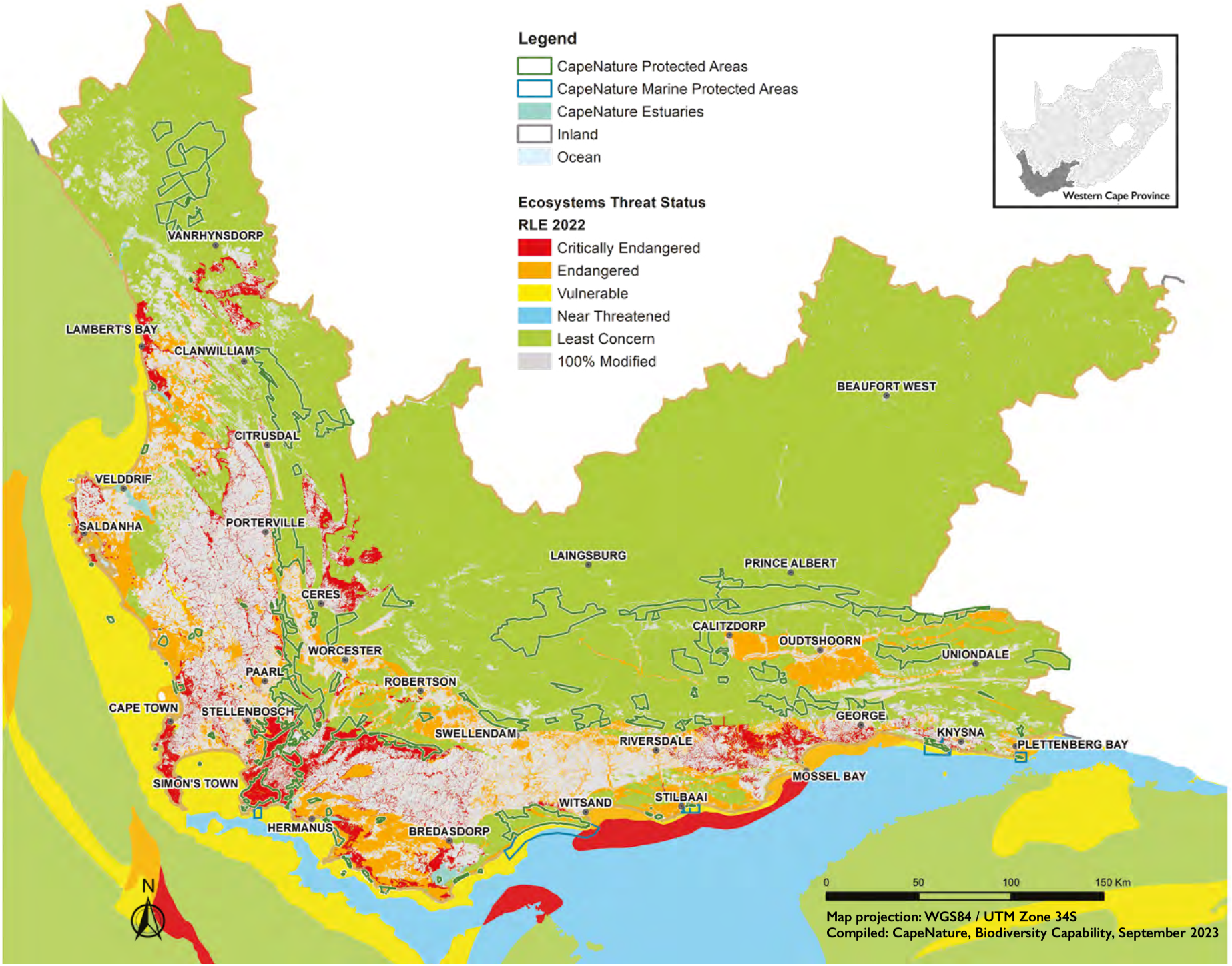



Figure 1.1. Threat status of the Ecosystems of the Western Cape (CapeNature 2022a).

## 1.3 DISCUSSION AND RECOMMENDATIONS

Key threats to ecosystems include habitat loss (due to urban and agricultural expansion and mining amongst others), habitat modification (due to invasive alien species, and inappropriate fire regimes), climate change (particularly changes in temperatures and rainfall patterns), over-exploitation of natural resources, and illegal harvesting of natural resources.

CapeNature contributes to RLE revisions led by SANBI and the results together with the mapped ecosystems and their established protection targets, have been incorporated into the newly revised Biodiversity Spatial Plan which spatially locates various categories of biodiversity priority areas as mandated by the Western Cape Biodiversity Act (6 of 2021). The resultant prioritisation of areas important for biodiversity is used to inform land use and development planning, environmental assessment and regulation, and natural resource management. The delineation of Critical Biodiversity Areas (CBA) and Ecological Support Areas (ESA) are essential for guiding decision-makers to prioritise and ensure the protection and maintenance of areas that are crucial for the continued existence and functioning of species and ecosystems.

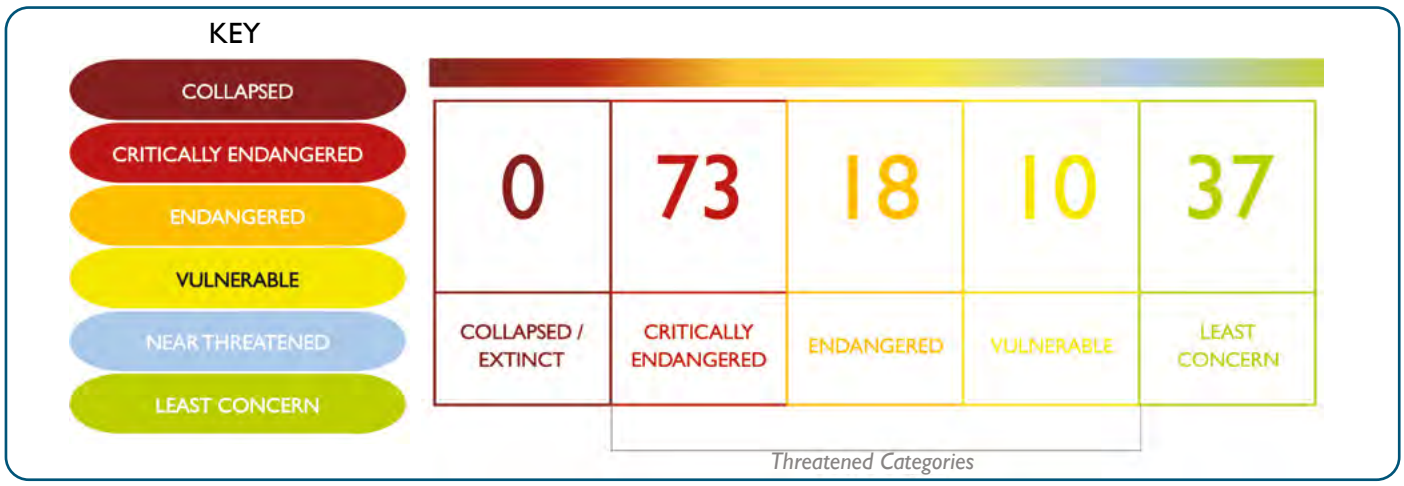
### E-Links

**Ecosystem Status** http://ecosystemstatus.sanbi.org.za

Groot Winterhoek Wilderness Area
© Scott Ramsay

Freshwater ecosystems remain under pressure globally from anthropogenic impacts and climate change and the decline of ecological health in these systems have continued (Gouws & Gordon 2017; Gozlan *et al.* 2018; CapeNature 2022a). Wetlands and estuaries are the most threatened ecosystems nationally, and similarly, in the Western Cape, 80% of these ecosystems are threatened, (Skowno *et al.* 2019a, see Western Cape summary report). This is concerning because freshwater ecosystems provide important services, especially in terms of ecosystem services, water resilience and water security.

Threats to inland freshwater ecosystems are driven by changes to the hydrological (or flow) regime and by pollution. Diversity is driven by geomorphological zones (Rowntree *et al.* 2000), seasonality of flow, ecoregions of rivers (Kleynhans *et al.* 2005), the hydro-geomorphic wetland types (Ollis *et al.* 2013) and the specific vegetation bioregion (van Deventer *et al.* 2019). The water sources of freshwater ecosystems are influenced by surface and groundwater, which depend on the prevailing hydrological function, the landscape topography, and underlying hydro-geological structures and pathways (Day & Davies 2023). Many freshwater ecosystems are groundwater or aquifer dependent. (Colvin *et al.* 2007; Strydom *et al.* 2021). Several wetland and river systems also form peatlands and the upper zones of many of these systems fall into either or both surface and groundwater Strategic Water Source Areas (SWSA's; Lotter & Le Maitre 2021).




## 2.1 METHODS

Threat statuses according to IUCN categories and protection levels of freshwater ecosystems were obtained from the latest National Biodiversity Assessment (Skowno *et al.* 2019a). Rivers and wetland threat assessments were conducted based on spatial datasets, ecosystem type and ecological condition (van Deventer *et al.* 2019). A subset of the data was used in the review to assess the status of rivers and wetland ecosystems in the Western Cape. This dataset was supplemented with more recent reports and data where available (Thirion & Jafta 2019, Dallas *et al.* 2022). The combined length of rivers (in meters) and area of wetlands (in hectares) per threat status category for CapeNature managed properties were sourced from the 2018 NBA (van Deventer *et al.* 2019).

### 2.1.1 River Ecosystems

River condition in the Western Cape was assessed using the 2018 NBA rivers layer (van Deventer *et al.* 2019). This was supplemented with river health data from selected sites in the Berg, Riviersonderend and Garden Route catchments during the 2017/2018 period (Thirion & Jafta 2019). No ecological health data was available for the Olifants-Doring and Gouritz river catchments from 2017 to 2023. To address this, data was sourced from the Freshwater Biodiversity Information System (FBIS) database, which included data from CapeNature river surveys (Dallas *et al.* 2022). The South African Scoring System version 5 (SASS 5) macro-invertebrate data from Western Cape rivers were download from the FBIS platform and assessed from April 2018 to March 2023.

### 2.1.2 Wetlands

The wetland ecological condition assessment in the Western Cape was assessed from data collected during the mapping process for the update of the National Wetlands Map (NWM) version 5 (Van Deventer *et al.* 2019). Further information was sourced from the South African National Biodiversity Institute's Ecological Infrastructure for Water Security Project (SANBI, in prep. 2023). Information on confirmed and unconfirmed peatlands was obtained from the Agricultural Research Council (ARC) (A Grundling, pers. comm; J Le Roux, pers. comm.).

## 2.2 RESULTS

### 2.2.1 River Ecosystems

A total of 64 different river types are located within the Western Cape, 24 of which are Critically Endangered with a majority of these occurring in the lower foothill and lowland areas (Skowno *et al.* 2019a; see Western Cape summary report; Figure 2.1).

CapeNature managed protected areas plus stewardship sites include 1 452 km of the total mapped river length (about 24 268 km) in the Western Cape. This equates to a 6% contribution to the total length of rivers of the Western Cape. Rivers in the CapeNature protected areas and stewardship sites have significant lengths of especially Endangered (EN), Vulnerable (VU) and Least Threatened (LT) river types relative to those outside of these protected areas (Figure 2.2). The Critically Endangered (CR) river lengths within CapeNature protected areas are less than the percentage CR river length mapped in the province (13.9% vs. 22.0% respectively). These results emphasise the positive role that protected areas play in the conservation of threatened river ecosystems.

Keurbooms River Nature Reserve
© Scott Ramsay

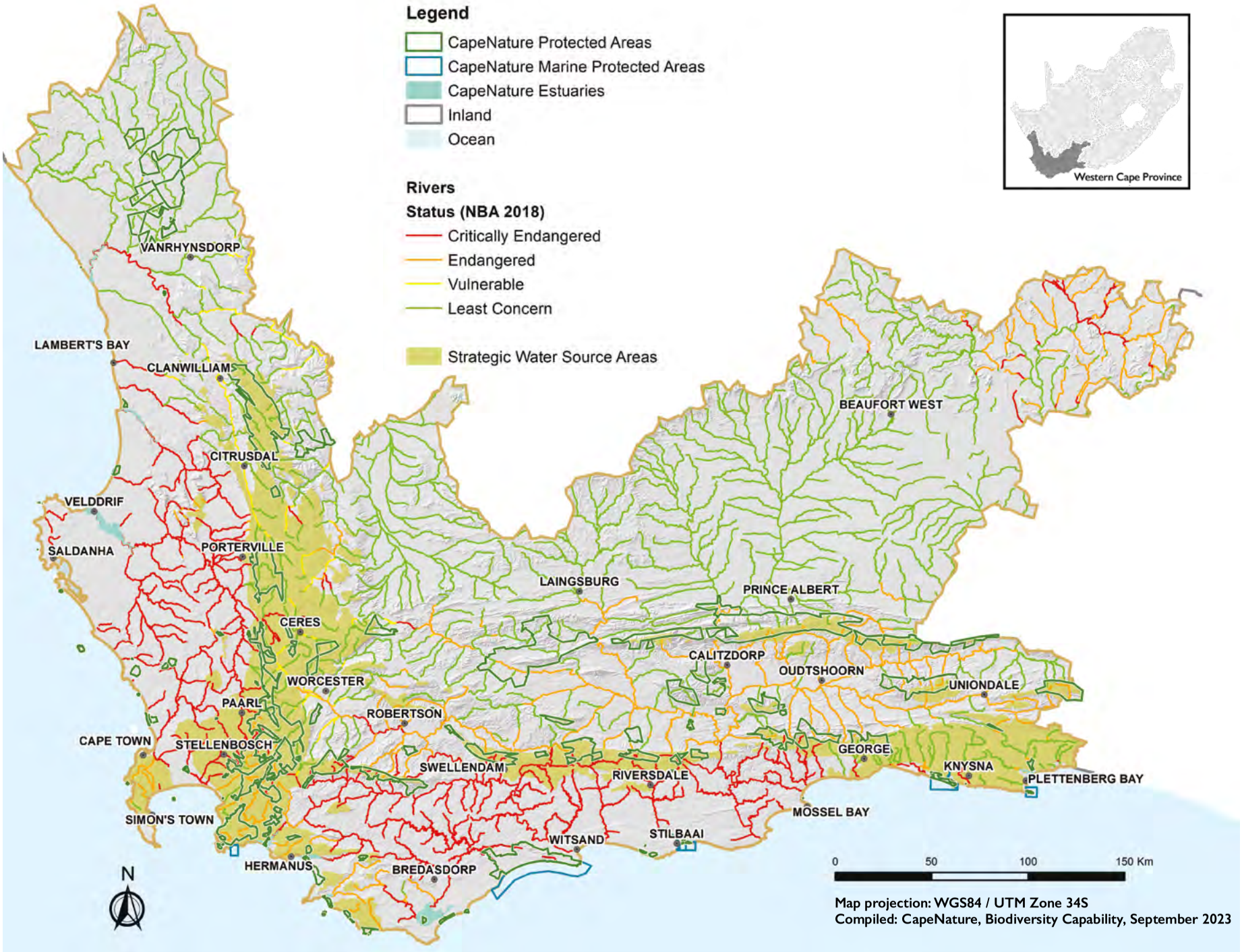



Figure 2.1. Threat status of rivers of the Western Cape according to the NBA 2018 rivers layer.

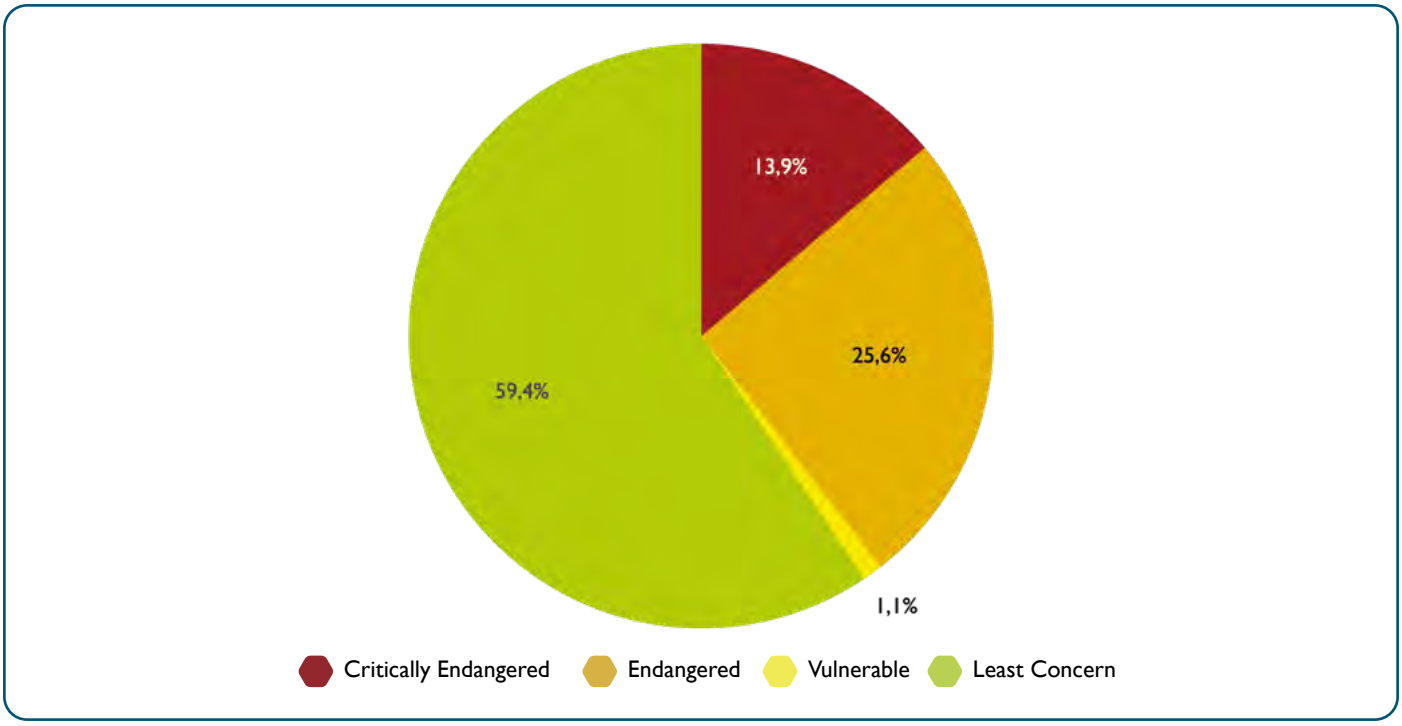



Figure 2.2. The threat status of rivers as percentage of their length (in meters) in CapeNature Protected Areas and Stewardship sites.

A total of 10 rivers in the Western Cape are still free flowing (as identified in the National Freshwater Ecosystem Priority Areas (NFEPA) project of 2011 (Nel *et al.* 2011; van Deventer *et al.* 2019; Petersen *et al.* 2023). Three of the 10 free-flowing rivers were designated as flagship rivers, including the Doring River and its tributaries, the Rooiels River and the Groot River (near the Eastern Cape border, in the Garden Route). The other free-flowing rivers are the Klaas Jagers, Touws, Karatara-Hoogkraal, Homtini, Knysna, Bietou-Palmiet and Bloukrans rivers, most of which are in the Garden Route area. Reaches of both the Doring River system and the Rooiels River are located within the CapeNature managed Cederberg Wilderness area and Kogelberg Nature Reserve respectively.

### 2.2.2 River Health

An almost equal length of rivers is in a "natural" condition in and outside of the CapeNature Protected Area Estate (which is comprised of CapeNature managed protected areas and formal stewardship sites supported by CapeNature (Figure 2.3). The CapeNature Protected Area Estate contains 52.6% "natural" and "near natural" river reaches, compared to 44.8% outside these protected areas. The higher proportion of natural and near natural rivers in protected areas highlights the value of protected areas in conserving these ecosystems. However, almost half of the rivers in CapeNature protected areas are in a modified condition (moderately to critically modified; 46.9% combined), illustrating that inclusion of particularly lower river reaches within protected areas does not guarantee their health or conservation.

**E-Links**

**Freshwater Biodiversity** https://freshwaterbiodiversity.org/

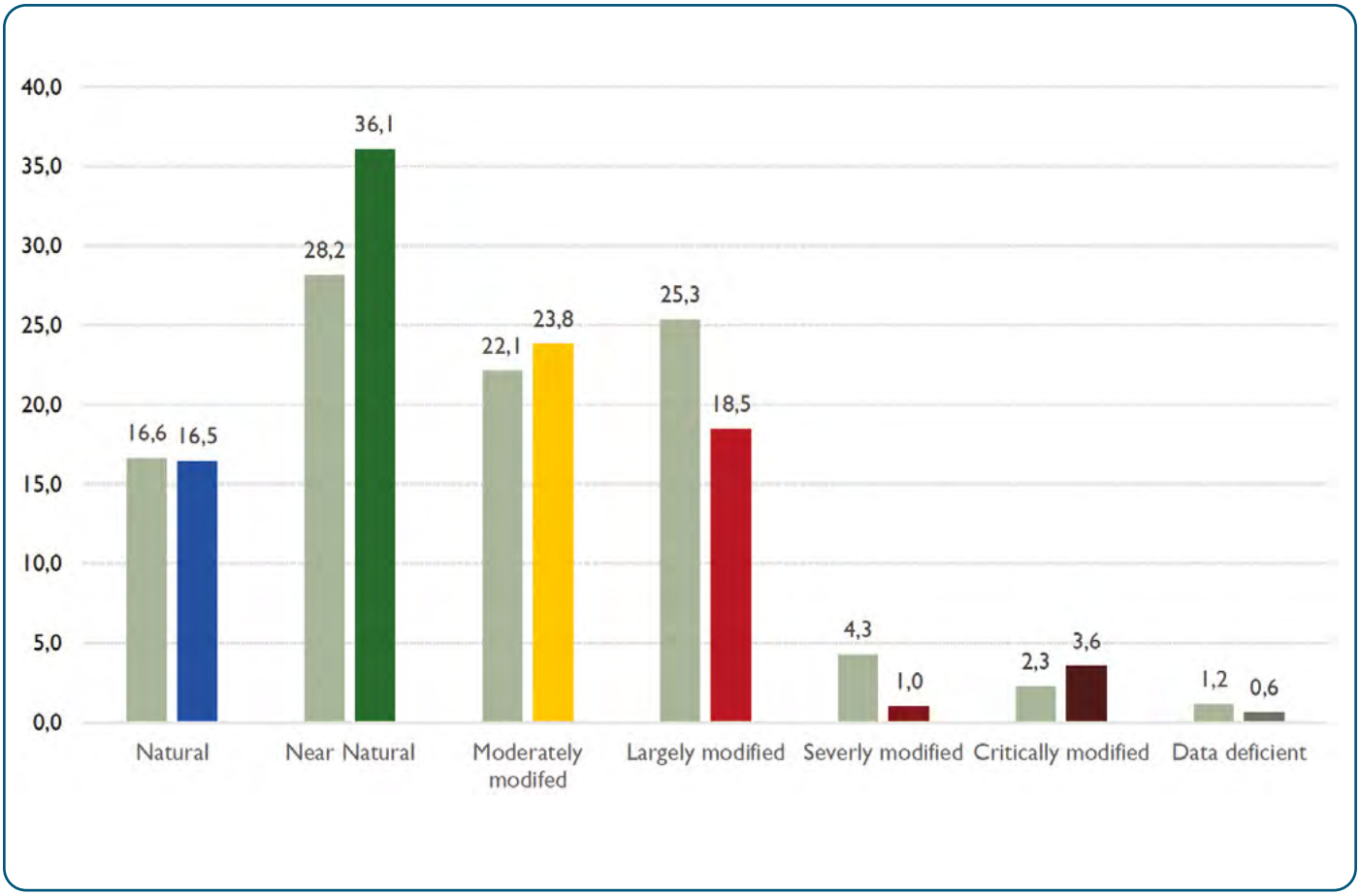



Figure 2.3. Ecological condition of rivers as percentage of provincial length (grey) and their percentage of length in CapeNature Protected Areas and Stewardship sites.

River health surveys data for selected sites in the Berg, Riviersonderend and Garden Route systems was collected by the Breede-Olifants Catchment Management Agency (BOCMA) and the provincial Department of Water Affairs and Sanitation (DWS) during the 2017/2018 period (Thirion & Jafta 2019). However, the Olifants-Doring and Gouritz river catchments were not surveyed during the DWS ecological monitoring cycles from 2017-2023. Of the sites sampled in the Western Cape catchments, none were found to be in a natural (A) category, but a few sites were near natural (B category).

Results from water quality surveys of rivers are available in the Freshwater Biodiversity Information System database (Dallas *et al.* 2022).

South African Scoring System version 5 (SASS 5) macro-invertebrate data from April 2018 to March 2023 within the FBIS platform, are available for 131 river sites in the Western Cape that were visited during the period for this review (Figure 2.4). The different colour bars depict the Present Ecological State (PES) per river site visit. The sites included those surveyed for CapeNature related freshwater monitoring and baseline surveys (e.g., CapeNature 2022a). These surveys showed that 72 of the 131 sites were in a natural or near natural condition, with 50 of these sites being in the upper zones (upper foothills, transitional areas, and mountain streams) of the catchment areas Freshwater Biodiversity Information System (FBIS: Dallas *et al.* 2022).

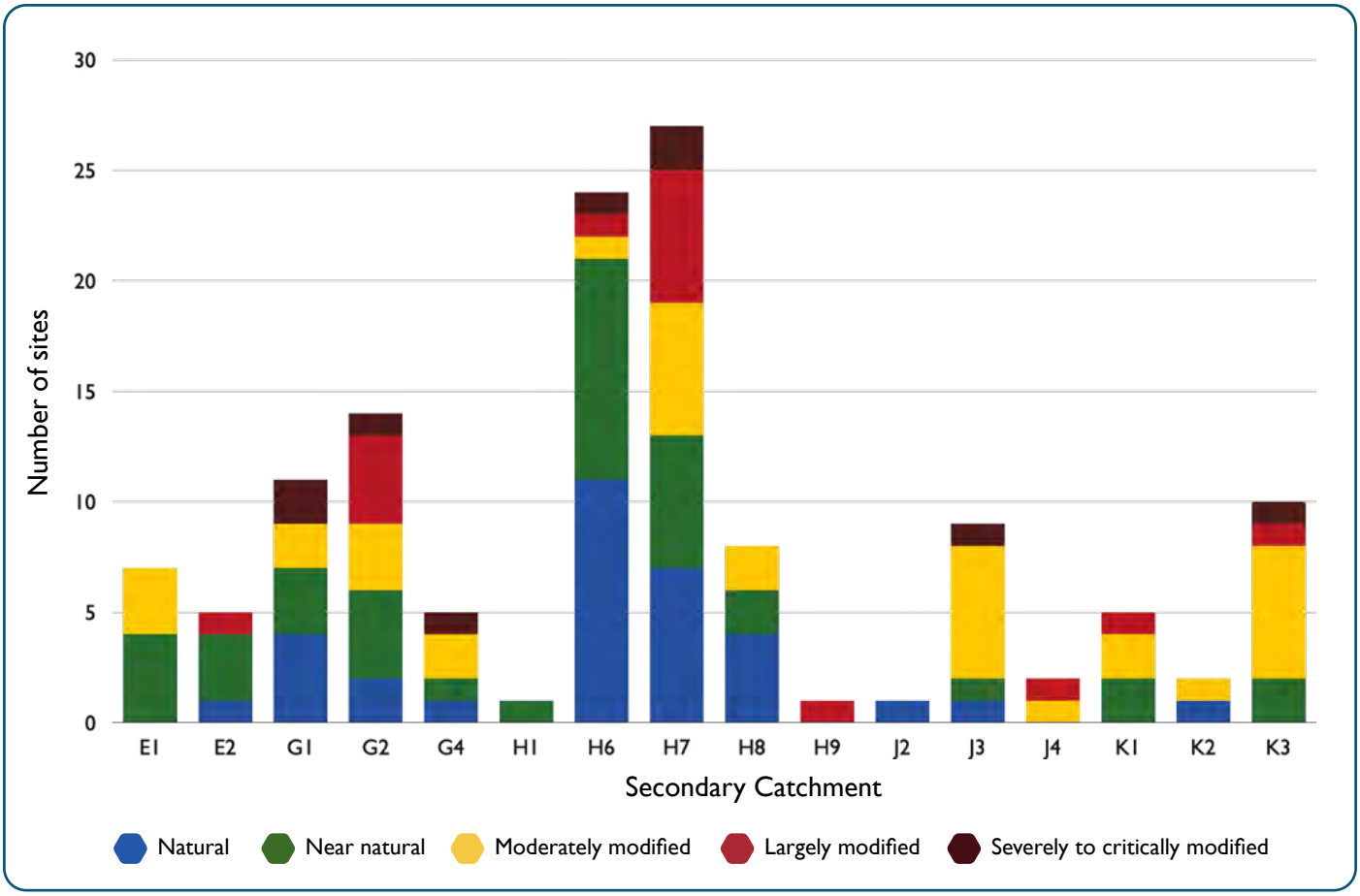



Figure 2.4. Ecological condition of the 131 river sites in each relevant secondary catchment, visited between April 2018 to March 2023.

### 2.2.3 Wetland Ecosystems

A total of 73 different wetland types occurs within the Western Cape (Skowno *et al.* 2019a; van Deventer *et al.* 2019), where type is based on a combination of vegetation bioregion and hydrogeomorphic type, i.e., depression, floodplain, valley-bottom or seep (van Deventer *et al.* 2019). Nationally, 135 inland wetland types were identified as part of the NBA (Van Deventer *et al.* 2019). The Western Cape, therefore, supports more than 50% of South Africa's wetland types, despite covering only 10.6% of the area of the country (Statistics South Africa 2016). Since the NBA 2018, the wetland map has been subject to review updating and improvement, in preparation for the NBA 2025. Several interim projects have improved the mapping of wetland extent, condition, and type (Figure 2.5).

Greater Flamingo *(Phoenicopterus roseus)* © Scott Ramsay

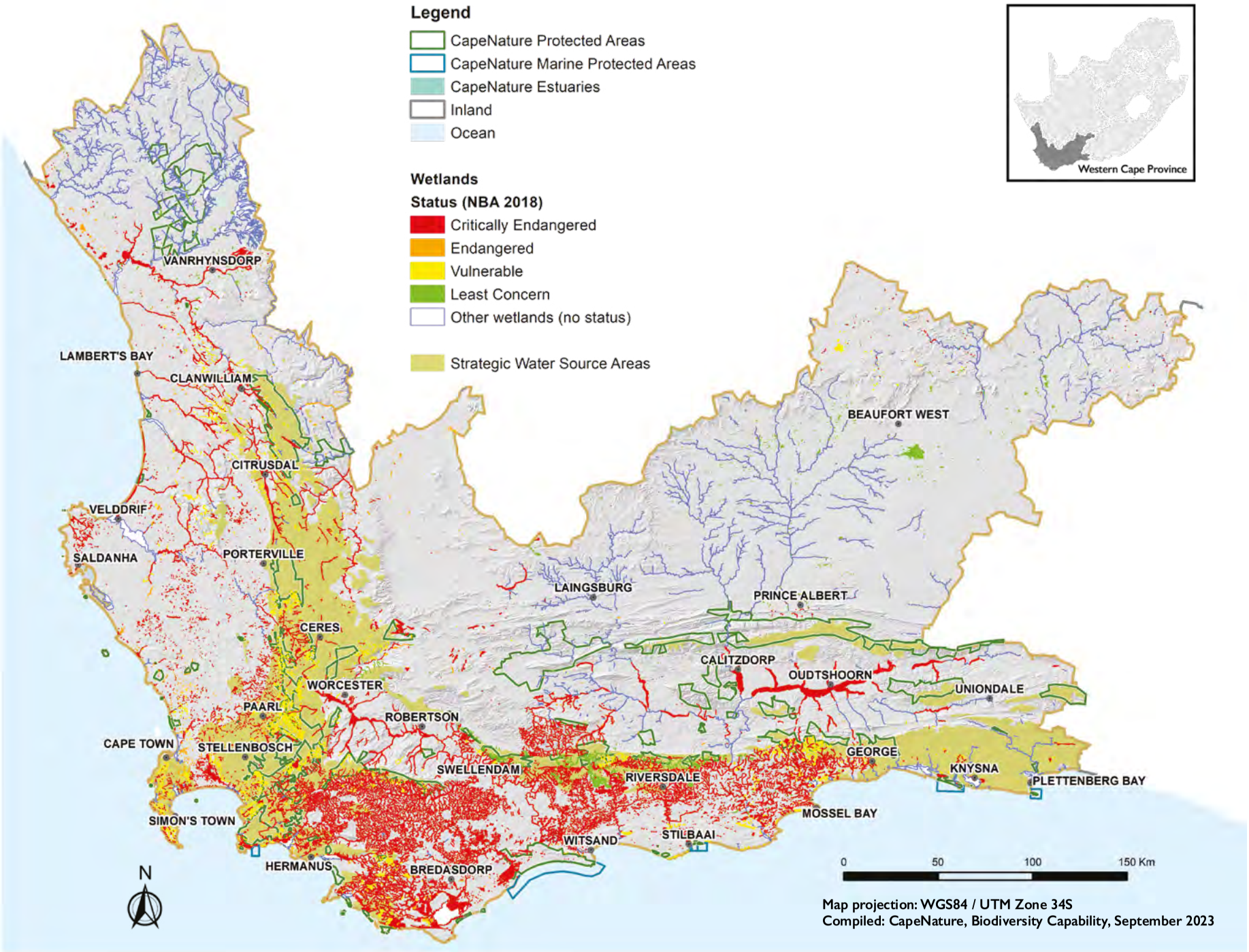



Figure 2.5. Threat status of wetlands of the Western Cape according to the NBA 2018 rivers layer (van Deventer *et al.* 2019).

Eighty percent of the wetlands of the Western Cape are threatened (CR, EN and VU), and 50 of the 73 inland wetland ecosystem types mapped within the Western Cape are CR (Figure 2.6). Wetlands in higher-lying areas tend to be in a healthier state. Forty-two of the 50 Critically Endangered wetland types are in the lower lying areas of the province. Floodplain and valley-bottom (channelled and un-channelled) wetlands are the most threatened wetland type in the province, with depression wetland types following closely. Least Threatened are predominantly seep wetland types. An estimated 19 374.8 ha of wetland area is located within CapeNature managed protected areas plus Stewardship sites, this amounts to about 4.4% of the wetland area that has been mapped in the Western Cape (Figure 2.6).

Peatlands are a special inland wetland ecosystem that is important for carbon and water storage. Peatlands occur in permanently wet environments with a high rate of organic matter accumulation, typically in wetlands that have a sustained water inflow (such as from groundwater) and are permanently or near-permanently saturated, where there is no flow or very slow water flows with low oxygen levels. Therefore, wetlands are very sensitive to a drop in water level. If this occurs it can lead to drying out of the wetlands and extensive erosion and subsurface peat fires which can last for months or even years, such as was the case in the Jakkalsvlei wetland on the west coast and the Onrus wetland.

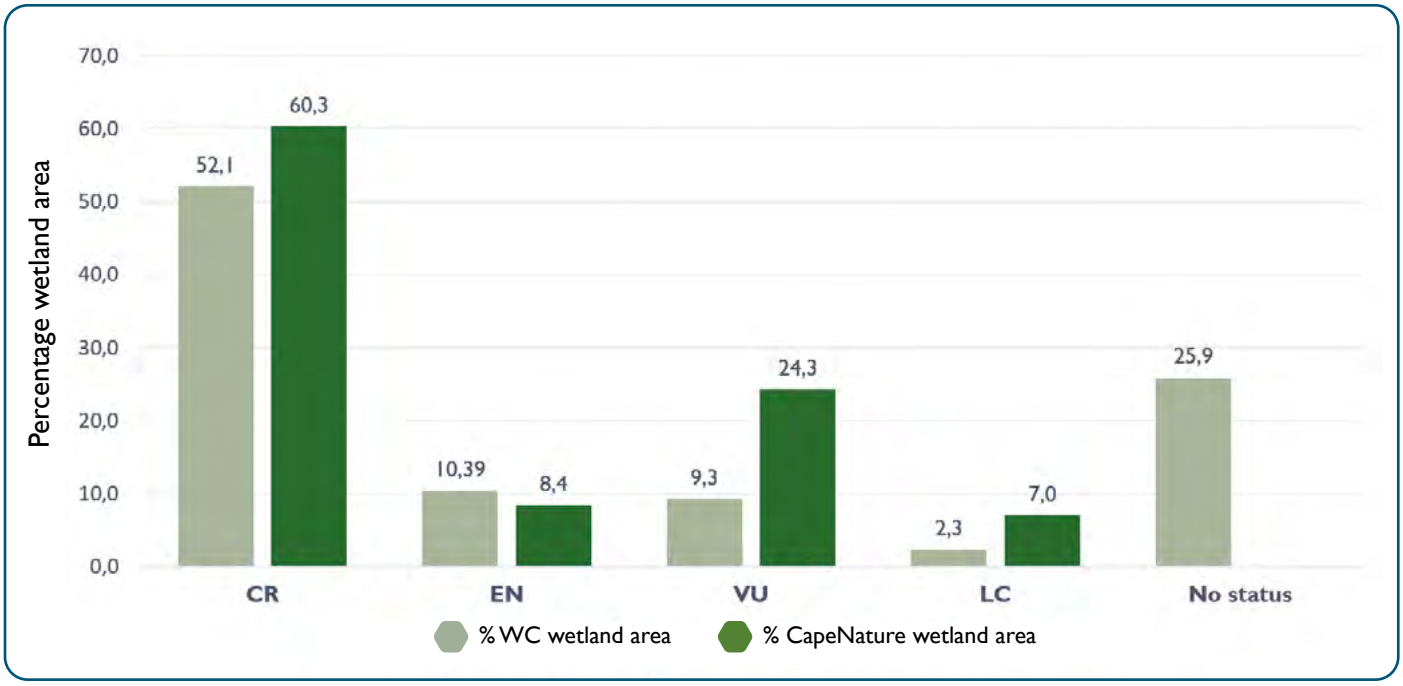



Figure 2.6. The threat status of wetlands as percentage of total provincial area as a percentage of located in CapeNature Protected Areas and Stewardship sites.

These subsurface fires are difficult to extinguish if the water table cannot be raised. Studies of these ecosystems observed erosion gullies in most of the remaining palmiet peatlands (Job 2014; Rebelo *et al.* 2015). In the Western Cape, peat wetlands fall into the Cape Fold Mountains and the Western and Southern Coastal Belt level 1 aquatic ecoregions (after Kleynhans *et al.* 2005; Grundling *et al.* 2017). Twenty-three peatlands have been confirmed in the Western Cape (Grundling *et al.* 2017, and more recently by Jason Le Roux from the ARC, unpublished data). Fifteen of these occur in or are close to CapeNature managed areas. A further 44 unconfirmed peatland sites were also identified in the Western Cape, 15 of which are at least partly within CapeNature managed land (Table 2.1). Other potential peat wetlands relevant to CapeNature could include the upper Swartboskloof and Sossyskloof wetland systems in the Jonkershoek Nature Reserve.

Table 2.1. Unconfirmed peatlands in the Western Cape associated with CapeNature managed Protected Areas.

| Relevant Nature Reserve | River Catchment or area | Level 1 Ecoregion | No. of sites |
|---|---|---|---|
| Cederberg Wilderness Area | Matjies & Tee rivers | Western Folded Mountains | 4 |
| Hottentots Holland NR | Riviersonderend River, Vyeboom area | Southern Folded Mountains | 1 |
| Kogelberg NR | Lamloch wetlands & Bot River | Southern Folded Mountains | 2 |
| Salmonsdam NR | Paardensberg River | Southern Folded Mountains | 1 |
| Uilkraalsmond NR | Uilkraals River, upstream of estuary | Southern Folded Mountains | 1 |
| Pearly Beach NR | Lower Haelkraal River | Southern Coastal Belt | 1 |
| Grootvadersbosch NR | Duiwenhoks River, Boosmansbos Wilderness Area | Southern Coastal Belt | 3 |
| Grootvadersbosch NR | Goukou River, Kris River Wetland Nature Reserve | Southern Coastal Belt | 2 |

### 2.2.4 Wetland Health

Currently there is no national monitoring programme for wetland systems (Roux *et al.* 2023). Consequently, there is no current ecological wetland condition dataset available across the Western Cape. Ecological health of wetlands was therefore drawn from the National Wetlands Map 5 modelled ancillary data (van Deventer *et al.* 2019). The mapped wetland areas in the CapeNature protected areas and Stewardship sites are mostly in a "heavily to critically modified" state (57.5%), compared to 50% provincially (Figure 2.7). However, the modelled results showed that about 29.8% of wetland areas on the CapeNature managed areas are still in natural/near natural condition, with a further 12.7% (Figure 2.7) of wetland areas being moderately modified in protected areas.

Efforts are being made to improve the information available on wetland and river health. The Department of Water and Sanitation is currently undertaking a national project to update Present Ecological State and Ecological Importance and Sensitivity for main rivers and for those wetlands associated with main rivers and proposes to review this information against the last such national assessment in 2014, to report a rate of change.

As part of SANBI's Ecological Infrastructure for Water Security Project, an assessment was undertaken for wetlands in the Berg and Breede catchments (SANBI 2023a). Wetland condition across the Berg River catchment ranged between A and F, with approximately 54% assessed as moderately modified (Present Ecological Score C; Figure 2.7). Wetlands in a natural state were largely located within the higher altitude areas. Wetlands in poor condition were mostly in and around urban and cultivated areas.

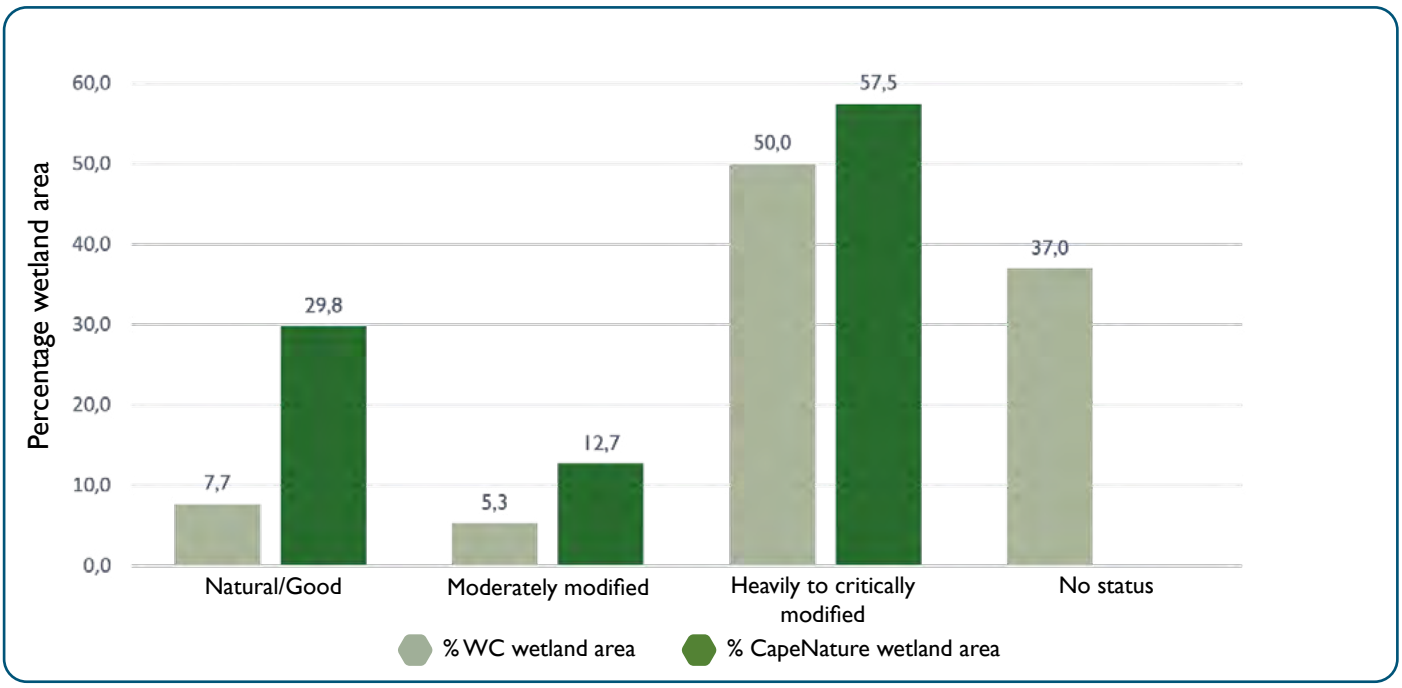



Figure 2.7. Ecological condition of wetlands as percentage of provincial area and that of the area within CapeNature Protected Areas and Stewardship sites.

The dominant hydrogeomorphic type in the Berg catchment is seep wetlands. More than 60% of the seeps, mostly located in upper catchment areas, were in good condition. Floodplain wetlands, associated with the main rivers in the catchment, ranged between near natural (64%) and moderately modified (26%). Channelled valley-bottom wetlands were mostly moderately modified, but the unchanneled valley- bottoms, ranged evenly between natural and moderately modified.

The updated condition assessment of wetlands in the Breede catchment showed that approximately 23% were near- natural, 30% moderately modified, and 17% seriously modified. Only 11% of the catchment wetlands were in a natural condition. These wetlands were mostly small seeps on mountain slopes, while poor condition wetlands were typically along the valley floor, coinciding with high levels of cultivation and settlements. More than 50% of channelled valley- bottom were moderately modified, while the largest floodplains in the catchment, along the main Breede and Riviersonderend rivers, had condition scores of B (good) and C (moderately modified) respectively. Floodplains contain extensive cultivation and limited field validation of selected wetland condition scores for the demonstration catchments took place. Therefore, further work is needed to compare the desktop derived condition score with a field validated condition score.

### 2.2.5 Threats to Rivers and Wetlands

The most significant threats to inland aquatic ecosystems in the Western Cape include habitat loss, changes to the hydrological (or flow) regime of rivers and wetlands and the impacts of pollution (Skowno *et al.* 2019a). These impacts include over-utilisation of water for both urban and agricultural use, urban (wastewater from wastewater treatment works and storm water) and agricultural (run-off from cultivated fields and application of herbicides and pesticides), together with point source pollution events. Other significant threats are posed from invasive alien plants and the effects of climate change (Figure 2.8).

The riparian zones in especially the lower lying agricultural areas have been greatly reduced or removed to make space for fruit trees, vineyards, or fields for grazing. Many riparian zones and wetland areas have been invaded by invasive alien trees, which reduces riverbank stability and can lead to erosion, amongst other impacts. Lower foothill and lowland wetlands are also the most impacted, with urban and agricultural development leading to wetland ecosystem degradation and loss.

CapeNature responds to some of these threats in the following way: through management of water abstraction (nature reserve water use), commenting on land use and water use license applications (development related and habitat degradation), response to disaster related spills in or near Protected Area boundaries and management of invasive alien plant species and wetland rehabilitation (Working for Wetlands projects). Mitigation for climate change takes place through the protected area expansion process, continued adaptive management of the protected areas and creating corridors for species movement.

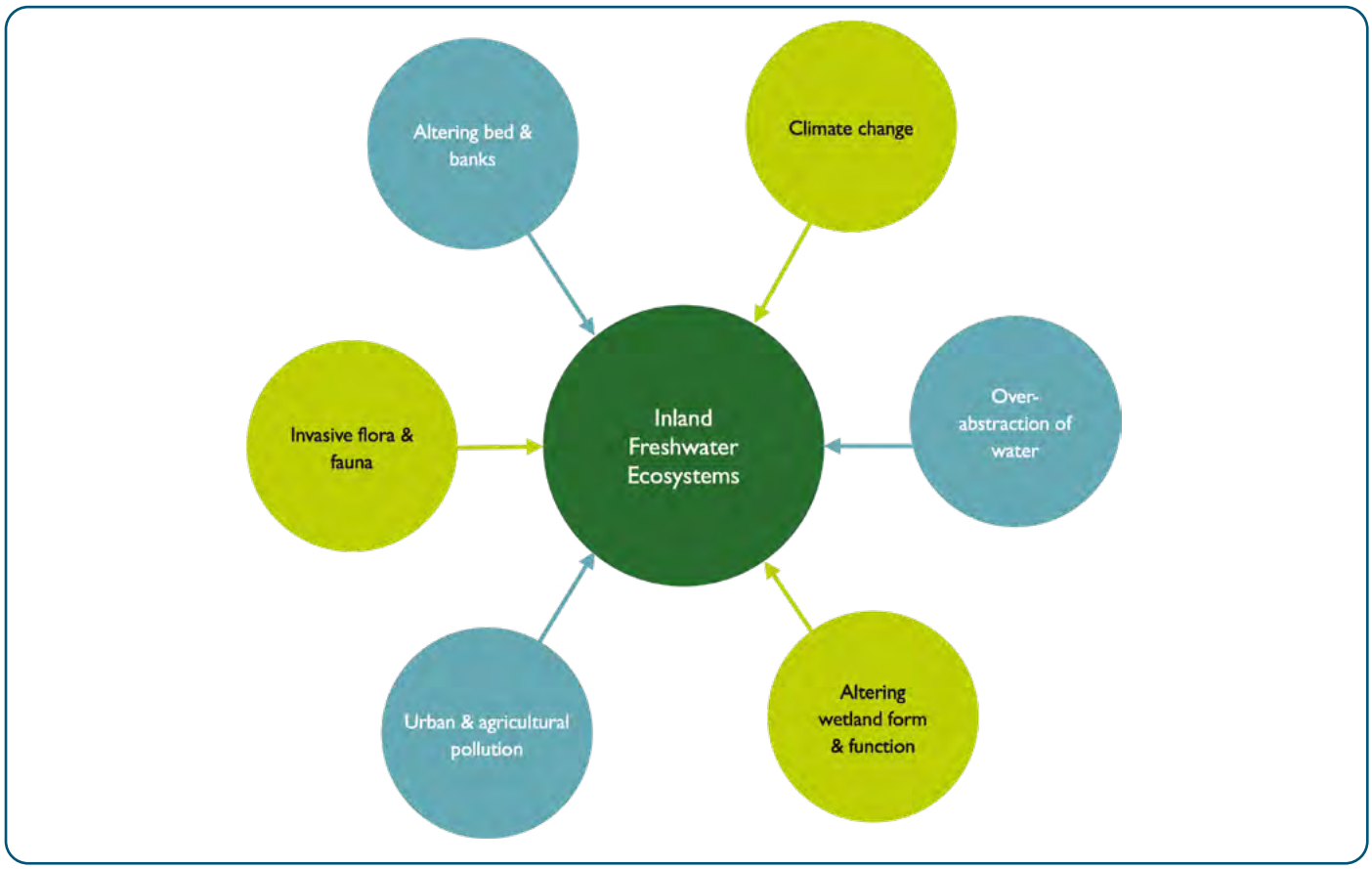



Figure 2.8. The threats most relevant to inland freshwater ecosystems.

### 2.2.6 Groundwater and Pressures from Drought

The Western Cape experienced a multi-year drought where monthly precipitation levels were below average over three winters from 2015-2017, leading to a significant drop in water supply dam levels and flow in rivers (e.g., Burls *et al.* 2019). Although the drought finally broke in 2020, it led to a sustained increase in pressures on groundwater sources, amongst others, for water augmentation for municipal and rural (agricultural) water use. Water use pressures continue, specifically with the aim of avoiding another "Day Zero" scenario, as experienced in the City of Cape Town municipal area during the recent drought. Increased abstraction of groundwater resources is likely to impact both rivers and wetland systems and ultimately the estuarine systems. Many of these systems are dependent on groundwater or aquifer water for continued hydrological function throughout every season (Colvin *et al.* 2007; Strydom *et al.* 2021). The baseflows of many of the rivers draining from the mountain catchments and even lowland rivers, come from groundwater additions (e.g., WWF 2019; Pietersen 2021; Cornelius 2023).

## 2.3 DISCUSSION AND RECOMMENDATIONS

Continued and improved conservation and maintenance of ecological infrastructure, particularly the freshwater ecosystems in the Strategic Water Source Areas are imperative for water security given the current trends in impacts related to climate change (Le Maitre *et al.* 2018; Lötter and Le Maitre 2021). Without sustainable management and best practice application of the catchment to coast management approach, it is likely that the health of all inland freshwater ecosystem types, especially the lower lying rivers and wetlands, will deteriorate further which in turn negatively affects estuarine and marine ecosystems.

These systems are not only important from a biodiversity conservation perspective, but also because they provide important ecosystem services. They are particularly important for water security, and they mitigate climate change effects, such as flood attenuation and flow regulation, as well as supporting climate resilience (see also Roux *et al.* 2023). Of particular concern is the deteriorating trend in modelled results for the ecological condition of wetlands, including those located inside protected areas (Roux *et al.* 2023). A similar trend was observed on the national scale and within SANParks protected areas (Roux *et al.* 2023). Improving the ecological condition of wetlands within protected areas in the Western Cape could lead to a much greater addition to the Ecosystem Protection Levels of these systems (Roux *et al.* 2023).

Ensuring the monitoring of and informed conservation of inland freshwater ecosystems is becoming increasingly constrained by available budget and staff capacity within conservation agencies and other provincial departments. This has made partnerships an essential part of continued conservation efforts. Several partnerships have formed to facilitate freshwater ecosystem management, with major role-players including CapeNature, the South African National Biodiversity Institute (SANBI), the provincial Department of Water Affairs and Sanitation (DWS), the Breede-Olifants Catchment Management Agency (BOCMA), the provincial Department of Environmental Affairs and Development Planning, the Nature Conservancy (TNC), the World Wildlife Fund South Africa (WWF) and several more.

Targeting areas that include important freshwater ecosystems has gained a lot of traction over recent years (e.g., CapeNature Biodiversity Spatial Plan, CapeNature Protected Areas Expansion Strategy, Overberg Renosterveld Conservation Trust, and the Gouritz Cluster Biosphere). However, ground-truthing of river and wetland systems should continue, to improve the knowledge on the ecological health and extent of these systems. Through this, the spatial layers can also be improved for mapping and planning purposes, such as updating provincial inventories, the National Wetlands Map 5, the National Freshwater Priority Areas (NFEPA) maps, the Biodiversity Spatial Plan, and the next National Biodiversity Assessment in 2025.

Kogelberg Nature Reserve
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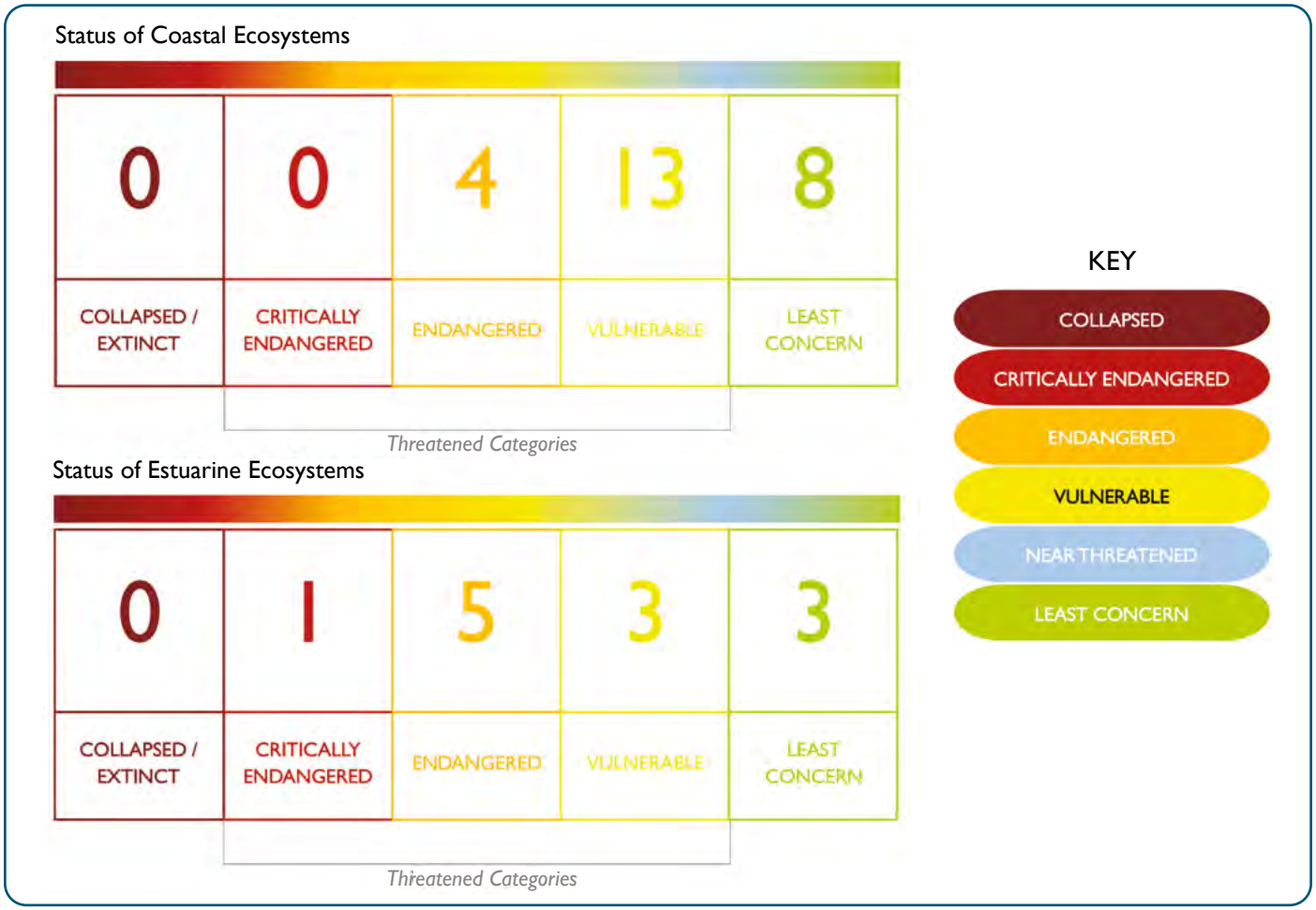
The coastline of the Western Cape is over 1 500 km (nearly half of South Africa's total coastline (DEA&DP 2022) abutting the Atlantic and Indian oceans and is positioned where two major ocean currents meet and interact. The mixing currents create unique oceanic, estuarine, and terrestrial ecosystems with distinct patterns in temperature, rainfall and geology that result in diverse ecosystems, habitats, and species and thus exceptional biological diversity.

Like the terrestrial ecosystems discussed in Chapter 1, the offshore ecosystems are impacted upon by a range of factors. These include harvesting marine living resources, shipping, mining, and coastal development. To conserve vital aspects of this large marine ecosystem, the South African Government has created a network of Marine Protected Areas (MPAs) (Figure 3.1), many of which fall under the jurisdiction of National Government and are thus not discussed further within this report. There are however a few MPA's and islands which fall under the jurisdictional mandate of the Western Cape Provincial Government, with the management authority of these being assigned to either CapeNature, SANParks or the City of Cape Town (Figure 3.2).



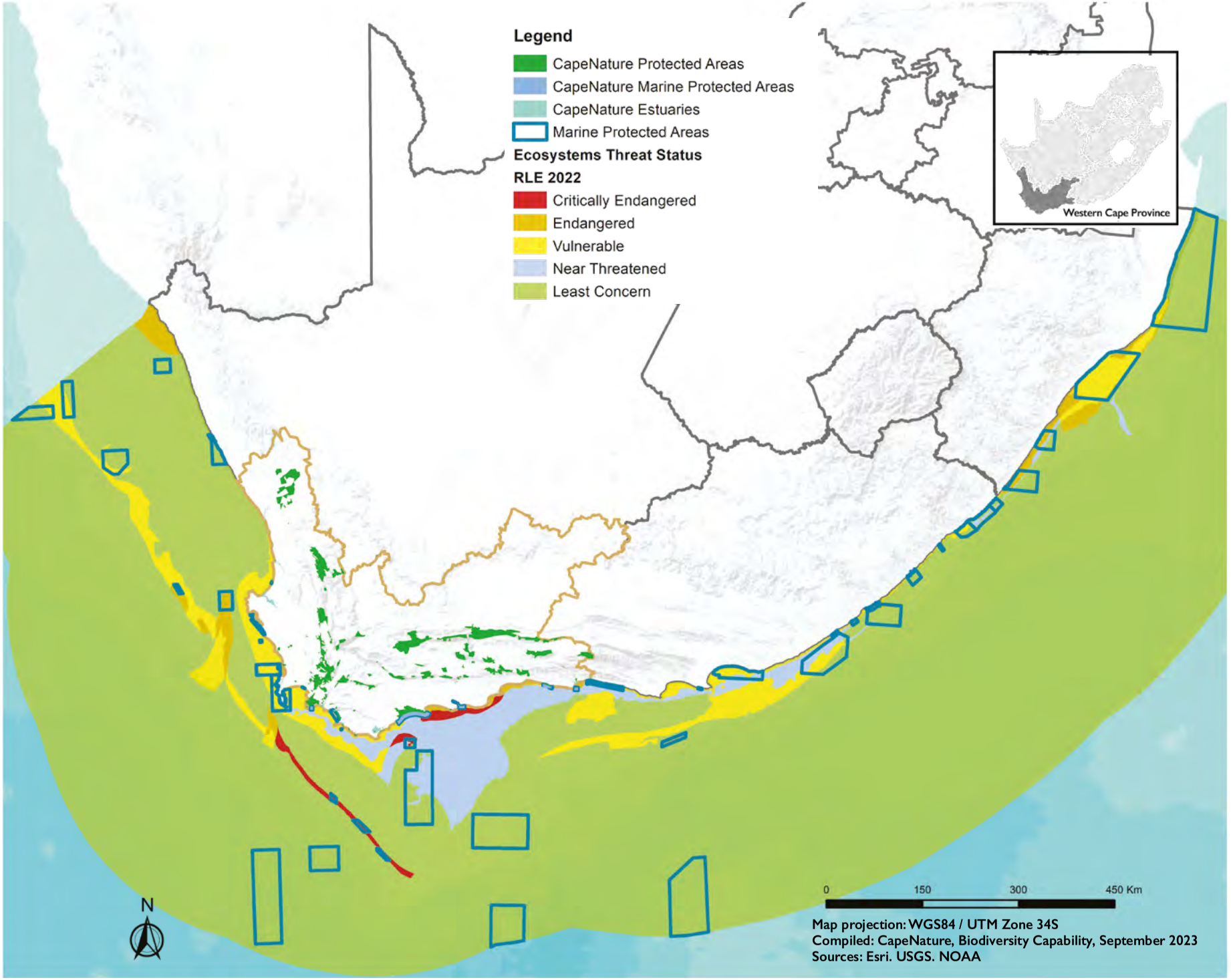



Figure 3.1. Marine Protected Area distribution and ecosystem status for South Africa (SANBI 2019b).

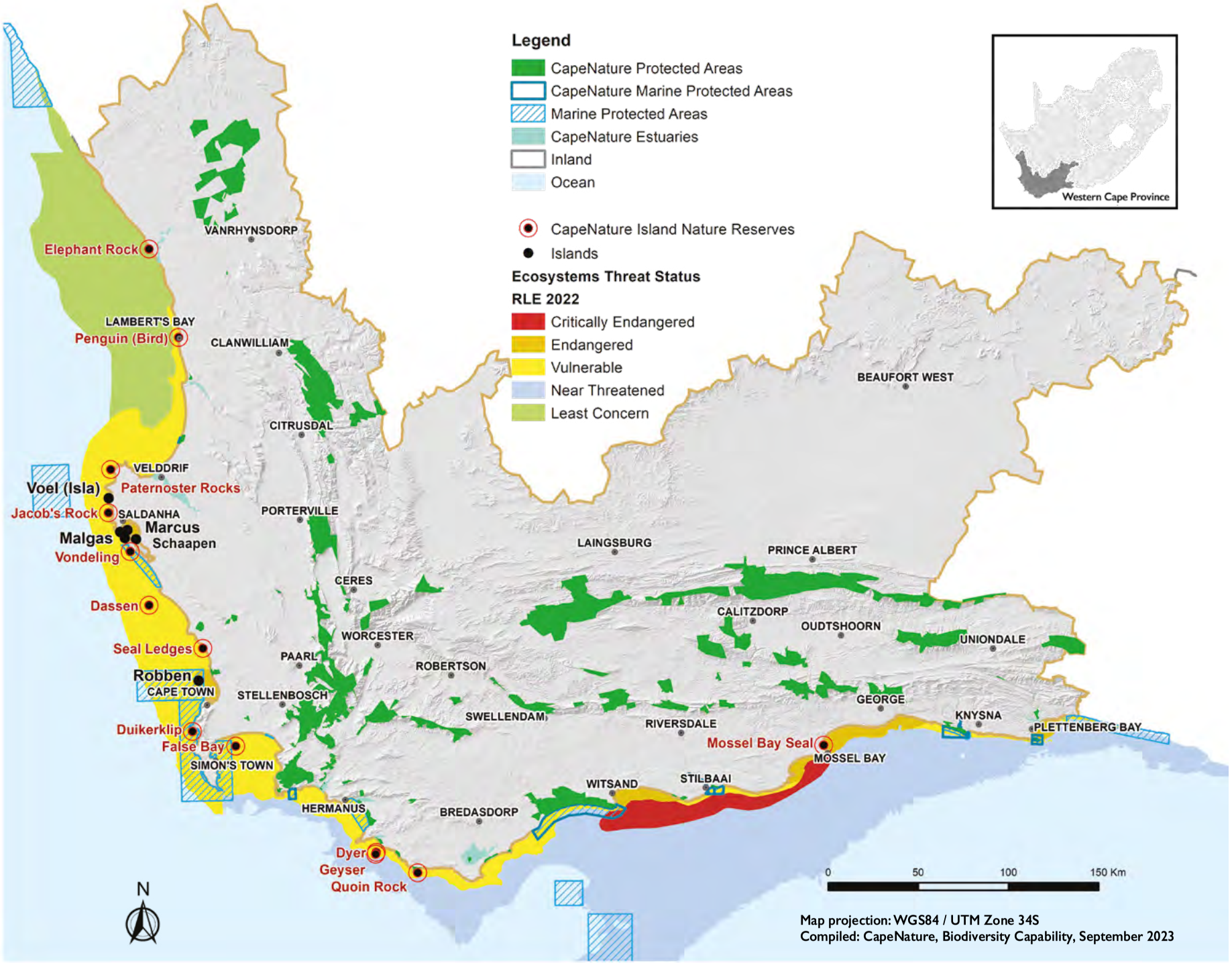



Figure 3.2. Marine Protected Area distribution and ecosystem status along the Western Cape Coastline based on addressing biodiversity importance and impact status (extracted from SANBI 2019b).

MPAs play a critical role in maintaining food and job security in South Africa by supporting sustainable fisheries. Fish stocks can recover in unfished areas where they can reproduce and grow undisturbed, spilling over into adjacent fishing grounds. MPAs also play an important role in tourism and provide sites for cultural and spiritual practices. MPAs may be zoned to allow low-impact harvesting, including traditional harvesting. Protecting ocean wildlife benefits local economies, providing jobs, and increasing revenue to the tourism sector. Monitoring priority species, such as threatened species or species of economic value, is thus critical.

The Western Cape coastline is a unique national asset, rich in biodiversity, history, and cultural significance. Nationally, despite comprising only 4% of the mainland extent, the ecologically determined coastal zone (as defined in the NBA 2018) includes nearly a fifth (19%, 186) of its 987 ecosystem types. The most intensive pressures in the Western Cape's coastal zone are biological resource use, coastal development, and mining. Many of the coastal species targeted by recreational and small-scale fishers are assessed in the estuarine and marine technical reports as overexploited or collapsed and/or threatened, with open access and poaching playing a key a role in stock or threat status. Several forms of pollution also impact coastal biodiversity, but many are understudied and poorly understood and/or are not well mapped, precluding use in the NBA 2018 (SANBI 2019b), including: chemicals (from heavy metals to pharmaceuticals; note, though, that wastewater discharge is included in the assessment), plastics and microplastics, light and noise pollution.

## E-Links

**Biodiversity and Coastal Management** https://encr.pw/jMSdn
**Sandy Shores Environments** https://www.ecoshape.org/en/landscapes/sandycoasts/sandy-shore-environments/

Estuaries in the Western Cape play an important role as fish nurseries contributing significantly to biodiversity, estuarine fisheries, and nearshore marine fisheries. Estuaries are the links between the land and sea. Spatially defined by the "Estuarine Functional Zone" (EFZ), this delineated area encapsulates all estuarine processes and biotic responses, including the maximum extent of open water area subjected to tidal effect and/or back flooding under closed mouth conditions; all estuarine associated habitat (sand and mudflats, rock and plant communities); vegetation ecotones that have elements of estuarine habitat; all supporting floodplain areas; geomorphic active zones (maximum movement of the mouth from historical imager; as well as all contiguous supporting freshwater ecosystems (e.g. springs and seeps) that contribute to habitat diversity in the estuary.

In South Africa, estuary types are defined based on the status of their mouth (either continuously or periodically open to the sea on decadal time scales), their size (extending as far as the upper limit of tidal action or salinity penetration), and the nature of their associated waterbody (a permanent water body or not). During floods an estuary can become a river mouth with no seawater entering the formerly estuarine area. When there is little or no fluvial input, an estuary can be isolated from the sea by a sandbar and become fresh or hypersaline (Van Niekerk *et al.* 2019).

Estuarine lakes and predominantly open estuarine systems are of national and global importance. The Western Cape hosts six of the 42 micro-estuaries occurring country-wide, with an additional 32 coastal outlets/seeps that contribute micro-habitats to coastal diversity. The highly diverse estuarine types in the province are listed in Table 3.1, with their locations being represented in Figure 3.3.

Table 3.1. Estuary Types represented in the Western Cape (Van Niekerk *et al.* 2019)

| Estuary Type | Number | Estuary/ies |
|---|---|---|
| Arid Predominantly Closed | 2 | Wadrif, Sout (Noord) |
| Estuarine Bay | 1 | Knysna |
| Estuarine Lagoon | 1 | Langebaan |
| Estuarine Lake | 7 | Verlorenvlei, Bot/Kleinmond, Klein, Heuningnes, Touw/Wilderness, Swartvlei, Seekoeivlei (highly degraded) |
| Predominantly Open | 8 | Berg, Olifants, Breede, Gourits, Goukou, Duiwenhoks, Uilkraal, Keurbooms |
| Large Temporarily Closed | 15 | Piesang, Goukamma Maalgate, Grootbrak, Kleinbrak, Hartenbos, Palmiet, Eerste, Zandvlei, Silwermyn, Wildevoelvoelvlei, Disa, Sout (Wes), Diep, Jackals |
| Small Fluvially Dominated | 4 | Matjies, Bloukrans, Steenbras', Noetsie |
| Small Temporarily Closed | 16 | Groot (Wes), Gwaing, Gericke, Tweekuilen, Blinde, Klipdrifsfontein, Ratel, Onrus, Buffels, Rooiels, Sir Lowerys Pass, Lourens, Krom, Schuster, Houtbay, Bokramspruit |
| Total | 54 | |

Robberg Nature Reserve
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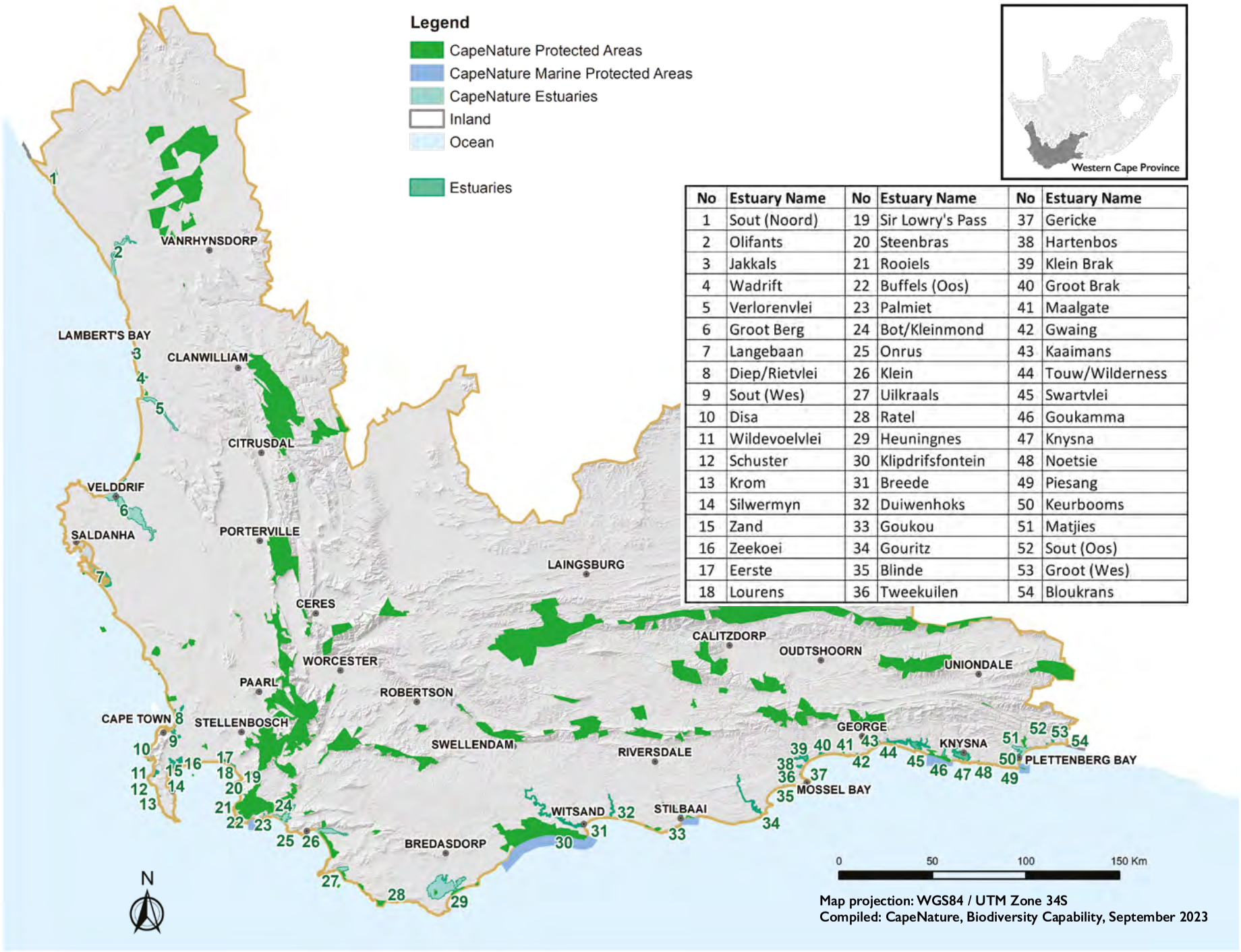


| No | Estuary Name | No | Estuary Name | No | Estuary Name |
|---|---|---|---|---|---|
| 1 | Sout (Noord) | 19 | Sir Lowry's Pass | 37 | Gericke |
| 2 | Olifants | 20 | Steenbras | 38 | Hartenbos |
| 3 | Jakkals | 21 | Rooiels | 39 | Klein Brak |
| 4 | Wadrift | 22 | Buffels (Oos) | 40 | Groot Brak |
| 5 | Verlorenvlei | 23 | Palmiet | 41 | Maalgate |
| 6 | Groot Berg | 24 | Bot/Kleinmond | 42 | Gwaing |
| 7 | Langebaan | 25 | Onrus | 43 | Kaaimans |
| 8 | Diep/Rietvlei | 26 | Klein | 44 | Touw/Wilderness |
| 9 | Sout (Wes) | 27 | Uilkraals | 45 | Swartvlei |
| 10 | Disa | 28 | Ratel | 46 | Goukamma |
| 11 | Wildevoelvlei | 29 | Heuningnes | 47 | Knysna |
| 12 | Schuster | 30 | Klipdrifsfontein | 48 | Noetsie |
| 13 | Krom | 31 | Breede | 49 | Piesang |
| 14 | Silwermyn | 32 | Duiwenhoks | 50 | Keurbooms |
| 15 | Zand | 33 | Goukou | 51 | Matjies |
| 16 | Zeekoei | 34 | Gouritz | 52 | Sout (Oos) |
| 17 | Eerste | 35 | Blinde | 53 | Groot (Wes) |
| 18 | Lourens | 36 | Tweekuilen | 54 | Bloukrans |

Figure 3.3. Estuaries in the Western Cape (CapeNature 2022a).

CapeNature is responsible for the management of 13 estuaries where CapeNature manages the adjoining terrestrial protected areas or the estuaries form part of the Western Cape Protected Areas Expansion Strategy, and these include Keurbooms/ Bitou, Goukamma (MPA), Goukou (MPA), Klipdriftsfontein (PA), Heuningnes (PA and Ramsar site), Uilkraals, Klein, Bot/Kleinmond (Ramsar site), Palmiet, Rooiels, Verlorenvlei (Ramsar site), Jackalsvlei and Olifants estuaries. The Breede estuary is managed in collaboration with DEA&DP. The Berg Estuary is a Ramsar site managed in partnership with DFFE.

Six different macrophyte habitats are recognised in South Africa estuaries, four of which occur in the Western Cape (Salt marsh, reeds and sedges, submerged macrophytes, macroalgae). The spatial distribution of different macrophyte communities along the length of an estuary is dependent on the salinity created by a continual flow of freshwater into the system. This spatial distribution is of significance as it gives a good indication of the health of the estuary.

Estuarine ecosystems are threatened by over abstraction of freshwater, pollution, over harvesting of natural resources (fish, bait, etc.), and illegal development within the floodplain or estuary functional zone. A range of tools exist that can be used to manage these threats, including the designation of Protected Areas or Marine Protected Areas, the publication of Resource Quality Objectives, and the use of other effective area-based conservation methods (CBD 2018).

A third of South Africa's freshwater flow no longer reaches the coast, with 20% of estuaries under high or very high flow modification (Van Niekerk *et al.* 2019). This freshwater flow reduction impacts on the state of estuary mouths as well as the extent of the estuarine plume into the ocean during mouth opening events. These estuarine plumes introduce sediment and nutrients into the ocean in general and the coastal zone specifically. The socio-economic impact of catchment-based sediment not reaching the ocean and the associated beaches is massive (shrinking beaches and increased coastal erosion).

Specifically, the sand delivery to the coast via rivers and estuaries, and movement of sand across land as part of mobile dune fields and in the surf and inner shelf has never been well managed, with the net and overlooked result that many beaches are sand-starved and in a state of erosion.

Invasive species in the terrestrial portion of the coast are an established threat to biodiversity largely from deliberate introductions to stabilize dunes (Avis 1989) but are an emerging threat to estuarine and coastal marine biodiversity from unintended introductions, mostly reported from ports and harbours that serve as both entry points and refugia for these alien species. Both invasive species and climate change are exacerbating pressures to coastal biodiversity by changing natural ecological processes and reducing the resilience of indigenous species. Some of the most important climate-change impacts for coastal systems are sea-level rise, increases in the frequency and intensity of extreme storms, and temperature change driving shifts in species distributions. The former two are most important in urban areas where there is coastal development inappropriately close to the shore, where risks to human safety, biodiversity and infrastructure are most high.

## 3.1 METHODS

As the Marine realm falls under the National jurisdiction, Marine Ecosystems in the coastal zone were assessed and classified for the compilation of the National Biodiversity Assessment on a 5-yearly cycle.

The Coastal regions represent the terrestrial/marine interface. In the associated terrestrial ecosystems, a one km coastal buffer (representing ecological infrastructure focussing on coastal protection) and key associated threatened species associated with this coastal zone are incorporated into the Western Cape systematic conservation planning process to identify key biodiversity priority areas which will, in turn, be used to guide terrestrial land-use change. The

process to identify key biodiversity priority areas which will, in turn, be used to guide terrestrial land-use change. The resultant revised Biodiversity Spatial Plan then informs all land-use change decisions with the aim of ensuring sustainable development within this region. In the marine environment, a series of monitoring and survey work is undertaken by conservation authorities (e.g., monitoring dune rehabilitation projects, Giant Kelp Forests, Southern Right Whale, and stranding information) is being gathered and fed into national databases that will inform the national assessments.

Estuary water quality monitoring data collected at priority CapeNature managed estuaries contributes the national Department of Water Affairs and Sanitation (DWS) database and is used in the five-yearly revision of the National Biodiversity Assessment. This includes water temperature, dissolved oxygen, and salinity and water level.

## 3.2 RESULTS

As a result of the high level and diversity of pressures to coastal biodiversity, 60% (112 of 186) of South Africa's coastal ecosystem types are threatened, comprising 55% of the coastal extent (Figure 3.4), compared to 85 (19%) threatened ecosystem types that comprise 6% of the rest of the country (non-coastal land and sea). Proportionately, this means the coast has three times the number of threatened ecosystem types and an order of magnitude more threatened area than the rest of the South African mainland territory.

Of the 112 (of 186) threatened coastal ecosystem types, 102 (91%) are under-protected. Thirteen of these are highly threatened (Critically Endangered or Endangered) (Figure 3.5).

De Mond Nature Reserve
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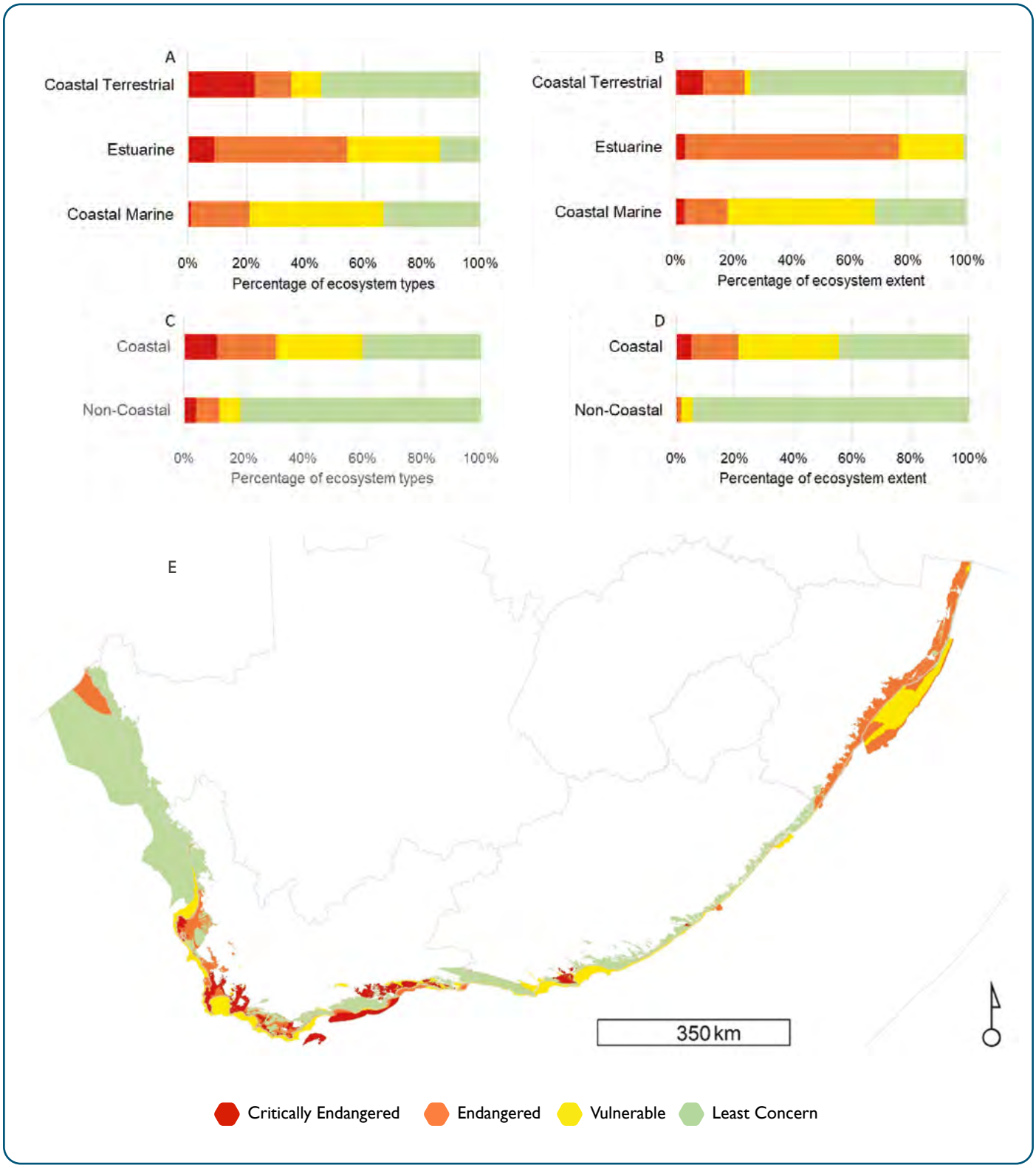



Figure 3.4. Ecosystem classification in terms of threat status (Harris *et al.* 2019). (a) The percentage of ecosystem types and (b) ecosystem extent in each threat status category the coastal ecosystem types in each realm. (c) The percentage of ecosystem types and (d) ecosystem extent in each threat status category for the coast compared to the rest of South Africa (land and sea combined). (e) Spatial distribution of threatened coastal ecosystem types in South Africa.

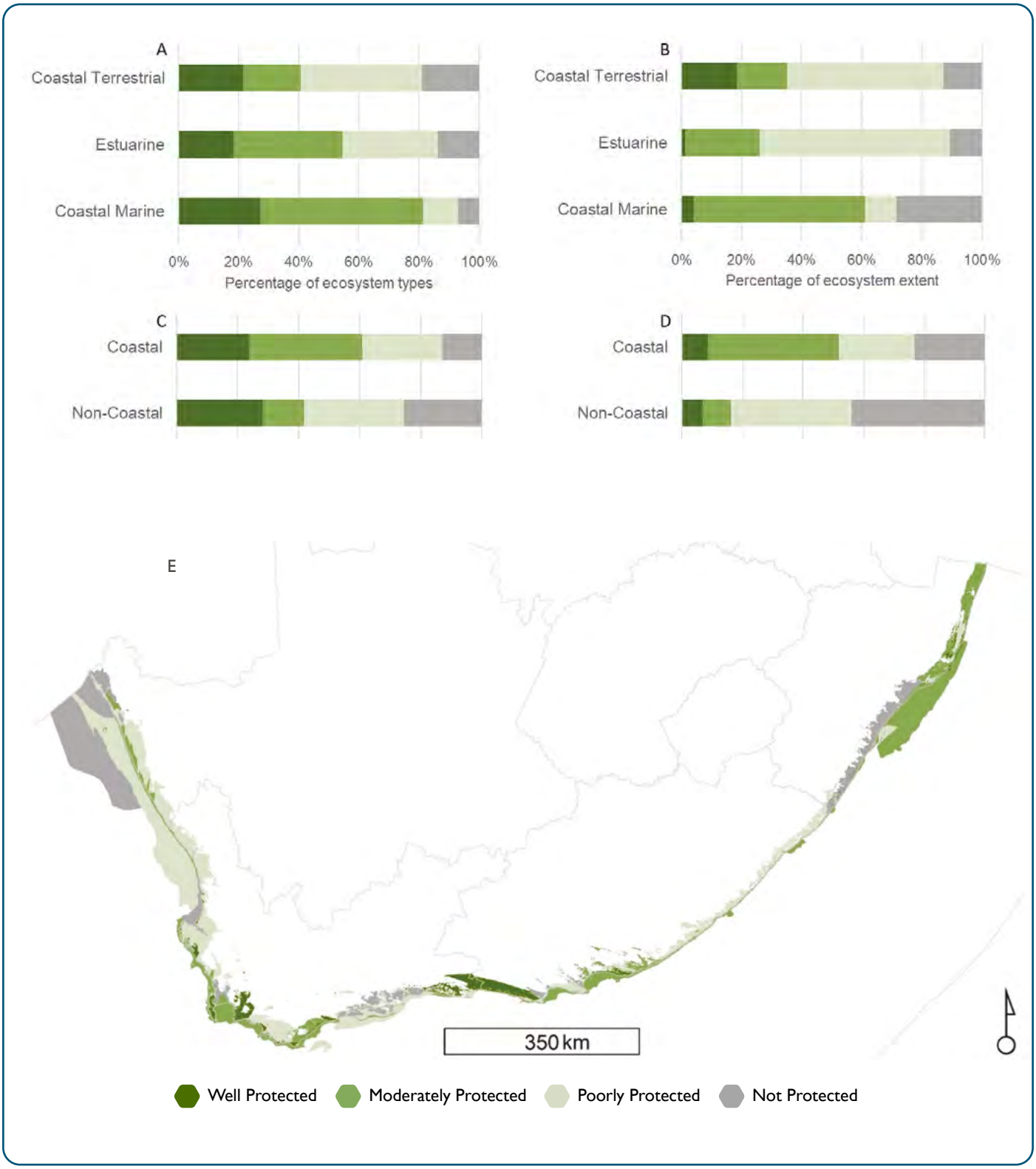



Figure 3.5. Protected status of marine ecosystems along the SA coastline (Harris *et al.* 2019). (a) The percentage of ecosystem types and (b) ecosystem extent in each protection level category for the coastal ecosystem types in each realm. (c) The percentage of ecosystem types and (d) ecosystem extent in each protection level category for the coast compared to the rest of South Africa (land and sea combined). (e) Spatial distribution of protection levels of coastal ecosystem types in South Africa.

A total of 84.6% of estuary ecosystem types in the Western Cape are threatened (Skowno *et al.* 2019).

Almost 23% of estuarine systems were classified as highly important nurseries (e.g., Great Berg, Olifants, Breede, Gourits estuaries), while an additional 26 % of systems (e.g., Klein Brak, Groot Brak), were deemed of Medium-High or Medium importance in terms of their contribution (Van Niekerk *et al.* 2019). However, 13 estuaries in the Western Cape have experienced fish kills in the last 10 years that indicate clear signs of ecosystem stress (Van Niekerk *et al.* 2019).

The 2018 National Biodiversity Assessment classified South Africa's estuaries according to threat status (Van Niekerk *et al.* 2019). Figure 3.6 reflects a subset of these findings highlighting the status of only those estuaries within the Western Cape (extract from Van Niekerk *et al.* 2019). Figure 3.7 highlights the protection levels for each of the estuarine types as extracted from Van Niekerk *et al.* 2019.

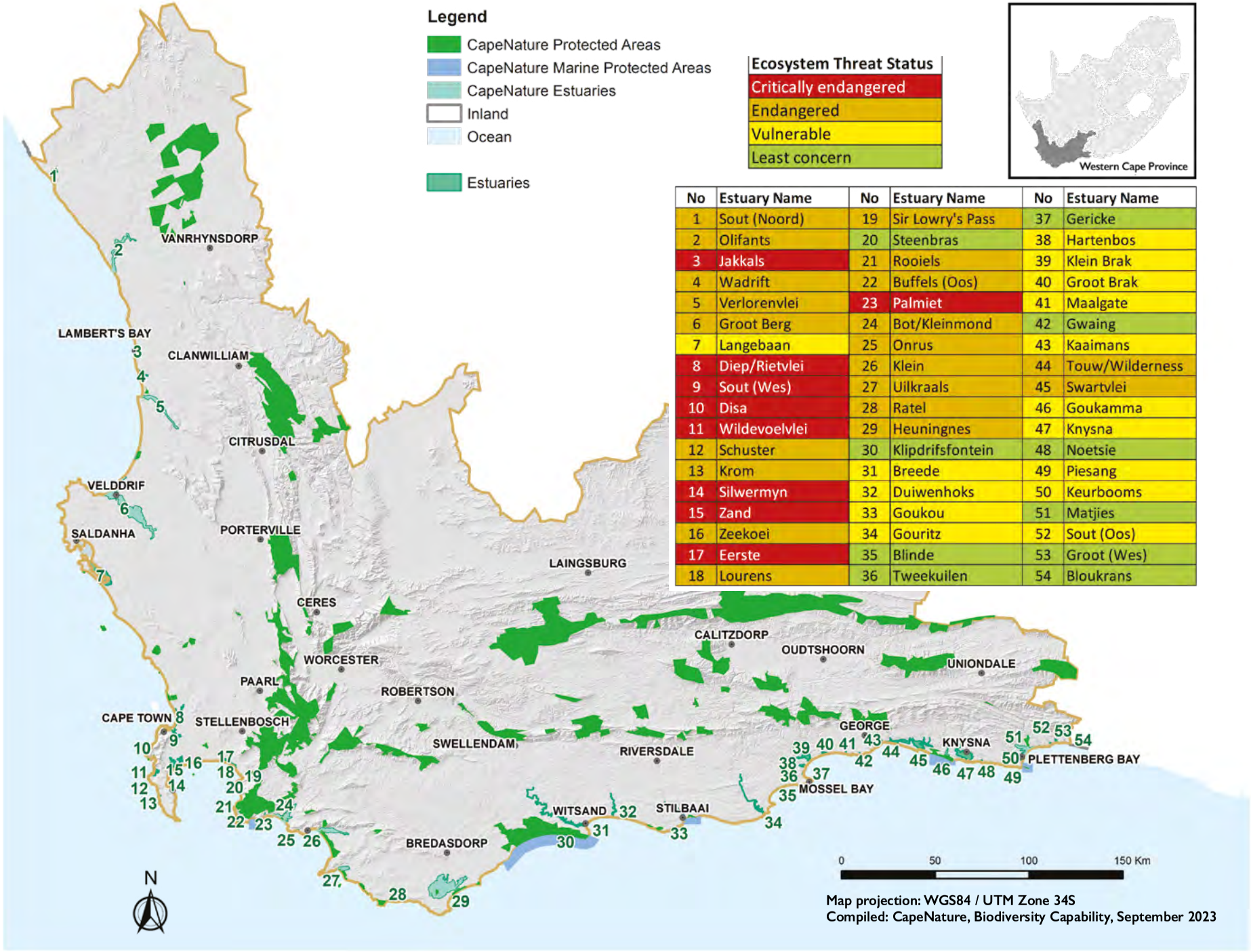
## 3.3 DISCUSSION AND RECOMMENDATIONS

It is clear from the results above that all three realms are subject to huge pressures in terms of development, alien species, resource over-utilisation and pollution. Monitoring and surveillance has a big part to play in helping understand the dynamics involved, as well as help guide a way forward in how to address the various challenges listed above. A cross-sectoral approach is required for the protection and appropriate management of marine and coastal ecosystems while monitoring and surveillance are required to track the health of ecosystems and threat reduction results.

Mechanisms such as Estuarine Management Plans (EMPs) for the 13 priority CapeNature estuaries (CapeNature 2022a) and six associated estuary mouth maintenance management plans (MMPs) are aimed at achieving a cross-sectoral approach to management.

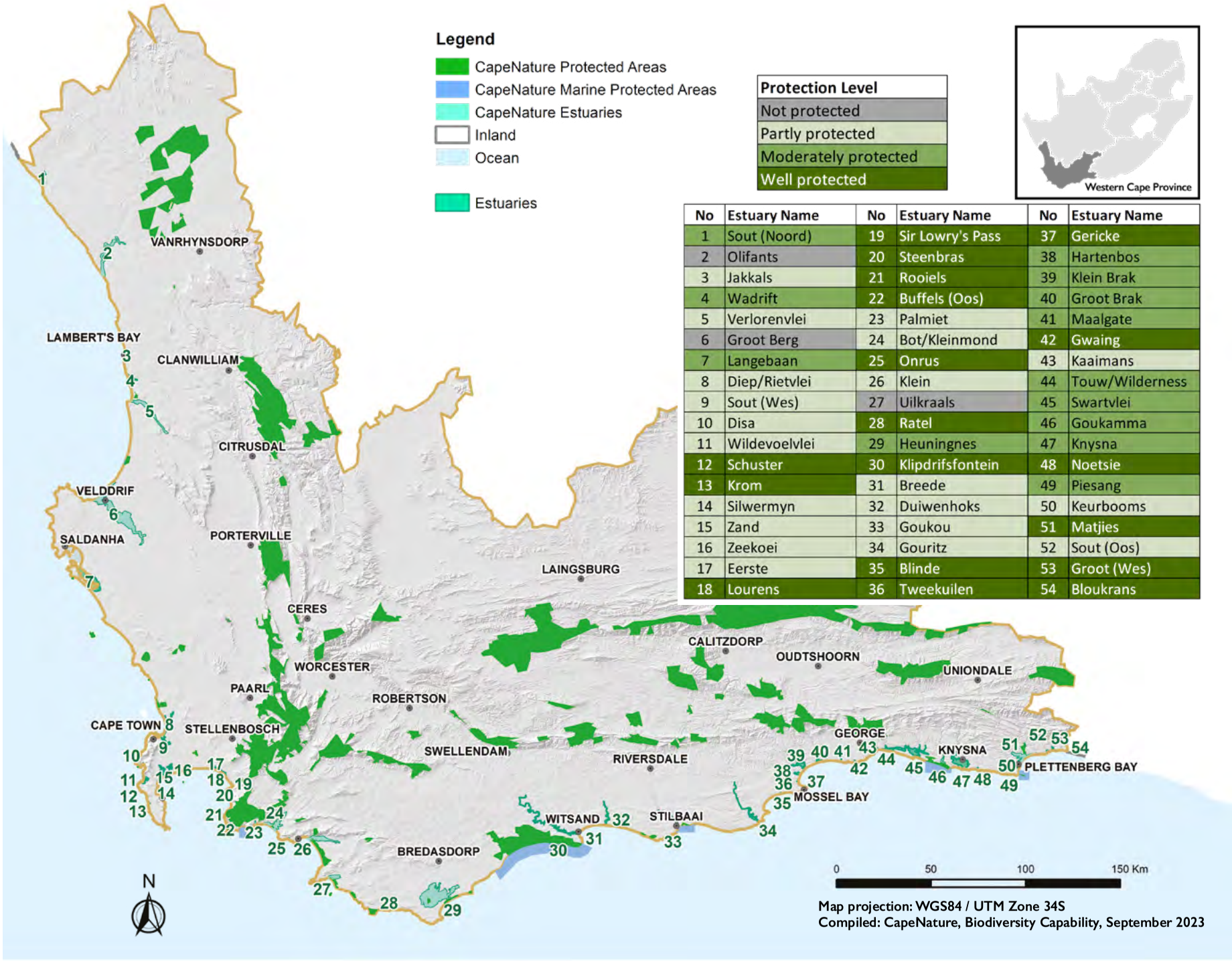
This reporting period also covers the setting up of Marine and Coasts Operations within CapeNature. This period was used to identify monitoring and management gaps and to set up partnerships to address these gaps. The following five-year period will see much of what has been set up being implemented.

Finally, minimising activities in the coastal zone, developing agreed upon vehicle access sites in partnership with stakeholders and DFFE and dune restoration projects are identified as key strategies for the way forward, aligned and in support of the Western Cape Coastal Management Programme (DEA&DP 2023).




| No | Estuary Name | No | Estuary Name | No | Estuary Name |
|---|---|---|---|---|---|
| 1 | Sout (Noord) | 19 | Sir Lowry's Pass | 37 | Gericke |
| 2 | Olifants | 20 | Steenbras | 38 | Hartenbos |
| 3 | Jakkals | 21 | Rooiels | 39 | Klein Brak |
| 4 | Wadrift | 22 | Buffels (Oos) | 40 | Groot Brak |
| 5 | Verlorenvlei | 23 | Palmiet | 41 | Maalgate |
| 6 | Groot Berg | 24 | Bot/Kleinmond | 42 | Gwaing |
| 7 | Langebaan | 25 | Onrus | 43 | Kaaimans |
| 8 | Diep/Rietvlei | 26 | Klein | 44 | Touw/Wilderness |
| 9 | Sout (Wes) | 27 | Uilkraals | 45 | Swartvlei |
| 10 | Disa | 28 | Ratel | 46 | Goukamma |
| 11 | Wildevoelvlei | 29 | Heuningnes | 47 | Knysna |
| 12 | Schuster | 30 | Klipdrifsfontein | 48 | Noetsie |
| 13 | Krom | 31 | Breede | 49 | Piesang |
| 14 | Silwermyn | 32 | Duiwenhoks | 50 | Keurbooms |
| 15 | Zand | 33 | Goukou | 51 | Matjies |
| 16 | Zeekoei | 34 | Gouritz | 52 | Sout (Oos) |
| 17 | Eerste | 35 | Blinde | 53 | Groot (Wes) |
| 18 | Lourens | 36 | Tweekuilen | 54 | Bloukrans |

Figure 3.6. Conservation status of estuaries in the Western Cape (extract from Van Niekerk *et al.* 2019).



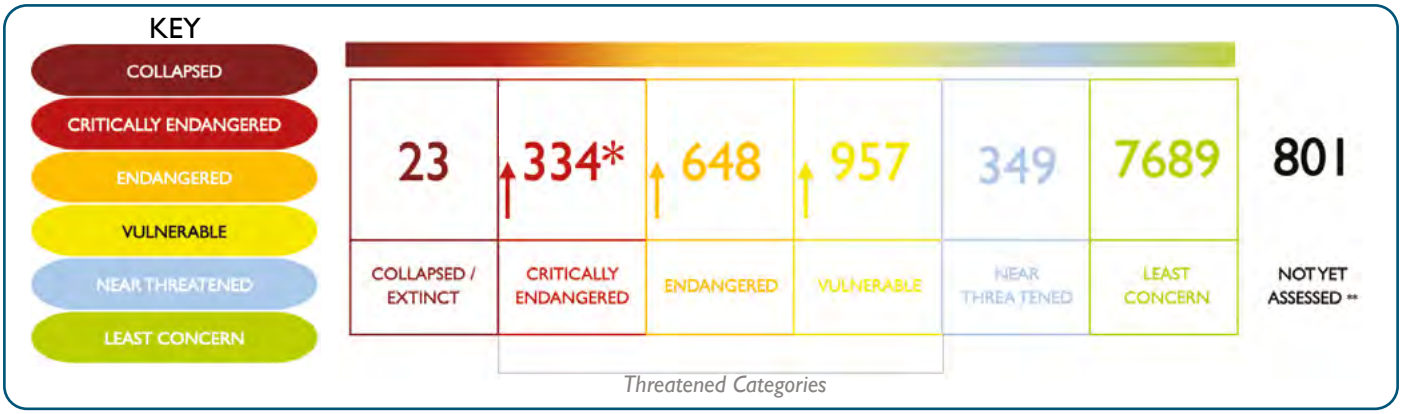

| No | Estuary Name | No | Estuary Name | No | Estuary Name |
|---|---|---|---|---|---|
| 1 | Sout (Noord) | 19 | Sir Lowry's Pass | 37 | Gericke |
| 2 | Olifants | 20 | Steenbras | 38 | Hartenbos |
| 3 | Jakkals | 21 | Rooiels | 39 | Klein Brak |
| 4 | Wadrift | 22 | Buffels (Oos) | 40 | Groot Brak |
| 5 | Verlorenvlei | 23 | Palmiet | 41 | Maalgate |
| 6 | Groot Berg | 24 | Bot/Kleinmond | 42 | Gwaing |
| 7 | Langebaan | 25 | Onrus | 43 | Kaaimans |
| 8 | Diep/Rietvlei | 26 | Klein | 44 | Touw/Wilderness |
| 9 | Sout (Wes) | 27 | Uilkraals | 45 | Swartvlei |
| 10 | Disa | 28 | Ratel | 46 | Goukamma |
| 11 | Wildevoelvlei | 29 | Heuningnes | 47 | Knysna |
| 12 | Schuster | 30 | Klipdrifsfontein | 48 | Noetsie |
| 13 | Krom | 31 | Breede | 49 | Piesang |
| 14 | Silwermyn | 32 | Duiwenhoks | 50 | Keurbooms |
| 15 | Zand | 33 | Goukou | 51 | Matjies |
| 16 | Zeekoei | 34 | Gouritz | 52 | Sout (Oos) |
| 17 | Eerste | 35 | Blinde | 53 | Groot (Wes) |
| 18 | Lourens | 36 | Tweekuilen | 54 | Bloukrans |

Figure 3.7. Protection levels of estuaries in the Western Cape (extract from Van Niekerk *et al.* 2019).

South Africa is ranked sixth among the world's 17 megadiverse countries (as rated by Conservation International in 1998 - Mittermeier *et al.* 1997) and the Cape Floristic Region, located mainly in the Western Cape, is one of 25 global biodiversity hotspots (Myers *et al.* 2000). Megadiversity is largely based on species richness and endemism, while biodiversity hotspots are the most species-rich and threatened terrestrial regions in the world. The Cape Floristic region is also a UNESCO World Heritage Site, with 68% of vascular plant taxa endemic to what is now regarded as the Core Cape Subregion of the Greater Cape Floristic Region (Manning & Goldblatt 2012).

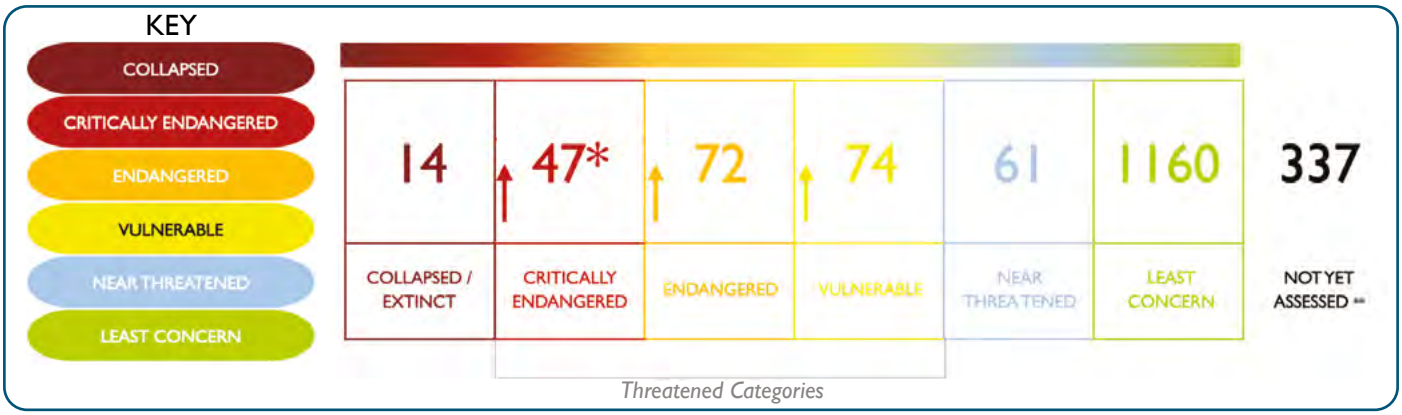
In this chapter, the diversity, provincial endemism, and threat status of indigenous taxa (for the purposes of this report, defined as species, sub-species, and lineages) in selected taxonomic groups in the Western Cape is described and changes in the conservation status of taxa since the 2017 Western Cape Province State of Biodiversity Report (CapeNature 2017b) are highlighted.

Number of assessed Western Cape **Flora** Taxa per Red List category.




* Includes Critically Endangered - Possibly Extinct
** Includes Data Deficient

Number of assessed Western Cape **Fauna** Taxa per Red List category.




* Includes Critically Endangered - Possibly Extinct
** Includes Data Deficient

## 4.1 METHODS

Monitoring the threat status of taxa provides information to inform conservation actions. The conservation status of taxa is tracked on the IUCN Red List of Threatened Species but also through South African Red Data Lists. The species lists used in the 2017 CapeNature State of Biodiversity Report (CapeNature 2017b), were reviewed, and updated with inputs from experts. For this chapter, analyses of threat status only included indigenous taxa within the Western Cape. The following indigenous taxa were excluded: (a) pelagic taxa, (b) taxa whose distributions reach their southernmost extremity in the Western Cape, and (c) taxa which have only been recorded as vagrants in the province or for which there are only a few unconfirmed records. Taxa with unresolved taxonomy were also excluded: These include eight freshwater fish taxa (three *Galaxias* and five *Sandelia* lineages) which were included in Chakona *et al.* (2013) but were not considered in a freshwater fish species account for South Africa by Chakona *et al.* (2022). Also excluded are three reptile taxa (subspecies of the tent tortoise) as well as reptile taxa that have been subsumed in other taxa e.g., *Psammophis namibensis* included in *Psammophis leightoni* (Taft *et al.* 2022) and other taxonomic changes e.g., *Pachydactylus serval* now restricted to Namibia.

Comparative analyses were based on South African Red List assessments where all taxa within taxonomic groups have been assessed (Bates *et al.* 2014, BirdLife 2019, Child *et al.* 2017, Davis *et al.* 2020, Mecenero *et al.* 2013, Samways & Simaika 2016, Taylor *et al.* 2015, Measey 2011), with reference to other relevant publications (BirdLife 2019, Mecenero *et al.* 2020, Underhill *et al.* 2018) and South African Red Data lists for fauna and flora. Some, but not all, of these assessments have been incorporated into the IUCN Red List. For *Scarabaienae* (dung beetles), there is uncertainty regarding the threat status of some taxa, and these have been tentatively assigned to threat categories e.g., DD/CR (Data Deficient – Critically Endangered) (Davis *et al.* 2020). For the purposes of this chapter, these taxa were generally treated as Data Deficient. Linefish of commercial importance that were assessed as part of the National Marine Linefish System (DFFE 2020) were also considered in this chapter. Several Red List assessments have not included all taxa within a group, e.g., *Orthoptera* (crickets, grasshoppers, locusts), crabs, and millipedes.

Red List Indices (RLI) are used to show changes in extinction risk over time (IUCN 2014, Butchart *et al.* 2010). An RLI value of 1.0 results if all taxa are Least Concern, while a value of 0.0 is obtained if all taxa have gone extinct. RLIs based on South African Red List assessments were also used to compare extinction risk between the main taxonomic groups, using threat categories assigned through South African assessments. In this chapter, RLI values for butterflies were compared for the period 2016-2022.

For selected taxonomic groups, the number of taxa which have been up- or downlisted since 2017 was summarized: where South African Red List assessments indicated a genuine change in threats, taxa were included in the results; whereas, when this distinction could not be made from IUCN Red List assessments, the results included all changes.

Examples of research into genetic diversity for Western Cape taxa are provided in Table 4.2.

### E-Links

**IUCN Red List** http://iucnredlist.org/
**South African Red List** http://redlist.sanbi.org/

## 4.2 RESULTS

A total of 10 778 plant taxa in the Western Cape are recognised, and 61% of these are endemic to the province (SANBI 2020). The number of invertebrate taxa in the province is unknown, but the numbers of recognised invertebrate and vertebrate taxa in selected taxonomic groups (with taxon exclusions as described in the methods) are illustrated in Figure 4.1. Of the faunal groups assessed, colophon beetles, freshwater fish and amphibians have the highest proportions of provincial endemics (100%, 71% and 60%, respectively).

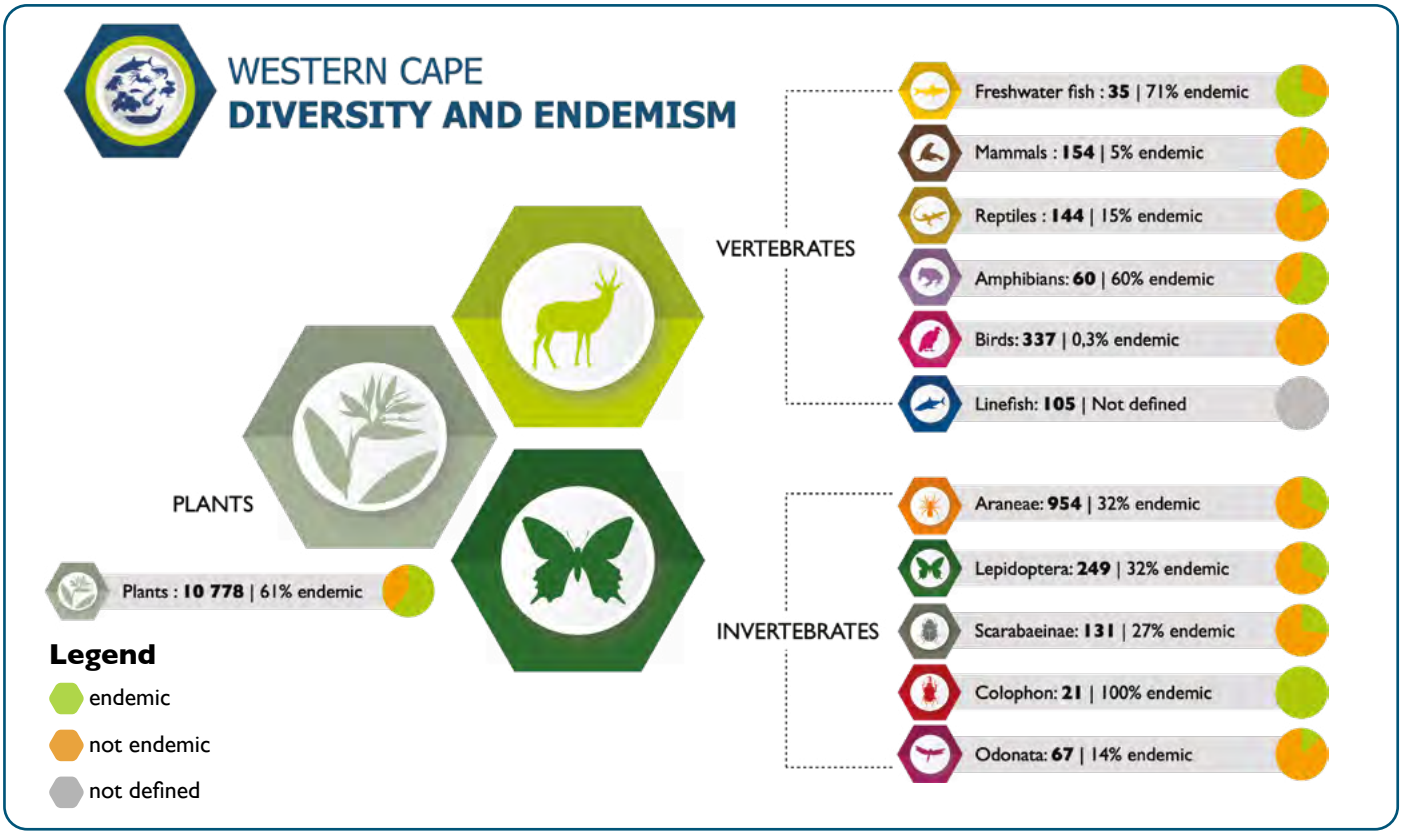



Figure 4.1. Recognised number of indigenous taxa in the Western Cape (March 2023) in selected taxonomic groups, and percentage of taxa that are endemic to the province.

One butterfly, seven bird and six mammal taxa are globally and/or provincially extinct. The numbers of taxa per taxonomic group in each of the remaining assessment categories are presented in Table 4.1, and relative percentages are illustrated in Figure 4.2a. The assessment is based on South African Red List assessments and CapeNature's March 2023 taxon lists. CR-PE: Critically Endangered, Possibly Extinct; CR: Critically Endangered; EN: Endangered; VU: Vulnerable. Taxon exclusions as described in the methods section. The two groups with by far the highest percentage of threatened taxa (CR-PE, CR, EN and VU combined) are colophon beetles and freshwater fish. Plants have the third highest percent (18%) of threatened taxa. The percentages of threatened taxa per taxonomic group are lower for the Western Cape than they are world-wide for taxa in equivalent or similar groups (Figure 4.2a and b).

Table 4.1. Number and percentage of Western Cape taxa per Red List category

| TAXONOMIC GROUP | CR-PE | CR | EN | VU | Total threatened | Percentage threatened |
|---|---|---|---|---|---|---|
| Plants | 42 | 292 | 648 | 957 | 1939 | 18 |
| Beetles, *Colophon* | 0 | 8 | 7 | 0 | 15 | 88 |
| Beetles, Scarabaeinae | 0 | 0 | 4 | 8 | 12 | 10 |
| Dragon- and damselflies | 0 | 0 | 3 | 4 | 7 | 11 |
| Butterflies | 5 | 12 | 11 | 4 | 32 | 11 |
| Spiders | 0 | 8 | 9 | 10 | 27 | 3 |
| Linefish | 0 | 0 | 2 | 10 | 12 | 13 |
| Fish, freshwater | 0 | 4 | 13 | 7 | 24 | 69 |
| Amphibians | 0 | 5 | 3 | 0 | 8 | 14 |
| Reptiles | 0 | 1 | 2 | 4 | 7 | 5 |
| Birds | 0 | 1 | 11 | 15 | 27 | 8 |
| Mammals | 0 | 3 | 7 | 12 | 22 | 14 |

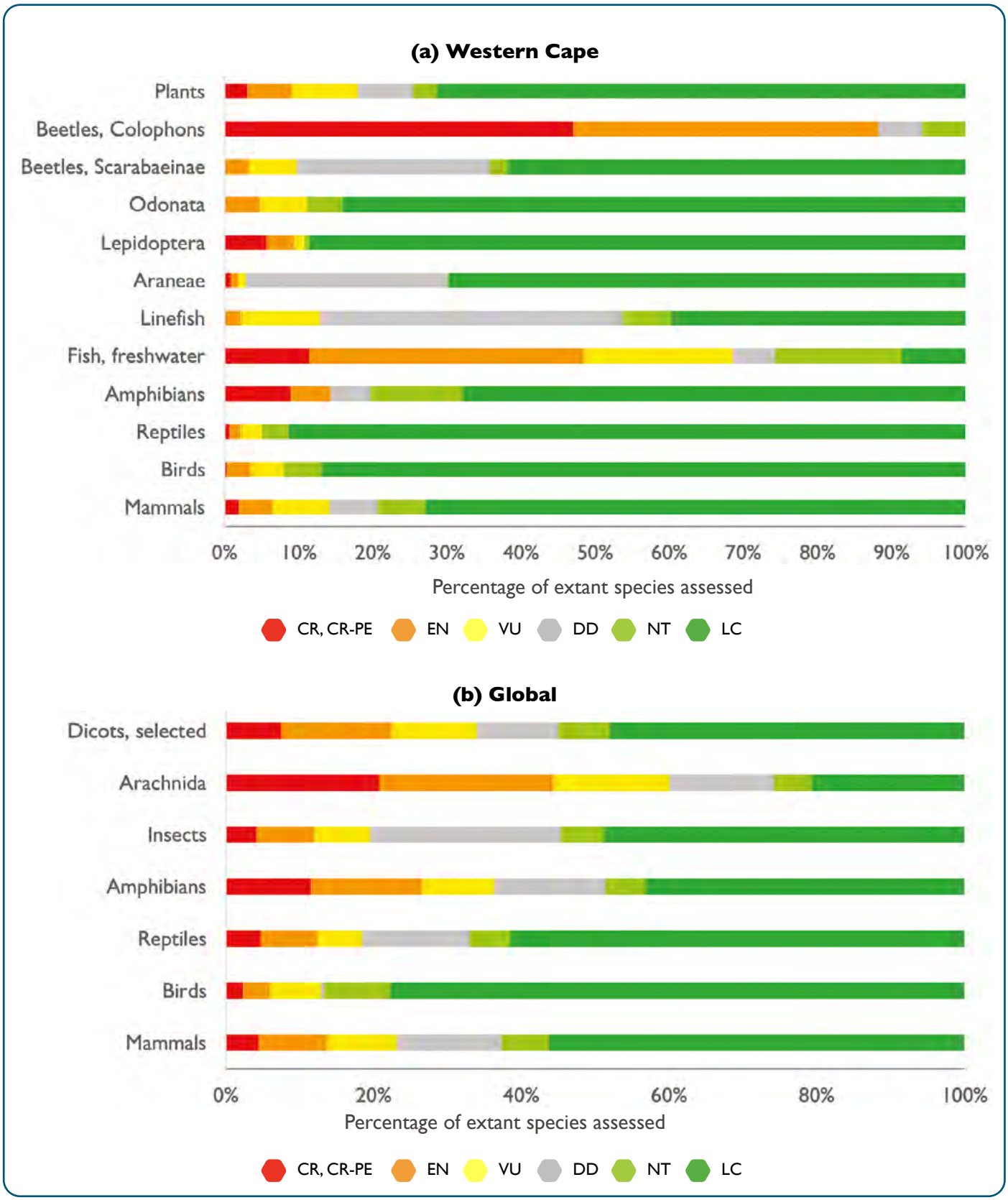



Figure 4.2. Percentage of extant taxa per taxonomic group per Red List assessment category. (a) Western Cape (Red List status based on South African assessments). (b) World-wide (data extracted from IUCN 2022).

Relative RLI values reveal the relatively high proportion of threatened taxa in colophon beetles, freshwater fish, and amphibians (Figure 4.3). If dung beetle taxa classified in a threat category tentatively due to a paucity of data are assigned to those threat categories rather than the Data Deficient category, then the RLI value for *Scarabaeinae* is 0.86 – the same value as amphibians – rather than 0.93. For mammals and birds, RLI values for marine taxa are lower than those for non-marine taxa (Figure 4.4). For both amphibians and freshwater fish, endemic taxa have considerably lower RLI values than non-endemic taxa (Figure 4.5).

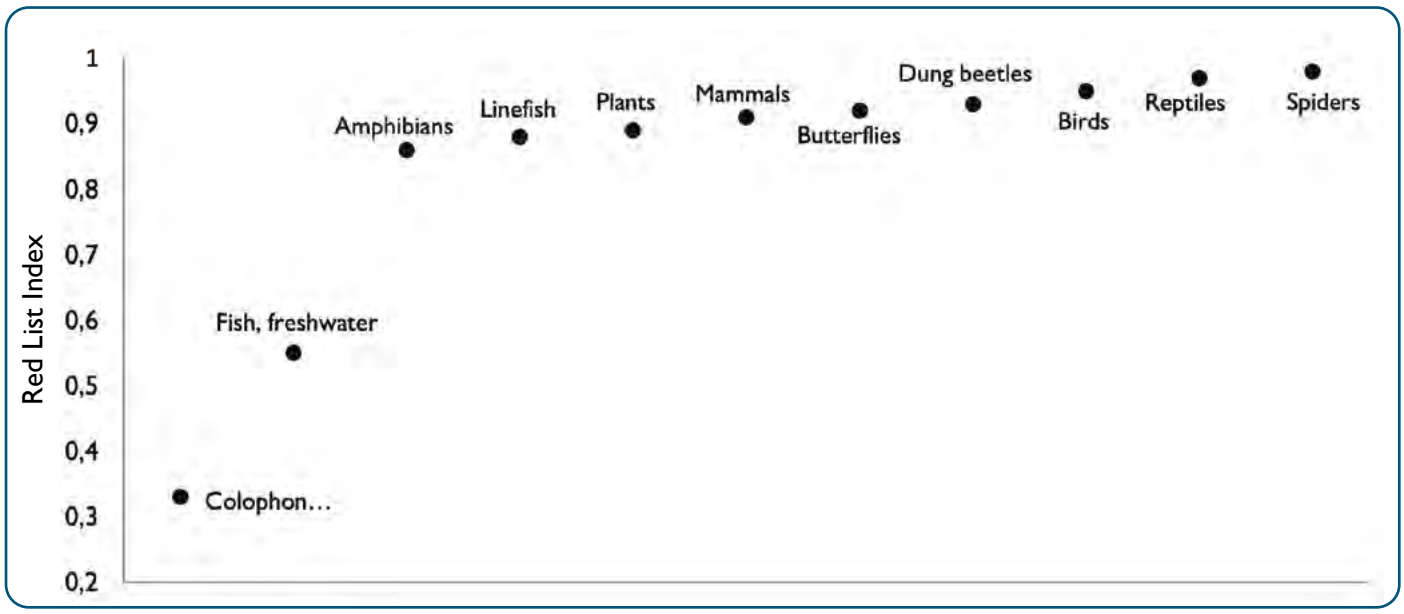



Figure 4.3. Red List Indices based on South African Red List assessments for selected taxonomic groups in the Western Cape.

RLI reflects extinction risk, with an RLI value of 1 indicating zero extinction risk and value of 0 indicating that all taxa within a group are extinct. Note for the RLI value for *Scarabaeinae* (dung beetles), taxa assessed tentatively as threatened (e.g., DD/CR or DD/EN) were treated as DD.

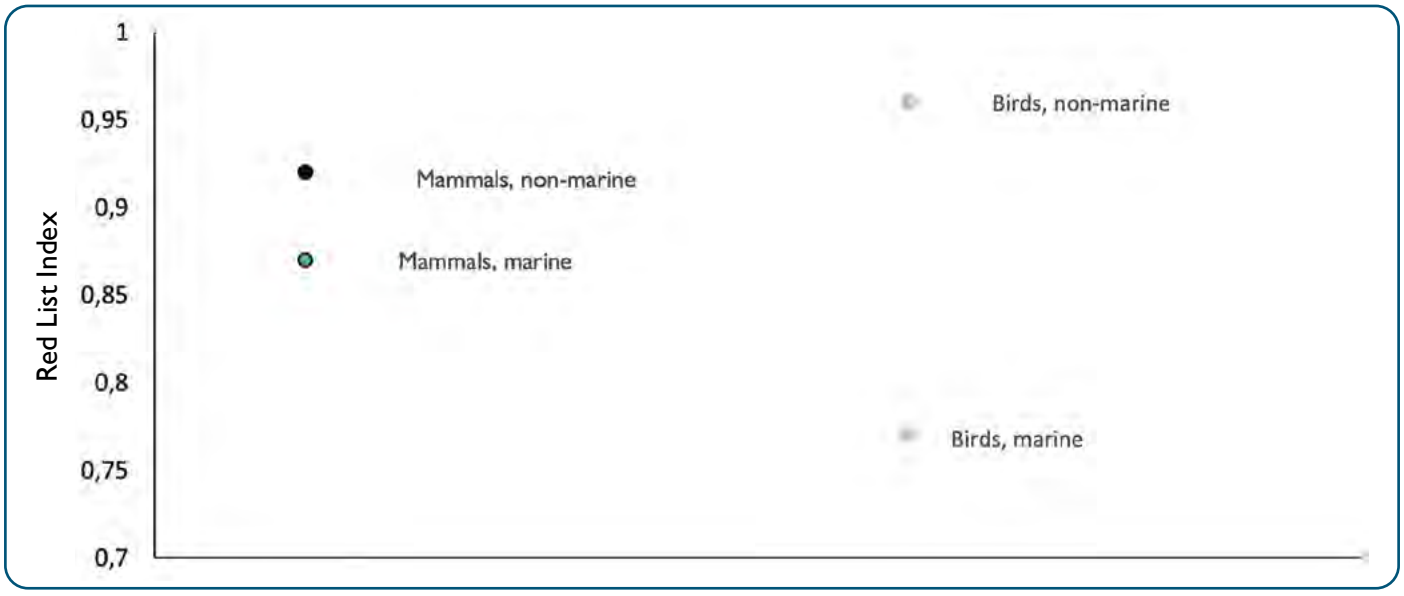



Figure 4.4. Comparison of Red List Indices based on South African Red List assessments for marine and non-marine birds and mammals in the Western Cape.

RLI reflects extinction risk, with an RLI value of 1 indicating zero extinction risk and value of 0 indicating that all taxa within a group are extinct.

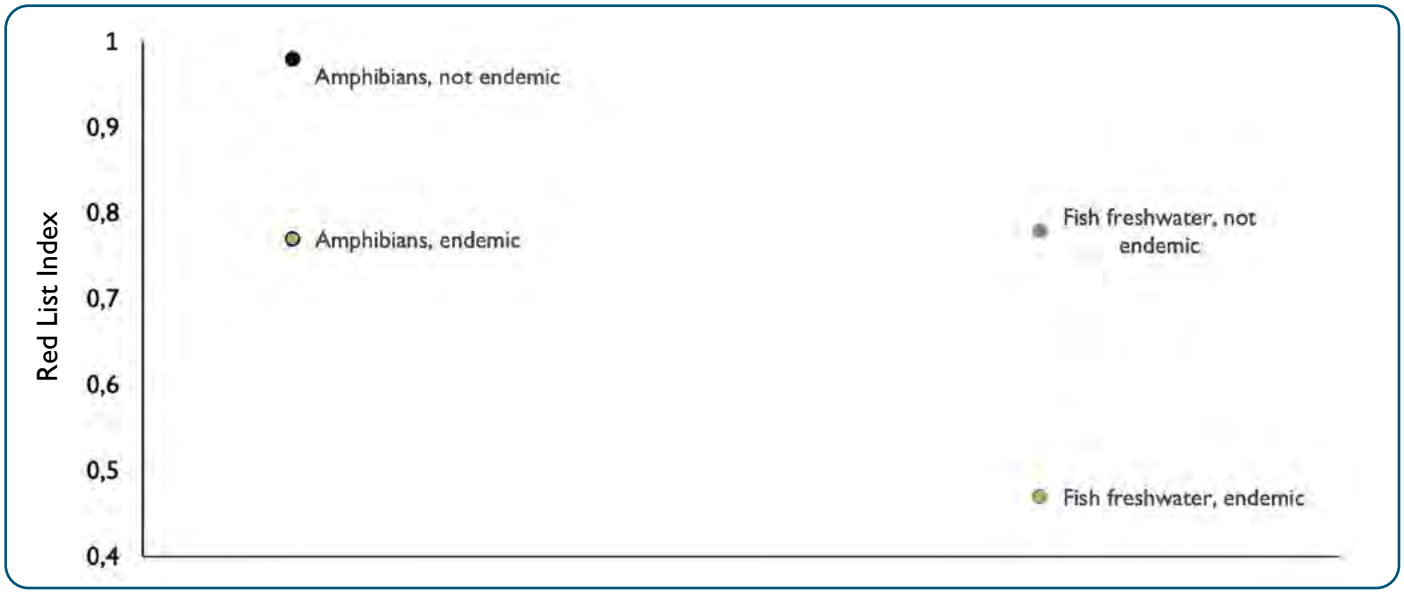



Figure 4.5. Comparison of Red List Indices based on South African Red List assessments for endemic and non-endemic amphibians and freshwater fish in the Western Cape.

RLI reflects extinction risk, with an RLI value of 1 indicating zero extinction risk and value of 0 indicating that all taxa within a group are extinct.

Since the 2017 Western Cape State of Biodiversity Report (CapeNature 2017b), South African Red List assessments have resulted in the uplisting of 64 taxa due to real changes in threat levels – 53 plants, nine butterflies, and two reptiles (Figure 4.6). This excludes changes in red list category for other reasons, e.g., improved data. There has been a slight decrease in the RLI for butterflies since the 2017 Western Cape State of Biodiversity Report (RLI=0.94 based on butterfly Red List available in 2017 corrected for non-genuine status changes, and RLI=0.92 based on status.

Based on IUCN Red List assessments, 26 taxa have been uplisted and 20 have been downlisted (Figure 4.7), but it should be noted that these changes were for a variety of reasons including improved information available and prior incorrect application of Red List criteria, and do not necessarily indicate changes in threat intensity.

Selected examples of research findings regarding genetic diversity, and the conservation management implications of these in the Western Cape, are summarised in Table 4.2.

Silver Arrowhead *(Phasis thero)*
© Scott Ramsay

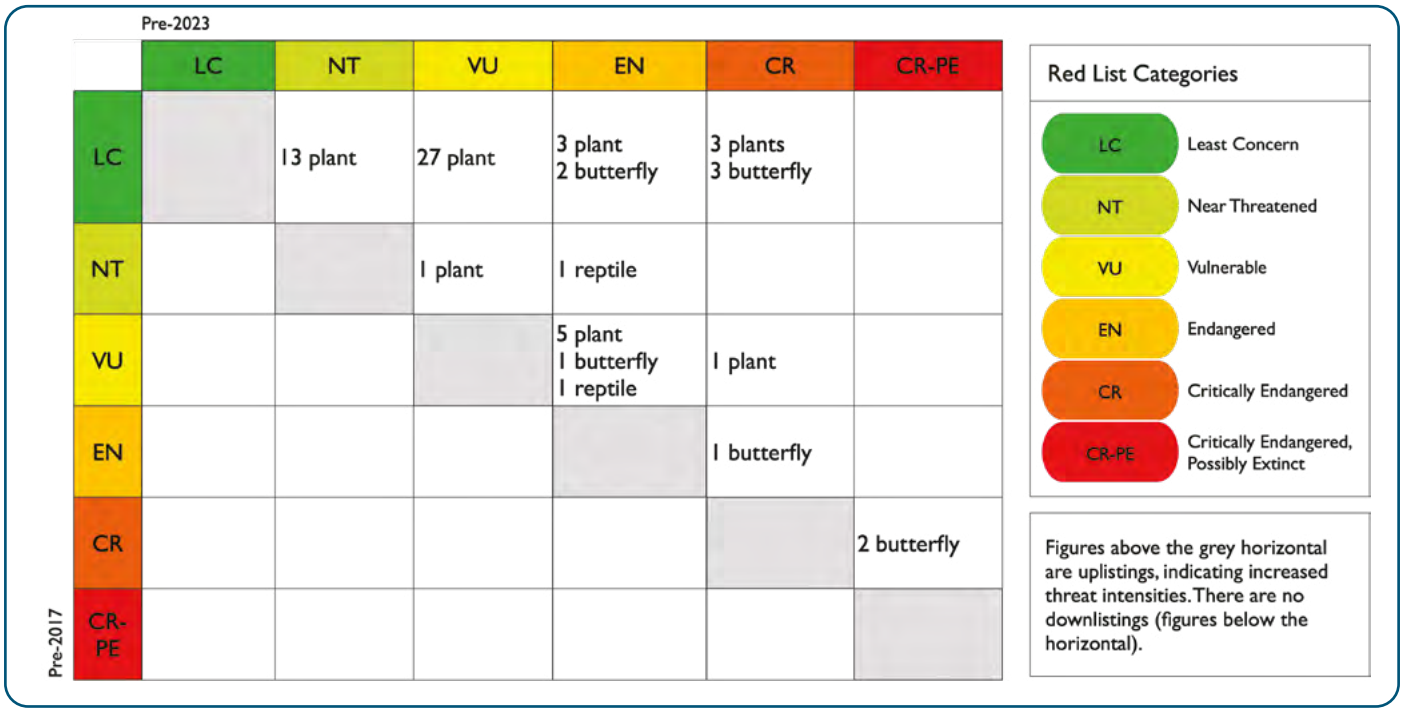



Figure 4.6. Changes in South African red list status since 2016 for plant, butterfly, and reptile species.

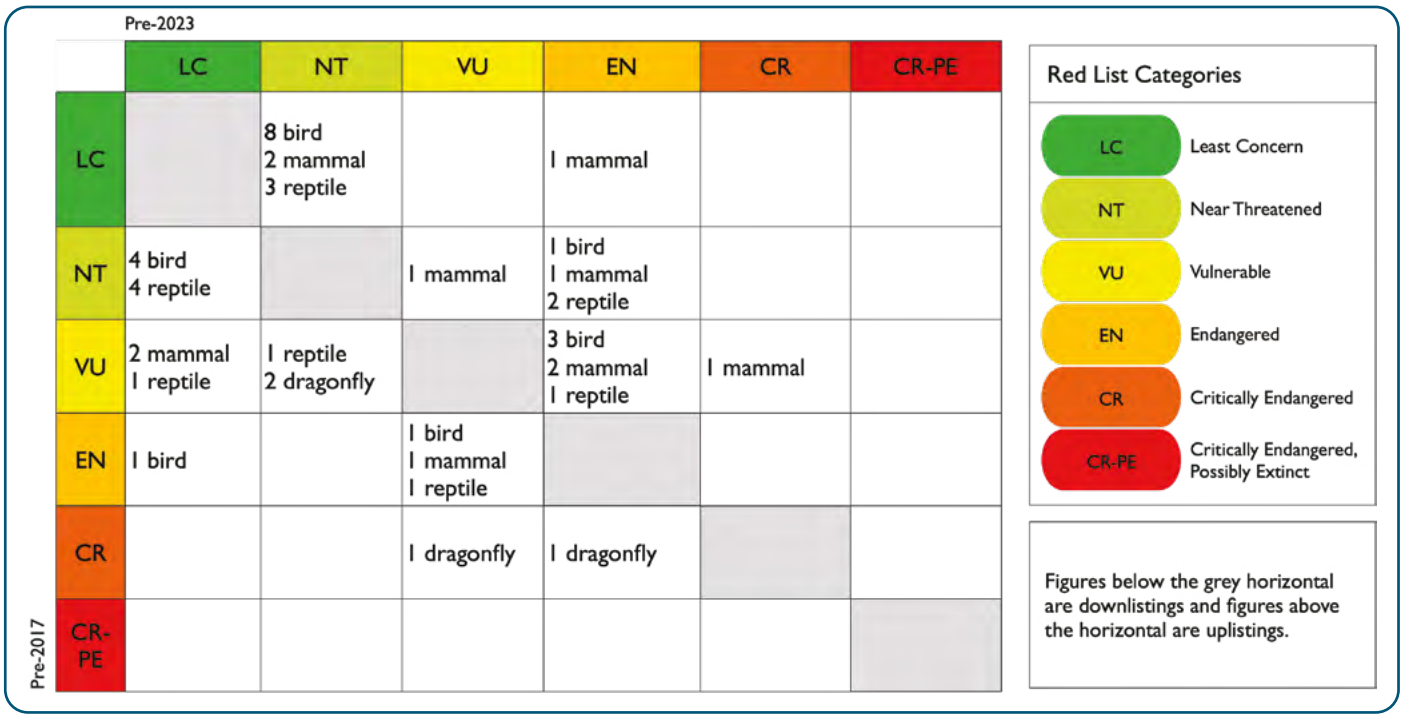



Figure 4.7. Changes in IUCN red list status since 2016 for mammal, bird, reptile, and dragonfly species.

Table 4.2. Examples of research into genetic diversity, with management implications.

| | Conservation status & Western Cape endemism | Genetic Research | Take Home Message | Management recommendations |
|---|---|---|---|---|
| Chubby-headed barb (*Enteromius anoplus*) | *E. anoplus* – VU; endemic to Gouritz system. *E. cernuus* – VU, endemic to Olifants-Doring system, extending into Oorlogskloof River in Northern Cape. *E. mandelai* – LC. Widely distributed in Eastern Cape with marginal distribution in Western Cape. | *E. anoplus* is the most widely distributed freshwater fish in South Africa but has recently been shown to comprise four distinct lineages, equivalent to four species (Kambikambi *et al.* 2021). Pseudobarbus, Sandelia, Galaxias, Enteromius, Labeo and Labeobarbus are other complexes represented in the Western Cape which contain several evolutionarily distinct genetic lineages that must still be formally described. | Although the taxonomy of freshwater fish is well-studied, ongoing research is still discovering undescribed taxa. The diversity of freshwater fish in the Western Cape is likely far greater than currently recognized. | Encourage and support systematics research in general. Monitor freshwater fish populations. Address threats in the Gouritz and Olifants-Doring systems, in particular invasive alien fish. |
| Rose's Mountain Toad (*Capensibufo rosei*) | CR., Endemic; range-restricted to Cape Peninsula (two extant populations). | The two populations were genetically dynamic from 2011-2015, with the loss and gain of rare alleles, but levels of genetic diversity increased slightly. This increase corresponds to an increase in the population after a fire, suggesting that habitat disturbances such as fire and grazing facilitate recruitment, dispersal and/or population growth (da Silva & Tolley 2018). | Appropriate habitat is essential for avoiding genetic erosion. | Remaining breeding sites and surrounding areas should be maintained to prevent vegetation from becoming overgrown and similar interventions could help to restore some historical sites where populations have gone extinct. |
| Tent tortoise (*Psammobates tentorius*) | NT., Not endemic. | By the Mid-Miocene, *P. tentorius* had begun to differentiate into four lineages: the recognized subspecies *P. t. tentorius* and *P. t. trimeni*, and two *P. t. verroxii* subclades (Hofmeyr *et al*. 2016). *P. t. trimeni* has been globally assessed as Endangered (Hofmeyr *et al.* 2018). | Genetic research is uncovering previously undiscovered diversity in well-known species complexes. | Address habitat degradation and predation by crows in the range of *P.t. trimeni.* |
| African Penguin (*Spheniscus demersus*) | EN., Not endemic. | There is low genetic diversity in the innate immune region of the species, suggesting it has experienced a genetic bottleneck which could increase disease susceptibility (Dalton *et al.* 2016). The loss of functional genetic diversity in captive animals might indicate a loss of adaptive potential. Based on comparisons of first- and second-generation birds, it appears that the ex-situ population is at risk of future loss of genetic variability (Labuschagne *et al.* 2016). | Loss of genetic variation can decrease disease resistance, and the captive African Penguin population is at risk. | Exchange birds between captive facilities. Consider adding wild-caught birds to captive breeding programs, where these birds cannot be rehabilitated. Ascertain the extent to which in situ genetic variation is represented in ex situ populations. |
| Cape mountain zebra (*Equus zebra zebra*) | LC., Not endemic. Restricted to fynbos, grassland and Karoo habitats. No free-ranging populations thus dispersal dependent on human intervention. | Three genetically distinct stocks exist (Moodley & Harley 2005), with 90% of Cape mountain zebra in the province belonging to Cradock (C) stock. Kammanassie (K) and Gamkaberg (G) stocks are represented in two small, isolated populations while animals on De Hoop Nature Reserve, Overberg Test Range and Sanbona Wildlife Reserve are of mixed C-K stock. There has, however, been a substantial loss in heterozygosity at De Hoop in recent years (Kotzé *et al.* 2019). Cape mountain zebra populations with low genetic diversity are known to exhibit sarcoidosis, a papillomavirus (Sasidharan *et al.* 2011). There is also a risk of hybridization with other equids (Dalton *et al.* 2017). | Habitat fragmentation and population isolation has resulted in inbreeding and loss of genetic diversity. | Secure access to additional good zebra habitat around Gamkaberg and Kammanassie nature reserves, to encourage population growth. Mix the three genetic stocks and monitor the outcomes. Genetically bolster small populations on private land. |

## 4.3 DISCUSSION AND RECOMMENDATIONS

The extraordinary biodiversity of the Western Cape is illustrated by the coverage and concentration of Key Biodiversity Areas in the province – areas which contribute significantly to the global persistence of biodiversity. Fifty- three percent of South Africa's plant taxa are represented in the province (10 778 of the 20 401 taxa) (SANBI 2020; Raimondo *et al.* 2023), despite the Western Cape comprising only 11% of the total surface area of the country. Faunal diversity is also high and is not only evident from number of taxa per group but also from the proportion of taxa which are endemic to the province.

The percentage of threatened taxa in the Western Cape compares favourably to the percentage of threatened taxa globally, but there is still cause for concern. The 2018 National Biodiversity Assessment (Skowno *et al.* 2019a) highlighted changes in hydrological regime and poor water quality, compounded by the influences of invasive alien taxa, as major pressures on inland aquatic, estuarine and coastal biodiversity of the province. This is reflected in the high percentage of threatened freshwater fish and amphibians relative to other groups. Extinction risk is particularly high for endemic taxa, whose restricted distributions mean that they are vulnerable to localized threats. This is clearly illustrated by the lower RLI values for endemic than non-endemic amphibians and freshwater fish, and the extremely high number of threatened colophon beetles. Also of concern are seabirds and marine mammals, which are at greater risk than their terrestrial counterparts. However, knowledge gaps and lack of capacity have resulted in relatively few assessments of marine taxa (Raimondo *et al.* 2023).

Relative to the number of taxa assessed, there have been few changes in threat status since the 2017 Western Cape State of Biodiversity Report was written. This is at least partly due to the short period – relatively few national re-assessments have been carried out since 2017 – rather than no changes in extinction risk. However, all the changes made in South African assessments are uplistings rather than downlistings i.e., threat intensity has increased. This is unsurprising – for South Africa as a whole, extinction risk has increased significantly over recent years (Raimondo *et al.* 2023). An assessment of protection level has shown that most native fishes and five reptile taxa are inadequately protected within the current protected area network in the Western Cape (Jordaan *et al.* 2020, Tolley *et al.* 2019b). Similar assessments for other taxonomic groups in the province, especially those with a high proportion of provincial endemics or near-endemics, would be valuable since they would help to inform provincial protected area expansion plans and to focus conservation actions outside of protected areas.

Regular re-assessments of taxonomic groups are essential for assessing the state of provincial, national and biodiversity and for tracking progress towards Global Biodiversity Framework targets. The process of re-assessing the status of South African mammals is underway and will be completed in 2024. Genetic indicators will be incorporated for the first time. Genetic diversity is an important aspect of biodiversity and is related to evolutionary potential or the ability to adapt to environmental change. It is eroded through pressures such as habitat fragmentation, selective breeding, and hybridization (Tolley *et al.* 2019a). Where possible, the updated red list assessments will also incorporate Green Status Assessments which measure the recovery of populations and thus conservation success.

Monitoring and surveillance are distinct but complimentary tools used for the management of biodiversity. Surveillance projects usually comprise opportunistic and ad hoc data collection with the data generally not aimed at determining population trends, but rather to determine the presence/absence and distribution ranges of taxa. Monitoring on the other hand relies on the use of standardized methodologies and protocols to determine trends in population responses to the changes in the environment particularly where these responses are because of management action or inaction (CapeNature 2022b). Thus, in the context of the adaptive management framework, appropriate, regular, and consistent monitoring and surveillance is an essential function. Data from monitoring and surveillance projects aid in species threat status assessments, advise land use decision making (including protected area expansion) and provide a decision support basis for policy and legislative tools aimed at biodiversity conservation. Other important applications of monitoring and surveillance data are servicing Biodiversity Management Plans (BMPs), providing a baseline for selecting and implementing future monitoring projects, informing consumptive use/offtake quotas, detecting emerging threats such as novel invasive species and guiding management actions generally.

Biodiversity monitoring and surveillance are conducted both on and off CapeNature's protected areas and this chapter focusses on the protected area component. Monitoring and surveillance efforts are specified by an ecological matrix (hereafter "Eco-matrix") specific to each protected area complex. The Eco-matrix is informed by priorities from the Protected Area Management Plans as well as by a priority species list compiled by CapeNature (CapeNature 2021b). Monitoring and surveillance is focused on priority species that are either absent from or poorly represented in the protected area network, species that are harvested or utilized and species involved in human-wildlife conflict. These projects are often implemented in collaboration with partner institutions. All data, including that which is collected by external researchers and collaborators, is consolidated in the State of Biodiversity database from where the data is available for analysis. CapeNature refined the list of priority species for monitoring and surveillance, which was initially based on regional and global red list status, degree of endemism, provincial/national/international reporting requirements, the existence of species ecotypes, and alien invasive status.

## 5.1 METHODS

Eco-matrix projects for the reporting period (2018-2023) were consolidated. Projects were classified as non- biological or biological and only the latter projects were included for further analysis. For faunal projects, the biological data collection was divided into three categories, namely "priority species", "non-priority species" and "multi-species monitoring and surveillance". The latter category was used for multi-species monitoring and surveillance projects where both priority and non-priority species were expected to be included. For flora, the projects were split into "rare flora and priority species", "post fire and permanent protea plots" and "other". The latter category mainly included projects related to alien vegetation management and veld restoration. Following the analysis of the eco-matrix projects, selected monitoring and surveillance projects and the application of the data were discussed.

## 5.2 RESULTS

### 5.2.1 All Eco-matrix Projects

A total of 565 protected area eco-matrix projects were listed for the reporting period. Of these 405 (71.7%) were biological projects.

A total of 72 871 species records were captured on the State of Biodiversity database by CapeNature staff over the last five-year period (Figure 5.1). Mammals, plants, and birds are most frequently collected as *ad hoc* surveillance due to the relatively simple observation methodology and conspicuousness of these species.

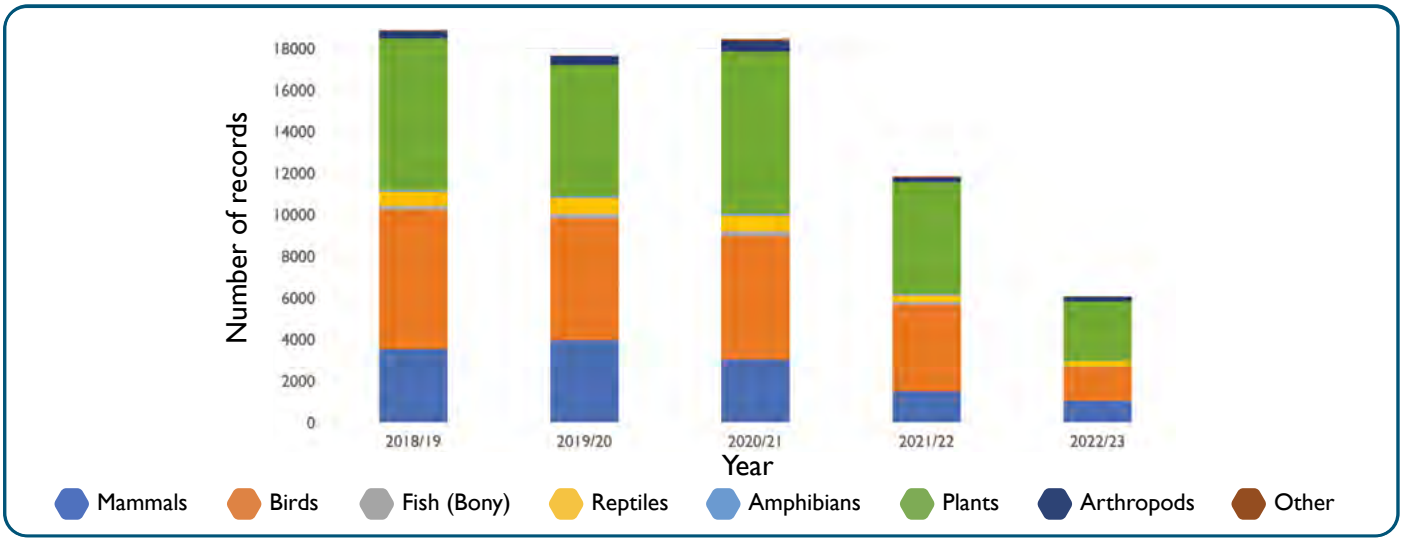



Figure 5.1. Number of records per taxon group per year logged on the State of Biodiversity database.

### 5.2.2 Fauna Monitoring and Surveillance Eco-matrix Projects

#### *5.2.2.1 Composition of Eco-matrix fauna projects*

Of the 405 Eco-matrix projects executed on CapeNature managed protected areas, 286 (70.6%) target faunal species and include projects across all taxonomic groups. Of these projects, 61% have a multi-species focus with the remaining 39% focused on a combination of priority and other species (Figure 5.2). Of the priority species projects (n=66), monitoring and surveillance is mainly concentrated on avifauna and mammals with 39 avifaunal projects and 22 mammal projects. In additional there are three projects focused on amphibian monitoring and another two on reptile monitoring.The absence of both marine and freshwater fish from the list of priority species for monitoring and surveillance is not a real absence as these species, many of which are threatened, are included under the multi-species monitoring and surveillance projects.

Stony Point Nature Reserve - African penguin *(Spheniscus demersus)* ©Andrew Turner

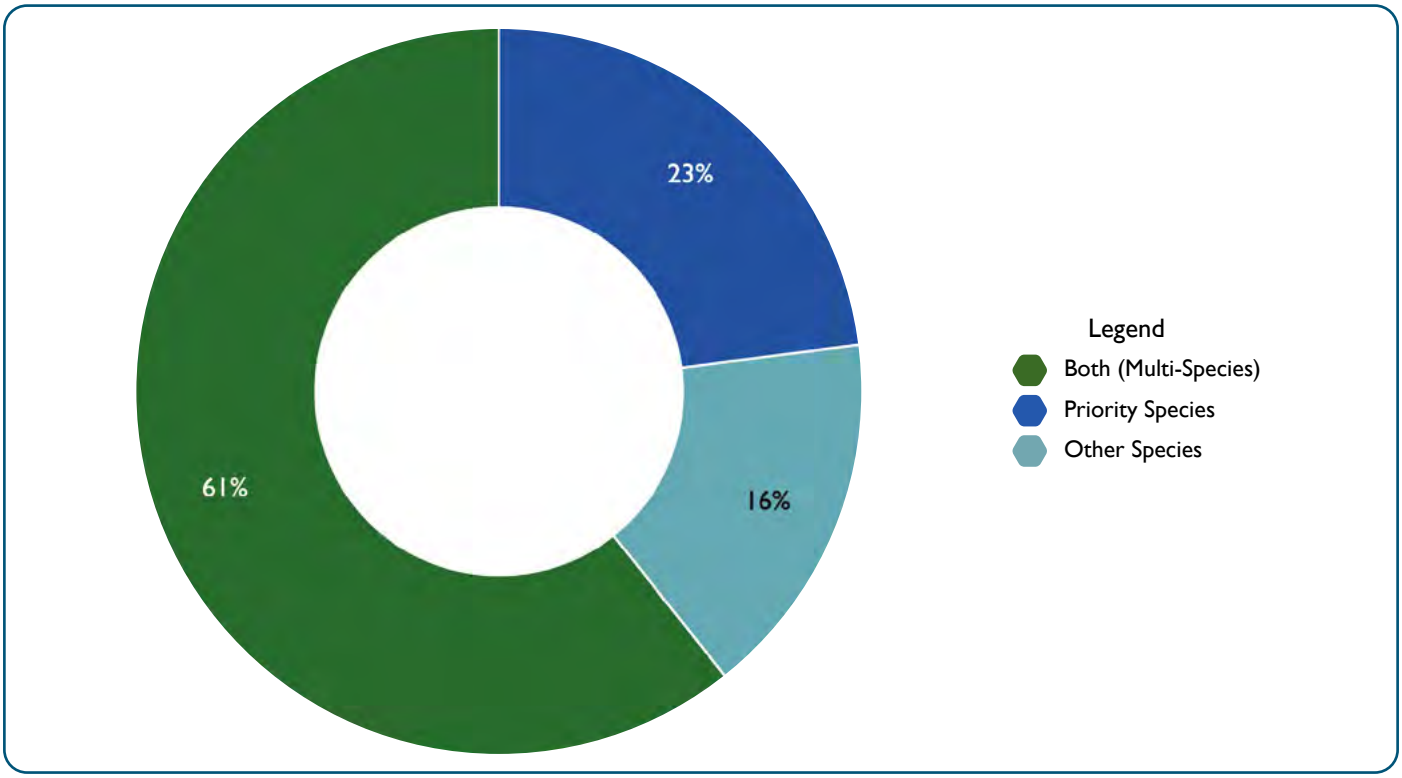



Figure 5.2. Composition of fauna Eco-matrix projects in terms of priority species, other species and both monitoring and surveillance.

### *5.2.2.2 Examples of fauna monitoring and surveillance projects*

a) Cape mountain zebra long term monitoring

Cape mountain zebra are endemic to Fynbos, Grassland and Karoo habitats and their Natural Distribution Range (NDR) is mainly in the Western and Eastern Cape provinces but extends marginally into the Northern Cape (Hrabar *et al.* 2016). In the Western Cape, almost all properties with this species fall within the NDR (Figure 5.3).

Data obtained between sampling years are a combination of vehicle and aerial surveys and thus not directly comparable.

CapeNature is an implementing agent for the Biodiversity Management Plan for Cape mountain zebra in South Africa (Birss *et al.* 2016) which is aimed at the long-term survival of this species in the wild. There are several monitoring and surveillance requirements that CapeNature implements and some of the monitoring results are presented in Figures 5.4 and 5.5 (CapeNature 2023b).

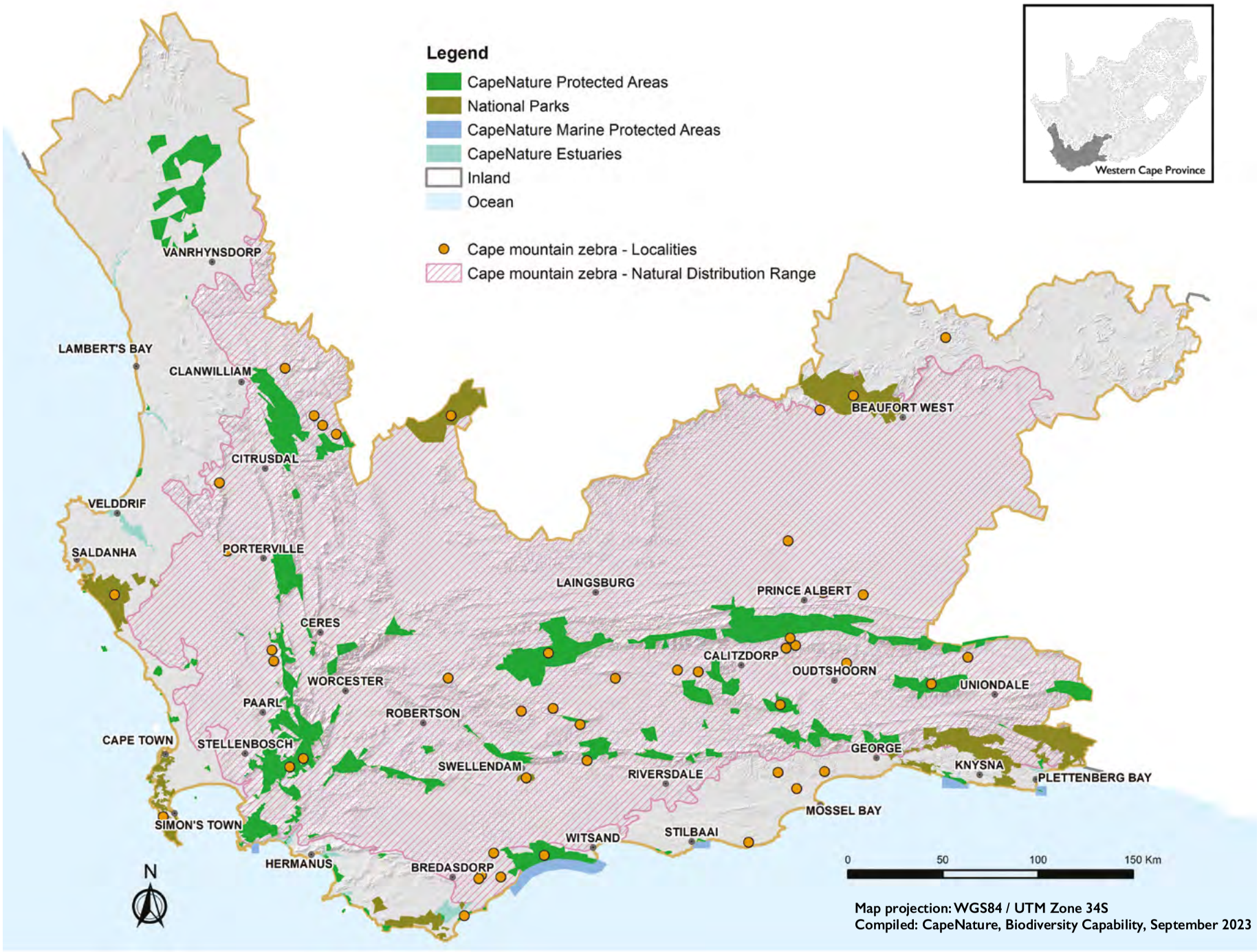



Figure 5.3. Distribution of Cape mountain zebra in the Western Cape, 2022.

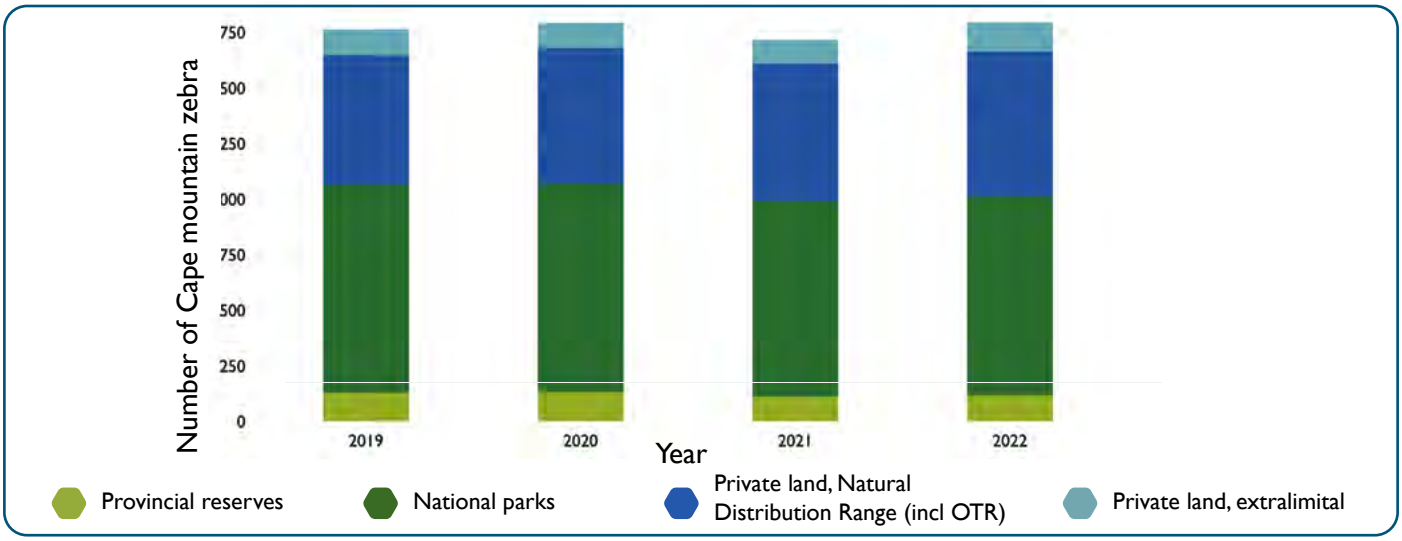



Figure 5.4. Cape mountain zebra numbers in the Western Cape, 2019-2022.

Note that Overberg Test Range (OTR) adjacent to De Hoop Nature Reserve is included under "Private land, NDR".

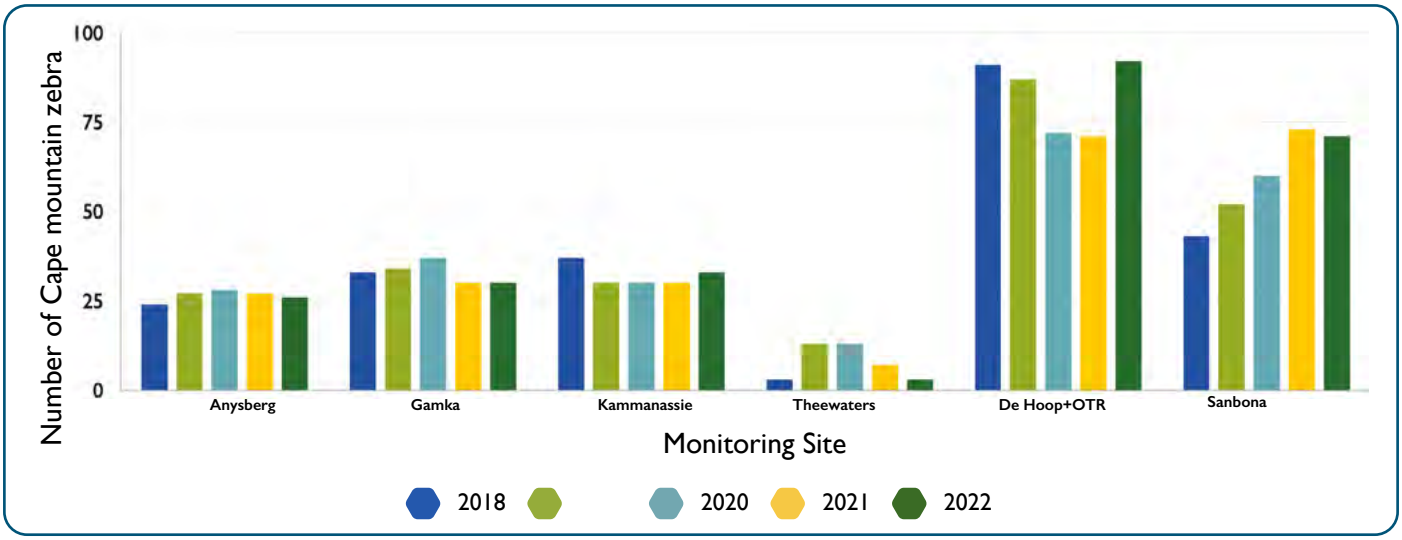



Figure 5.5. Comparison of Cape mountain zebra population estimates, 2018-2022, for seven monitoring sites.

b) Bontebok monitoring

Bontebok (*Damaliscus pygargus pygargus*) are endemic to the southern part of the Western Cape. The Natural Distribution Range (NDR) of the subspecies is a narrow band along the coastal plains of the Overberg region, but due to the limited availability of natural habitat within the NDR, CapeNature supports introductions of Bontebok outside of the NDR into a defined Extended Natural Distribution Range (ENDR) (Figure 5.6). Bontebok have also been translocated extensively outside of the ENDR (Cowell and Birss 2017).

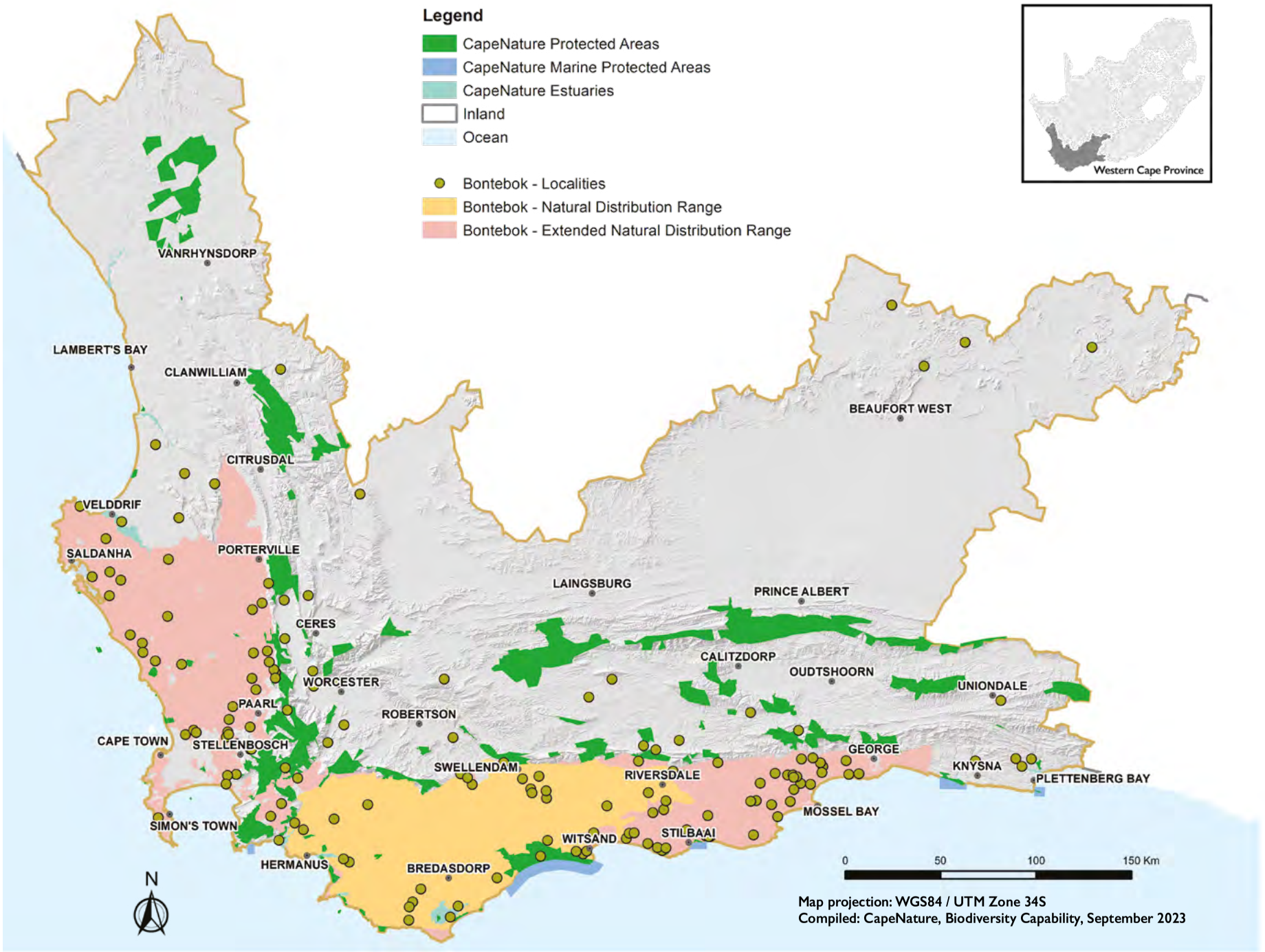



Figure 5.6. Distribution of Bontebok in the Western Cape, 2022.

In the Western Cape, Bontebok are present on two provincial reserves (De Hoop and Theewaterskloof), on four national parks (Bontebok, West Coast, Table Mountain, and Agulhas National Parks) and on many private properties. The Greater De Hoop Conservation Area, comprising De Hoop Nature Reserve and the adjacent Overberg Test Range, is home to the largest Bontebok herd in the province. Short-term population trends for De Hoop Reserve are illustrated in Figure 5.7 (CapeNature 2022c).

Table 5.1. Summary of bontebok numbers and distribution in the Western Cape, 2017-2022.

(a) Number of Bontebok

| Year | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| **Provincial reserves** | 433 | 352 | 361 | 362 | 302 | 390 |
| **National parks** | 457 | unknown | unknown | 346 | 314 | 281 |
| **Municipal reserves** | 0 | 5 | 0 | 0 | 0 | 0 |
| **Private land in NDR and ENDR** | 2129 | 1975 | 1676 | 1804 | 1729 | 1843 |
| **Private land, extralimital** | 765 | 719 | 708 | 715 | 741 | 698 |
| **Total number bontebok** | 3585 | >3051 | >2745 | 3227 | 3086 | 3212 |

(b) Number of properties with Bontebok

| Year | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|
| **Provincial reserves** | 2 | 2 | 2 | 2 | 2 |
| **National parks** | 4 | 4 | 4 | 4 | 4 |
| **Municipal reserves** | 1 | 0 | 0 | 0 | 0 |
| **Private, ENDR & ENDR** | 105 | 104 | 103 | 99 | 101 |
| **Private, extralimital** | 53 | 47 | 50 | 48 | 47 |
| **Total number properties** | 165 | 157 | 159 | 153 | 154 |

Genetic contamination through hybridisation with Blesbok (*D. p. phillipsi*) is a risk to Bontebok and thus hybrid testing is important to ensure genetic purity of herds. Inadequate testing remains a constraint and the testing results up to 2021 is presented in Table 5.2 (CapeNature 2022c).

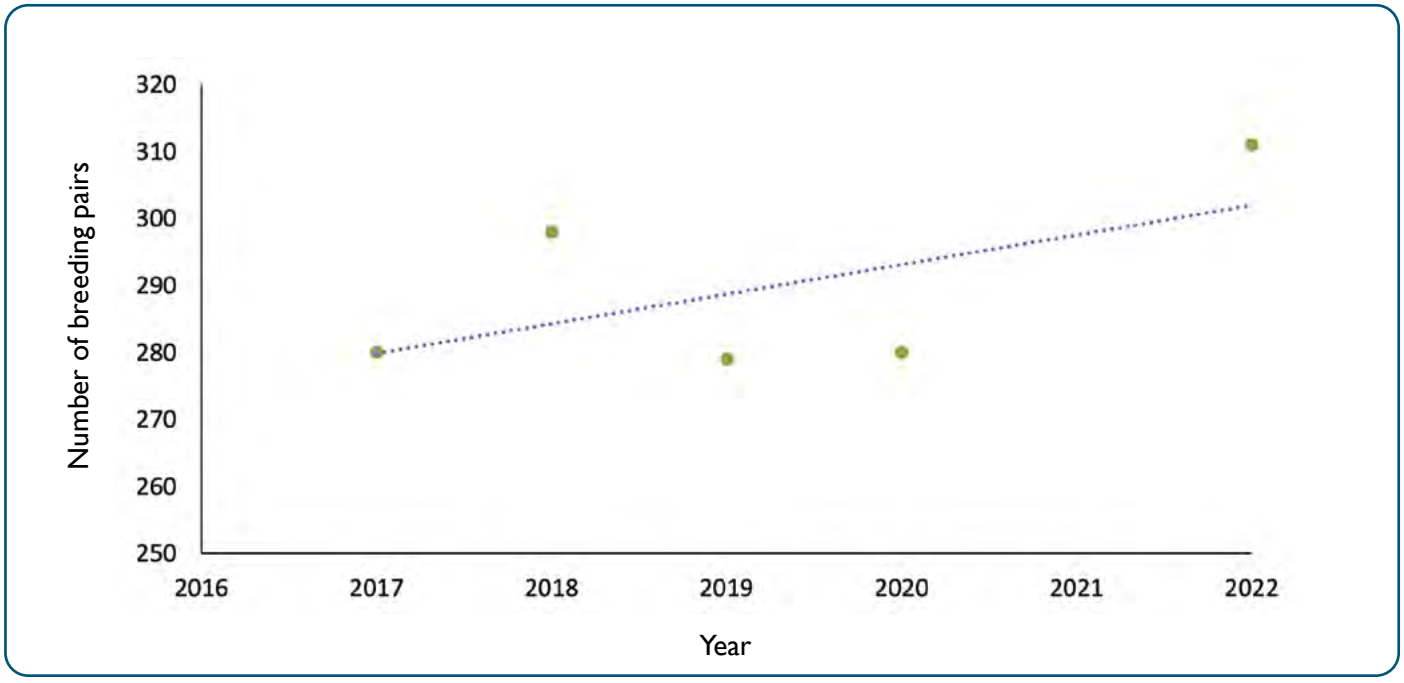



Figure 5.7. Bontebok numbers on De Hoop Nature Reserve, 2017-2022.

Table 5.2. Hybrid testing in the Western Cape Province, December 2021 Bontebok Register.

| | 2021 |
|---|---|
| Properties tested, no hybrids | 55 |
| Properties tested, 1 hybrid | 1 |
| Properties tested; hybrids detected | 3 |
| Properties, only 10% tested | 1 |
| Properties tested, results unavailable | 18 |
| Properties not tested | 79 |
| Unknown | 3 |
| **TOTAL NO. OF PROPERTIES** | **160** |

c) Threatened seabird long term monitoring

The Western Cape is home to several bird species that utilise the near shore marine and coastal environment. Many of these species are threatened by a range of anthropogenic impacts including reduced food availability, habitat degradation, disease, pollution, fishing gear entanglement and climate change. Annual monitoring is conducted by a range of partners and is focused primarily on the Endangered African Penguin (*Spheniscus demersus*) but monitoring efforts also target species such as Cape Gannet (*Morus capensis*), Cape Cormorant (*Phalacrocorax capensis*), Bank Cormorant (*Phalacrocorax neglectus*) and Crowned Cormorants (*Phalacrocorax coronatus*).

Note that the reduced number of breeding pairs in 2020 is not a real reduction and is the result of a non-count at Dassen Island for that year.

The African Penguin is monitored at several breeding colonies including four CapeNature-managed colonies. While there is an increase in breeding pairs at these colonies (Figure 5.8), the overall trend for this species is still negative (Masotla *et al.* 2023). Threats and conservation interventions required to protect the African Penguin are listed in the new BMP for the species and conservation efforts are ongoing to ensure the long-term survival of the African Penguin in the wild.

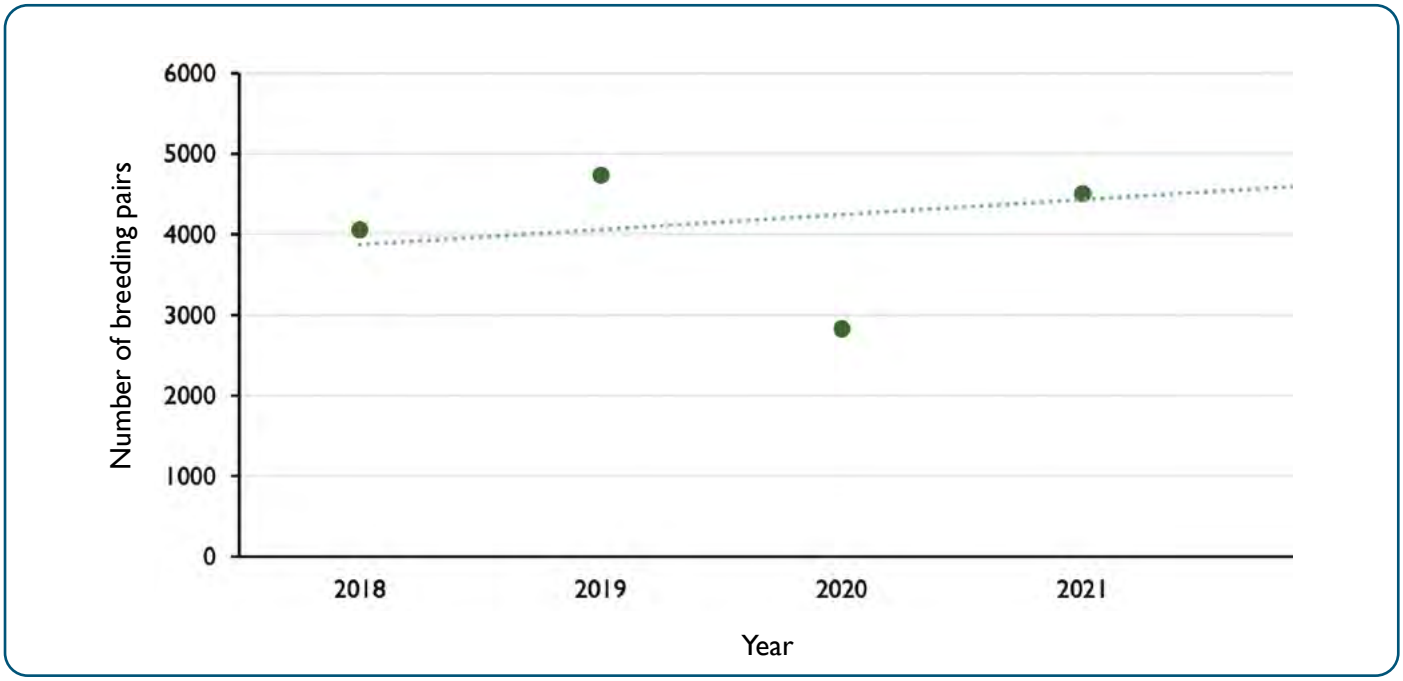



Figure 5.8. Total number of breeding pairs of African Penguin (*Spheniscus demersus*) at four CapeNature breeding colonies (Dassen, Dyer and Seal Island and Stony Point).

The Cape Cormorant is a southern African endemic seabird which inhabit near-shore coastal habitat. While previously abundant, Cook (2015) reported a >50% decline in population numbers which resulted in its status of Endangered, both globally and regionally. While the number of breeding pairs at CapeNature managed colonies are stable and increasing at present (Figure 5.9), the regional population is reported to be in decline (Cook 2015).

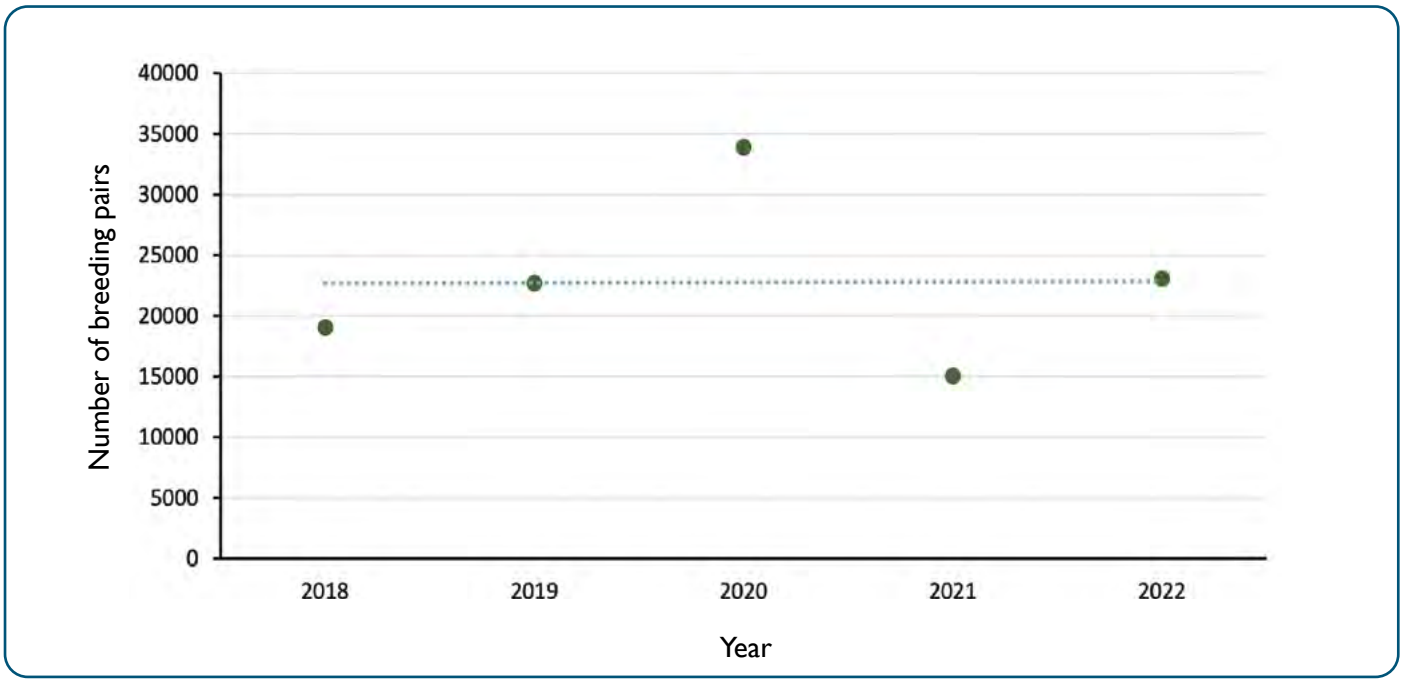



Figure 5.9. Total number of breeding pairs of Cape Cormorant (*Phalacrocorax capensis*) at five breeding colonies (Lambert's Bay, Vondeling, Dassen and Dyer Islands and Stony Point).

d) Amphibian long term monitoring

CapeNature conducts long-term frog monitoring to investigate the effect of climate change and fire frequency on moss frogs and to determine the conservation requirements for these species. The project has been running for over 20 years

and recent results indicate that alien plant invasions and too short fire return intervals can have significant effects. For example, the 2021 fire that burnt through the entire Swartboskloof negatively affected frog populations, particularly De Villiers's Moss Frog (*Arthroleptella villiersi*). Recovery of the latter species was faster at Swartboskloof, a mid-altitude site, than at Landdroskop, a high-altitude site (six years versus 10 years) (Figure 5.10). The three marked declines coincide with three fires which were followed by population recoveries.

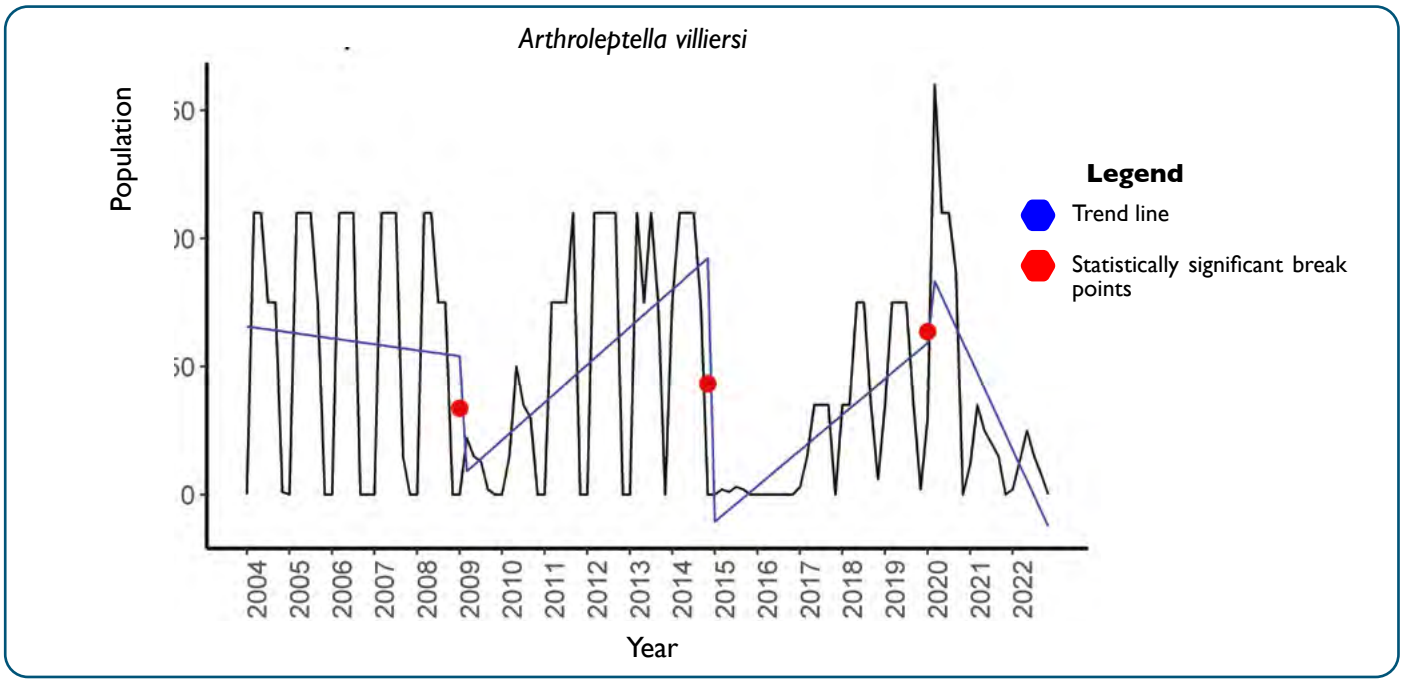



Figure 5.10. Population estimates and trends of De Villiers's Moss Frogs (*Arthroleptella villiersi*) from Swartboskloof.

Landdroskop Moss Frogs (*Arthroleptella landdrosia*) were even slower to recover (Figure 5.11), and this species now only persists in a very small population at the Landdroskop monitoring site; the marked decline coincides with a fire from which the population has not yet recovered. It is now 13 years after the last fire indicating that fire return intervals for this species need to be longer than this. Determining the range of fire return intervals across space and time informs fire management which can contribute to the persistence of multiple species.

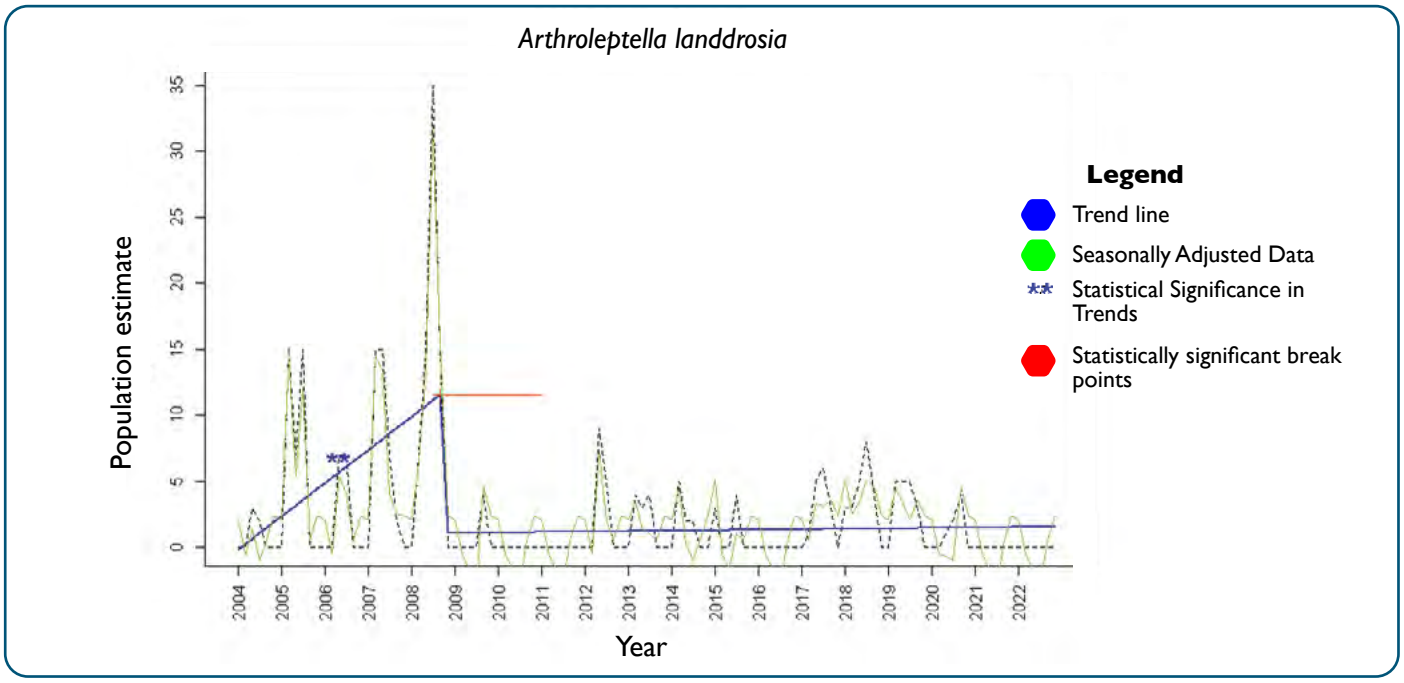



Figure 5.11. Population estimates and trends of Landdroskop Moss Frogs (*Arthroleptella landdrosia*) from Landdroskop.

e) Freshwater fish surveillance

The Western Cape has a unique freshwater fish fauna characterised by high levels of endemism and many species are threatened (Chakona *et al.* 2022). Freshwater fish surveillance sites have been identified for each of the four major river systems in the province (Figure 5.13). These are surveyed as part of the implementation of the Protected Area Management Plan for each reserve, but also include off-reserve areas with species of high conservation value.

The different coloured points denote sites in each of the four primary river systems on the province namely the Berg (red), Breede (orange), Olifants-Doring (yellow) and Gouritz (brown). Blue polygons indicate freshwater fish sanctuaries.

The aim of these surveys was to compare historical and current freshwater fish distributions and to determine the current state of freshwater fish species on and associated with protected areas. Seven major surveys, including 100 sample sites have been conducted to date and four surveys were in the reporting period. The results are presented in Figure 5.12. Ecological categories range from "very good", indicating the presence of all size classes of all expected indigenous fish species to "poor", where indigenous species were either absent or only present in very low numbers and the fish community was dominated by alien invasive fish species.

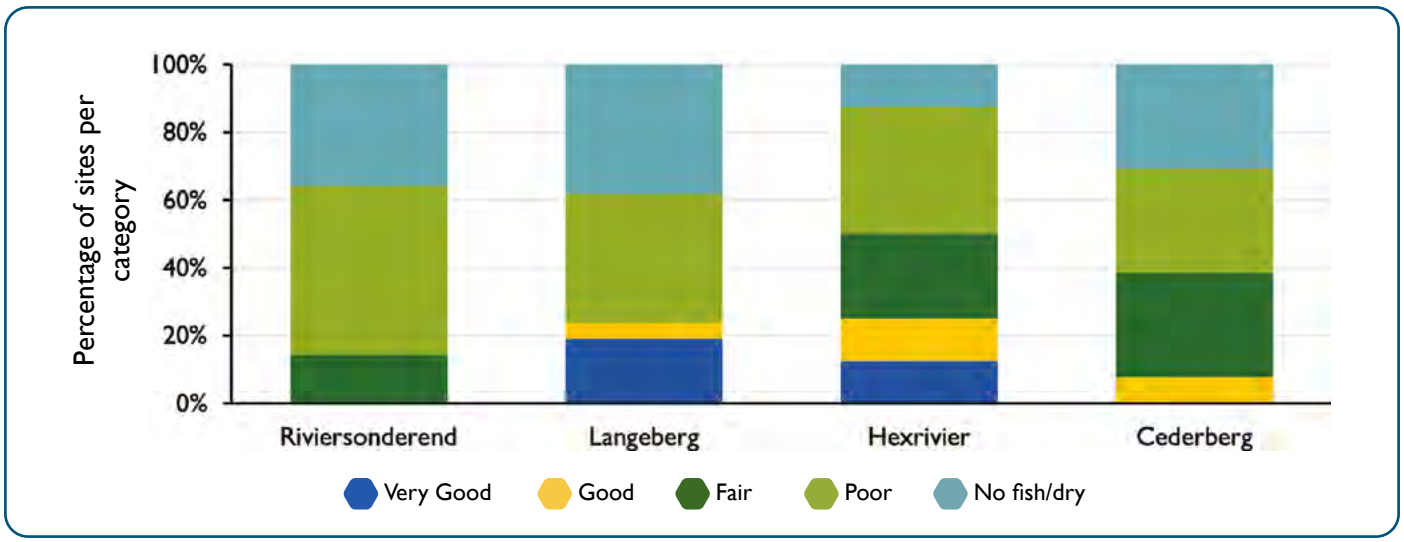



Figure 5.12. Ecological categories of freshwater fish sampling sites for four nature reserve complex surveys conducted in the reporting period.

Surveillance surveys can yield data that serves to inform future monitoring projects. An example is the recent detection of the extralimital and highly invasive Sharptooth Catfish (*Clarias gariepinus*) in the Groot River in Meiringspoort, Groot Swartberg Nature Reserve. An initial 2022 survey detected catfish in the four furthest downstream sampling sites (Figure 5.14a) and a follow up indicated their presence at the furthest upstream sampling site, presenting evidence for expansion of their invasive range (Figure 5.14b). The impacts of catfish on the highly threatened indigenous fish communities of the Cape Fold Ecoregion remain poorly understood and monitoring at this and other sites in the Western Cape is ongoing.

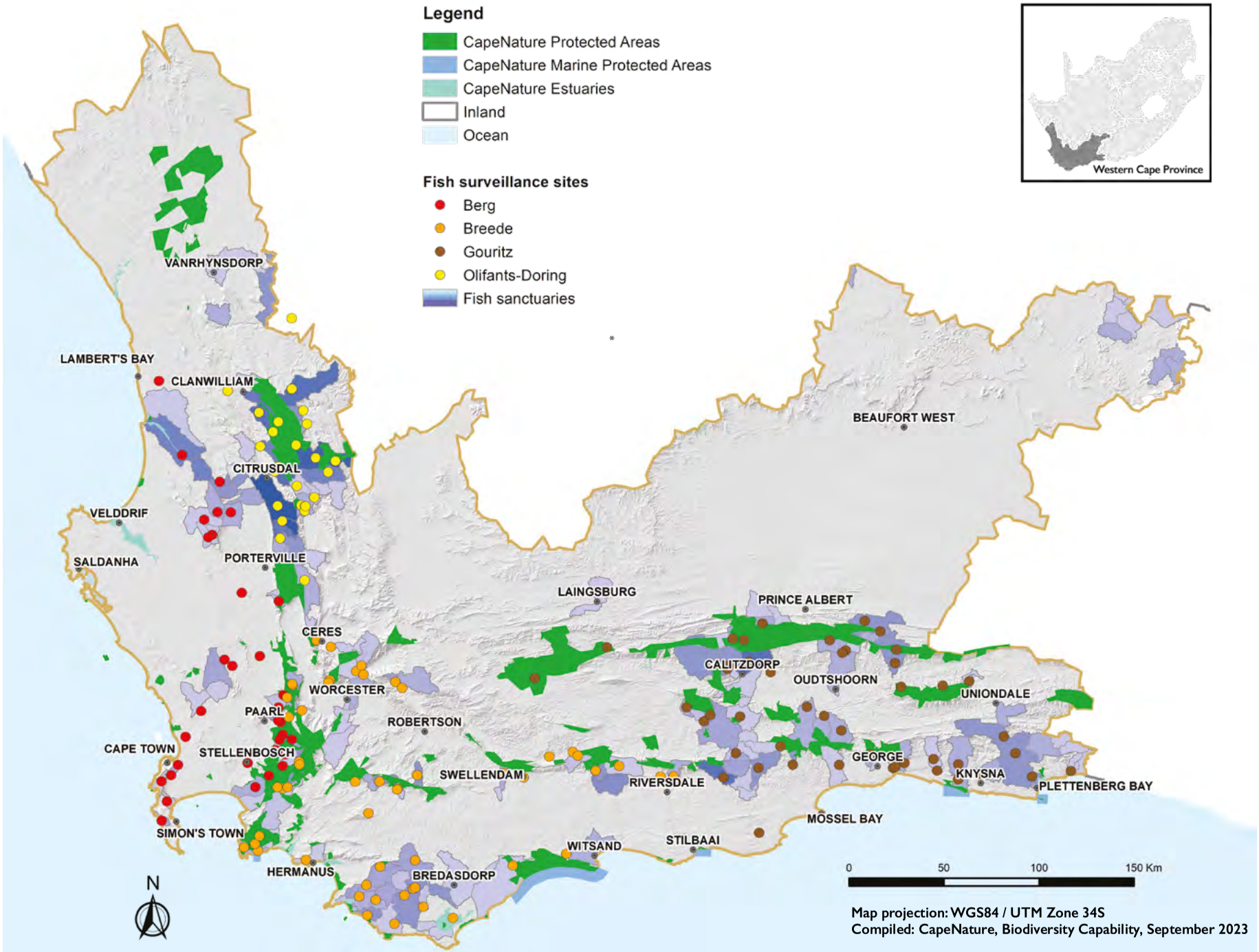



Figure 5.13. Freshwater fish surveillance sites in the Western Cape.

* - Note: Graded colour representation is used to highlight individual catchments

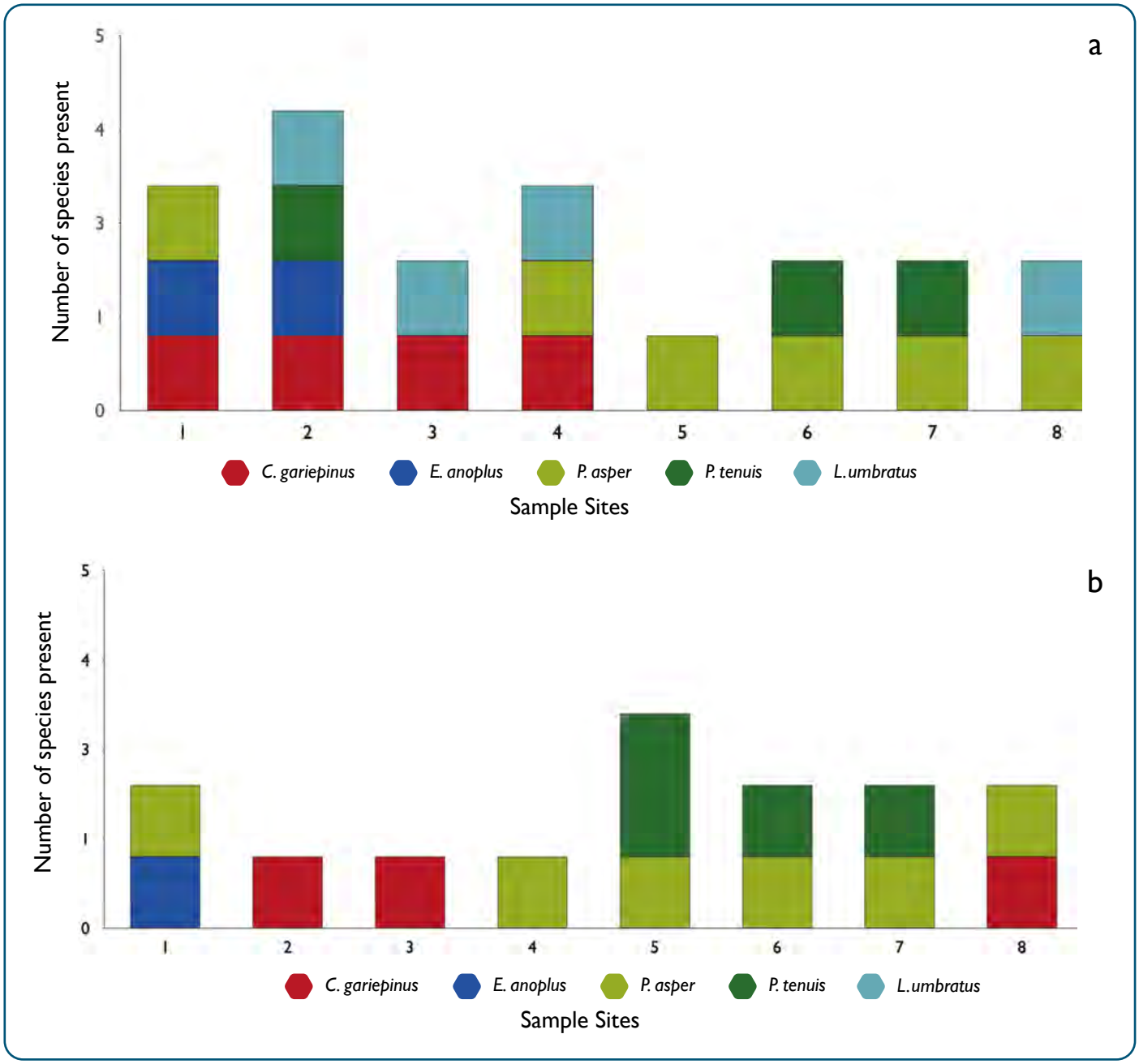



Figure 5.14. Species composition for each of the eight sites sampled during the (a) 2022 and (b) 2023 (CapeNature 2023c)

### *5.2.2.3 Plant monitoring and surveillance projects*

Of the 405 Eco-matrix projects executed on CapeNature's protected areas, 119 (29.4%) target plant species and include projects across many taxonomic groups. Of these projects, 27 (22.7%) are dedicated to rare flora and priority plant species and 36 (30.3%) are focused on post-fire and permanent protea plot monitoring. The remaining 56 projects (47%) are dedicated mainly to obtaining data related to the management of alien invasive vegetation and veld restoration initiatives (Figure 5.15). In addition to the 119 dedicated floral monitoring and surveillance projects, 52 projects exist that are focused on either opportunistic data collection or focused biodiversity surveys, and these include observations of flora.

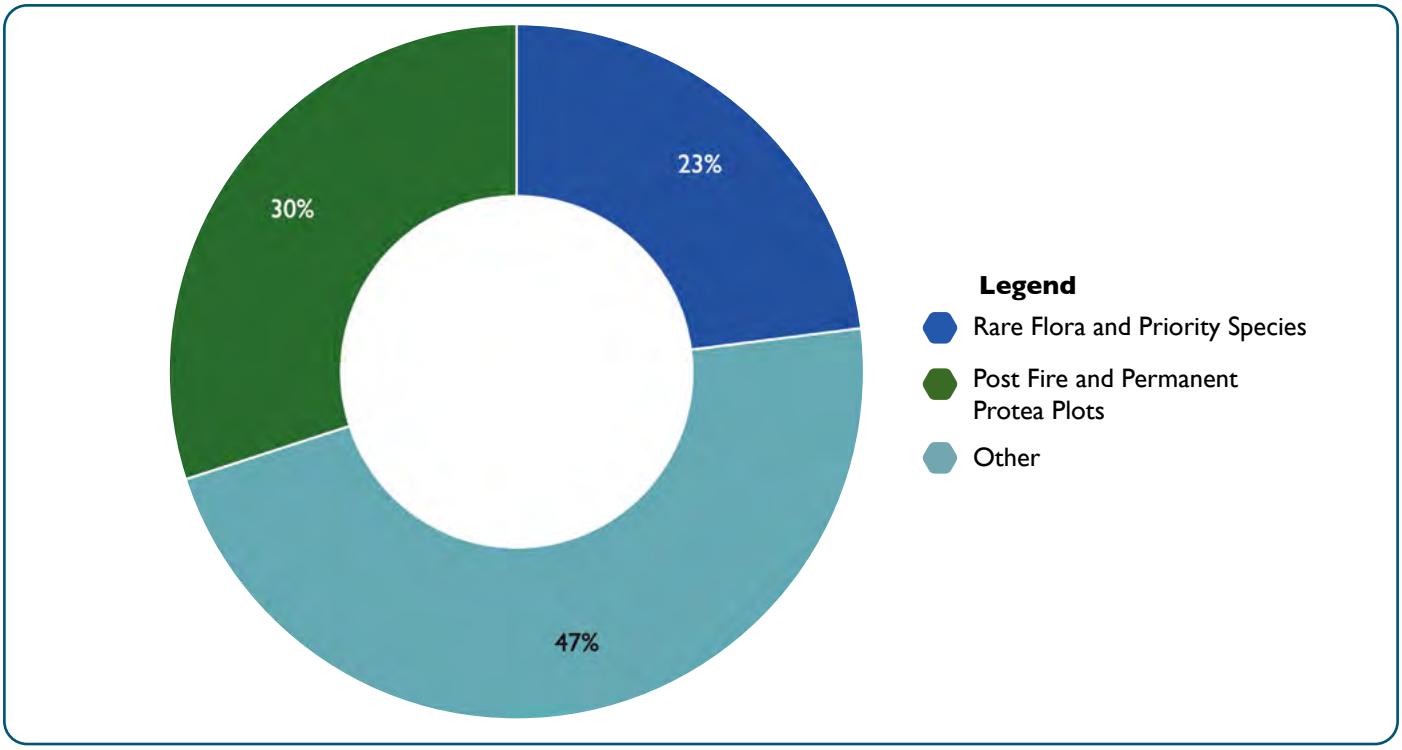



Figure 5.15. Composition of flora Eco-matrix monitoring and surveillance effort

### *5.2.2.4 Examples of plant monitoring and surveillance projects*

a) Rare and priority plant species

CapeNature conducts annual monitoring of selected Red Data listed plant species on protected areas, including stewardship sites (Figure 5.16; Table 5.3). In total, monitoring is conducted on 15 reserves and for 43 species (Table 5.3). An example is the annual monitoring of the Critically Endangered *Diosma aristata* on the Diosma Local Authority Contract Nature Reserve belonging to the Mossel Bay Local Municipality. This species is only known from two small, fragmented subpopulations and is heavily threatened by urban expansion and coastal development. Figure 5.17 presents the population total of the Mossel Bay subpopulation over the last ten years. The monitoring efforts followed a fire prior to 2011. The sharp decrease in individuals between 2016 and 2017 is due to a fire that burnt the whole reserve in June 2017.

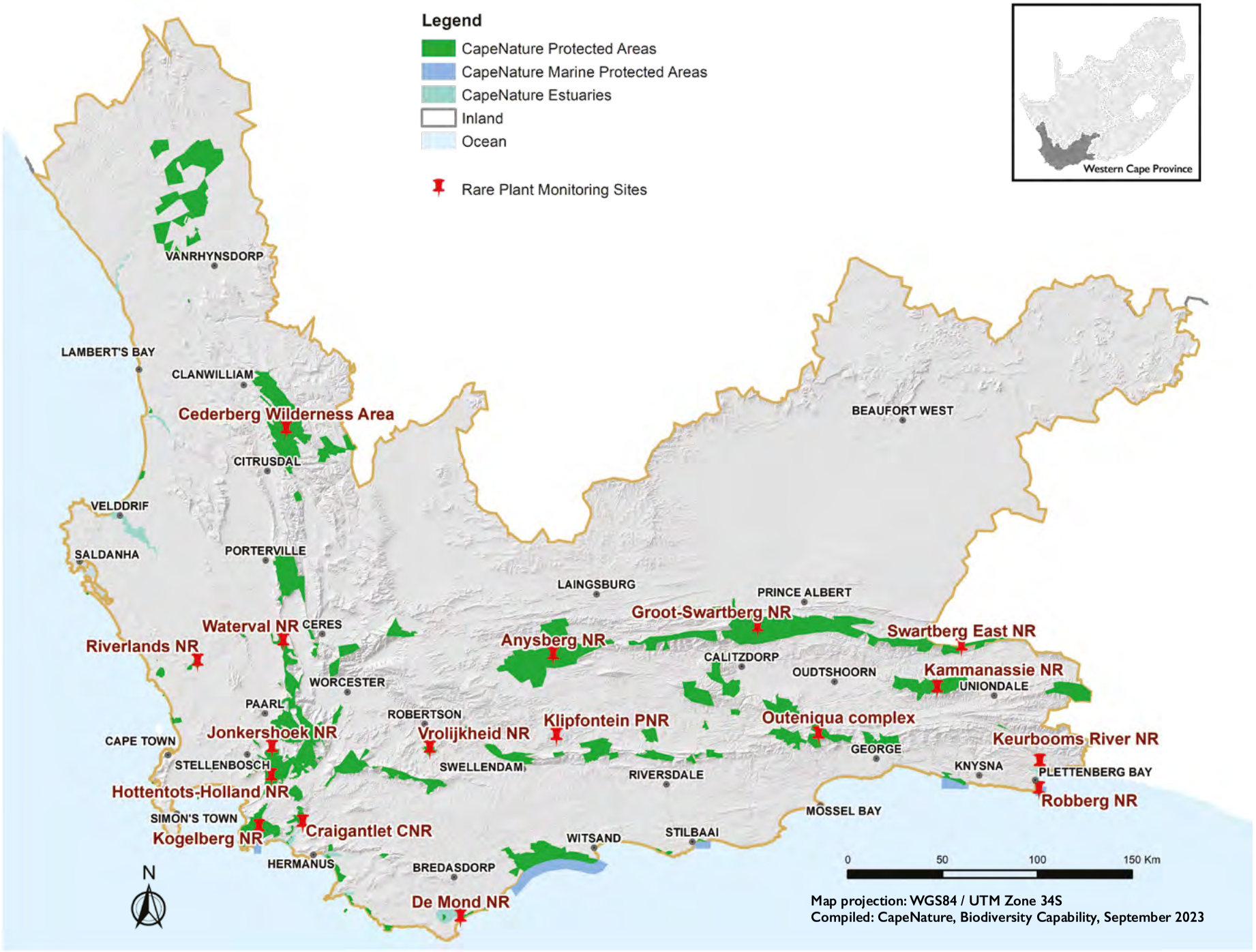



Figure 5.16. Map of protected areas indicating annual flora monitoring projects.

Table 5.3. List of Red Data listed species monitored by CapeNature on protected areas and stewardship sites.

| Protected Area | Plant taxa monitored annually |
|---|---|
| Anysberg | *Cliffortia conifera* (EN); *Diosma strumosa* (EN); *Protea convexa* (CR); *Tanquana hilmarii* (CR); *Zeuktophyllum suppositum* (EN) |
| Cederberg | *Widdringtonia wallichii* (CR) |
| Craigantlet | *Leucadendron elimense* subsp. salteri (CR) |
| De Mond | *Lachenalia sessiliflora* (VU); *Lampranthus debilis* (EN) |
| Hexriver | *Erica atrovinosa* (VU); *Leucospermum catherinae* (EN) |
| Hottentots Holland | *Mimetes hottentoticus* (CR); *Protea stokoei* (EN) |
| Jonkershoek | *Serruria florida* (CR) |
| Kammanassie | *Cyclopia plicata* (EN); *Protea grandiceps* (NT) |
| Klipfontein | *Leucadendron elimense* subsp. vyeboomense (CR) |
| Kogelberg | *Mimetes capitulatus* (EN); Mimetes *hottentoticus* (CR) |
| Outeniqua | *Gladiolus roseovenosus* (CR); *Protea grandiceps* (NT) |
| Riverlands | *Agathosma corymbosa* (EN); *Athanasia rugulosa* (EN); *Disa barbata* (CR); *Echiostachys spicatus* (EN); *Elegia acockii* (EN); *Gladiolus quadrangulus* (EN); *Hessea cinnamomea* (EN); *Hypodiscus rugosus* (EN); *Leucadendron lanigerum* var. lanigerum (EN); *Leucadendron thymifolium* (CR); *Marasmodes defoliata* (CR); *Oxalis levis* (CR); *Protea odorata* (CR); *Relhania rotundifolia* (EN); *Serruria brownii* (EN); *Skiatophytum flaccidifolium* (CR) |
| Robberg/Keurbooms | *Disa hallackii* (EN); *Erica glumiflora* (VU); *Leucospermum glabrum* (EN); *Selago villicaulis* (VU); *Wahlenbergia* sp. nov. |
| Swartberg | *Protea pruinosa* (EN) |
| Vrolijkheid | *Protea holosericea* (EN) |
| Waterval | *Diastella myrtifolia* (EN); *Leucadendron lanigerum* var. lanigerum (EN); *Polhillia ignota* (CR); *Sorocephalus imbricatus* (CR); *Stylapterus ericoides* subsp. ericoides (CR) |

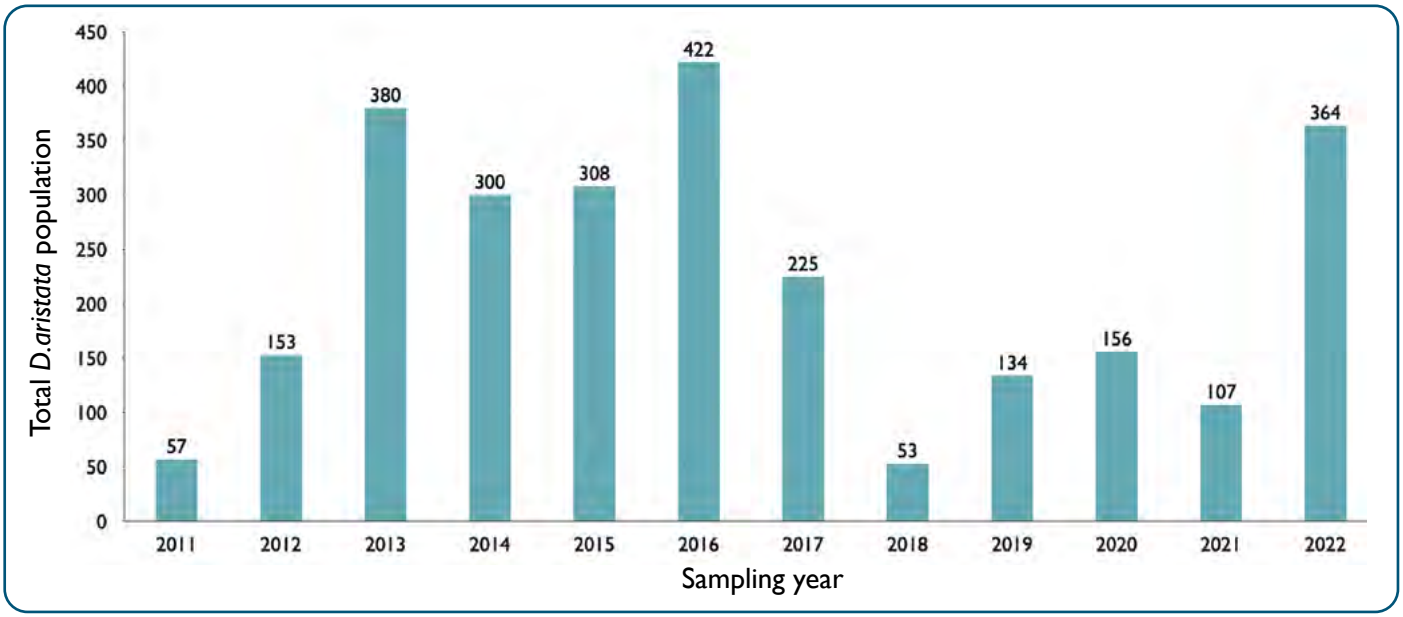



Figure 5.17. Population total of *Diosma aristata* at the Diosma Local Authority Contract Nature Reserve over the past ten years.

b) Post-fire and permanent Protea monitoring plots

While fire is an important ecosystem driver in the fynbos biome, it can also be one of the main threats to biodiversity in CapeNature's protected areas if areas burn too often or too infrequently. Thus, it is essential that the ecological effects of each fire be documented and understood. In this regard, CapeNature is documenting the density of non-sprouting overstorey Protea species as an indicator of the diversity of fynbos communities. *Proteaceae* monitoring is used to set specific thresholds of potential concern for each protected area. Permanent Protea plot monitoring provides guidance on optimal fire return intervals for a specific vegetation unit on a specific reserve. As supported by Geerts (2021), Protea plot monitoring guidelines state that at least 50% of a population of the slowest-maturing obligate seeded Protea species must have flowered for three successive seasons.

Permanent Protea monitoring in combination with post-fire recruitment data are used to determine the required fire return interval and to make management recommendations. One example is the data collected in Boland Mountain Complex since 2003 over 134 plots (Figures 5.18 and 15.9). Summary data shows that several Protea species need fire return intervals of more than 12 years to ensure good seedling recruitment (Figure 5.18).

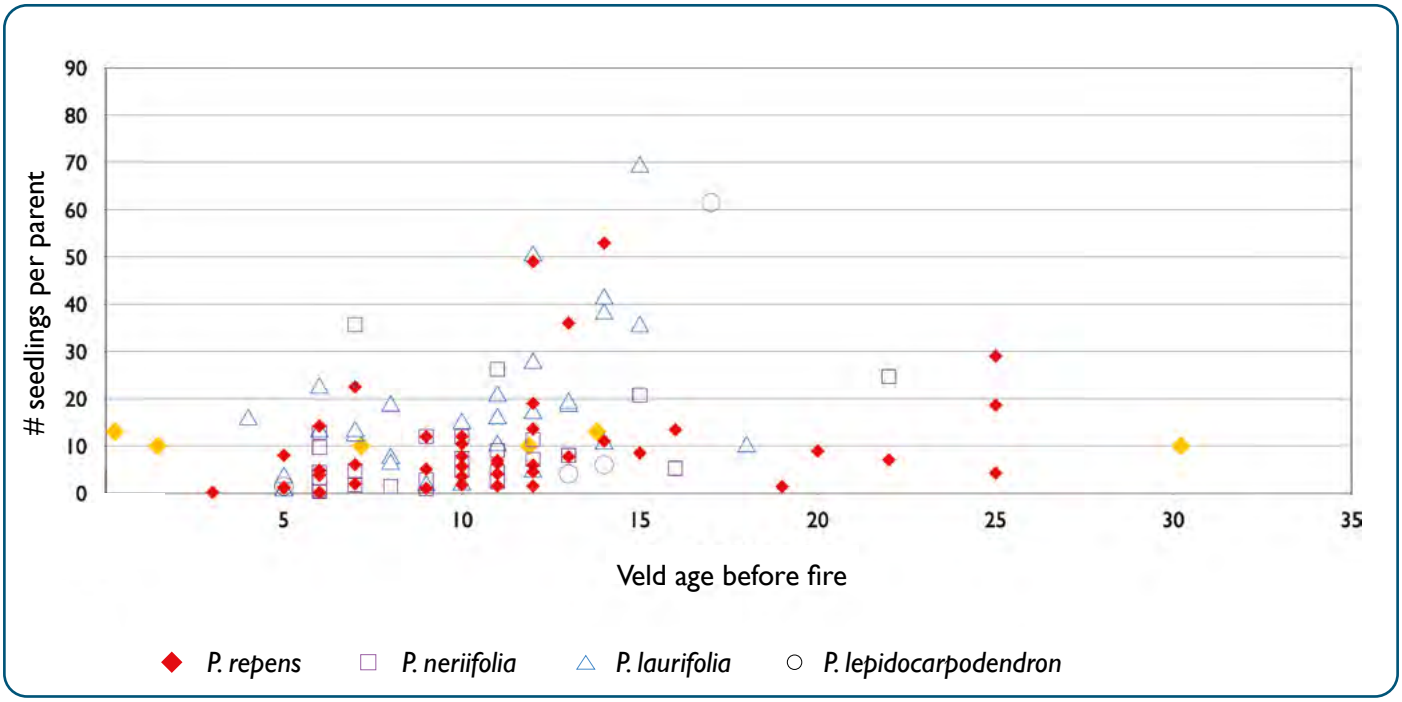



Figure 5.18. Effect of veld age on seedling recruitment of Protea species in the Boland Mountain Complex

Permanent Protea monitoring data have been collected at Eerste Waterval in the Jonkershoek Nature Reserve since 2005 to present. Figure 5.19 reflects the Permanent Protea monitoring and post-fire recruitment data collected at Eerste Waterval in the Jonkershoek Nature Reserve since 2005 to present and shows the proportion of *Protea neriifolia* plants that have flowered 0x , 1x , 2x , 3x or more times. The recruitment rate (parent: seedling ratio) is represented in red in the bottom right-hand corner of each graph. A recruitment rate of 1: 5 is needed for healthy regeneration.

Fires were burnt in 2009, 2015 and 2020. In figure 5.19 the graphs a, b and c refer to time periods over which data were collected: a) 2005 – 2008; b) 2013 - 2014; c) 2018 – 2020

c) Monitoring and surveillance projects related to BMPs and consumptive harvesting.

CapeNature is one of the implementing agencies for the Bitter or Cape Aloe (Aloe ferox) and Honeybush (Cyclopia subternata and Cyclopia intermedia) BMP-s. Specific responsibilities include the establishment and implementation of resource monitoring systems for these species to inform sustainable quantities for off-reserve harvesting. Aloe ferox is arguably the most commercially utilized indigenous plant in South Africa and one of the most highly traded botanical species in the world.

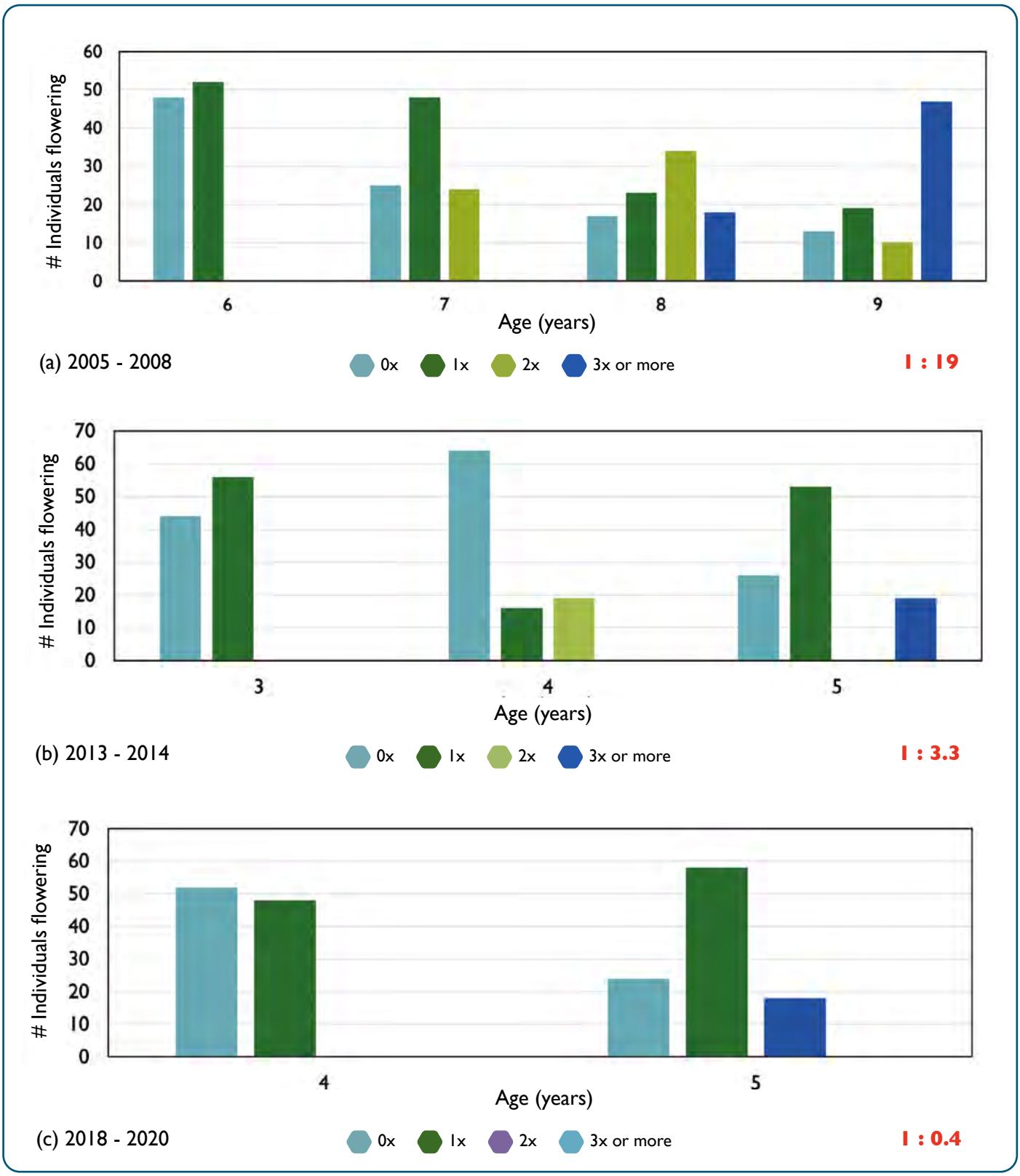



Figure 5.19 The proportion of *Protea neriifolia* plants that have flowered 0x, 1x, 2x, 3x or more times over different time periods between fire events, with the recruitment rate (parent : seedling ratio).

## 5.3 DISCUSSION AND RECOMMENDATIONS

There is good representation of priority faunal and plant species included in the current Eco-matrix projects associated with CapeNature's protected areas. Analysis of the Eco-matrix data indicated that some species are subject to extensive monitoring despite not threatened, but due to reporting requirements, such as those associated with BMPs.

To ensure the long-term protection of the province's critical resources for current and future generations, CapeNature works with conservation partners to ensure a systematic and prioritised approach to meeting biodiversity conservation targets. A strong network of private and state protected areas is an important mechanism to conserve biodiversity and improve land management (Donald *et al.* 2019). CapeNature continues to be a leader in driving protected area expansion, specifically through its innovative stewardship models that ensure efficient approaches to expanding the protected area network.

The various protected area expansion mechanisms provide a level of safeguarding to important biodiversity priority areas within the Western Cape. This chapter aims to quantify and qualify the contribution that the new formally declared nature reserves, protected environments, and signed protected area management agreements are making towards the objectives of the Western Cape Protected Area Expansion Strategy (CapeNature. 2021a), and to determine the success of the implementation of the strategy.

As of 31 March 2023, the Western Cape Protected Area Estate comprises approximately 2 278 910 ha including National Parks, Local Authority Nature Reserves, Mountain Catchment Areas, Protected Environments, Private Nature Reserves and Marine Protected Areas. The CapeNature Protected Area Estate, totalling 1 039 374 ha, includes CapeNature managed protected areas and formal stewardship sites supported by CapeNature (Table 6.1).

Please note: The Western Cape Protected Areas Estate reported on here is constrained within the jurisdiction of the Western Cape and thus includes protected areas in both terrestrial and coastal environments. CapeNature, the City of Cape Town, and SANParks are assigned management authority for a subset of the Marine Protected Areas (MPAs) and islands adjacent to nature reserves (Figure 6.1).

Table 6.1 Breakdown of the Protected Area categories reflected in the Western Cape Protected Areas Estate and the current areal extents.

| Western Cape Conservation Estate | Area (hectares) |
|---|---|
| CapeNature vested State Land/Sea Protected Areas | 659,233 + |
| CapeNature Managed Protected Areas | 169,209 |
| **CapeNature Managed Protected Area Estate** | **828,441 +** |
| CapeNature Protected Area | 210,932 |
| **CapeNature Protected Areas Estate** | **1,039,374 +** |
| Western Cape Protected Areas | 1,239,537 |
| **Western Cape Protected Areas Estate** | **2,278,910** |

## 6.1 METHODS

Priority areas for both protected area expansion and stewardship site identification in the Western Cape are informed primarily by the Critical Biodiversity Area (CBA) designation derived from the 2017 Western Cape Biodiversity Spatial Plan (2107 WC BSP) (CapeNature 2017a). CBAs consist of terrestrial and aquatic features that need to be kept in a natural to near-natural state to retain a reasonable and representative proportion of all biodiversity ecosystems that are both ecologically functional and viable both now and into the future. The prioritisation of CBAs for formal protection is informed by both the importance of the biodiversity and the urgency to protect it. An area is considered important for the expansion of the terrestrial protected area network if it is one of the best remaining examples of a critically endangered ecosystem, contributes to meeting biodiversity thresholds for under-protected terrestrial or freshwater ecosystems, maintains ecological processes, contributes to climate change resilience, provides essential habitat for threatened and under-protected taxa, or a combination of these. Urgency is determined by the extent to which spatial options for meeting targets (and optimal protected area design) persists, which is often linked to the degree of competing land or resource uses in an area.

The specific spatial priority areas identified by CapeNature for focussed landscape-scale protected area expansion in the Western Cape are identified in a Conservation Action Priorities map (CAP map). This CAP map is underpinned by the CBA information and by comprehensive operational data related to objectives, mechanisms, responsible organisation, and capacity.

The declaration of protected areas in terms of the National Environmental Management: Protected Areas Act (Act No. 57 of 2003) (NEM: PAA) directly contributes towards the primary focus of the Western Cape Protected Area Strategy (CapeNature 2021a) which is to expand the Western Cape protected area network to include a better representation of the diverse ecological systems of the province. The Strategy enables proactive protected area expansion targets to be met and contributes to the achievement of international and national protected area priorities and strategies, aligning with the South African National Protected Area Expansion Strategy (DEA 2018), the 2018 National Environmental Management: Protected Areas Act and the 2021-2025 CapeNature Strategic Plan (CapeNature 2021a).

Protected Areas that are recognised as falling within the Western Cape Conservation Estate are divided into three Western Cape Conservation Categories (WCCCs) which are in turn defined according to the degree of legislative security associated with the sub-categories:

- Western Cape Conservation Category 1 (WCCC1) includes sub-category private biodiversity stewardship protected areas declared in terms of Section 23 or 28 of NEM: PAA, National Parks, World Heritage sites, Wilderness Areas, Provincial Nature Reserves, Island Nature Reserves, Marine Protected Areas, and State Forest Reserves.
- Western Cape Conservation Category 2 (WCCC2) includes sub-category Protected Areas and Conservation Areas with some legislative security such as Local Authority Nature Reserves, Mountain Catchment Areas, Private Nature Reserves and Biodiversity Agreements.
- Western Cape Conservation Category 3 (WCCC3) are Conservation Areas with little or no legislative security and includes Biodiversity Partnership Areas, Biosphere Reserves and Conservancies.
- Although Biodiversity Stewardship sites (WCCC2) and Conservation areas (WCCC3) contributes significantly to the conservation of priority areas, only WCCC1 sites relate to the objectives of the WCPAES.

Both the 2015-2020 and 2021-2025 Western Cape Protected Area Expansion Strategies overlap the period of April 2017 to March 2023. Although both strategies account for different time periods, they have the same objectives that achieve multiple biodiversity outcomes as the highest priorities for protected area expansion and are grouped into the following objectives:

- To secure at least one 'best remaining' site in each of the province's poorly protected Critically Endangered ecosystems to ensure that the ecosystem structure and functioning remains at least partially in place to prevent further loss of species associated with the ecosystem.
- To make a significant contribution towards meeting protected area targets for under-represented ecosystems in the province, including fully meeting protection targets for at least an additional five ecosystems, in strategic locations.
- Secure at least one site considered essential to ensuring the long-term viability of the following threatened species or species groups such as Cape mountain zebra, Bontebok, Riverine Rabbit, Geometric Tortoise or Endemic Fish Species.
- To advance marine, estuarine, and coastal conservation in the Western Cape through a set of interventions aimed at addressing key gaps in protection, and by supporting national MPA expansion efforts, and.
- To secure at least one 'special' (i.e., unique, threatened, and under-protected) freshwater ecosystem per District Municipality.

The protected areas that were declared, or those sites that signed a Protected Area Management Agreement with CapeNature were included and categorised according to the year of declaration or signing. The total number of hectares per year added to the WCCC1, were calculated.

Spatial extent data layers were used to calculate how many hectares the sites contribute to the expansion strategy's objectives. The data layers that present the multiple biodiversity outcomes associated with the strategy themes are:

- The 2019 updated Conservation Action Priorities Map (CapeNature 2019)
- The 2017 WC BSP CBA layer (CapeNature 2017a)
- The Red List of Ecosystems (RLE) Vegetation map and remnants coverages (Skowno and Monyeki 2021)
- Table Mountain Fund Climate Change Adaptation Corridors (CapeNature 2023a)
- Species habitat - Riverine Rabbit/CMZ/Bontebok
- The 2021 revised Strategic Water Source Areas (Lötter and Maitre 2021)

## 6.2 RESULTS

In the last five years, 313 potential stewardship sites were reviewed by the Western Cape Stewardship and Protected Area Review Committee and an appropriate stewardship category (Protected Area and Conservation Area classification) was recommended for each to ensure that all properties meet the objectives of the strategy.

A total of 48 new protected areas were added, contributing 149 297ha to the Western Cape Conservation Estate (Table 6.2). The figures below (Figures 6.1 and 6.2) show the contribution these protected areas has made and compare it to 2017. Private land conservation through stewardship and land acquisition has increased the most.

Table 6.2. The increase in protection of Priority Biodiversity Areas in the Western Cape Conservation Estate between 2017 and 2023.

| | 2017 | | 2023 | | Change | |
|---|---|---|---|---|---|---|
| **Biodiversity Areas** | Area (ha) | % of WCP | Area (ha) | % of WCP | Area (ha) | % changed since 2017 |
| **Western Cape** | 12 942 655 | % | 12 942 655 | % | | |
| **PA** | 1 843 030 | 14 | 2 123 696 | 16 | 280 666 | 15 |
| **CBA** | 2 859 785 | 22 | 3 052 179 | 24 | 192 394 | 7 |
| **ESA** | 1 644 500 | 13 | 1 740 298 | 13 | 95 798 | 6 |
| **Other Natural Areas** | 4 137 040 | 32 | 3 758 549 | 29 | - 378 491 | -9 |
| **No Natural Area** | 2 445 210 | 19 | 2 267 932 | 18 | - 177 278 | -7 |

For this reporting period 23 sites, of which four were identified as 'best remaining', sites were secured and contributed 3 556.2 ha's towards Critically Endangered ecosystems (CR).

Gamkaberg Nature Reserve
© Scott Ramsay

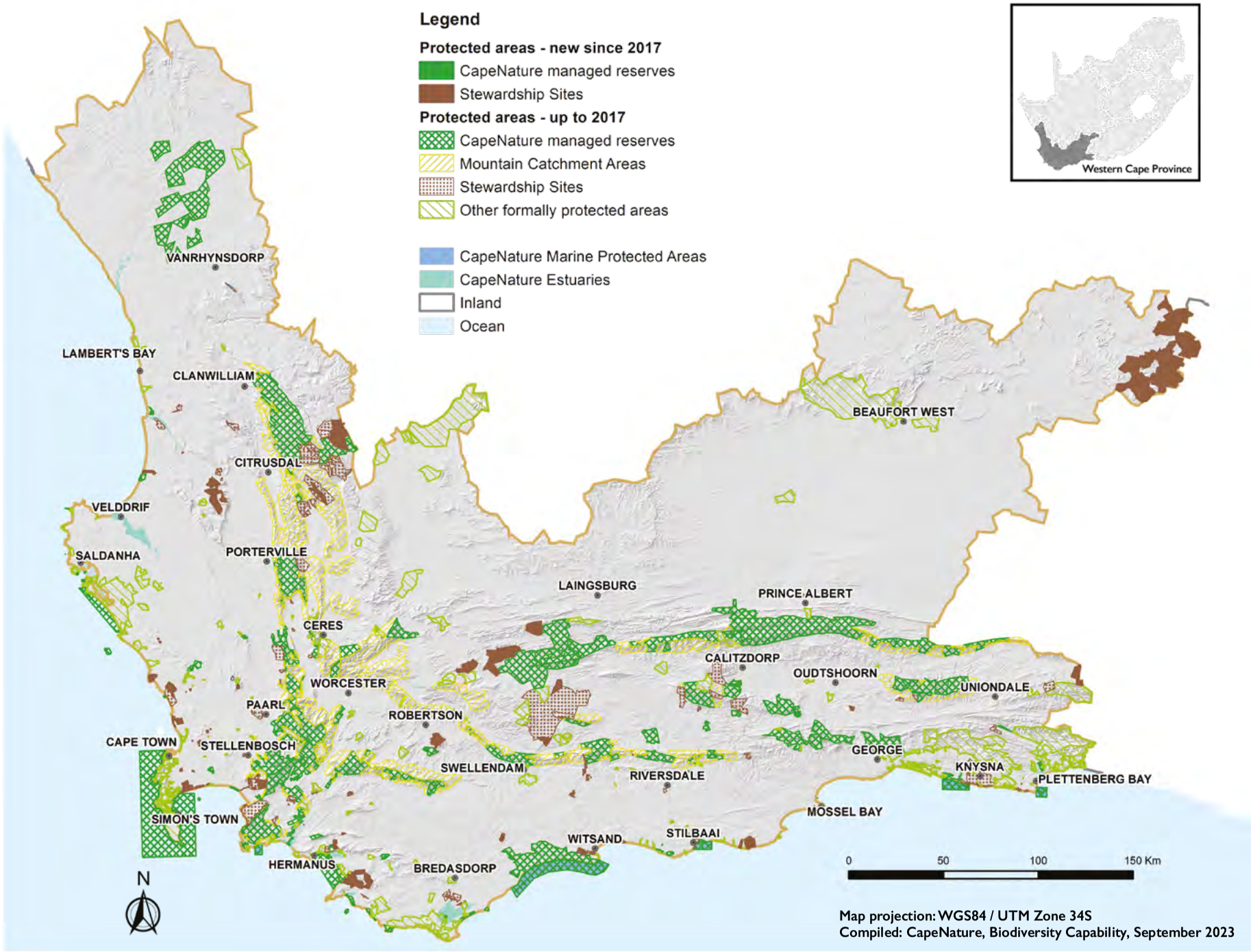



Figure 6.1. The Western Cape Conservation Estate.

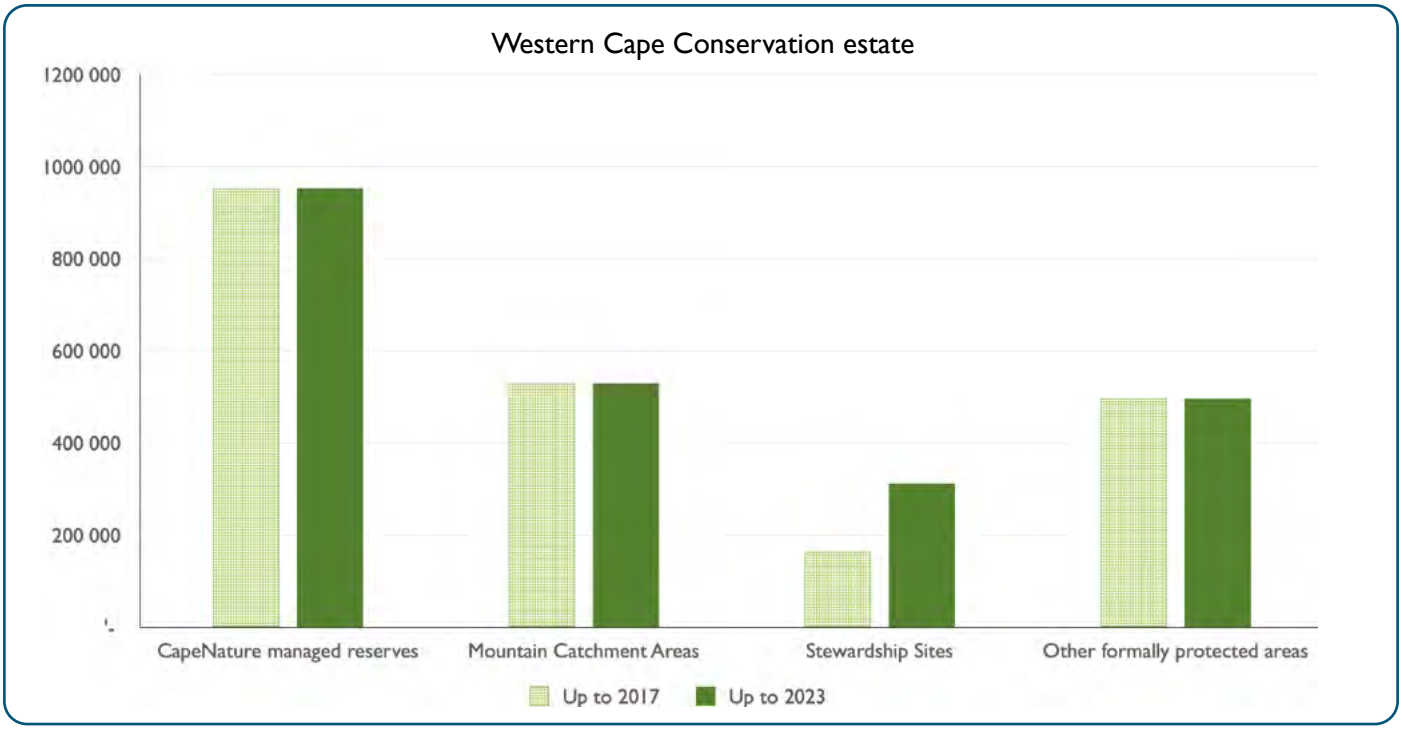



Figure 6.2. Number of hectares added to the Western Cape Conservation Estate.

This increase in Conservation Estate has also seen greater levels of protection in the defined surface Strategic Water Source Areas (Table 6.3).

Table 6.3. The increase in protection for the Strategic Water Source Areas (Lötter and Maitre 2021)

| Conservation level | Area of PAs inside SWSA (2017) | % PAs in SWSA (2017) | Area of PAs inside SWSA (2023) | % PAs in SWSA (2023) |
|---|---|---|---|---|
| State Conservation Land vested with CapeNature | 371 469.4 | 20.48 | 371 469.4 | 20.48 |
| CapeNature Managed Protected Areas | 194.6 | 0.01 | 194.6 | 0.01 |
| CapeNature Protected Area Estate | 34 904.1 | 1.92 | 42 256.7 | 2.33 |
| Western Cape Protected Area Estate | 526 750.4 | 29.05 | 529 156.5 | 29.18 |
| Total | 933 318.5 | | 943 077.2 | |
| **Total area of SWSA in the Western Cape** | | **1 813 399.5 Ha** | | |

An area of 148 236.9 ha of under-protected ecosystems remnants are represented in part by 67 of 85 conservation areas (including both formal = 133 403.9 ha and informal = 14 832.9 ha protection status) added in the past five years. High levels of protection targets were achieved (>75%) in three ecosystems that include strategic locations; namely, Cape Flats Dune Strandveld (99% protection with five conservation areas), Cape Seashore vegetation (>100% protections in one conservation area), and Swartruggens Quartzite Karoo (>100% protection in one conservation area). Medium levels of protection targets were achieved (40 to 74%) in two ecosystems that include strategic locations; namely, Eastern Rûens Shale Renosterveld (46% protections with four conservation areas), and Piketberg Sandstone Fynbos (43% protection in one conservation area).

A total of 32 formally protected areas were secured that are considered essential to the long-term viability of the following threatened species or species groups.

- Cape mountain zebra – 15 formally protected areas were declared (19 080.2 ha), and 31 conservation areas were signed up (13 689.9 ha), and a further 12 protected areas are in process (30 803.8 ha).
- Bontebok - 13 formally protected areas were declared (8 706.3 ha), and 21 conservation areas were signed up (3 769.7 ha), and a further 11 protected areas are in process (7 917.6 ha).
- Riverine Rabbit – Two formally protected areas were declared (4 858.9 ha).
- Geometric Tortoise – No additional sites secured in the past five years.
- Endemic Fish Species - Two formally protected areas were declared (10 789.1 ha).

Over the last five years, 12 additional conservation areas falling within one km of the coastline and totalling 8 848 ha were secured. In addition, six Maintenance Management Plans prepared by CapeNature to address estuarine mouth management have been adopted by DFFE. The Diep and Breede EMP's have been approved by the MEC, with an additional 19 EMPs now awaiting approval (submitted by CapeNature (13) or DEA&DP (6)).

For this reporting period 22 sites, were secured in the City of Cape Town metropolitan area and four of the five District Municipalities and contributes 15 459 ha.

## 6.3 DISCUSSION AND RECOMMENDATIONS

The results show that a significant contribution towards the Western Cape Conservation Estate was made through private land conservation. Private land conservation through stewardship remains one of the most important mechanisms to secure and protect the priority biodiversity areas of the Western Cape. Biodiversity Stewardship, embedded in the WCPAES, not only drives the expansion of protected areas but also ensures that the specific provincial biodiversity outcomes and a far larger contribution to CBA conservation is being achieved. The increase in Priority Biodiversity Areas has been significant in PAs (15%), with CBAs and ESAs indicating a lesser percentage protection contribution (7% and 6% respectively). However, the overall contribution to the Western Cape's land surface area (12 942 655 ha) protection has increased from 14 to 16%. An important contribution to the ecological infrastructure and service provision for the Western Cape Province was the increase of 7 352.6 ha to the CapeNature Protected Areas Estate in Strategic Water Source Areas.

Four of the five WCPAES objectives were achieved over the five-year period with 3 556.2 ha contributing towards the 'best remaining' sites in Critically Endangered ecosystems and increased essential habitats for all the selected species except for the Geometric Tortoise. In addition, 15 459.4 ha was secured in favour of freshwater ecosystems in four District Municipalities, and advanced the protection of marine, coastal, and estuarine ecosystems through effective management and the securing of an additional 8 848 ha. Appropriate mechanisms to enhance further protection of these ecosystems need to be pursued to secure key areas in the province's coastal habitats.

The contribution towards under-protected ecosystems and strategic landscapes was partially achieved. High levels of protection targets were achieved in three ecosystems and medium levels of protection targets were achieved in two ecosystems, still making a significant contribution of 148 236.9 ha towards meeting protected area targets for under-represented ecosystems in the province.

Partnering with key stakeholders and developing resources to maintain the momentum of protected area expansion through stewardship and recognised mechanisms must continue as one of the most important CapeNature mandates for the protection of biodiversity in the Western Cape. The total area of land in Stewardship facilitated by CapeNature is 206 046.65 ha.

CapeNature managed protected areas and estuaries face a wide variety of threats, with some affecting certain protected areas and ecosystems more than others. It is therefore important to understand the impacts on ecosystems and species that these threats pose and to identify and implement strategies to address these threats.

During 2017, CapeNature initiated a process to strengthen adaptive management capability of protected areas under its management. To facilitate adaptive management, the planning process must be founded upon clearly articulated goals and measures of success. CapeNature thus piloted and adopted the Open Standards for the Practice of Conservation adaptive management framework as defined by the Conservation Measures Partnership (CMP 2020) for the development of management plans, enabling management teams to prioritise and develop the most effective conservation strategies based on the ecological condition and heritage values and the severity of identified threats using best available traditional, expert, and scientific knowledge.

## 7.1 METHODS

The planning process identified and articulated key biodiversity and heritage features and grouped these as biodiversity and heritage values based on criteria such as co-occurrence, similarity of management intervention required, and similarity of threats faced. Threats per set of values were identified, articulated, and rated using MIRADI Project Management Software in terms of scope, severity, and irreversibility. Threats were then ranked from Low to Very High and aggregated across biodiversity and heritage values where applicable. Threats were then prioritised according to values at highest risk and overall threat ranking. A process was then followed to evaluate the factors contributing to prioritised threats which allowed for the identification and selection of strategic pressure points for intervention, enabling the development of focussed action applicable to a range of values or threats.

## 7.2 RESULTS

The prioritised threats listed in Table 7.1 below were identified from CapeNature managed Protected Area Management Plans and CapeNature co-managed Estuary Management Plans.

Table 7.1. Threats identified for CapeNature managed protected areas and estuaries.

| | THREAT (rating) | PROTECTED AREAS IMPACTED | ECOSYSTEMS IMPACTED | FAUNA IMPACTED | STRATEGIES & PLANS |
|---|---|---|---|---|---|
| 1 | Inappropriate Fire Regime<br><br>(High to very high threat) | Cederberg Complex, Groot Winterhoek, Dassen Coastal Complex, Hexriver Complex, Boland Mountain Complex, Riviersonderend Complex, Garden Route Complex, Swartberg Complex, Langeberg Complex | All Sandstone Fynbos Types, Swartruggens Quartzite Fynbos, Atlantis Sand Fynbos, Breede Shale Fynbos, Breede Alluvium Fynbos, North & South Sonderend Fynbos Northern Inland Shale Band Vegetation, Cape Flats Dune Strandveld, freshwater ecosystems, and estuaries. All proteoid fynbos types are particularly heavily impacted. | Habitat specialists, for example, Cape mountain zebra, Cape Sugarbirds, rock jumpers, Brenton Blue Butterfly, Laminate vlei rat and other rare small mammals. | Implement an integrated veldfire management policy and guidelines to maintain acceptable fire regimes in consultation with stakeholders and partners to support management decisions with regards to fire and invasive alien vegetation management in protected areas and their zone of influence.<br><br>Develop and implement an integrated environmental education and awareness programme for neighbours, natural resource users, learner groups and visitors, in collaboration with partners, to nurture respect and care for the natural, cultural, and historic values of CapeNature. |
| 2 | Invasive Alien Plants<br><br>(High to very high threat) | All except De Mond Nature Reserve and Sandveld Coastal Complex | All rivers and riparian areas, Cape Lowland Freshwater Wetlands, all Fynbos vegetation types, all Renosterveld vegetation types, thicket vegetation, all freshwater and groundwater dependent ecosystems including estuaries. | Habitat specialists especially small mammals, birds, and insects. | Enhance the implementation efficiency of invasive alien plant eradication by the integration of fire and invasive alien plant management.<br><br>Develop and implement an integrated environmental education and awareness programme for neighbours, natural resource users, learner groups and visitors, in collaboration with partners, to nurture respect and care for the natural, cultural, and historic values of CapeNature. |

| | THREAT (rating) | PROTECTED AREAS IMPACTED | ECOSYSTEMS IMPACTED | FAUNA IMPACTED | STRATEGIES & PLANS |
|---|---|---|---|---|---|
| 3 | Overfishing<br><br>(High to very high localized threat) | Sandveld Complex, Dassen Coastal Complex, Walker Bay Complex, Stony Point Nature Reserve | All coastal, marine, and estuarine environments. | Due to lack of food the African Penguin and other seabirds especially, Cape Gannets, Cormorants (Bank, Cape and White-breasted) and tern species. | In partnership with national government, non-governmental Organisations and academic stakeholders, work towards solutions to address and mitigate threats to seabirds.<br><br>Enhance the understanding and raise awareness of all ecological values and where appropriate, within its zone of influence. |
| 4 | Land Invasion<br><br>(High, localized threat) | Boland Mountain Complex | Lower lying Fynbos vegetation types, wetlands, and riparian areas. | Species targeted for food and sport such as small antelope and reptiles. | Implement the Integrated Compliance and Enforcement Plan and implement CapeNature's land invasion response plan. |
| 5 | Modification of Estuarine Habitat (mechanical and chemical)<br><br>(High threat) | All estuaries | Estuaries of high concern include Olifants, Verlorenvlei, Berg, Bot, Klein, Uilkraalsmond, Breede, Goukou, Heuningnes, Gouritz and Keurbooms. | Bird and fish species which are dependent on part of their life cycle for breeding, feeding and shelter. | Through partnerships with relevant stakeholders' address water use best practice and compliance, natural resource use in the marine and estuarine environment.<br><br>Western Cape Biodiversity Spatial Plan (WC BSP) and land use guidelines to inform and promote appropriate and sustainable development. |
| 6 | Unauthorised Access and Illegal Utilisation of Natural Resources<br><br>(High threat) | Grootwinterhoek Complex, Hexriver Complex, Boland Mountain Complex, Anysberg Nature Reserve, Dassen Coastal Complex, De Mond Nature Reserve, all protected areas adjacent to and/or containing coastal, marine, and estuarine environments | All ecosystems but especially coastal, marine, and estuarine due to high level of marine poaching but also altimontane vegetation (poaching of rare beetles), Succulent Karoo (succulent poaching) and Proteoid vegetation types (illegal flower harvesting). Certain buchu species are also targeted. | Shellfish (particularly abalone), marine birds, Colophon beetles, reptiles, and small antelope species. | Develop and implement a natural resource utilisation framework to improve resource management and regulation of resource use.<br><br>Develop and implement integrated environmental awareness and education programmes for neighbours, resource users, school groups and visitors, to nurture protected area support and respect and care for natural values.<br><br>Monitor poaching and address illegal and unsustainable resource utilization through the implementation of the Integrated Compliance and Enforcement Plans (unauthorised access and poaching). |
| 7 | Mining and related activities<br><br>(Medium, localized threat) | Knersvlakte Complex | Loss of natural habitats connecting portions of the Knersvlakte Complex. | Reptiles e.g., girdled lizard. | Through partnerships, promote and facilitate pro-active law enforcement and compliance within the Knersvlakte; re-evaluate the expansion domain of the Knersvlakte Nature Reserve to facilitate protected area expansion and consolidation through stewardship, land purchases and state land transfer. |
| 8 | Over-abstraction of ground and surface water<br><br>(Medium threat) | Dassen Coastal Complex, Cederberg Complex, Hexriver Complex, Boland Mountain Complex, Langeberg Complex, Garden Route Complex, Swartberg Complex, De Hoop Nature Reserve and De Mond Nature Reserve | Atlantis Sand Fynbos, Cape Flats Dune Strandveld, Langebaan Dune Strandveld, Swartland Renosterveld types, Breede Alluvium Fynbos, Ceres Shale Renosterveld, Atlantis aquifer, TMG aquifer, lowland and high wetlands and seeps, rivers, and riparian zones. Estuaries identified as being of high risk are Olifants, Goukou, Heuningnes, and Gouritz. | Indigenous fish species, in particular:<br>In the Cederberg Complex - Spotted rock-catfish, Clanwilliam rock-catfish, Clanwilliam redfin, Clanwilliam sandfish, Clanwilliam Sawfin, Clanwilliam yellowfish, Fiery redfin, Doring fiery redfin and Cape Galaxius.<br>In the Boland Mountain Complex - Breede River redfin, giant redfin, Berg River redfin, Berg Breede River Cape galaxias and Cape Kurper. | Determine through empirical evidence the impact of groundwater abstraction on groundwater dependent ecosystems.<br><br>Develop and implement an integrated compliance plan in collaboration with partners and law enforcement entities.<br><br>Develop and implement integrated environmental awareness and education programmes for neighbours, resource users, school groups and visitors, to nurture protected area support and respect and care for natural values.<br><br>Through partnerships, address agricultural water use best practice and compliance with landowners within river systems. |
| 9 | Invasive Alien Animals<br><br>(Medium threat) | Grootwinterhoek Complex, Cederberg Complex, Garden Route Complex, Anysberg Nature Reserve, Boland Mountain Complex | Rivers, streams, wetlands, and estuaries are impacted by alien invasive fish.<br>Succulent Karoo, Fynbos, Renosterveld, Karroid Renosterveld, Subtropical Thicket are all impacted by various introduced and escaped non-indigenous mammals. | Fish species (same as above) and extralimital game species. | Implementation of alien invasive fish control and/or removal, guided by Invasive Alien Species Monitoring, Control and Eradication Plans in priority rivers. |

## 7.3 DISCUSSION & RECOMMENDATIONS

The threats facing the Western Cape's terrestrial and marine protected areas are diverse. Inappropriate fire regime, Invasive alien plants and Overfishing have the highest threat rating. Fire regimes remain a concern due to the high number of anthropogenic ignitions which far exceed the natural ignitions in the past (64.2% human induced ignitions versus 29.9 natural fires in the 2022-2023 fire season alone). The chapter on fire later in this report deals with the impact of fire and clearly shows that although fewer hectares burnt over the last 3 years, 2017-2018 and 2018-2019 saw over 150 000 hectares burnt per fire season. Based on the above, inappropriate fire regimes can have a significant impact on the stability of biodiversity in protected areas and zone of influence.

Invasive Alien Plants pose as significant a risk to biodiversity as fire does. In the 2019-2020 financial year 42 943 hectares were cleared, however COVID and other factors reduce the hectares cleared in 2020-2021 to 19 331. By the end of March 2023, 24 804 had been cleared for the financial year.

Overfishing is a localised threat affecting areas off the coast close to communities. In 2019, Marine Protected Areas (MPA) were shown to assist fish stocks to recover and spill over into adjacent fishing grounds.

Rapid urban expansion places pressure on CapeNature's Protected Area boundaries with land invasion and poaching being directly related to this expansion. The significant impacts of land invasion were felt during the COVID pandemic when, in June 2020, Driftsands Nature Reserve on the Cape Flats within the City of Cape Town metropole, was subjected to a mass movement of people onto the reserve and the building of informal homes. This resulted in the de-proclamation of Driftsands Nature Reserve and a significant loss of protected habitat for the remnants of the endangered veld type Cape Flats Dune Strandveld. The proximity of urban settlements to nature reserves also increases the risk of uncontrolled fires.

Freshwater, estuarine, and marine ecosystems continue to be vulnerable to the impacts of pollution and habitat modification.

Mining, agricultural expansion and over abstraction of water that takes place within the zones of influence of protected areas will also affect the threat status. High water demand places severe strain on the required ecological reserves of the Western Cape's rivers and associated wetlands. Riverlands Nature Reserve in the Dassen Coastal Complex is one such example, where runoff from agricultural crops resulted in infestations of kikuyu grass (*Pennisetum clandestinum*) on boundary areas on the nature reserve.

Invasive alien animals continue to be a threat on some CapeNature Protected Area's. Progress was made with the control and eradication of feral pig in West Coast renosterveld and house mice on Dassen Island with the introduction of automated mouse traps in July 2022.

The Polyphagous Shothole Borer Beetle (*Euwallacea fornicatus*), recorded in the Western Cape in 2020, poses a threat to indigenous trees, however no CapeNature areas have been affected.

In the Western Cape, the agricultural economy is concentrated within the areas which are suitable for cultivation, which is predominantly on the nutrient-rich soils on the lowlands, derived from shale and granite geologies, which make it highly suitable for cultivation of grain crops (wheat) and vineyards. In addition to supporting the largest agricultural economy of all South Africa's provinces, cultivation in the Western Cape has the longest history of the South African provinces. As such, the areas which are suitable for cultivation have been subjected to high levels of modification with few remnants of natural vegetation within these areas.

The expansion of irrigation schemes and new technologies have allowed expansion of cultivation into new agricultural areas. Many areas not suitable for cultivation are utilised for livestock farming, examples being the extensive grazing land-uses found in the Succulent and Nama Karoo. Land management is important in these areas for maintaining biodiversity and productivity, as overgrazing is a common practice and can result in high levels of degradation, and arid ecosystems take a long time to recover from disturbance. Ostrich farming in the Little Karoo is typically more intensive with high levels of disturbance and modification. No new soil loss or degradation data has been compiled for the Western Cape since 2005 and this represents a significant barrier to understanding the quality of topsoil reserves in the province and the scale of loss of productive land and biodiversity integrity (DEA&DP 2018).

Urban development is another driver of habitat modification. Cape Town, as the second largest city in South Africa and one of the country's major economic hubs, is the focus of the rapid modification through urbanisation. The City of Cape Town Metropolitan Municipality additionally contains very high levels of biodiversity even by the high standards of biodiversity within the province. There are likely to be very few major cities in the world that can compare with Cape Town in terms of the levels of biodiversity within the municipal boundaries. Many of the species and habitats are restricted to the municipal boundaries and cannot be conserved elsewhere.

Finally, whilst climate change itself poses one of the biggest threats to biodiversity globally (Habibullah *et al.* 2021, IPCC 2023) and locally (Midgley *et al.* 2003, Slingsby *et al.* 2017, Tanner *et al.* 2022), its effects often compound the negative impacts on biodiversity resilience already being experienced because of habitat loss and fragmentation. Preserving intact ecosystems and species populations, maintaining connectivity, and ameliorating compounding anthropogenic stressors are vital for preserving adaptive capacity across all realms (SANBI 2019b). Intact biodiversity supports ecosystem functioning and can increase resilience to climate change impacts in both natural and managed systems. The 2023 WC BSP identifies climate change adaptation corridors as being important to safeguard biodiversity resilience, whilst the Western Cape Protected Area Expansion Strategy 2021-2025 is informed by the 2017 WC BSP and the targeted inclusion of climate change corridors into the conservation estate forms part of the strategy.

## 8.1 METHODS

Land cover data is a key dataset used to identify, at a given time period, where vegetation types and other biodiversity features (e.g., wetlands, threatened species habitat), as well as elements of ecological infrastructure (e.g., climate corridors, foredunes, water source areas) are considered to be in a natural (or near-natural) state versus having been modified to a point beyond which biodiversity function, structure and composition are considered intact. Lands without intact natural vegetation do not contribute to representation targets, though they may contribute to ecological process and functioning.

The 2017 CapeNature State of Biodiversity Report and 2017 WC BSP utilised a land cover product initially generated by GeoTerraImage to reflect the land cover / land use of the Western Cape circa 2013/14 (GTI 2015a and 2015b). Unfortunately, a second product has not yet been developed utilising the same methods in its generation.

The latest National Land cover product currently available is the South African National Land Cover 2020 product developed by DFFE (DFFE 2021). For the purposes of this analysis, this product, along with geographic masks depicting roads, railways, electrified structures, dams, and additional agricultural fields that were mapped circa 2020, were used to revise the finer resolution and more detailed Western Cape 2013/14 land cover product utilised in the 2017 WC BSP (CapeNature 2023d & 2023e). In addition, the maximum surface water extents were also embedded into these products to remove the variance derived through fluctuating water levels over time. These modifications were made in order ensure consistency between the various products and thus render more consistent and accurate findings.

This revised version cannot be considered as a truly comparable land cover map for 2020 however, because the natural classes reflected have not been revised from those reflected in the 2013/14 Western Cape Land cover product. Only the areas that have changed land cover from a natural to near natural category to a category reflecting a category devoid of natural habitat have been amended (Figure 8.1).

The primary purpose of these amendments was to determine a) the remaining extent of the natural to near natural regions within the province, and b) to conduct preliminary analyses indicating the rate of habitat loss. The revised 2020 Western Cape Land cover product consists of 113 classes which were used as surrogates for three broad categories of ecological condition: (i) natural to near-natural, (ii) degraded and severely modified, to (iii) completely devoid of natural habitat (100% modified).

To monitor the relative success in trying to protect Climate Change Adaptation Corridors identified in the previous State of Biodiversity Report, a 2010 baseline Climate Change Adaptation Corridor Network was delineated by refining the network originally identified by the Table Mountain Fund (Pence 2009) using the 2010 Western Cape Biodiversity Framework 2010 (Kirkwood *et al.* 2010). This Network encompasses corridors outside protected areas (including a sub-set of Ecological Pinch Point sections where the corridors were less than 1km in width), as well as including Protected Areas and Mountain Catchment Areas (or portions thereof). Using this coverage as reference, one can now determine the relative increase in protection and habitat loss as they relate directly to these corridors.

## 8.2 RESULTS

Figure 8.2 indicates the location of the identified 100% modified areas as they relate to the threatened ecosystems in the Western Cape. Table 8.1 provides more detail on the apportionment of this modification across the different threated ecosystem classes (based on the 2022 Red Listed Ecosystems list: SANBI 2023b).

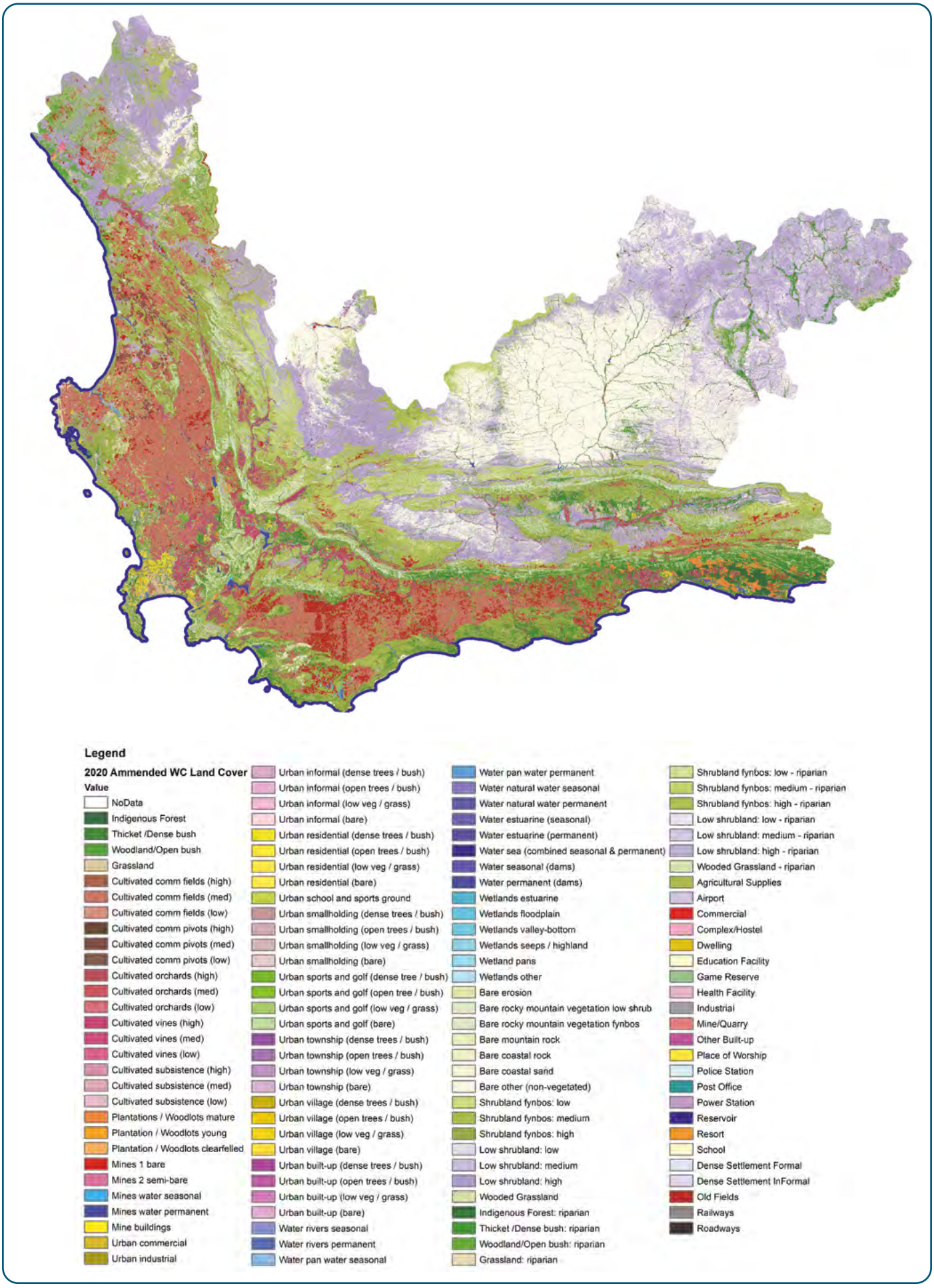



Figure 8.1 The 2020 amended Western Cape Land Cover (CapeNature 2023e).

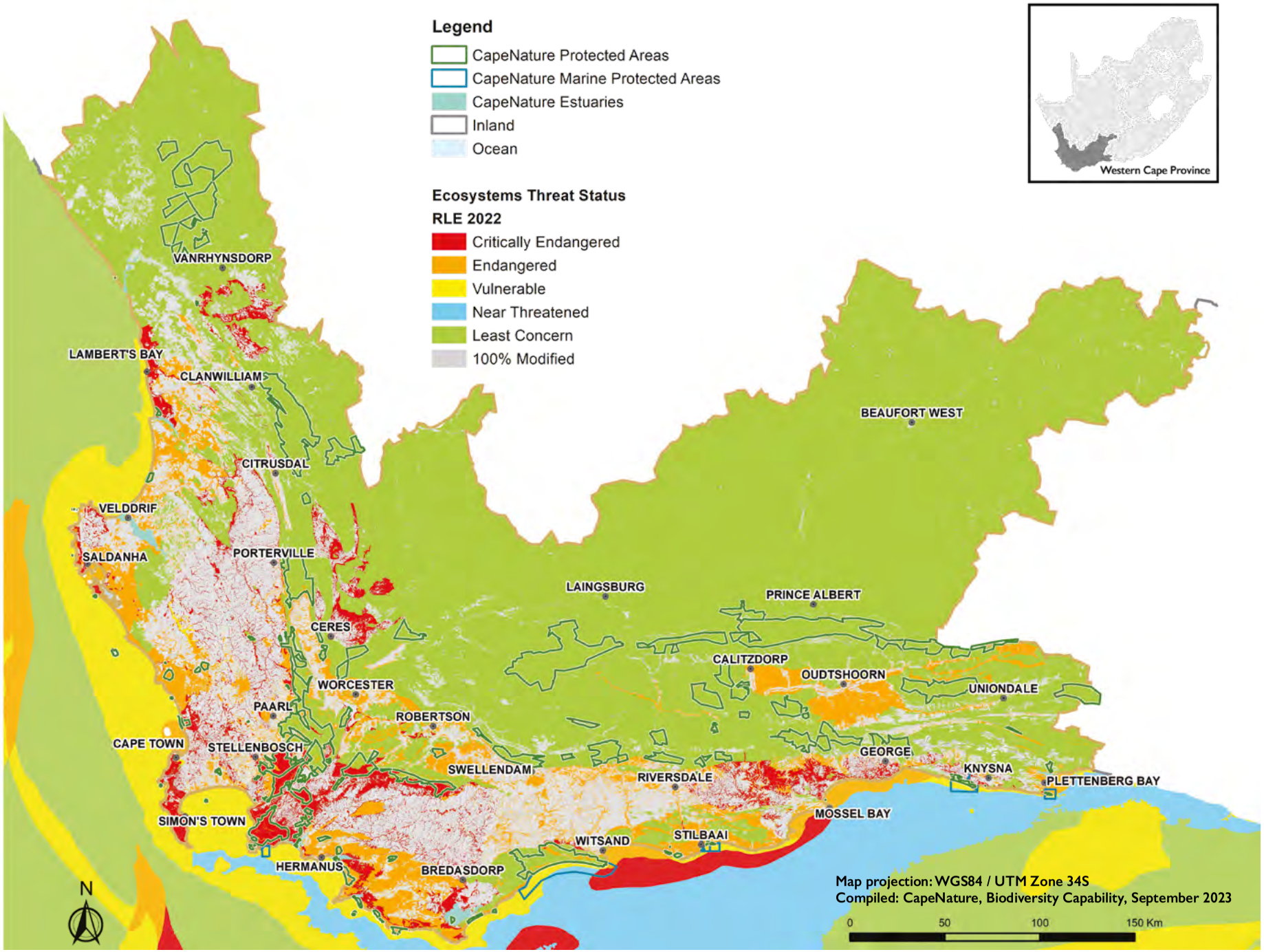



Figure 8.2. Habitat areas that are 100% modified relative to the Threatened Ecosystems.

Table 8.1. Comparison of loss rates between 2013/2014 and 2020 within the different Red Listed Ecosystem categories.

| Ecosystem Threat Status (2022) | No. Ecosystems | Remaining ha (2013/14) | Remaining ha (2020) | Ha lost | % Lost |
|---|---|---|---|---|---|
| Critically Endangered | 35 | 647 891 | 563 749 | 84 142 | 13 |
| Endangered | 27 | 1 163 446 | 1 028 460 | 134 986 | 12 |
| Vulnerable | 2 | 5 427 | 4 758 | 676 | 12 |
| Least Concern | 107 | 8 879 437 | 8 742 181 | 137 256 | 2 |

Figure 8.3 highlights the areas in which the highest rates of modification were recorded (as a percentage change within a 3 min arc) between the amended 2014 and 2020 Western Cape Land Cover products (CapeNature 2023d & 2023e). This is a significant and worrying trend for, when compared with Figure 8.2 above, the highest levels of change are still occurring in the areas with the most threatened ecosystems.

Figure 8.4 compares the delineated Climate Changes Adaptation Corridors against the Protected Area Networks as they were in 2017 and 2023 respectively. As can be seen in Table 8.2, an additional 4 951 ha (0.29%) of the original Climate Change Adaptation Corridor Network extent (1 733 274 ha) came under formal protection during this period. Unfortunately, 102 057 ha was also lost (100% modified).

Keurbooms River Nature Reserve *(Virgilia divaricata)*
© Scott Ramsay

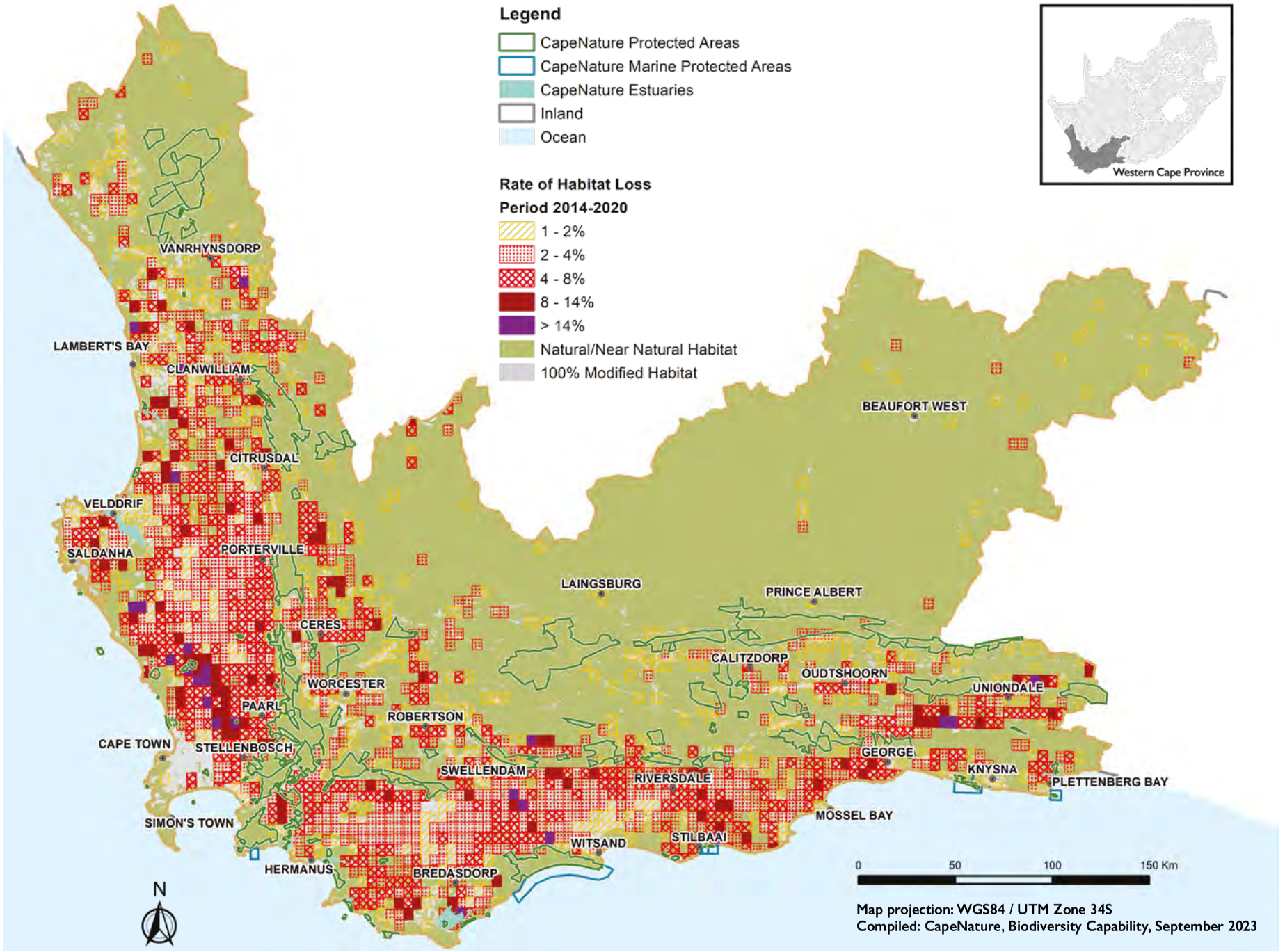



Figure 8.3. The degree of change between the modified land-use categories extracted from the Amended Western Cape Land Cover datasets (CapeNature 2023d & 2023e).

Table 8.2. Comparison on increases in protected level per Climate Adaptation Corridor sub-category between 2017 to 2023

| Area containing Climate Adaptation Corridor | Baseline ha (2010) | Remaining area in 2017 (ha) | Remaining area in 2023 (ha) | Difference in area from 2017 to 2023 (ha) | % Increased Protection in 2023 from 2017 |
|---|---|---|---|---|---|
| Unprotected Areas | 455 430 | 391 264 | 374 052 | -17 212* | 1.49 |
| Unprotected Ecological Pinch Points | 6 367 | 4 757 | 4 639 | -118 | N/A |
| Mountain Catchment Areas | 614 432 | 607 040 | 606 646 | -394 | 0.06 |
| Protected Areas | 657 045 | 641 345 | 645 880 | 4 535 | 0.71 |
| TOTAL REMAINING | 1 733 274 | 1 644 406 | 1 631 217 | | |

*4 535 of which transferred to Protected Areas

## 8.3 DISCUSSION AND RECOMMENDATIONS

As illustrated in Figure 8.2, most of the habitat loss is confined to the coast and immediate inland areas of the coast where the rainfall is higher and agricultural capabilities are greatest. Unfortunately, even though there is already an extreme high modification level recorded within these areas, it is still within these areas that the highest rates of change are occurring (Figure 8.3).

Whilst technologies to allow near-real time automated remote-sense time series to detect land use changes and degradation, are increasingly becoming available, (Moncrieff 2021) the extent and scale of these impacts cannot be readily and accurately quantified due to the time lapse in available technologies.

Groot Winterhoek Wilderness
© Scott Ramsay

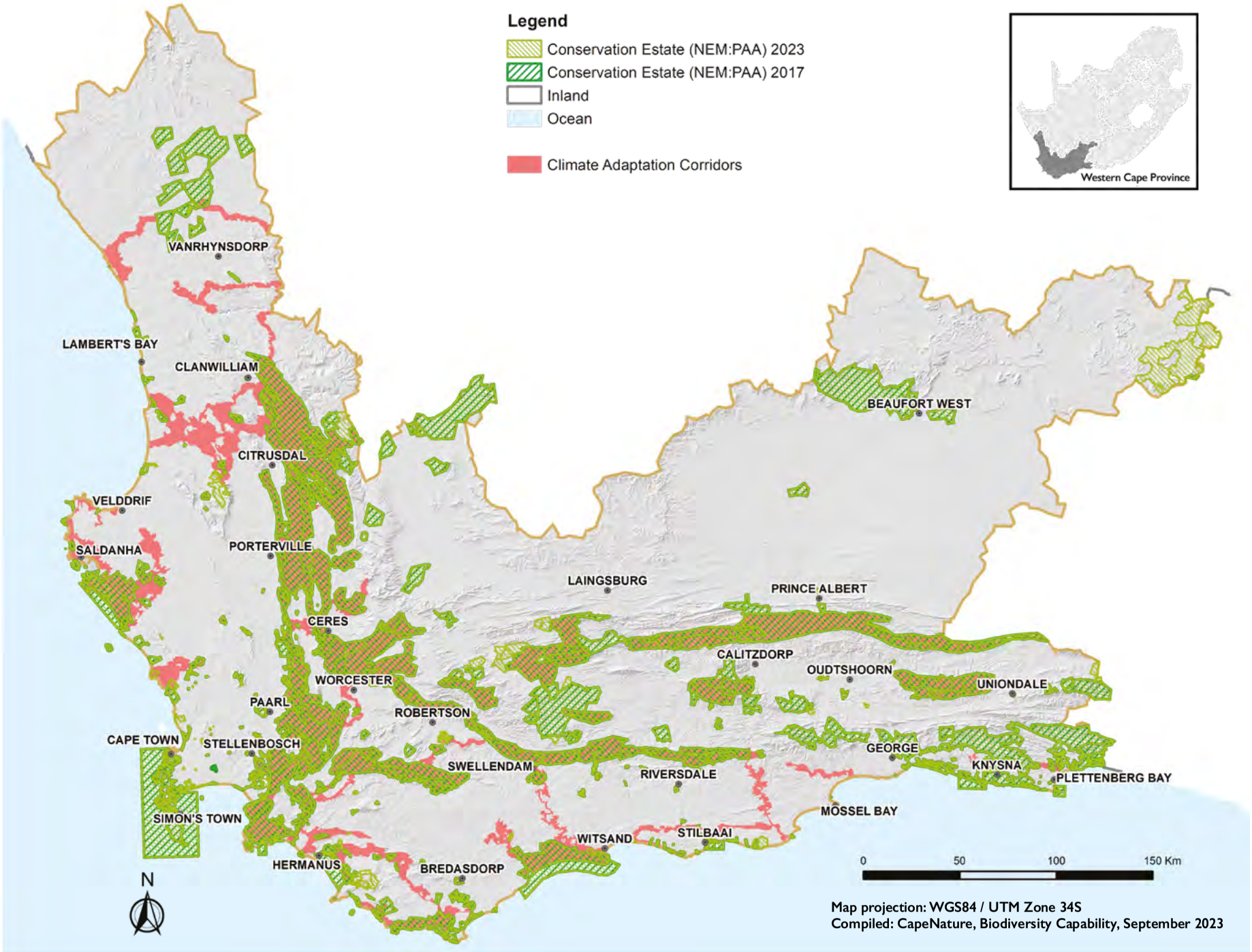



Figure 8.4. A comparison of the protection levels of the Climate Change Adaptation corridors over the period 2018 to 2023.

The second United Nations Office on Drugs and Crime (UNODC) World Wildlife Report published on 9 July 2020 shows that wildlife crime presents a significant global threat to biodiversity, and this is especially evident in the Western Cape (UNODC 2020). Within CapeNature, illegal harvesting and trade is seen as a direct threat to biodiversity for Invertebrates, Marine fish, Plants, Reptiles and Amphibians. In this context, the entity has maintained efforts to combat illegal and unsustainable utilisation of the Western Cape's natural resources. During the reporting period, the pressure on indigenous succulent flora increased significantly. Capacity building activities were conducted to capacitate and enable staff and other partner agencies engaged in compliance and enforcement activities.

## 9.1 METHODS

Data generated through the entity's enforcement actions are represented in tables and charts below to illustrate the entity's response to biodiversity crime. It must be borne in mind that the data represent a small segment of the actual scale of illegal activities, and the concealed nature of illegal activities makes it difficult to quantify the actual impacts on biodiversity.

## 9.2 RESULTS

Enforcement actions constitute the issuance of Spot Fines (J534s) and the registration of case dockets. During the reporting period, the entity issued 392 J534 fines and registered 269 criminal case dockets, for a total of 661 enforcement actions (Figure 9.1).

### 9.2.1 Criminal Cases Involving Succulents

During the reporting period, there was a marked increase in incidents of succulent poaching and trafficking. During 2018-2019, succulent trafficking cases constituted 4% of all cases registered, and in 2019-2020, succulent trafficking cases constituted 20% of all cases registered. However, during 2020-2021, succulent cases constituted 40% of the total number of cases registered in the Western Cape. This trend continued into 2021-2022, with succulent cases constituting 54% of the total number of cases registered during that year. In 2022-2023, succulent cases constituted 38% of the total number of cases registered during that financial year (Figure 9.2).

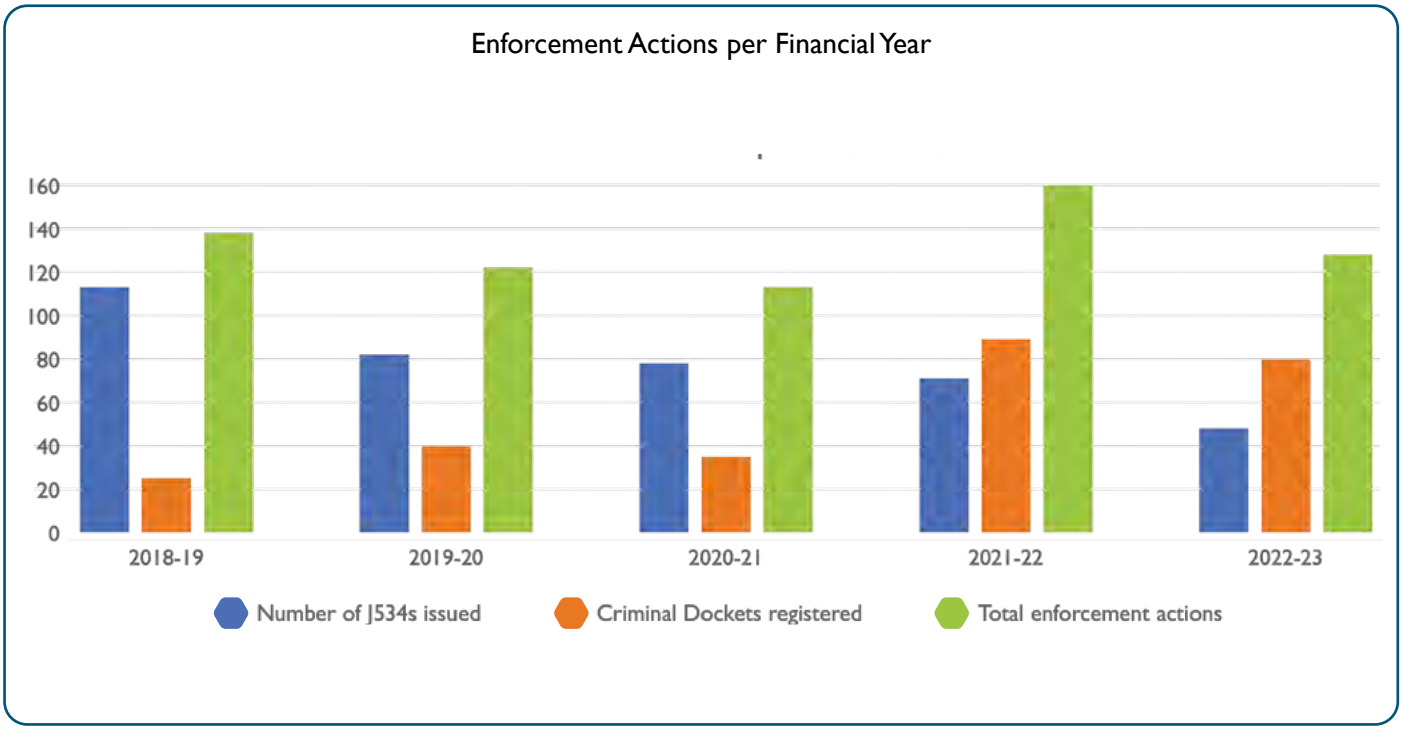



Figure 9.1. Enforcement Actions Conducted per Financial Year.

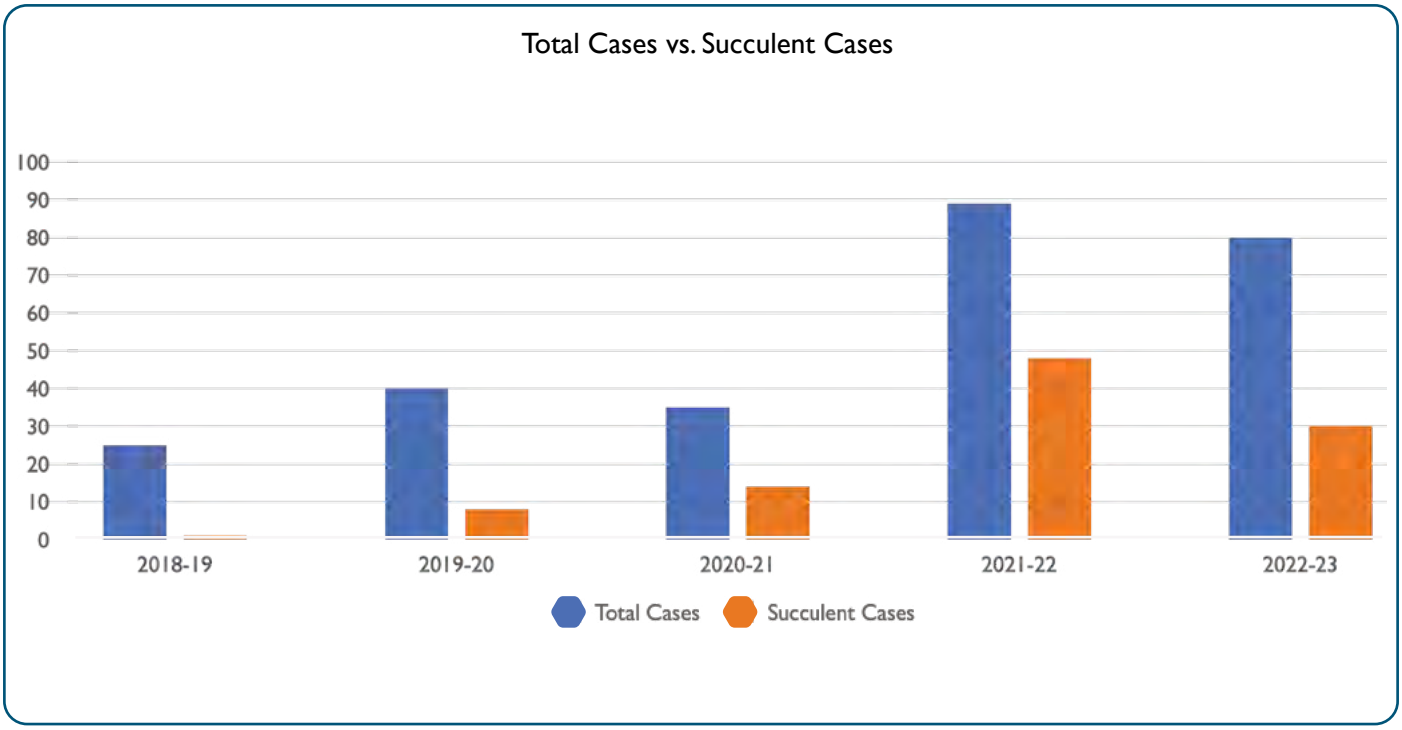



Figure 9.2. Representation of Succulent Cases against Total Number of Cases.

### 9.2.2 Capacity Building

The entity conducted a range of activities to expand and reinforce capacity to combat biodiversity crime. During the reporting period, the entity designated 16 employees as Peace Officers, and field rangers underwent training in the application of the Western Cape Nature Conservation Ordinance, no. 19 of 1974. Additionally, 18 employees were trained and designated as Environmental Management Inspectors (EMIs).

## 9.3 DISCUSSION & RECOMMENDATIONS

The most significant trend evident during the reporting period was the increase in succulent trafficking cases. This is attributed to the transformation of the activity from foreign individuals collecting for their own gain to organised syndicates recruiting local inhabitants to collect succulents for international markets. Succulent plants are collected *in-situ*, packaged, and transported either to Cape Town or Gauteng for export, using existing trafficking networks.

Evidence compiled during investigations indicates that most succulent plants are destined for Chinese markets. Additionally, South African succulents are regularly offered for sale on online markets and social media platforms. The entity has partnered with other agencies involved in the fight against succulent poaching, and one result of these partnerships has been the formulation of a National Strategy to combat succulent flora poaching. The entity also makes use of various media to broadcast information to inform and educate the public about biodiversity crime in general and succulent flora poaching in particular.

A second trend noted in the enforcement action data shows a decrease in the number of J534 fines issued over the reporting period. At the same time, there has been an increase in the number of case dockets registered. This downward trend also occurred during the period where the above-mentioned dramatic increase in succulent flora trafficking took place. These trafficking incidents are often too serious for a spot fine to be issued and case dockets must be registered. The reporting period also covered the extraordinary events related to COVID, such as the lockdowns and restrictions on travel and public interaction. This created an artificial downturn in activities during at least the 2020-2021 financial year.

Fire is a necessary ecological driver of the Fynbos Biome (Kruger 1977, Cowling 1987, van Wilgen 1987) and occurs occasionally in other vegetation types such as Thicket and Forest. Thus, management of fire in CapeNature's Fynbos-dominated protected areas requires that fire be maintained and managed as an ecological process so that when fires occur it has a positive ecological effect and that loss of life, infrastructure and agricultural crops is minimized. If fire frequencies are too high, then there may be insufficient time for reseeding plants species and some animals to recover population levels between these frequent fires. Very long intervals between fires e.g., >30 years (Kruger 1977) or > 40 years (Bond 1980) can lead to senescence of fynbos species. When Fynbos vegetation reaches this stage then fire is desirable and if it does not start naturally then prescribed and controlled ecological burns can be executed. This will assist in achieving a diverse mosaic of veld ages within Protected Areas and across landscapes. Fire dynamics in fynbos are complicated by the presence of invasive alien plants (IAPs). Many IAPs are large woody species that are structurally very different to fynbos species and contribute much more fuel than Fynbos (van Wilgen & Richardson 1985, van Wilgen & Scott 2001). This in turn leads to hotter fires that are more difficult to manage especially under hot, dry, and very windy conditions (Kraaij *et al.* 2018).

CapeNature reports regularly on fires through CapeNature's Annual Fire Reports and State of Conservation Reports (CapeNature 2002, 2020a, 2020b, 2021c, 2021d). The 2017 CapeNature State of Biodiversity Report did not deal with fire as a separate topic but did cover its effects throughout the report (CapeNature 2017b).

## 10.1 METHODS

Data on fires in CapeNature Protected Areas was accessed from CapeNature's Central Fire Database. This comprehensive database stores information on all formally reported fires that have occurred on or immediately adjacent to CapeNature Protected Areas and has records dating as far back as 1944. Data after 1980 is generally complete. The period used for these analysis runs from 1980 to 2022.

The features of fire that were used for analysis in this report are:

- The number and area of fires with breakdowns according to land ownership and veld age (time since last fire). Vegetation age (veld age) at time of fire was categorised according to the following categories: Young (0-6 years), Medium (7-12 years), Mature 13-17 years and Old (>=17 years). Note that these categories vary across the full extent of the fynbos in the province (e.g., drier areas have older age limits) and that these generalised categories represent an average descriptor.
- Season of fires according to the season in which they occurred was simply classified as winter (June to September) or summer (December – April). The timing of fires across the province varies with rainfall which shows a distinct change in seasonality from winter rain in the west to more a-seasonal rain in the east (Chase & Meadows 2007). Fires regularly occur naturally in winter in the a-seasonal rainfall regions. Only winter fires burning summer fire season Protected Areas are presented.
- Frequency of fires was calculated for all Protected Areas as the number of fires per area over 7-, 12- and 17- year periods. The percentage attribution of ignition causes to set categories as determined from ignition points (where this information was available) was also calculated.
- Time series analyses using the R greenbrown package was applied to examine the statistical trends and breaks in trends using Mann-Kendall tests on the slope. All statistical analyses were conducted in R 4.2.1 (R Core Team 2022).

## 10.2 RESULTS

Fire characteristics such as the number of fires and the area burned varied quite widely across the reporting period from a minimum of six fires and a total area burned of 200.7 ha to a maximum of 160 fires and 23 7940.6 ha burned.This is expected as weather conditions change over time and as large fires leave less opportunity for fires in the following three or more years.

The number of fires per year shows a significant positive but weak increasing trend over the period (Mann-Kendall Test: slope=0.85%, p=0.037) (Figure 10.1). The area of fires shows a non-significant positive increasing trend over the period. Mann-Kendall Test: slope = 0.33%, p = 0.82, see Figure 10.2.

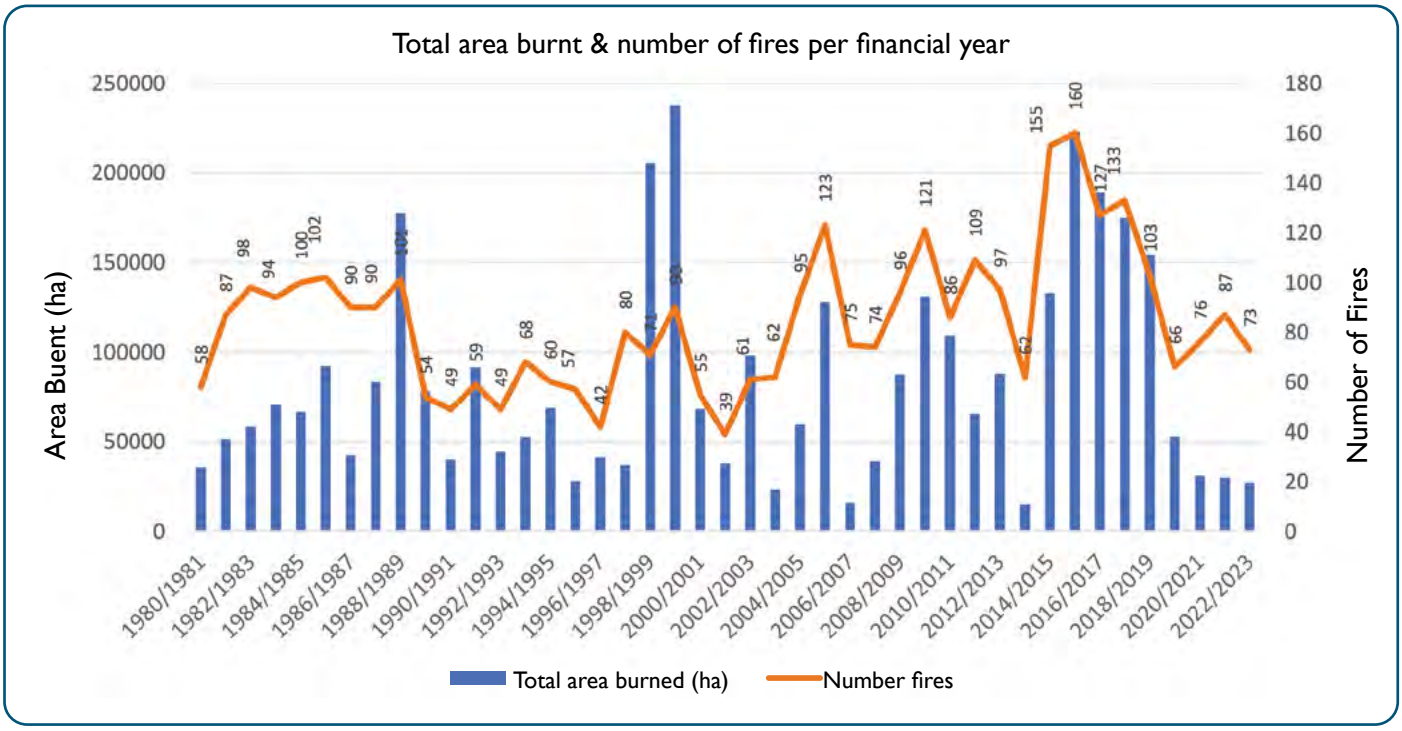



Figure 10.1. Total area of fires recorded in CapeNature Protected Areas over the period 1980-2023.

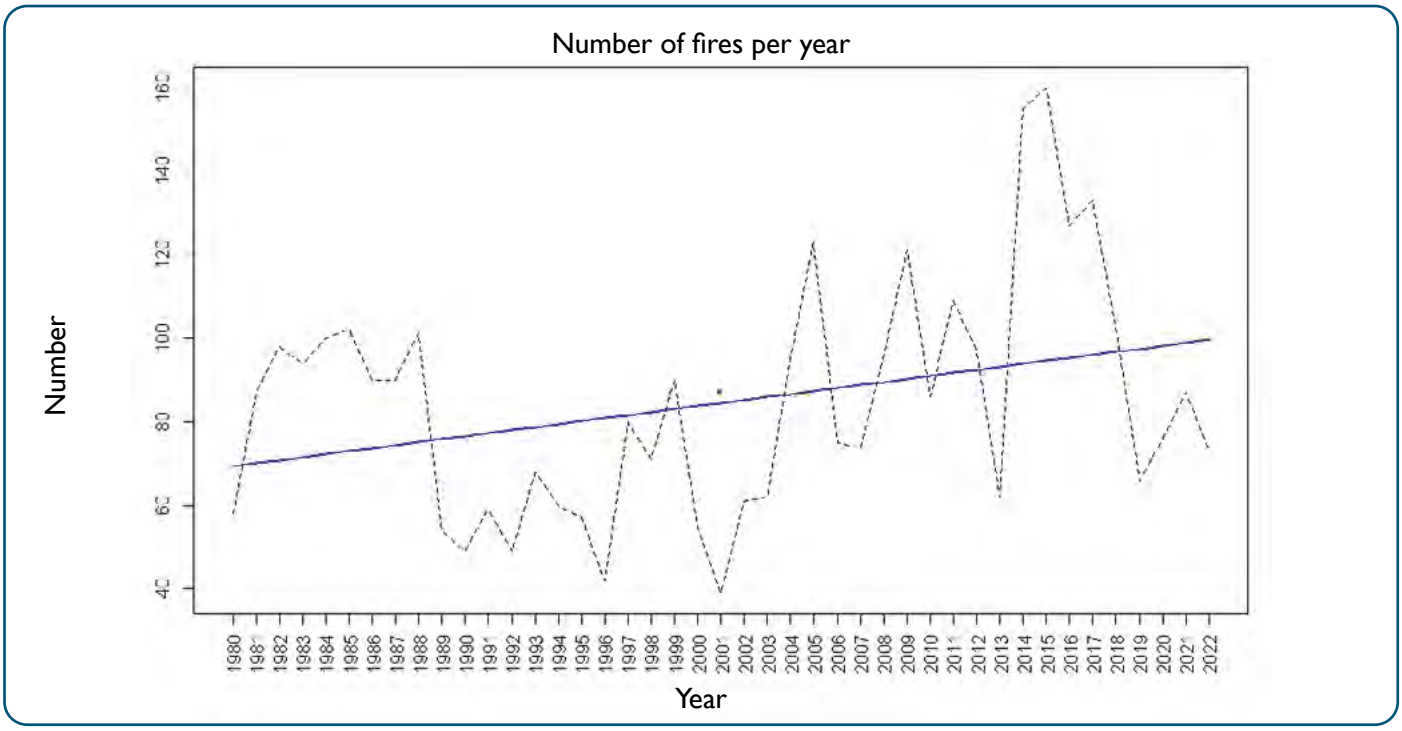



Figure 10.2. Long-term trends (1980 - 2022) in the number of fires per year (asterisk indicates a significant positive trend).

### 10.2.1 Season

Over the period 1980 to 2022 there was a minimum of zero fires and a maximum of 14 fires reported in the winter months in the winter-rainfall area (the western parts of the province) in which winter fires are not desirable (Figures 10.3 & 10.4). There were only six years in this period without any winter fires in summer fire season Protected Areas. The red line shows a positive trend over the period.

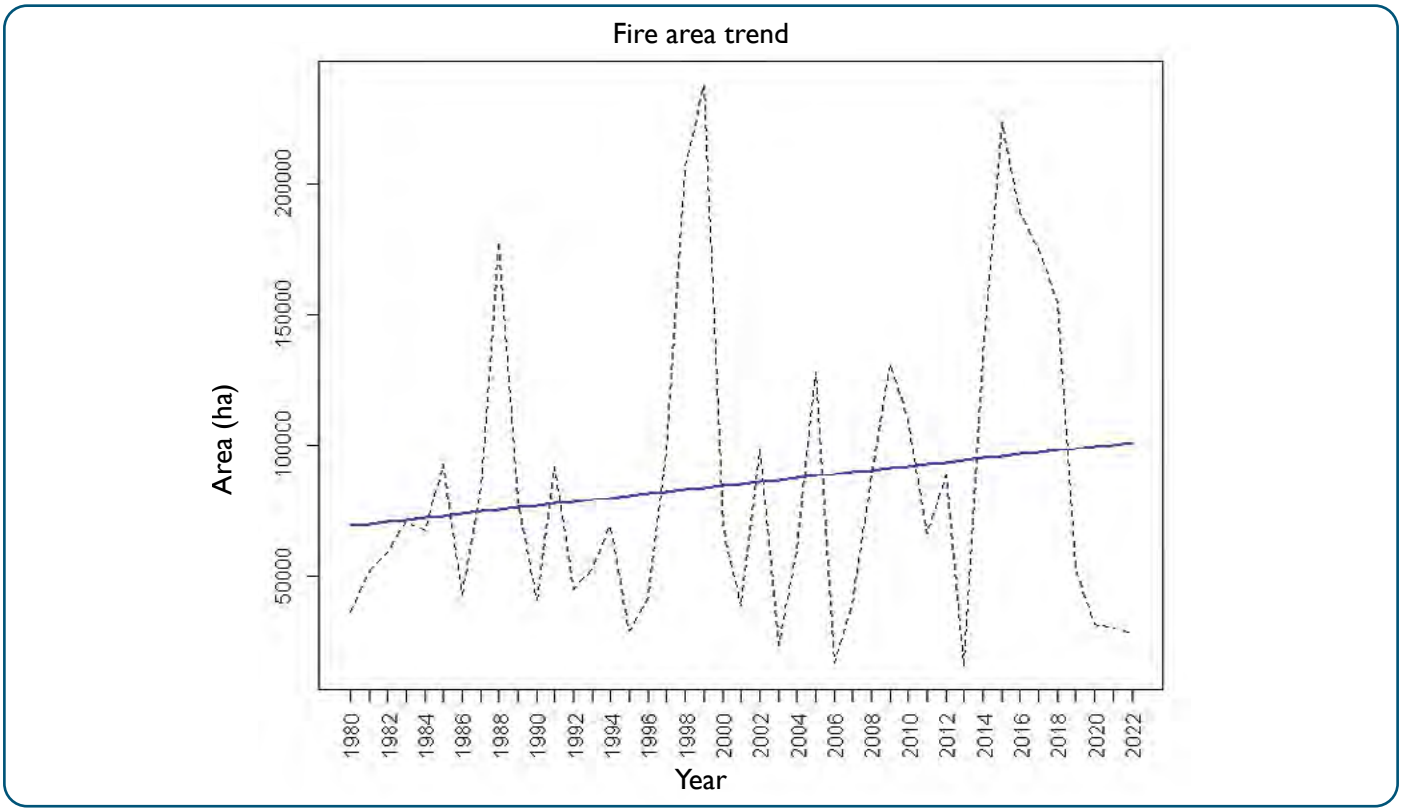



Figure 10.3. Long-term trends (1980 - 2022) in the area burnt per year (non-significant positive trend).

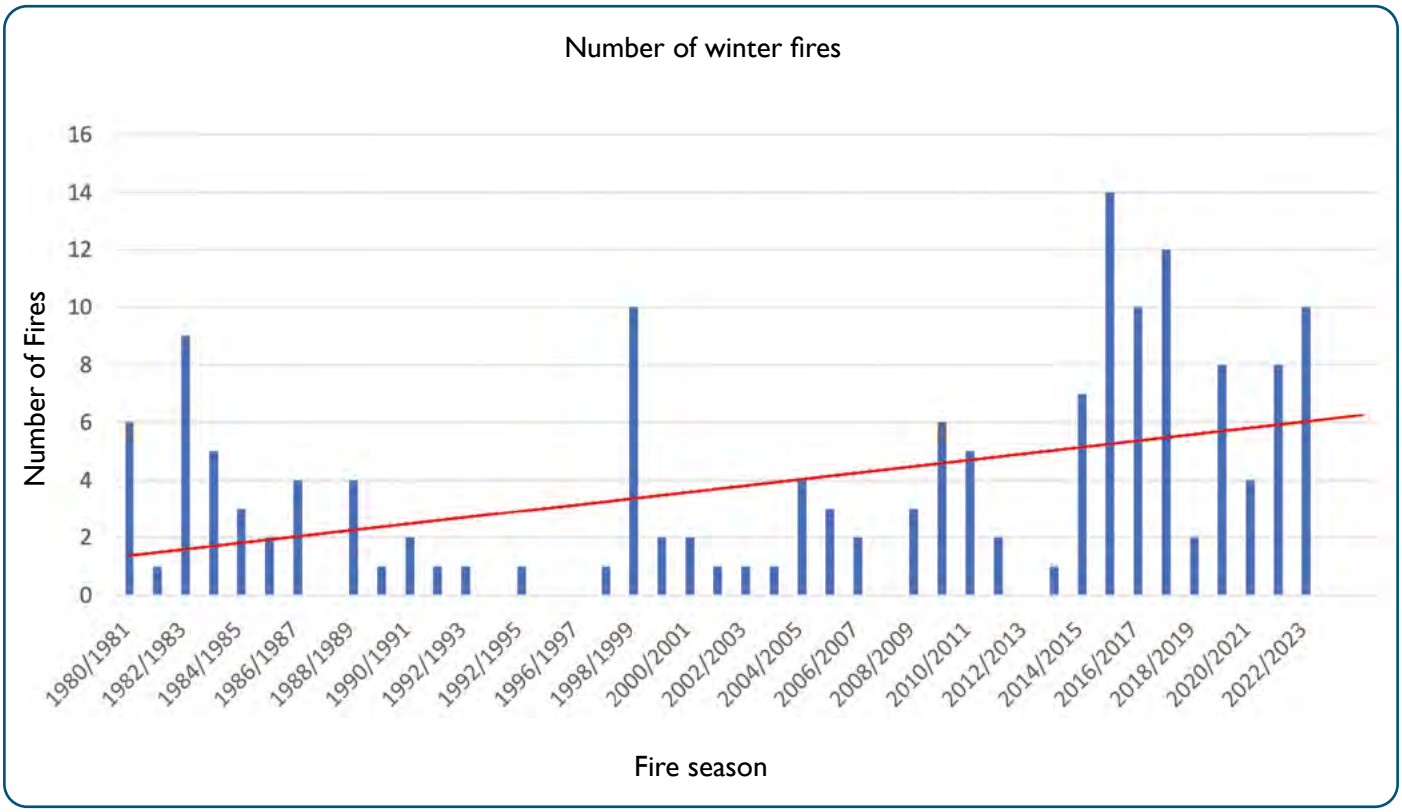



Figure 10.4. Number of fires burning in winter in summer fire season Protected Areas.

Vegetation age per financial years is provided for the period 2009/2010 to 2022/2023 as figures for financial years dating back to 1980 are not readily available. Currently, the area of veld in the mature and old age categories (>=13 years) is improving in its percentage representation in recent (after 2018/2019) fires (Figure 10.5). Ideally there will be equal representations of young, medium, mature and old veld.

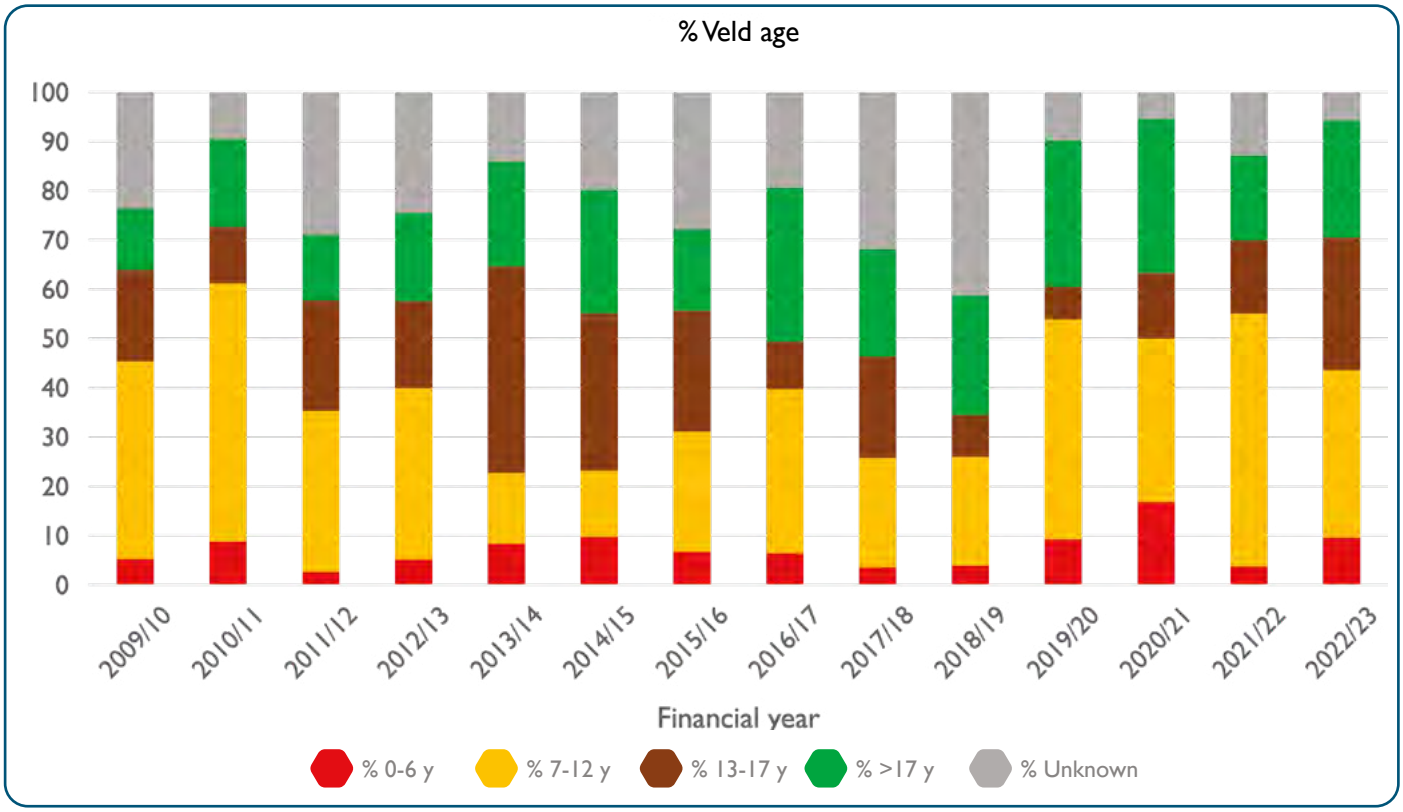



Figure 10.5. Percentage of veld per age category: Young: 0-6 y, Medium: 7-12 y, Mature: 13-17 and Old: > 17 years.

Figures 10.6 to 10.8 illustrate which areas have burned more than once in each interval (7-, 12- and 17-years respectively). For most areas of the fynbos biome fires should only occur once every 12 to 17 years. These maps provide an indication of where fires are continuously too frequent.

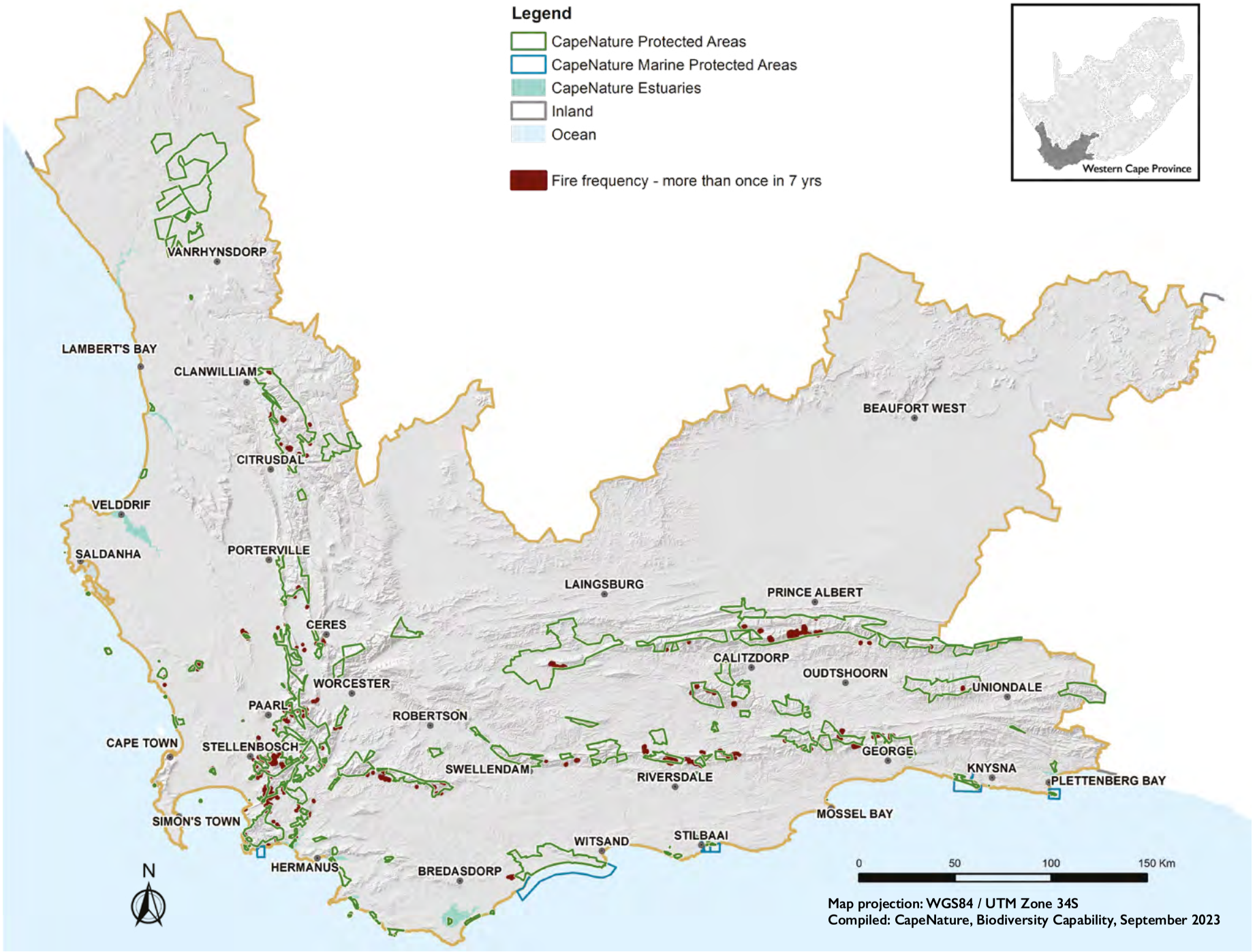



Figure 10.6. Areas burned more than once in the past 7 years (2017-2023).

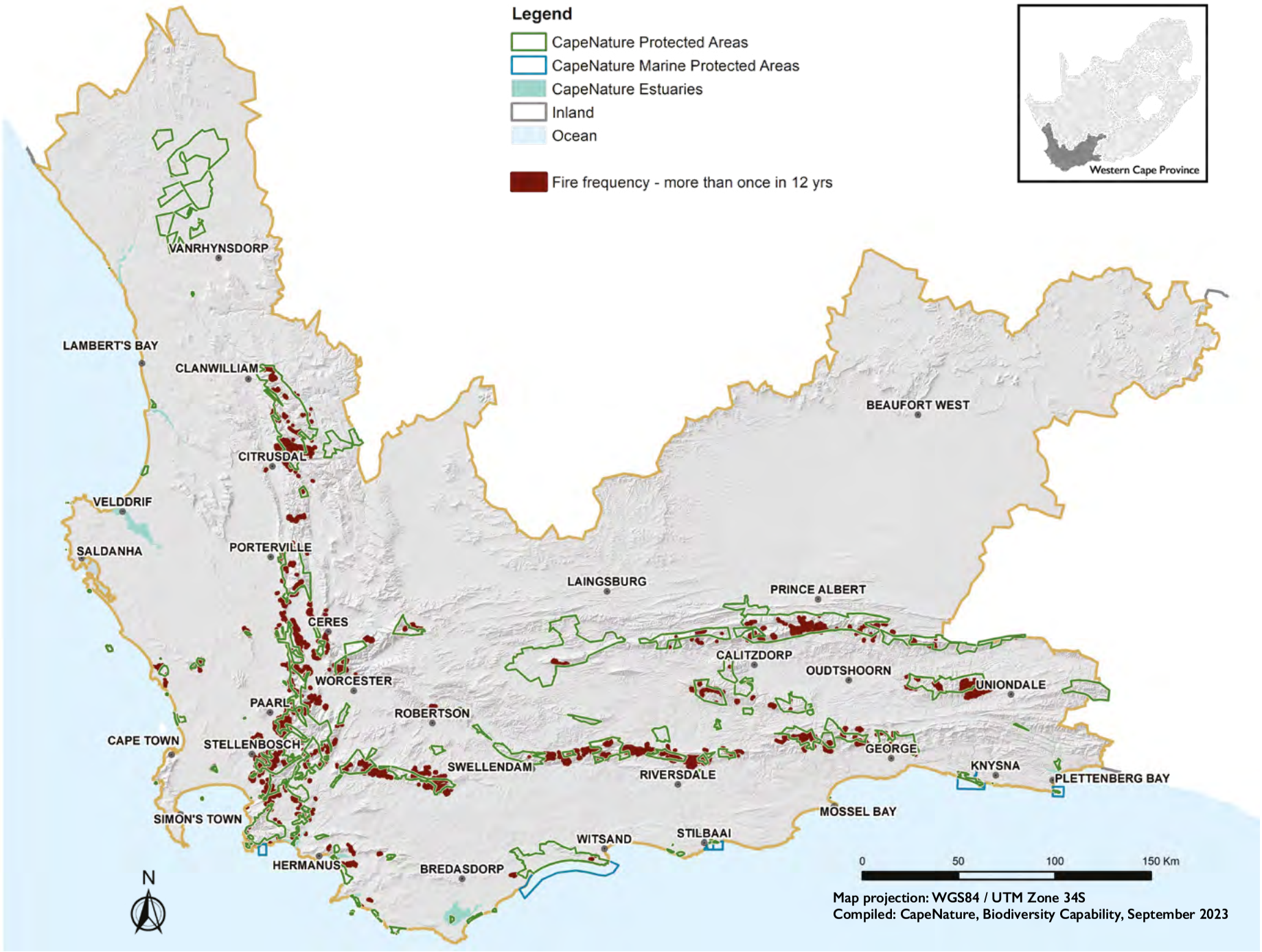



Figure 10.7. Areas burned more than once in the past 12 years (2012-2023)

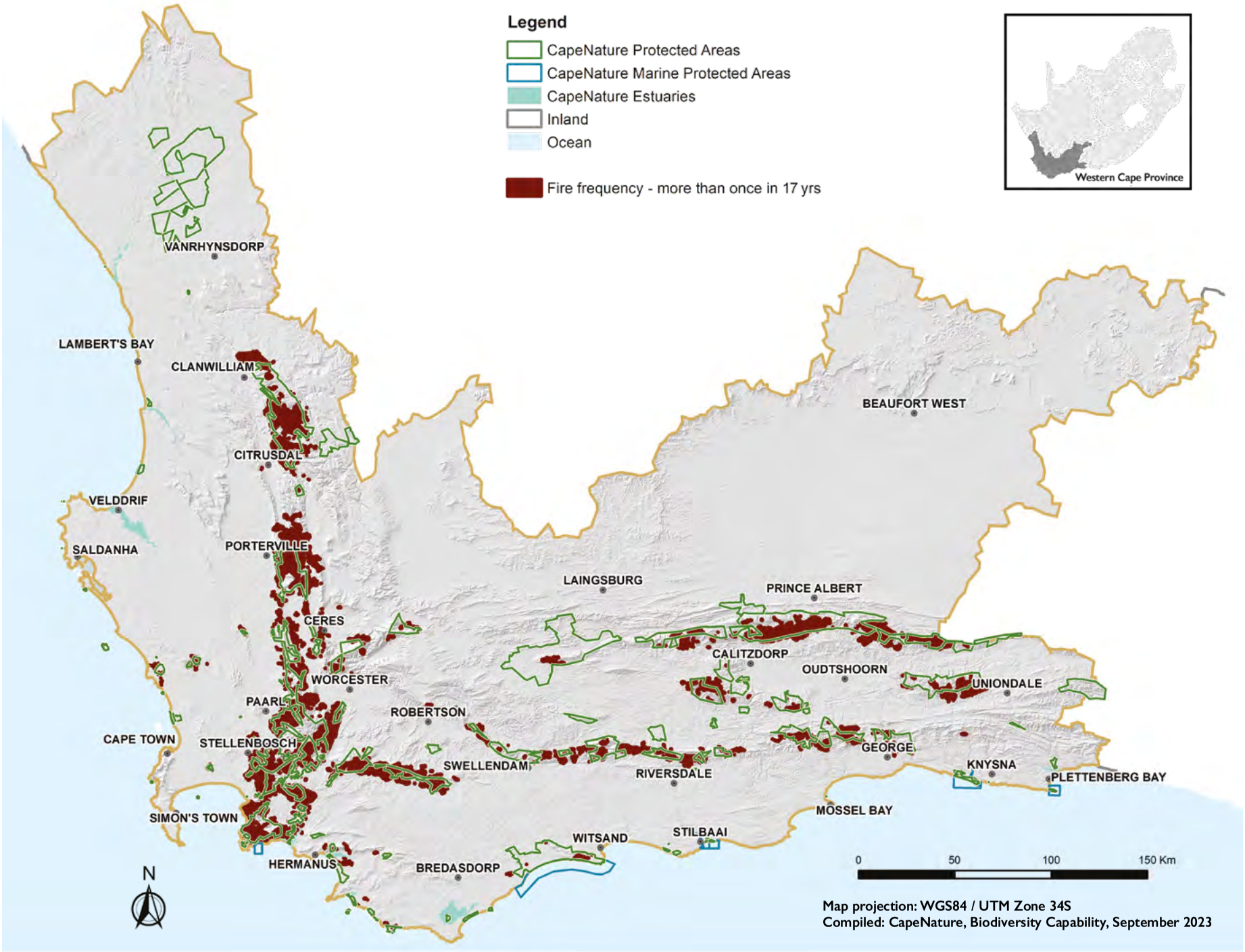



Figure 10.8. Areas burned more than once in the past 17 years (2007-2023).

### 10.2.2 Cause of Fires

The number of fires caused by people (including mechanical causes) per year shows a highly significant positive increasing trend over the period. Mann-Kendall Test: slope = 1.18 %, p <0.001, as shown in Figure 10.9. However, the trend over the last few years (after 2016) shows a decline, although this is not a statistically significant breakpoint, it is an indication that there is a recent relative improvement in the number of anthropogenic ignitions.

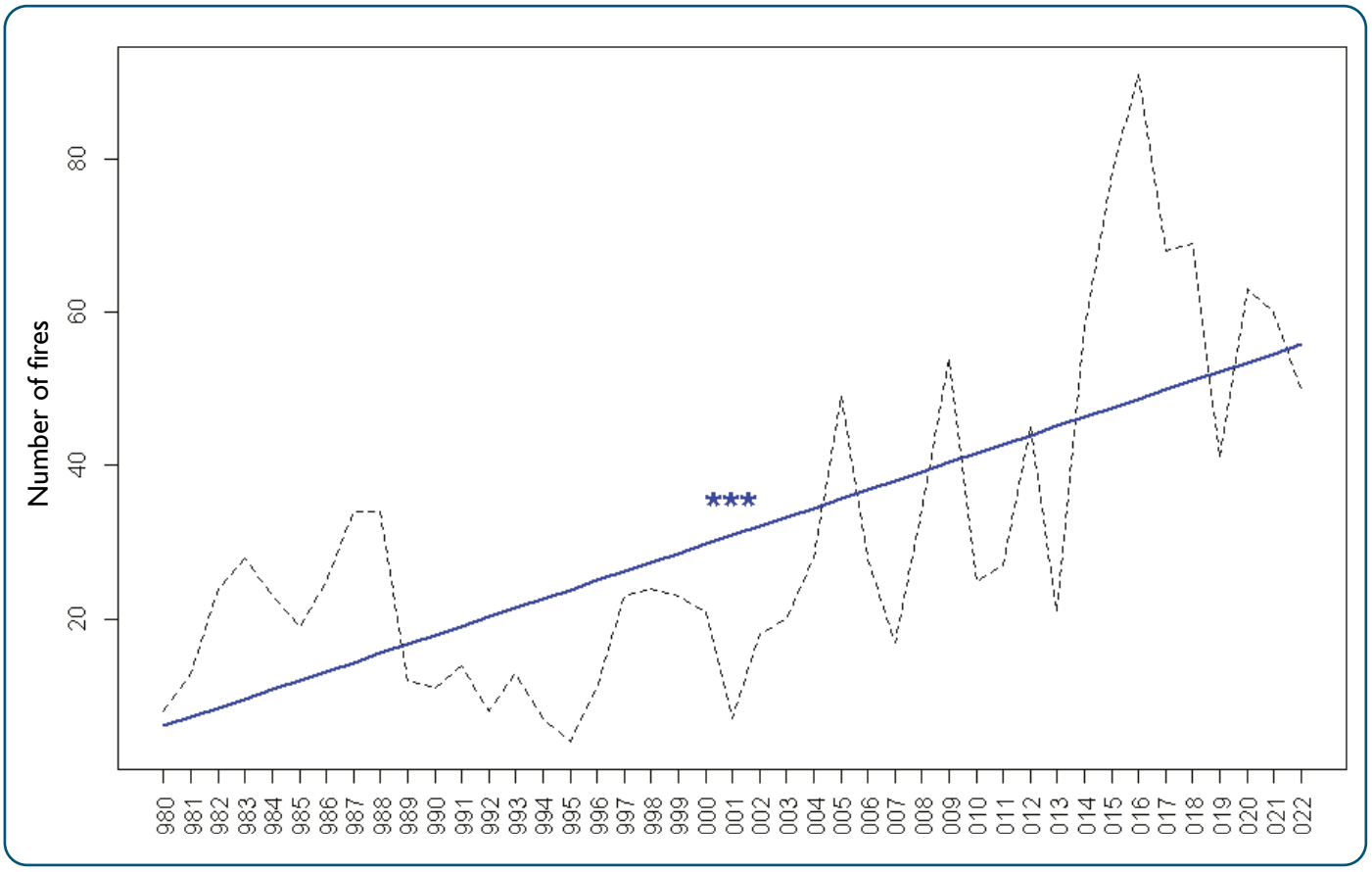



Figure 10.9. Long-term trends (1980 - 2023) in fires caused by people and mechanical causes (mechanical causes included as mechanical equipment operated by people) *Asterisks indicate the highly significant positive upward trend.

## 10.3 DISCUSSION AND RECOMMENDATIONS

Fires, and particularly wildfires, are often scary phenomena that have the potential to cause much harm. However, fire is very much a part of much of the natural history and evolutionary context for the existence and persistence of the fynbos biome.

The percentage of veld within the old age category (>=13 years) is improving which gives us options for future fire management, both for wildfires and importantly, for planned, controlled ecological burns. However, it must be borne in mind that the 13-year cut-off is a generic one that does not accommodate the variation in ideal veld ages across the province. The drier and slower growing areas often require periods more than this to reach full maturity (three years with more than 50 % of reseeding Proteaceae species flowering). For example, the high altitudes of the Boland Mountain Complex require a veld age of around 17 years (Le Maitre *et al.* 1991, CapeNature 2020b) and the drier slopes of the inland Cape Fold Mountains this figure may approach or exceed 20 years (CapeNature 2020b). Ideally, there should be roughly equal proportions of veld in the young, medium plus mature and old categories with the cut-offs appropriate to the vegetation type in each area. Senescent Fynbos (>30 years old) is infrequent across CapeNature Protected Areas.

Over the 1980 to 2023 period there has been a long-term trend of increasing numbers of fires and area burned. However, these statistics have decreased over the last seven years. This indicates that CapeNature is managing towards fewer wildfires totalling a smaller burned are to avoid too much veld within the young age categories and increase area in the older categories. This in turn provides more opportunities for controlled management fires to reduce fuel load where appropriate and rejuvenate fynbos vegetation (van Wilgen & Scott 2001). Gaining control of the fire regime is going to be increasingly important as climate change increases its impacts and as the pressure to gain control of alien plant invasions increases. Given the strong trend in increasing anthropogenic causes of fires this also indicates that CapeNature should continue its fire education and awareness campaigns to prevent unplanned ignitions.

Anysberg Nature Reserve - Gemsbok or
South African Oryx *(Oryx gazella)* © Scott Ramsay

Invasive Alien Species (IAS) are a threat due to their negative impacts on biodiversity, the ability of ecosystems to supply the ecosystems services on which all society depends and directly on people (Pyšek *et al.* 2020, IPBES 2023). This is illustrated by the effects of IAS on reducing water supply form catchments (Le Maitre *et al.* 2019, Le Maitre *et al.* 2020), outcompeting and displacing indigenous species (Clusella-Trullas *et al.* 2017, Zengeya *et al.* 2020) and increasing biomass and therefore fuel loads (van Wilgen & Richardson 1985, van Wilgen & Scott 2001). Given this last-mentioned relationship, it is important to read this chapter in conjunction with the Chapter 10.

Managing the eradication of invasive alien species is one the primary interventions conducted by CapeNature to promote ecosystem restoration. There are at least 344 invasive alien species recorded from the Western Cape (SANBI and CIB 2018, SANBI and CIB 2020).

## 11.1 METHODS

Data accessed for this report covers the period from 2018 – 2023. Data on IAP management (primarily mechanical clearing) was obtained from CapeNature's, Greater Cape Town Water Fund (GCTWF) and Department of Forestry Fisheries and the Environments (DFFE) records on IAP clearing projects which are primarily confined to the Protected Area estate.

### 11.1.1 Invasive Alien Plants Density and Distributions

The mapping of Invasive Alien Plant (IAP) species is done annually, per protected area, managed by CapeNature, according to management compartments (5ha to 2000ha). This type of mapping is called wall-to-wall mapping as it covers the entire reserve. The IAP species density information for the top five dominant species is captured using field-based knowledge of the protected area, visual assessments using digital aerial and satellite imagery, as well as in-field verifications. The information is captured in a standard spreadsheet format that links to a spatial feature for each compartment.

Figure 11.1. Ongoing invasion of Mediterranean Cluster Pines *(Pinus pinaster)* into fynbos are one of the dominant invasive alien plant species in the mountain catchment areas.

### 11.1.2 Invasive Alien Animals' Surveillance and Projects

Information on invasive alien animals was collected from invasive alien animal management projects for feral pig, European Carp (including Mozambique Tilapia) and house mouse and surveillance data on animal presence from CapeNature Protected Areas.

## 11.2 RESULTS

### 11.2.1 Number of Invasive Alien Species (IAS)

There were 193 alien species recorded across all Cape Nature protected areas and all protected areas had at least one alien species. Table 11.1 shows the taxonomic breakdown of the species.

As shown in Figure 11.2 and Figure 11.3, there are greater densities of IAPs in the south-western and southern parts. These areas are dominated by Pines, Hakeas and Australian Acacias which all have the capacity to invade and reach very high densities. Generally, the more arid interior of the Western Cape does not support high densities of IAPs. There are, however, limited areas where species such as *Prosopis sp.* can become locally problematic. Biocontrol for Prosopis is available (a moth in the genus *Evippe*) and is showing promising results (Kleinjan *et al.* 2021).

Table 11.1. Invasive Alien Species recorded in CapeNature Protected Areas as of March 2023.

| Taxonomic grouping | Number of alien species |
|---|---|
| Amphibians | 0 |
| Birds | 4 |
| Terrestrial invertebrates | 4 |
| Microbe | 0 |
| Mammals | 13 |
| Freshwater and terrestrial plants | 155 |
| Reptiles | 2 |
| Freshwater fish | 13 |
| Marine invertebrate | 2 |
| **Total** | **193** |

### 11.2.2 Area and Density of Invasive Alien Plants 2018-2023

Over and above the agencies listed in Table 11.2 below it is interesting to note that volunteer groups cleared nearly 5 300 ha of land per year with estimated labour contributions of ZAR 5.1 million (Jubase *et al.* 2021). Incorporating these willing volunteers and recording their work, so that it can complement official alien clearing is likely to be a fruitful and efficient exercise.

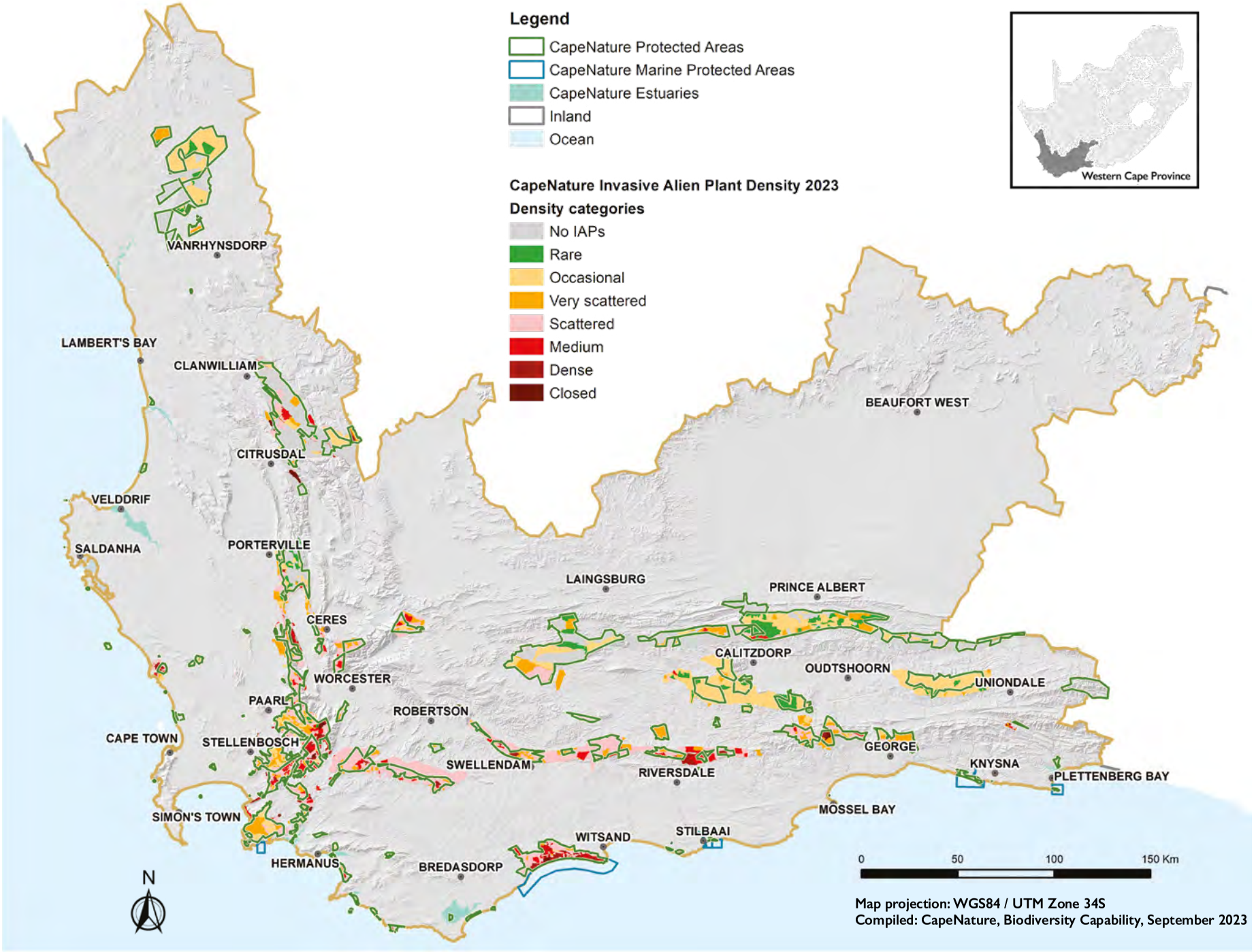



Figure 11.2. Invasive Alien Plant (IAP) densities per compartment in CapeNature protected areas.

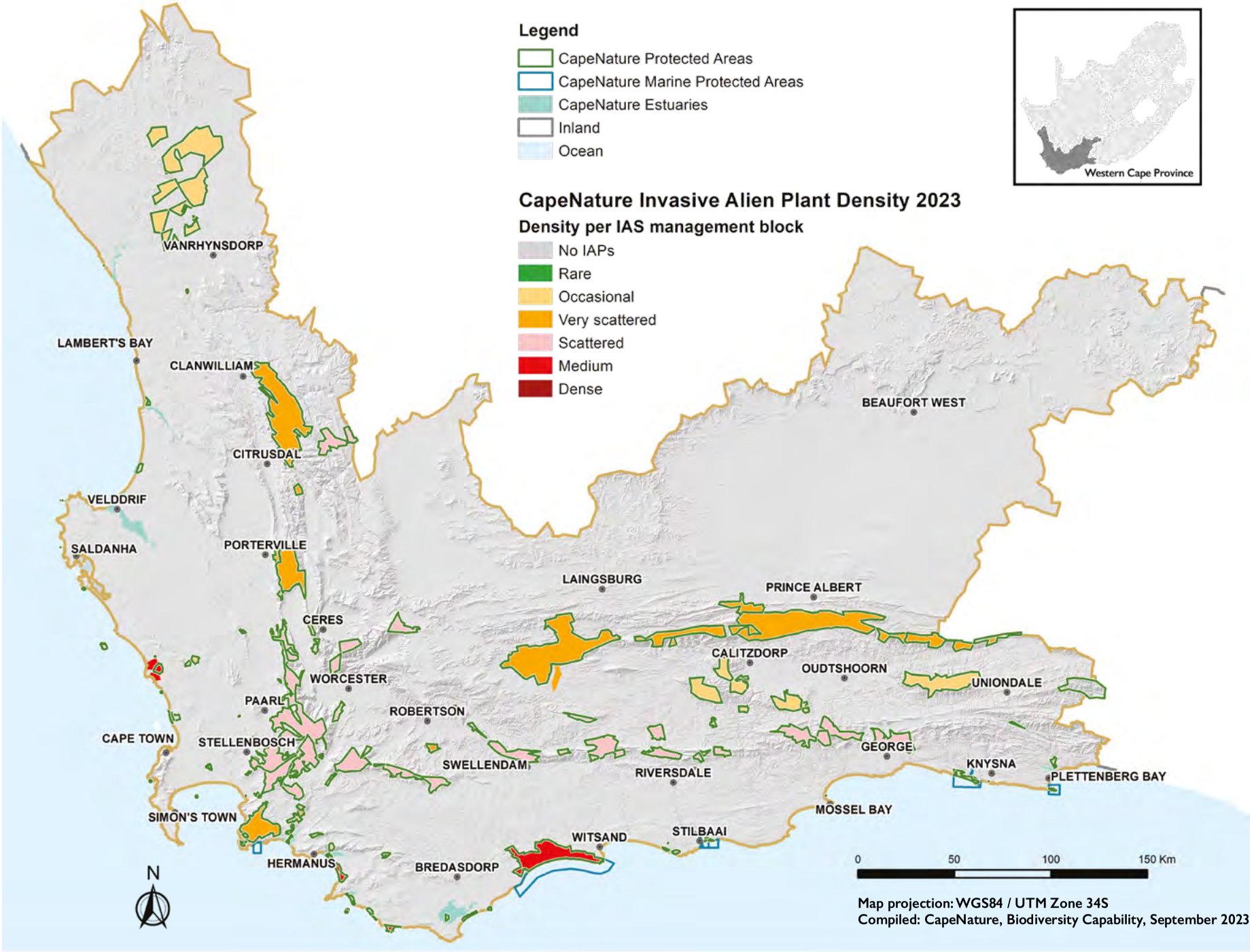



Figure 11.3. Invasive Alien Plant (IAP) densities per CapeNature protected areas (averaged across IAS management compartments).

Table 11.2. Extent in hectares of Invasive Alien Plant clearing per funding source.

| | Year | | | |
|---|---|---|---|---|
| **Funding source** | **2019/20** | **2020/21** | **2021/22** | **2022/23** |
| EPWP | | | | 7 415 |
| DFFE NRM | 35 725 | 11 082 | 1 117 | 4 632 |
| CapeNature | 2 048 | 110 | 0.4 | 509 |
| GCTWF | 5 169 | 8 139 | 18 936 | 12 248 |
| **Total** | **42 943** | **19 331** | **20 053** | **24 804** |

### 11.2.3 Changes, Trends

The change in densities of invasive alien plant species in CapeNature protected areas over the period 2018 to 2023 (Figure 11.4) shows that despite the invasive alien plant programmes carried out on CapeNature protected areas, there are still large proportions of areas that have moderate increases in invasive alien plant density that still exceed the moderate decreases. Moderate and major increases from 2021/2022 to 2022/2023 are also concerning as they take upon the greatest percentage change in 2022/2023.

## 11.3 INVASIVE ALIEN ANIMAL SPECIES

### 11.3.1 Feral Pig

Feral pigs (*Sus scrofa*) are a threat to the remnants of critically endangered renosterveld in the West Coast. CapeNature implemented the Feral Pig Eradication Programme funded by DFFE Natural Resource Management (NRM) Programme in the West Coast area from 2016 to 2018 and then again from April 2020 until March 2023. A total of 526 individuals were killed by the DFFE contractor over the 2020 to January 2023 period.

### 11.3.2 House Mouse

The presence of the house mouse (*Mus musculus*) on Dassen Island is a major concern as they impact on the breeding success and health of many seabirds. (Jones & Ryan 2010; Dilley *et al.* 2016). Research is being done to improve humane mouse control methods whilst recording data for research purposes. The initial results show that GoodNature A24 automated mouse traps are very effective in mouse eradication and at least 201 house mice (with 16 in-field traps) have been humanely killed on Dassen Island using this method from July 2022 to March 2023.

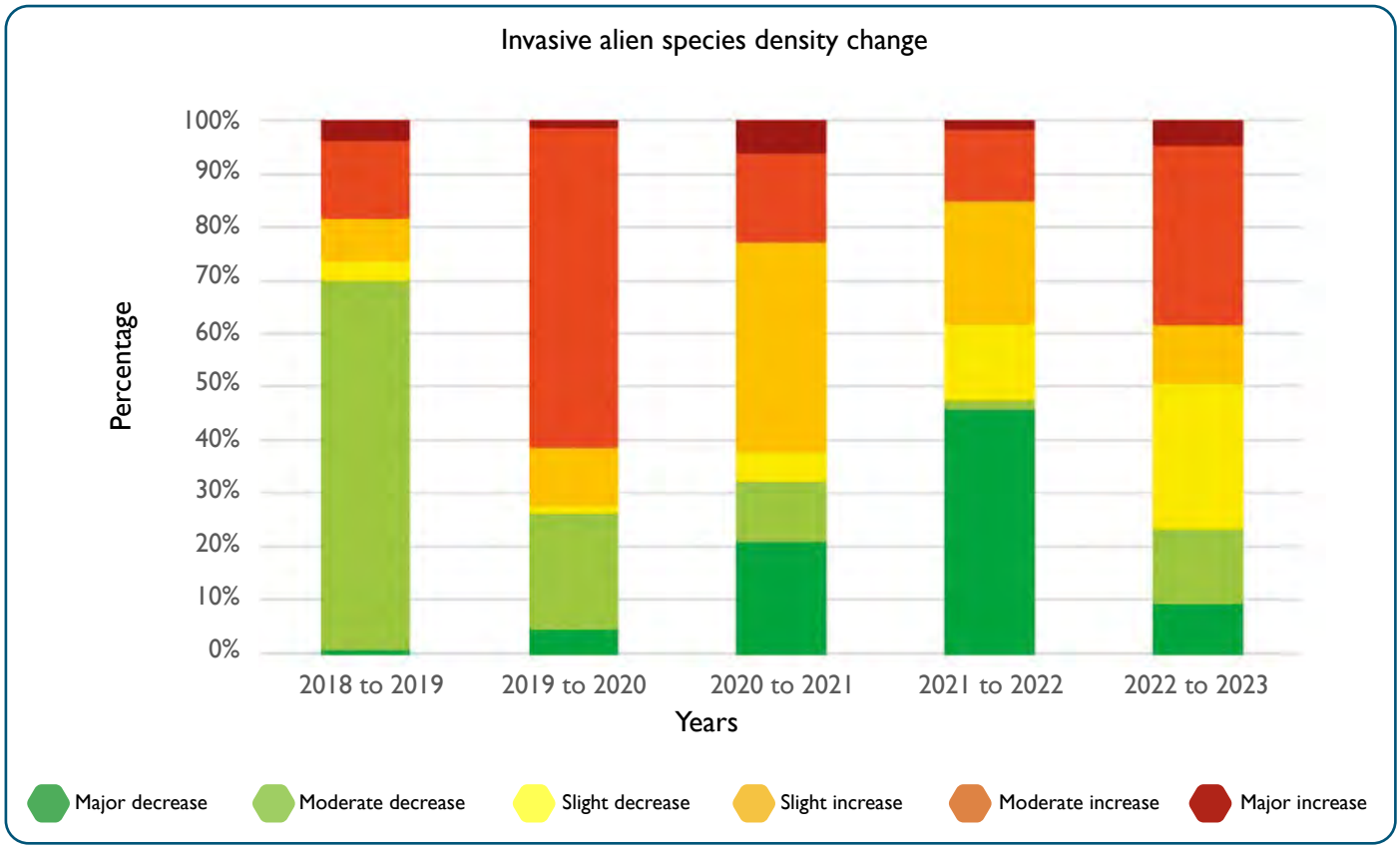



Figure 11.4. Change in Invasive Alien Plant (IAP) density in CapeNature protected areas from 2018 – 2023.

### 11.3.3 Polyphagous Shothole Borer Beetle

The Polyphagous Shothole Borer Beetle (*Euwallacea fornicatus*) has been identified as a major threat to certain indigenous trees in the Western Cape and Nationally (van Rooyen *et al.* 2021). A task team has been established to determine the province's response. The beetle has not been recorded on any of CapeNature Protected Areas even though it continues to spread in the Western Cape (van Rooyen *et al.* 2021). CapeNature has identified vulnerable reserves through tree species composition (e.g., Riverlands Nature Reserve will not be affected due to the Lowland Fynbos shrublands) and is doing regular surveillance and monitoring in priority Protected Areas. CapeNature's policy of no external firewood being brought onto the reserve at tourism sites, since 2020, are one of the methods used to prevent contamination of the Protected Areas.

### 11.3.4 Freshwater Fish

Invasive alien fish are one of the biggest threats to the indigenous freshwater fish and other aquatic animals of the Western Cape (Woodford 2005, Ellender *et al.* 2018, Shelton *et al.* 2014) so managing invasive alien fish is necessary to safeguard indigenous species. The Freshwater Research Centre (FRC) Alien Fish Eradication Project has prioritised the Biedouw and Breekkrans rivers and the FRC has played a pivotal role in alien fish management interventions in these catchments. For the Biedouw catchment, several farm dams were cleared of alien fish (mainly Small-mouth Bass) between 2020-2022 and stocked with young indigenous sandfish from the Biedouw river to enable a head-starting project. These Sandfish were left to grow to a size where they were not considered prey for bass prior to release back into the Biedouw River. In addition, the Goukamma alien fish management project is aimed at managing invasive European Carp at Groenvlei in the Goukamma Nature Reserve. This is to improve water quality as well as restore growth of aquatic plants. A private volunteer completed removal of 1 297 Eurasian Carp totalling 3 287 kg and 144 Mozambique Tilapia from Goukamma's Groenvlei in the 2021/2022 period alone. The removed Carp were utilised as a food source for people in need.

## 11.4 DISCUSSION AND RECOMMENDATIONS

### 11.4.1 Effectiveness

Management to achieve further decreases in IAP density needs to be extended and have less area under increasing densities needs to be improved and maintained. To achieve this, both more effective and efficient (especially for the time component) methods are required to gain control over invasive alien species populations. It is also essential that these operations be conducted at landscape level to reach successful outcomes. It is important to note that evaluation of management interventions can only be done over long-term time windows as regrowth and reinvasion are processes that need to be overcome for effective control. Management options to control invasive alien animals are generally effective but there is a time pressure to achieve successes with these projects as the impacts of invasive alien animals, especially freshwater fish, can be severe.

### 11.4.2 Efficiency

Biocontrol is often a key part of integrated management of invasive alien species operations and can be a very cost-effective way of slowing or, in some instances, eradicating invasive alien species (Zachariades 2017). A strategic approach to improve the coverage of invaded areas by biocontrol is required to fully leverage the additional benefit provided by this cost-effective method that compliments other management interventions. Larger scale studies that investigate the landscape, socio-economic and ecosystem level changes and benefits due to biocontrol for invasive terrestrial plants are still required (Paterson *et al.* 2023).

### 11.4.3 Impacts

There are few formal monitoring or research projects measuring the impact of invasive alien species especially over the longer term, but this situation is improving (SANBI & CIB 2020, Zengeya *et al.* 2020). One of the ways to address this is the establishment of long-term monitoring plots that can measure the presence and density of IAS, indigenous species and record the effects of fire and IAS management practices over time. This type of monitoring is being rolled out in the Hottentots Holland Nature Reserve as part of the Greater Cape Town Water Fund's (GCTWF) monitoring protocol. The initial results from the baseline monitoring indicate that indigenous species richness is lower in invaded plots (Holmes 2022). This kind of monitoring must be expanded across the protected area networks and continued over multiple fire seasons and management operations to yield the kind of information required to accurately assess long-term impacts and management effectiveness.

### 11.4.4 Pathways

The pathways used by IAS to establish and invade are important to monitor and understand to minimise the probability of new IAS establishing and spreading. Unfortunately, this is another challenging process to get useful information on (Faulkner *et al.* 2015). A review of the pathways at national level is provided by Faulkner *et al.* (2020) and others, where they highlight the challenges to managing these pathways and note that for most of these pathways no measures are in place to prevent the introduction of alien species.

### 11.4.5 Research

Remote sensing is critical to solve the problem of long-term repeat reliable IAP density and distribution data. Substantial progress has been made in demonstrating that this is technically feasible (Slingsby *et al.* 2020, Holden *et al.* 2021, Mtengwana *et al.* 2021, Rebelo *et al.* 2021). Research is required to advise on methods for both the detection and control of Polyphagous Shothole Borer Beetle.

### 11.4.6 Funding

CapeNature is developing a new funding and operational model with the Department of Forestry, Fisheries, and the Environment (DFFE) – Environmental Programme in the upcoming funding cycle. DFFE Environment Programme recognise CapeNature as an entity and based on this this principle, CapeNature has entered funding negotiations for invasive alien plant clearing. This approach is new to the previous funding cycle where CapeNature had to bid for funding. The DFFE Environment Programme operates on a five-year funding cycle but sign three-year agreements with entities. CapeNature will appoint fixed-term employees (FTE's) for the duration of the three-year agreement. Teams will be placed at strategic protected areas aligned with the strategic water source areas. Maintaining funding for continuous operation of invasive alien management projects is critical to the success of these projects (e.g., Davies *et al.* 2020) and the new funding mechanisms and partnerships (see below) aim to address this critical aspect.

### 11.4.7 Partnerships and Collaborations for Scaling up Impacts

Partnerships are critical to the success of invasive alien species management. Invasive alien species are by their very nature capable of movement across landscapes, and control in one area whilst there is no or insufficient control in an adjacent area leads to reinvasion. This is particularly a challenge in the rugged terrain of the Cape Fold Mountains.

This means that planning and management needs to span ownership and management borders for effective control. Partnerships that involve all the role players responsible for land management from landowners, farmers, municipalities, conservation agencies, NGOs and national agencies are required to effect success at the scale commensurate with the scale of the invasive alien species problem. To this end CapeNature is actively involved in GCTWF and the newly established Boland-Groot Winterhoek Strategic Water Source Areas Collective which both expand collaborative planning, implementation, and reporting on improved catchment management.

Kogelberg Nature Reserve
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# ANNEXURE 1: PUBLICATIONS

CapeNature employees, author and co-author scientific and semi-scientific publications, contribute to chapters in books and technical reports and give presentations at provincial, national, and international conferences, and symposia. Between 2017 and March 2023, CapeNature employees contributed to 107 Publications and Presentations.

These contributions were in the form of Peer-reviewed Scientific Articles (32); Published Science-based Assessments (6); Scientific Reports, Book Reviews and Theses (8); Books, Guides, Chapters in Books and published semi-scientific outputs (8); Oral Presentations at International and National Symposia and Conferences (53 presentations).

The list below includes papers that have been printed in peer-reviewed scientific publications or formal presentations delivered at national or international conferences or symposia where a peer review process applies for acceptance of presentations. (Names of CapeNature employees are indicated in bold text).

Table Annexure 1. CapeNature* Contributions to Publications and Presentations: 2017** to 2023

** Excluding publications and presentations represented/listed in the 2017 State of Biodiversity Report

| Year | Reference | Journal / Book / Conference |
|---|---|---|
| PEER REVIEWED SCIENTIFIC ARTICLES | | |
| 2023 | Angus O, **Turner AA**, and Measey J. 2023. In a rough spot: Declines in *Arthroleptella rugosa* calling densities are explained by invasive pine trees. Austral Ecology: 498-512. https://doi.org/10.1111/aec.13273 | Austral Ecology |
| | Kajee M, Henry DA, Dallas HF, Griffiths CL, Pegg J, an der Colff D, **Impson D**, Chakona A, Raimondo DC, Job NM, Paxton BR, **Jordaan MS**, Bills R, Roux F, Zengeya TA, Hoffman A, Rivers-Moore N and Shelton JM. 2023. How the Freshwater Biodiversity Information System (FBIS) is supporting national freshwater fish conservation decisions in South Africa. Frontiers in Environmental Science, 1122223. https://doi.org/10.3389/fenvs.2023.1122223 | Frontiers in Environmental Science |
| | Russo IM, de Jage D, van Wyk AM, Klopper AW, Uiseb K, **Birss C**, Rushworth I, and Bloomer P. 2023. The Contribution of Digital Sequence Information to Conservation Biology: A Southern African Perspective. Advanced Genetics: https://doi.org/10.1002/ggn2.202200032 | Advanced Genetics |
| 2022 | Cerrilla C, Afrika J, **Impson D**, **Jordaan MS,** Kotze N, Paxton BR, Reed C, Schumann M, an der Walt JA, and Shelton JM. 2022. "Rapid population decline in one of the last recruiting populations of the endangered Clanwilliam sandfish (Labeo seeberi): The role of non-native species and other environmental factors". Aquatic Conservation: Marine and Freshwater Ecosystems. Published online 14/02/2022. https://doi.org/10.1002/aqc.3785 | Aquatic Conservation: Marine and Freshwater Ecosystems |
| | Chakona A, **Jordaan MS,** Raimondo DC, Bills R, Skelton P and Van der Colff D. 2022. "Diversity, distribution and extinction risk of native freshwater fishes of South Africa". Journal of Fish Biology. Published online 20/03/2022. https://doi.org/10.1111/jfb.15011 | Journal of Fish Biology |
| | Harper JRM, an Wilgen NJ, **Turner AA**, Tolley KA, Maritz B, Clusella-Trullas S, Da Silva JM, Cunningham SJ, Cheney C, De Villiers AL, Measey J and Foden W. 2022. Application of a trait-based climate change vulnerability assessment to determine management priorities at protected area scale. Conservation Science and Practice. e12756. https://doi.org/10.1111/csp2.12756 | Conservation Science and Practice |
| | MacFadyen S, Allsopp N, Altwegg R, Archibald S, Botha J, Bradshaw K, Carruthers J, De Klerk H, De Vos A, Distiller G, Foord S, Freitag-Ronaldson S, Gibbs R, Hamer M, Landi P, MacFadyen D, Manuel J, Midgley G, Moncrieff G, Munch Z, Mutanga O, Nenguda R, Ngwenya M, Parker D, Peel M, Power J, Pretorius J, Ramdhani S, Robertson M, Rushworth I, Skowno A, Slingsby J, **Turner AA**, Visser V, Van Wageningen G and Hui C. 2022. Drowning in data, thirsty for information and starved for understanding: A biodiversity information hub for cooperative environmental monitoring in South Africa. Biological Conservation Volume 274: 109736, ISSN 0006-3207. https://doi.org/10.1016/j.biocon.2022.109736 | Biological Conservation |

| Year | Reference | Journal / Book / Conference |
|---|---|---|
| 2021 | Seleteng-Kose L, Kobisi K, **Pool-Stanvliet R** and Mohapi K. 2021. 'A rapid biodiversity assessment of Lesotho's first proposed Biosphere Reserve: a case study of Bokong Nature Reserve and Tšehlanyane National Park', Bothalia 51(2), a6. http://dx.doi.org/10.38201/btha.abc.v51.i2.6 | Bothalia: African Biodiversity & Conservation |
| 2020 | Chakona A, Gouws G, Kadye WT, **Jordaan MS** and Swartz ER. 2020. Reconstruction of the historical distribution ranges of imperilled stream fishes from a global endemic hotspot based on molecular data: Implications for conservation of threatened taxa. Aquatic Conservation: Marine and Freshwater Ecosystems 30:144–158. https://doi.org/10.1002/aqc.3251 | Aquatic Conservation: Marine and Freshwater Ecosystems |
| | Dalu T, Bellingan T, Khosa D, **Gouws J, Impson D, Jordaan MS**, Marr SM, Mofu L, Schumann M, Slabbert E, Van der Walt R, Wasserman RJ and Weyl OLF. 2020. "Ecosystem responses to the eradication of common carp *Cyprinus carpio* using rotenone from a reservoir in South Africa". Aquatic Conservation: Marine and Freshwater Ecosystems. 30(12):2284-2297. https://doi.org/10.1002/aqc.3463 | Aquatic Conservation: Marine and Freshwater Ecosystems |
| | Davies SJ, Bell JA, **Impson D**, Mabin C, Meyer M, Rhoda C, Stafford L, Stephens K, Tafeni M, **Turner AA**, Van Wilgen NJ, Wilson JRU, Wood J and Measey GJ. 2020. Coordinating invasive alien species management in a biodiversity hotspot. The CAPE Invasive Alien Animals Working Group. Bothalia 50: a10. http://dx.doi.org/10.38201/btha.abc.v50.i1.10 | Bothalia |
| | Jackson M, Fourie H, Dalu T, Woodford D, Wasserman R, Zengeya TA, Ellender B, Kimberg P, **Jordaan MS**, Chimimba C and Weyl OLF. 2020. Food web properties vary with climate and land use in South African streams. Functional Ecology. 34:1653–1665. https://doi.org/10.1111/1365-2435.13601 | Functional Ecology |
| | **Jordaan MS**, Chakona A and Van der Colff D. 2020. Protected Areas and Endemic Freshwater Fishes of the Cape Fold Ecoregion: Missing the Boat for Fish Conservation? Frontiers in Environmental Science. 8:502042. https://doi.org/10.3389/fenvs.2020.502042 | Frontiers in Environmental Science |
| | **Pool-Stanvliet R** and Coetzer K. 2020. The scientific value of UNESCO biosphere reserves. South African Journal of Science, 2020;116(1/2), Art. #7432, 4 pages. https://doi.org/10.17159/sajs.2020/7432 | South African Journal of Science |
| | Somers MJ, Walters M, Measey J, Strauss WM, **Turner AA**, Venter JA, Nel L, Kerley GIH, Taylor WA and Moodley Y. 2020. The implications of the reclassification of South African wildlife species as farm animals. South African Journal of Science 116: https://doi.org/10.17159/sajs.2020/7724 | South African Journal of Science |
| 2019 | Bellingan TA, Hugo S, Woodford DJ, **Gouws J**, Villet MH and Weyl OLF. 2019. Rapid recovery of macroinvertebrates in a South African stream treated with rotenone. Hydrobiologia, Published Online, https://www.doi.org/10.1007/s10750-019-3885-z | Hydrobiologia |
| | Child MF, Nel L, Sellier SAJ, Power J, **Birss C**, Radloff FGT, Taylor A, Davies-Moster H, Okes N, Mallon D and Hoffman M. 2019. A framework to measure the wildness of managed large vertebrate populations. Conservation Biology, 33(5), pp.1106-1119. https://doi.org/10.1111/cobi.13299 | Conservation Biology |
| | Kotzé A, Smith RM, Moodley Y, **Birss C**, Grobler JP and Dalton DL. 2019. Lessons for conservation management: monitoring temporal changes in genetic diversity of Cape mountain zebra (*Equus zebra zebra*). PLOS One 14(7): e0220331. https://doi.org/10.1371/journal.pone.0220331 | PLOS One |
| | Measey GJ, Tarrant J, Rebelo A, **Turner AA**, Du Preez L, Mokhatla M and Conradie W. 2019. Has strategic planning made a difference to amphibian conservation research in South Africa? African Biodiversity & Conservation: Bothalia 49: https://doi.org/10.4102/abc.v49i1.2428 | Bothalia: African Biodiversity & Conservation |
| | Measey GJ, Tarrant J, **Turner AA,** Du Preez L, Mokhatla M, Channing A and Raimondo DC. 2019. SA-FRoG group. Has strategic planning made a difference to amphibian conservation research in South Africa? African Biodiversity & Conservation: Bothalia. https://hdl.handle.net/10520/EJC-197482ccba | Bothalia: African Biodiversity & Conservation |
| | Tolley KA, Weeber J, Maritz B, Verburgt L, Bates MF, Conradie W, Hofmeyr MD, **Turner AA**, Da Silva JM and Alexander GJ. 2019. No safe haven: Protection levels show imperilled South African reptiles not sufficiently safe-guarded despite low average extinction risk. Biological Conservation 233:61-72. https://doi.org/10.1016/j.biocon.2019.02.006 | Biological Conservation |

| Year | Reference | Journal / Book / Conference |
|---|---|---|
| 2018 | Dudley N, Hockings M, Stolton S, Amend T, Badola R, Bianco M, Chettri N, Cook CN, Day JC, Dearden P, Edwards M, Ferraro P, Foden W, Gambino R, Gaston KJ, **Hayward NA**, Hickey , Irving J, Jeffries B, Karapetyan A, Kettunen M, Laestadius L, Laffoley D, Lham D, Lichtenstein G, Makombo J, Marshall N, McGeoch M, Nguyen D, Nogué S, Paxton M, Rao M, Reichelt R, Rivas J, Roux D, Rutte C, Schreckenberg K, Sovinc A, Sutyrina S, Utomo A, Vallauri D, Vedeld PO, Verschuuren B, Waithaka J, Woodley S, Wyborn C and Zhang Y. 2018. Priorities for protected area research. PARKS 24 (1): 35-50. https://doi.org/10.2305/IUCN.CH.2018.PARKS-24-1ND.en | PARKS: The International Journal of Protected Areas and Conservation |
| | Marr SM, Gouws G, Avlijas S, Khosa D, **Impson D**, Van der Westhuizen M and Weyl OLF. 2018. Record of Blue tilapia *Oreochromis aureus* in the Eerste River catchment, Western Cape Province, South Africa. African Journal of Aquatic Sciences pp 187-193. https://doi.org/10.2989/16085914.2018.1455576 | African Journal of Aquatic Science |
| | Rhodin AGJ, Stanford CB, Van Dijk PP, Eisemberg C, Luiselli L, Mittermeier RA, Hudson R, Horne BD, Goode EV, Kuchling G, Walde A, **Baard EHW**, Berry, KH, Bertolero A, Blanck TEG, Bour, R, Buhlmann KA, Cayot LJ, Collett S, Currylow A, Das I, Diagne T, Ennen JR, Forero-Medina G, Frankel MG, Fritz U, García G, Whitfield Gibbons J, Gibbons PM, Shiping G, Guntoro J, Hofmeyr MD, Iverson JB, Kiester AR, Lau M, Lawson DP, Lovich JE, Moll EO, Páez VP, Palomo-Ramos R, Platt K, Platt SG, Pritchard PCH, Quinn HR, Rahman SC, Randrianjafizanaka ST, Schaffer J, Selman W, Shaffer HB, Sharma DSK, Haitao S, Singh S, Spencer R, Stannard K, Sutcliffe S, Thomson S and Vogt RC. 2018. Global Conservation Status of Turtles and Tortoises (Order Testudines). Chelonian Conservation and Biology 17(2):135-161. https:/doi.org/10.2744/CCB-1348.1 | Chelonian Conservation and Biology |
| | Russo IM, Hoban S, Bloomer P, Kotze A, Segelbacher G, Rushworth I, **Birss C** and Bruford M. 2018. Intentional Genetic Manipulation as a conservation threat Conservation Genetics Resources. https://doi.org/10.1007/s12686-018-0983-6 | Conservation Genetics Resources |
| | Van der Walt R, Marr S, **Wheeler M**, **Impson D**, Garrow C and Weyl OLF. 2018. Successful mechanical eradication of spotted bass (*Micropterus punctulatus* (Rafinesque, 1819)) from a South African river. Aquatic Conservation: Marine and Freshwater Ecosystems. https://doi.org/10.1002/aqc.3035 | Aquatic Conservation: Marine and Freshwater Ecosystems |
| 2017 | **Jacobs LEO**, Richardson DM, Lepschi BJ and Wilson JRU. 2017. Quantifying errors and omissions in alien species lists: The introduction status of *Melaleuca* species in the South Africa as a case study. NeoBiota 32: 89-105. Online reference: https://doi.org/10.3897/neobiota.32.9842 | NeoBiota |
| | Novellie P, **Birss C,** Cowell C, Kerley GIH, Peinke D, Pfab M, Sellier J and Zimmerman D. 2017. Adaptive governance for Cape mountain zebra, can it work? African Journal of Wildlife Research Vol. 47, No. 2. https://doi.org/10.3957/056.047.0079 | African Journal of Wildlife Research |
| | **Pool-Stanvliet R**, Stoll-Kleemann S and Giliomee JHG. 2017. Criteria for Selection and Evaluation of Biosphere Reserves in support of the UNESCO MAB Programme in South Africa. Land Use Policy. https://doi.org/10.1016/j.landusepol.2018.02.047 | Land Use Policy |
| | Russo IM, Hoban S, Bloomer P, Kotze A, Segelbacher G, Rushworth I, **Birss C** and Bruford M. 2017. Intentional Genetic Manipulation as a conservation threat. Conservation Letters. https://doi.org/10.1007/s12686-018-0983-6 | Conservation Letters |
| | Shelton J, Weyl OLF, Chakona A, Ellender B, Esler K, **Impson D**, **Jordaan MS**, Marr S, Ngobela T, Van der Walt JA, Paxton BR, and Dallas H. 2017. Vulnerability of Cape Fold Ecoregion to climate change and other human impacts. Aquatic Conservation: Marine and Freshwater Ecosystems. https://doi.org/10.1002/aqc.2849 | Aquatic Conservation: Marine and Freshwater Ecosystems |
| | Van Wyk AM, Dalton DL, Hoban S, Bruford MW, Russo IM, **Birss C,** Grobler P, Van Vuuren BJ, and Kotzé A. 2017. Quantitative evaluation of hybridization and the impact on biodiversity conservation. Ecology and Evolution, 7: 320–330. https://doi.org/10.1002/ece3.2595 | Ecology and Evolution |

| Year | Reference | Journal / Book / Conference |
|---|---|---|
| PUBLISHED SCIENCE-BASED ASSESSMENTS | | |
| 2018 | Hofmeyr MD and **Baard EHW.** 2018. *Psammobates geometricus*. The IUCN Red List of Threatened Species 2018: e.T18398A111553007. http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T18398A111553007.en | IUCN Tortoise Species Assessment |
| | Hofmeyr MD, Leuteritz T and **Baard EHW.** 2018. *Psammobates tentorius ssp. trimeni*. The IUCN Red List of Threatened Species 2018: e.T121936835A121936853. http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T121936835A121936853.en | IUCN Tortoise Species Assessment |
| | Hofmeyr MD, Leuteritz T and **Baard EHW**. 2018. *Psammobates tentorius*. The IUCN Red List of Threatened Species 2018: e.T170524A115656793. http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T170524A115656793.en | IUCN Tortoise Species Assessment |
| | Hofmeyr MD, Loehr JT and **Baard EHW.** 2018. *Chersobius signatus*. The IUCN Red List of Threatened Species 2018: e.T10241A115650943. http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T10241A115650943.en | IUCN Tortoise Species Assessment |
| | Hofmeyr MD, Loehr JT, **Baard EHW** and Juvik JO. 2018. *Chersobius boulengeri*. The IUCN Red List of Threatened Species 2018: e.T170521A115656360. http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T170521A115656360.en | IUCN Tortoise Species Assessment |
| | **Turner AA** and Marais J. 2018. Regional Red Assessments for Families Crocodylia and Colubridae (19 taxa). The IUCN Red List of Threatened Species 2018 | IUCN Species Assessment |
| BOOKS / GUIDES / CHAPTERS IN BOOKS | | |
| 2023 | **Jordaan MS**, Shelton J, Chakona A and Van der Colff D. 2023. Under water and out of sight: the hidden world of the threatened freshwater fishes of the Cape Fold Ecoregion. In: Sethusa T, Dalton DL and Pretorius C. 2022. South African animals at risk of extinction. South African National Biodiversity Institute. | South African Animals at Risk of Extinction |
| 2021 | Day J, **Cleaver-Christie G**, Day L and Stafford L. 2021. Water and the natural environment: biodiversity and urban water management. In: Swatuk LA, Brill G, Büchner-Marais C, Carden K, Conradie E, Day J, Fatch J, Fell J, Hara M and Ncube B. (eds). 2021. Towards the Blue-Green City: Building Urban Water Resilience. WRC Report no. SP 153/21. ISBN 978-0-6392-0317-1 | Water Research Council Report no. SP 153/21 |
| 2020 | Davies SJ, **Jordaan MS**, Karsten M, Terblanche JS, **Turner AA**, Van Wilgen NJ, Veldtman R, Zengeya TA and Measey GJ. 2020. Chapter 22: Experience and lessons from invasive and alien animal control projects carried out in South Africa. In: Van Wilgen BW. (ed.). 2020. Biological Invasions in South Africa, Invading Nature - Springer Series in Invasion Ecology 14. https://doi.org/10.1007/978-3-030-32394-3_22 | Invasion Ecology |
| 2019 | **Pool-Stanvliet R** and Coetzer-Hanack K. 2019. Innovative implementation of the UNESCO MAB Programme in South Africa towards the advancement of sustainable landscapes. Country chapter in: Reed MR and Price MF. (eds). 2019. UNESCO Biosphere Reserves: Supporting Biocultural Diversity, Sustainability and Society. UNESCO | UNESCO Biosphere Reserves |
| 2018 | **Pool-Stanvliet R**, Giliomee JHG, Stoll-Kleemann S and Pienaar R. 2018. The UNESCO MAB Programme: Linking natural and cultural capital towards sustainable landscape management. Pp. 205-213, In: Paracchini ML, Zingari PC and Blasi C. (eds). 2018. Reconnecting Natural and Cultural Capital. Contributions from Science and Policy. Italy: Italian Ministry of Environment, Land and Sea. | Science and Policy |
| SCIENTIFIC REPORTS / BOOK REVIEWS / THESES | | |
| 2019 | Job N, Van Deventer H, Smith-Adao L, Petersen C, Van der Colff D, **Impson D**, Samways MJ, Tarrant J, Masemola C, Grundling P-L, Collins N, Sherman P, Snaddon K, Ghente B, Walters D, Terarai F, McCann K and Ghente B. 2019. Chapter 9: Responses to Pressures in the Inland Aquatic Realm, in Van Deventer *et al.* 2019. South African National Biodiversity Assessment 2018: Technical Report. Volume 2b: Inland Aquatic (Freshwater) Realm. CSIR report number CSIR/NRE/ECOS/IR/2019/0004/A. South African National Biodiversity Institute, Pretoria. https://1nq.com/I7PQH | CSIR Report |
| | Van Der Colff D, Raimondo DC, Chakona KA, Child M, Fizziotti B, **Impson D**, **Jordaan MS**, Kubheka S, Measey J, Mtshali HM, Retief E, Roux F, Roxburgh L, Samways MJ, Sieben E, Taylor M, Tolley K A, Von Staden L, Weeber J and Weyl OLF. 2019. Chapter 7: Inland Aquatic Indigenous Freshwater Species Assessments, in: Van Deventer *et al.* 2019. South African National Biodiversity Assessment 2018: Technical Report. Volume 2b: Inland Aquatic (Freshwater) Realm. CSIR report number CSIR/NRE/ECOS/IR/2019/0004/A. South African National Biodiversity Institute, Pretoria. https://1nq.com/I7PQH | CSIR Report |

| Year | Reference | Journal / Book / Conference |
|---|---|---|
| | Van Deventer H, Collins NB, Genthe B, Grundling P-L, Grundling A, Grenfell M, Hill L, **Impson D**, Lötter M, Petersen C, Smith-Adao LB, Snaddon K, Tererai F, Van der Colff D and Van Rensburg S. 2019. Chapter 4: Pressures on the Inland Aquatic Realm, in Van Deventer *et al.* 2019. South African National Biodiversity Assessment 2018: Technical Report. Volume 2b: Inland Aquatic (Freshwater) Realm. CSIR report number CSIR/NRE/ECOS/IR/2019/0004/A. South African National Biodiversity Institute, Pretoria. https://11nq.com/I7PQH | CSIR Report |
| | Van Deventer H, Collins NB, Genthe B, **Impson D**, Petersen C, Raimondo DC, and Van der Colff D. 2019. Chapter 10: Key findings for the Inland Aquatic Realm, in: Van Deventer *et al.* 2019. South African National Biodiversity Assessment 2018: Technical Report. Volume 2b: Inland Aquatic (Freshwater) Realm. CSIR report number CSIR/NRE/ECOS/IR/2019/0004/A. South African National Biodiversity Institute, Pretoria. http://hdl.handle.net/20.500.12143/6230 | CSIR Report |
| | Van Deventer H, Smith-Adao L, Collins NB, Grenfell M, Grundling A, Grundling P-L, **Impson D,** Job N, Lötter M, Ollis D, Petersen C, Scherman P, Sieben E, Snaddon K, Tererai F and Van der Colff D. 2019. South African National Biodiversity Assessment 2018: Technical Report. Volume 2b: Inland Aquatic (Freshwater) Realm. CSIR report number CSIR/NRE/ECOS/IR/2019/0004/A. South African National Biodiversity Institute, Pretoria. https://11nq.com/I7PQH | CSIR Report |
| 2018 | Khomenko S, Abolnik C, Roberts L, **Waller L**, Shaw K, Monne I, Taylor J, Dhingra M, Pittiglio C, Mugyeom M, Roche X, Fredrick K, Kamata A, Okuthe S, Kone S, Wiersma L, Von Dobschuetz S, Soumare B, Makonnen Y, Morzaria S and Lubroth J. 2018. 2016–2018 Spread of H5N8 highly pathogenic avian influenza (HPAI) in sub-Saharan Africa: epidemiological and ecological observations. FOCUS ON, No. 12, Aug 2018. Rome | Food and Agriculture Organisation of the United Nations, FOCUS ON, No. 12 |
| | **Pool-Stanvliet R**, Carlisle J and Vise C. 2018. Contribution of the UNESCO MAB Programme to Sustainable Development in South Africa. Proceedings, Women in Science Without Borders (WiSWB): Resilience in Diversity. ISBN: 978-0-620-78656-0 | Resilience in Diversity |
| 2017 | **Jacobs LEO**. 2017. An assessment of *Melaleuca* as invasive species in South Africa. (MSc Thesis). Stellenbosch University, Stellenbosch | MSc Thesis |
| SEMI-SCIENTIFIC | | |
| 2019 | **Impson D** and **Henning S**. 2019. Rivers of importance to fish conservation in the Berg Water Management Area and associated Management Issues. CapeNature | Popular Article on CapeNature Website |
| 2018 | **Birss C**, Cowell C, **Hayward NA**, Peinke D, Hrabar HH and Kotze A. 2018. Biodiversity Management Plan for the Cape mountain zebra in South Africa. GOVERNMENT GAZETTE, 16 March 2018 No. 41498 | GOVERNMENT GAZETTE |
| 2017 | Cowell C and **Birss C.** 2017. Biodiversity Management Plan for Bontebok in South Africa. GOVERNMENT GAZETTE. | GOVERNMENT GAZETTE |
| ORAL PRESENTATIONS AT SYMPOSIA / CONFERENCES NATIONAL | | |
| 2023 | **Baard EHW** and **Turner AA.** Ten years of protected area expansion in the Western Cape: more permanent space for tortoises and terrapins? 15th Conference of the Herpetological Association of Africa, Hoedspruit, South Africa. | 15th Conference of the Herpetological Association of Africa |
| | **Jordaan MS**, Chakona A, Kadye W and De Villiers MS. 2023. A review of historical and present freshwater fish distributions of the Gouritz River system, South Africa. South African Society for Aquatic Science (SASAqS) conference, 25-28 June 2023, Lord Charles Hotel, Somerset West, Western Cape. | Southern African Society of Aquatic Science Conference |
| | Tarrant J, Armstrong A, Acker-Cooper C, Roxburgh L, Weeber J, **Turner AA**, Lynch A and Lynch K. 2023. Croaks, Chirps and Clumps: Long-term monitoring and surveillance efforts for priority South African threatened frog species. 15th Conference of the Herpetological Association of Africa, Hoedspruit, South Africa. | 15th Conference of the Herpetological Association of Africa |
| | **Turner AA**. 2023. Lessons from 18+ years of monitoring fynbos frog populations. Oral presentation delivered at the 15th Conference of the Herpetological Association of Africa, Hoedspruit, South Africa. | 15th Conference of the Herpetological Association of Africa |
| 2022 | **De Villiers M, Jacobs LEO and Jordaan MS.** 2022. CapeNature's Species Prioritization Framework - a monitoring and surveillance decision support tool. The Conservation Symposium, 31 October 2022, Virtual Webinar via Zoom. | Conservation Symposium |

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|---|---|---|
| 2017 | **Jacobs LEO**. 2017. An assessment of *Melaleuca* as invasive species in South Africa. (MSc Thesis). Stellenbosch University, Stellenbosch | MSc Thesis |
| SEMI-SCIENTIFIC | | |
| 2019 | **Impson D** and **Henning S**. 2019. Rivers of importance to fish conservation in the Berg Water Management Area and associated Management Issues. CapeNature | Popular Article on CapeNature Website |
| 2018 | **Birss C**, Cowell C, **Hayward NA**, Peinke D, Hrabar HH and Kotze A. 2018. Biodiversity Management Plan for the Cape mountain zebra in South Africa. GOVERNMENT GAZETTE, 16 March 2018 No. 41498 | GOVERNMENT GAZETTE |
| 2017 | Cowell C and **Birss C.** 2017. Biodiversity Management Plan for Bontebok in South Africa. GOVERNMENT GAZETTE. | GOVERNMENT GAZETTE |
| ORAL PRESENTATIONS AT SYMPOSIA / CONFERENCES INTERNATIONAL | | |
| 2018 | **Impson D**, Madikizela B, Muir D and Weyl OLF. 2018. Control of invasive fishes in South Africa's Cape Fold Ecoregion: partner agencies collaborate to ensure successful use of the piscicide rotenone. The African Fish and Fisheries Conference. 23-28 September, Mangochi, Malawi | African Fish and Fisheries Conference |
| 2017 | **Hayward NA**. 2017. The Stewardship Model: Enabling Protected Area Expansion. Oral Presentation at the GEF 5 Improving the Effectiveness of the Protected Areas Network South-South Collaboration Peer Learning between the National System of Protected Areas, Uruguay, and South Africa, 27 November – 01 December, Montevideo | GEF 5 |
| ORAL PRESENTATIONS AT SYMPOSIA / CONFERENCES NATIONAL | | |
| 2023 | **Baard EHW** and **Turner AA.** Ten years of protected area expansion in the Western Cape: more permanent space for tortoises and terrapins? 15th Conference of the Herpetological Association of Africa, Hoedspruit, South Africa | 15th Conference of the Herpetological Association of Africa |
| | **Jordaan MS**, Chakona A, Kadye W and De Villiers MS. 2023. A review of historical and present freshwater fish distributions of the Gouritz River system, South Africa. South African Society for Aquatic Science (SASAqS) conference, 25-28 June 2023, Lord Charles Hotel, Somerset West, Western Cape | Southern African Society of Aquatic Science Conference |
| | Tarrant J, Armstrong A, Acker-Cooper C, Roxburgh L, Weeber J, **Turner AA**, Lynch A and Lynch K. 2023. Croaks, Chirps and Clumps: Long-term monitoring and surveillance efforts for priority South African threatened frog species. 15th Conference of the Herpetological Association of Africa, Hoedspruit, South Africa | 15th Conference of the Herpetological Association of Africa |
| | **Turner AA**. 2023. Lessons from 18+ years of monitoring fynbos frog populations. Oral presentation delivered at the 15th Conference of the Herpetological Association of Africa, Hoedspruit, South Africa | 15th Conference of the Herpetological Association of Africa |
| 2022 | **De Villiers M, Jacobs LEO and Jordaan MS.** 2022. CapeNature's Species Prioritization Framework - a monitoring and surveillance decision support tool. The Conservation Symposium, 31 October 2022, Virtual Webinar via Zoom | Conservation Symposium |
| | **De Villiers M**. 2022. "Come out, come out, wherever you are": Distribution and emergence of the beetle, *Ichnestoma dealbata*. The Conservation Symposium, 4 November 2022, Virtual Webinar via Zoom | Conservation Symposium |
| | **Escott B.** 2022. Integrated planning, partnerships, and data synthesis - are we moving forward for freshwater ecosystems in South Africa? The Conservation Symposium, 1 November 2022, Virtual Webinar via Zoom | Conservation Symposium |
| | **Hayward NA** and **Turner AA**. 2022. Effective Conservation Action. MEDECOS Conference 2022, Langebaan | MEDECOS Conference |
| | **Huntly P**. 2022. Western Cape State of Conservation Report. The Conservation Symposium, 31 October 2022, Virtual Webinar via Zoom | Conservation Symposium |
| | Midgley J, **Veldtman A** and **Schutte-Vlok A**. 2022. Intense clumping of Cape Proteaceae seedlings; conservation, ecological and evolutionary implications. MEDECOS Conference 2022, Langebaan | MEDECOS Conference |
| | **Rossouw D** and **Turner AA**. 2022. Quantifying the impact and effectiveness of bark spot spray application of herbicide by helicopter on invasive alien pine trees and its non-target effect to indigenous vegetation. MEDECOS Conference 2022, Langebaan | MEDECOS Conference |

| Year | Reference | Journal / Book / Conference |
|---|---|---|
| | **Schutte-Vlok A** and **Meyer P.** 2022. Invasive alien plants on the Outeniquas… a never-ending battle. MEDECOS Conference 2022, Langebaan | MEDECOS Conference |
| | **Schutte-Vlok A**. 2022. Prescribed burning - The right option for fynbos. 13th Wildfire Management Symposium, Nelson Mandela University, George | 13th Wildfire Management Symposium |
| | **Turner AA**. 2022. Lessons from 18 years of frog population monitoring in the fynbos. MEDECOS Conference 2022, Langebaan | MEDECOS Conference |
| | **Turner AA**. 2023. Lessons from 18+ years of monitoring fynbos frog populations. 15th Conference of the Herpetological Association of Africa, Hoedspruit, South Africa | MEDECOS Conference |
| | **Turner AA.** 2022. Some lessons from 20 years of frog population monitoring. African Amphibian Working Group 2022 (Windhoek, Namibia, remote delivery) | African Amphibian Working Group |
| | **Turner AA.** 2022. The rough moss frog: a story of conservation action for a Critically Endangered species. Herpetological Association of Africa Virtual Mini-Symposium 2022, 10 May 2022 | Herpetological Association of Africa |
| | **Wheeler A**. 2022. Western Cape Protected Area Expansion Strategy. The Conservation Symposium, 31 October 2022, Virtual Webinar via Zoom | Conservation Symposium |
| | De Jager D, Russo I, Van Wyk A, Bloomer P, Klopper A, Van Heerden F, Uiseb K, **Birss C** and Rushworth I. 2021. Evaluation of a conceptual framework for genetic management of wildlife. The Conservation Symposium, 3 November 2021, Virtual Webinar via Zoom | Conservation Symposium |
| | De Jager D, Russo I, an Wyk A, Bloomer P, Klopper A, an Heerden F, Uiseb K, **Birss C** and Rushworth I. 2021. Genetic management guidelines to guide translocations of southern African vertebrates - part I. The Conservation Symposium, 3 November 2021, Webinar via Zoom | Conservation Symposium |
| | De Jager D, Russo I, Van Wyk A, Bloomer P, Klopper A, Van Heerden F, Uiseb K, **Birss C** and Rushworth I. 2021. Genetic management guidelines to guide translocations of southern African vertebrates - part II. The Conservation Symposium, 3 November 2021, Virtual Webinar via Zoom | Conservation Symposium |
| | **De Villiers M**. 2021. In the mix: Cape mountain zebra (*Equus zebra zebra*) conservation. The Conservation Symposium, 2 November 2021, Virtual Webinar via Zoom | Conservation Symposium |
| | **Duffell-Canham A** and **Veldtman A.** 2021. Using what is off to (better) protect what is on. The Conservation Symposium, 4 November 2021, Virtual Webinar via Zoom | Conservation Symposium |
| | **Hayward NA**. 2021. Managing uncertainty certainly: Re-visioning the adaptive management framework in a parastatal. The Conservation Symposium, 4 November 2021, Virtual Webinar via Zoom | Conservation Symposium |
| | **Huntly P** and **Birss C**. 2021. Western Cape State of Conservation Report 2020. The Conservation Symposium, 1 November 2021, Virtual Webinar via Zoom | Conservation Symposium |
| | **Jordaan MS**, Chakona A and Van Der Colff D. 2021. High and dry: Are protected areas in the Western Cape missing the boat for freshwater fish conservation? The Conservation Symposium, 4 November 2021, Virtual Webinar via Zoom | Conservation Symposium |
| | **Rampartab C**. 2021. The data-decision interface: how CapeNature is implementing strategic adaptive management in Western Cape, South Africa. International Congress of Zoology, 22 November 2021, Virtual Webinar via Zoom | International Congress of Zoology |
| | **Turner AA**, Tolley KA and Davies S. 2021. A new invader? An eastern dwarf chameleon (*Bradypodion ventrale*) example. The Conservation Symposium, 4 November 2021, Virtual Webinar via Zoom | Conservation Symposium |
| | **Turner AA**. 2021. A fresh look at biocontrol for pines. National Symposium on Biological Invasions, May 2021. Online | National Symposium on Biological Invasions |
| | **Turner AA**. 2021. Listening to the Fynbos. Fynbos Forum September 2021. Presented Online | Fynbos Forum |
| | **Turner AA**. 2021. New techniques and technologies for invasive alien species control – gathering speed and momentum. The Conservation Symposium, 4 November 2021, Virtual Webinar via Zoom | Conservation Symposium |
| 2020 | **De Villiers M** and Fourie A. 2020. Vanishing before our eyes: the mystery of the declining *Euphorbia colliculina* population. Arid Zone Ecology Forum virtual symposium. 5-8 October 2020 | Arid Zone Ecology Forum |
| | **Hudson V**, Juvik J and Kiester R. 2020. Tapping into a Tortoise's eau de Toilette: the use of Conservation Detection Dogs for mark recapture research on the Geometric Tortoise (*Psammobates geometricus*) in South Africa. Turtle Survival Alliance 18th Annual International Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles. Online | 18th Annual International Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles |

| Year | Reference | Journal / Book / Conference |
|---|---|---|
| | **Turner AA**, Atkins F and Slingsby J. 2020. Greater Cape Metro Long Term Ecological Research. Fynbos Forum 2020. 9-11 September 2020. Online | Fynbos Forum |
| | **Turner AA**. 2020. A fresh look at biocontrol for pines. Fynbos Forum 2020. 9-11 September 2020. Online | Fynbos Forum |
| 2019 | **De Villiers M** and Fourie A. 2019. Can a drone take the groan out of monitoring. Drone Users Conference in Conservation and Agriculture, Elsenberg | Drone Users Conference |
| | **Impson D**. 2019: Invasives Conference, Tulbagh. Invasive fish control projects in the Fynbos Biome: detailed monitoring and research confirm project successes | Invasives Conference |
| | **Jordaan MS** and Weyl OLF. 2019. A novel aquatic invader in the Cape Floristic Region: monitoring and future management of an early-stage invasion of Sharptooth catfish *Clarias gariepinus* in a Cape Mountain stream. National Symposium on Biological Invasions, 15-17 May 2019, Waterval Country Lodge, Tulbagh, Western Cape | National Symposium on Biological Invasions |
| | **Pool-Stanvliet R**. 2019. Social-ecological Systems and the Sustainable Development Goals. Startup bootcamp AfriTech (SBC) and RCS, The Future Cities Hackathon, 1 March 2019, Cape Town, South Africa | The Future Cities Hackathon |
| | **Turner AA**. 2019. Multi-species fire frequency thresholds for potential concern for Fynbos frogs. African Amphibian Working Group: 7-9 October 2019, George | African Amphibian Working Group |
| | **Turner AA**. 2019. Proposed CapeNature Invasive Alien Species Outcome Monitoring System. Fynbos Forum 2019: 5 - 8 August 2019, Elim | Fynbos Forum |
| 2018 | **Forsyth AT,** Hayward NA, and **Pence G**. 2018. Mechanisms to facilitate spatial planning adjacent to Protected Areas towards ensuring ecological integrity. The Conservation Symposium, 05 November – 08 November, Howick. | Conservation Symposium |
| | **Gouws J** and **Jordaan MS**. 2018. Short-term effects of a diesel spill on fish and invertebrates in the Groot River, Meiringspoort. South African Society of Aquatic Scientists Conference 2018: 25-28 June 2018, Cape St Francis Bay | South African Society of Aquatic Scientists Conference |
| | **Hudson V.** 2018. CapeNature Conservation Detection Dog program. Poster presentation at Working Dogs in Africa Conference, 2018. 09-12 April 2018, Birchwood, Gauteng | Working Dogs in Africa Conference |
| | **Impson D**, Muir D, Madikizela B, **Jordaan MS** and Weyl OLF. 2018. Invasive fish control projects in the Cape: progress so far and plans for the next three years. SASAQS. Cape St Francis, South Africa | Southern African Society of Aquatic Science Conference |
| | **Impson D**. 2018. Progress report: Capacity in government to manage freshwater ecosystems from an ecological perspective Freshwater Ecosystem Network, 26 July. SANBI, Pretoria | Freshwater Ecosystem Network |
| | **Jordaan MS**, Chakona A and **Birss C**. 2017. A Biodiversity Management Plan for Species (BMP-S) for the Barrydale redfin *Pseudobarbus burchelli 'sp.* Tradouw. Southern African Wildlife Management Symposium 10 – 14 September 2017, Goudini Spa, Western Cape | Southern African Wildlife Management Symposium |
| | **Turner AA**. 2018. Fynbos frogs, fire frequencies and multi-species thresholds for potential concern. Conservation Symposium 2018: 5-9 November 2018, Howick, South Africa | Conservation Symposium |
| | **Turner AA**. 2018. Groundwater Dependencies in the Cape: Research questions. Fynbos Forum 2018: 31 July - 3 August 2018, Goudini Spa, South Africa | Fynbos Forum |
| 2017 | **Impson D, Jordaan MS, Gouws J, Van der Walt R**, Marr S and Weyl OLF. 2017. Rehabilitation projects to conserve threatened Cape fynbos fishes: getting invasive fishes out of selected priority inland waters. Freshwater Ecosystem Network, 29 June, Boksburg, Gauteng | Freshwater Ecosystem Network |
| | Waller JL, **Birss C**, Hugo C, McGeroge C, Shaw KA, and Weller F. 2017. Managing predation at a land based African penguin colony. Southern African Wildlife Management Symposium 10 – 14 September 2017, Goudini Spa, Western Cape | Southern African Wildlife Management Symposium |

# ANNEXURE 2: PARTNERSHIPS

CapeNature acknowledges the importance of collaboration in sustaining biodiversity conservation and the Biodiversity Economy. CapeNature values and pursues working with communities, private landowners, civil society, conservation organisations, researchers, tertiary institutions, and other spheres of government to deliver on conservation targets. CapeNature engages in numerous, valued, formal and informal working collaborations. Formal agreements typically take the form of a Memorandum of Understanding or a Memorandum of Agreement. Less formal agreements are equally valued.

As at March 2023 there are 49 partners with whom the entity has formal agreements for biodiversity conservation.

Below is the List of formal CapeNature partners.

Berg River Municipality,
Buffalo Valley Trust,
Cape Peninsula Fire Protection Association (CPFPA),
Cape Winelands District Municipality,
City of Cape Town,
Conservation Outcomes,
Department of Forestry Fisheries and the Environment (DFFE),
Endangered Wildlife Trust (EWT),
Friends of the Toll House,
Gift of the Givers,
Greater Cederberg Fire Protection Association (GCFPA),
Heuningvlei Community,
Leisure Conservation Trust,
Mountains to Oceans (MTO) Forestry
National Research Foundation (NRF),
Overberg Renosterveld Conservation Trust,
South African Environmental Observation Network (SAEON),
South African National Biodiversity Institute (SANBI),
South African Shark Conservancy (SASC),
Swartland Municipality,
The Nature Conservancy (TNC),
University of the Western Cape (UWC),
West Coast District Municipality (WCDM),
Western Cape Umbrella Fire Protection Association (WCUFPA),
Working on Fire (WoF),
BirdLife South Africa,
Cape Leopard Trust,
Cape Peninsula University of Technology (CPUT),
Centre of Invasion Biology (CIB),
Conservation at Work,
Department of Agriculture,
Dyer Island Conservation Trust,
Flower Valley Conservation Trust,
Fynbos Trust,
Gouritz Cluster Biosphere Reserve (GCBR),
Greater Overberg Fire Protection Association (GOFPA),
Invasive Fish Species Management,
McGregor Tourism,
Nelson Mandela University (NMU),
Overberg District Municipality (ODM),
Overstrand Municipality,
South African Institute for Aquatic Biodiversity (SAIAB),
South African National Parks (SANParks),
Southern Cape Fires Protection Association (SCFPA),
Table Mountain Fund (TMF),
University of the Free State (UFS),
Volunteer Wildfire Services (VWS),
Western Cape Government,
Winelands FPA (WFPA).
World Wildlife Fund (WWF).

# REFERENCES:


Avis AM. 1989. A review of coastal dune stabilization in the Cape Province of South Africa. Department of Botany, Rhodes University, Grahamstown 6140 South Africa. https://doi.org/10.1016/0169-2046(89)90055-8

Bates MF, Branch WR, Bauer AM, Burger M, Marais J, Alexander GJ and de Villiers MS (eds). 2014. Atlas and Red List of the Reptiles of South Africa, Lesotho, and Swaziland. *Suricata* 1. South African National Biodiversity Institute, Pretoria. https://11nq.com/OhUE9

BirdLife. 2019. *Regional and Global Red List Categorizations 2019*. BirdLife South Africa Unpublished document.

Birss C, Cowell C, Hayward N, Peinke D, Hrabar HH and Kotze A. 2016. Biodiversity Management Plan for the Cape mountain zebra in South Africa. Jointly developed by CapeNature, South African National Parks, Eastern Cape Parks and Tourism Agency, National Zoological Gardens, Department of Environmental Affairs, Northern Cape Department of Environment and Nature Conservation, Eastern Cape Department of Economic Development, Environmental Affairs and Tourism and Free State Department of Economic, Small business, Tourism and Environmental Affairs. Version 1.0.

Bond WJ. 1980. Fire and senescent fynbos in the Swartberg, Southern Cape. South African Forestry Journal: 114, 68-71.

Botts EA, Skowno A, Driver A, Holness S, Maze K, Smith T, Daniels F, Desmet P, Sink K, Botha M and Nel J. 2020. More than just a (red) list: Over a decade of using South Africa's threatened ecosystems in policy and practice. Biological Conservation: 246.108559.

Burls NJ, Blamey RC, Cash BA, Swenson ET, al Fahad A, Bopape JM, Straus DM and Reason CJC. 2019. The Cape Town "Day Zero" drought and Hadley cell expansion. Nature Partner Journals: Climate and Atmospheric Science, 2:27. DOI: https://doi.org/10.1038/s41612-019-0084-6

Butchart S, Walpole M, Collen B, Van Strien A, Scharlemann J, Almond R, Baillie J, Bertzky B, Brown C, Bruno J, Carpenter K, Carr G, Chanson J, Chenery A, Csirke J, Davidson N, Dentener F, Foster M, Galli A and Watson R. 2010. Global biodiversity: indicators of recent declines. Science 328: 1164–1168.

CapeNature. 2002. Biodiversity of the Western Cape 2002. Baard and de Villiers (ed). Internal report, CapeNature. Cape Town. https://www.capenature.co.za/uploads/files/Resources/State-of-Biodiversity-Western-Cape-2002.pdf

CapeNature. 2007. Western Cape Province State of Biodiversity 2007. Turner AA (ed). CapeNature Scientific Services. Stellenbosch. ISBN 978-0-620-39289-1. https://www.capenature.co.za/resources/state-of-biodiversity-report-2007

CapeNature. 2012. Western Cape Province State of Biodiversity 2012. Turner AA (ed). CapeNature Scientific Services. Stellenbosch. ISBN: 978-0-621-41407-3. https://www.capenature.co.za/resources/state-of-biodiversity-report-2012

CapeNature. 2017a. The Western Cape Biodiversity Spatial Plan: Technical Report. Unpublished report. CapeNature.

CapeNature. 2017b. Western Cape Province State of Biodiversity 2017. Turner AA (ed). CapeNature Scientific Services. Stellenbosch. ISBN: 978-0-621-45962-3. https://www.capenature.co.za/uploads/files/Resources/State-of-Biodiversity-Western-Cape-2017.pdf

CapeNature. 2019. Conservation Action Priority Map. Unpublished report. CapeNature.

CapeNature. 2020a. 2020 Western Cape State of Conservation Report. CapeNature. https://www.capenature.co.za/uploads/files/CapeNature-2020-State-of-Conservation-Report.pdf

CapeNature. 2020b. Fire Regime of the Boland Mountain Complex. Unpublished CapeNature Report. CapeNature.

CapeNature. 2021a. The Western Cape Protected Area Expansion Strategy: 2021 – 2025. Unpublished report. CapeNature.

CapeNature. 2021b. Priority fauna species and monitoring report 2020/2021. Unpublished Internal Report. CapeNature.

CapeNature. 2021c. CapeNature Annual Fire Report 2020-2021. CapeNature.

CapeNature. 2021d. 2021 Western Cape State of Conservation Report. CapeNature. https://www.capenature.co.za/resources/state-of-conservation-report-2021

CapeNature. 2022a. 2022 Western Cape State of Conservation Report. CapeNature. https://www.capenature.co.za/uploads/files/Western-Cape-State-of-Conservation-Report-2022.pdf

CapeNature. 2022b. Ecological Surveillance, Monitoring & Research Framework 2022 – 2026, Unpublished internal report. Framework 1/2022. CapeNature.

CapeNature. 2022c. Annual biodiversity monitoring report: Bontebok 2020-2022, Unpublished Technical Report.

CapeNature. 2023a. The Provincial Climate Change Adaptation Corridor Framework. Spatial coverage. CapeNature.

CapeNature. 2023b. Annual biodiversity monitoring report: Cape mountain zebra 2022-2023. Unpublished internal report. CapeNature.

CapeNature. 2023c. Meiringspoort fish survey report: 2023. Unpublished internal report. CapeNature.

CapeNature. 2023d. 2013/14 Updated Western Cape Land Cover. CapeNature.

CapeNature. 2023e. 2020 Updated Western Cape Land Cover. CapeNature.

CBD. 2018. Recognising and reporting other effective area-based conservation measures. Convention on Biological Diversity. CBD/COP/14/8.

CBD. 2022. Kunming-Montreal Global biodiversity framework. Convention on Biological Diversity. CBD/COP/15/L.25.

Centre for Sustainable Systems. 2022. "Biodiversity Factsheet." University of Michigan. Pub. No. CSS09-08.

Chakona A, Swartz ER and Gouws G. 2013. Evolutionary Drivers of Diversification and Distribution of a Southern Temperate Stream Fish Assemblage: Testing the Role of Historical Isolation and Spatial Range Expansion. PLoS ONE 8(8): e70953. doi:10.1371/journal.pone.0070953.

Chakona A, Jordaan MS, Raimondo DC, Bills RI, Skelton PH and van Der Colff D. 2022. Diversity, distribution and extinction risk of native freshwater fishes of South Africa. *J. Fish. Biol.* 100: 1044–1061. doi:10.1111/jfb.15011.

Chase BM and Meadows ME. 2007. Late Quaternary dynamics of southern Africa's winter rainfall zone. Earth- Science Reviews. 84:103-38.

Child MF, Roxburgh L, Do Linh San E, Raimondo D and Davies-Mostert HT (eds). 2017. *The Red List of Mammals of South Africa,* Lesotho and Swaziland. South African National Biodiversity Institute and Endangered Wildlife Trust. South Africa.

Clusella-Trullas S and Garcia RA. 2017. Impacts of invasive plants on animal diversity in South Africa: A Synthesis. *Bothalia*. 47: a2166.

Colvin C, Le Maitre D, Saayman I and Hughes S. 2007. Aquifer Dependent Ecosystems in Key hydro-geological type settings in South Africa. Water Research Commission report. Report No TT 301/07.

Cook TR. 2015. Bank cormorant (*Phalacrocorax neglectus*). In: Taylor, MR, Peacock F and Wanless RM. (eds) 2015, The Eskom Red Data Book of Birds of South Africa. Lesotho and Swaziland. BirdLife South Africa, Johannesburg, pp. 104–106

Cornelius A. 2023. Assessing the surface water – groundwater interaction and its influence on the water quality form headwaters to lowlands. Master of Science Thesis. Environmental and Water Sciences. University of the Western Cape.

Cowell CR and Birss C. 2017. Biodiversity Management Plan for The Bontebok (*Damaliscus pygargus pygargus*) in South Africa. Unpublished Report, jointly developed by South African National Parks, CapeNature and the National Department of Environmental Affairs. Version 1.0.

Cowling RM. 1987. Fire and its role in coexistence and speciation in Gondwanan shrublands. South African Journal of Science. 83: 106–112.

CMP. 2020. Open Standards for the Practice of Conservation. Conservation Measures Partnerships Version 4.0. https://conservationstandards.org/wp-content/uploads/sites/3/2023/09/CMP-Open-Standards-for-the-Practice-of-Conservation-v4.0-English.pdf

Dallas H, Shelton J, Sutton T, Tri Cuptura D, Kajee M and Job N. 2022. The Freshwater Biodiversity Information System (FBIS) – mobilising data for evaluating long-term change in South African rivers, African Journal of Aquatic Science. 47:3, 291-306, DOI: 10.2989/16085914.2021.1982672.

da Silva J and Tolley K. 2018. Conservation genetics of an endemic and threatened amphibian (*Capensibufo rosei*): a leap towards establishing a genetic monitoring framework. *Conservation Genetics* 19. 10.1007/s10592-017-1008-9.

Dalton DL, Vermaan E, Roelofse M and Kotze A. 2016. Diversity in the toll-like receptor genes of the African Penguin (*Spheniscus demersus*). *PLoS ONE* 11(10): e0163331. doi: 10.1371/journal.pone.0163331.

Dalton DL, Zimmerman D, Mnisi C, Taplin M, Novellie P, Hrabar H and Kotzé A. 2017. Hiding in plain sight: evidence of hybridization between Cape mountain zebra (*Equus zebra zebra*) and plains zebra (*Equus quagga burchelli*). *African Journal of Wildlife Research* 47(1): 59-64.

Davies SJ, Jordaan MS, Karsten M, Terblanche JS, Turner AA, van Wilgen NJ, Veldtman R, Zengeya TA and Measey J. 2020. Experience and lessons from alien and invasive animal control projects in South Africa. In: Biological Invasions in South Africa pp. 629-663. Cham: Springer International Publishing.

Davis ALV, Deschodt CM and Scholtz CH. 2020. Conservation assessment of Scarabaeine dung beetles in South Africa, Botswana and Namibia: IUCN Red List categories, atlas and ecological notes. Suricata 6. South African National Biodiversity Institute, Pretoria.

Day J. and Davies B. 2023. Vanishing Waters. Third revised edition. Water Research Commission book. Book No SP 160/23. ISBN 978-0-6392-0451-2.

DEA. 2016. National Biodiversity Research and Evidence Strategy 2015-2025. Department of Environmental Affairs. Internal report. DEA. Pretoria.

DEA. 2018. National Protected Areas Expansion Strategy for South Africa 2018. Department of Environmental Affairs, Pretoria, South Africa.

DEA&DP. 2016. The Provincial Biodiversity Strategy and Action Plan 2015 to 2025. Department of Environmental Affairs and Development Planning. Cape Town.

DEA&DP. 2018. State of Environment Outlook Report for the Western Cape Province 2014 – 2017. Department of Environmental Affairs and Development Planning. Cape Town.

DEA&DP. 2022. Western Cape Coastal Management Programme 2022 to 2027. https://www.westerncape.gov.za/eadp/about-us/meet-chief-directorates/environmental-sustainability/biodiversity-and-coastal-management

DEA&DP. 2023a. Western Cape Climate Change Response Strategy: Vision 2050. Department of Environmental Affairs and Development Planning. Cape Town.

DEA&DP. 2023b. Draft Provincial Biodiversity and Action Plan 2020-2030. Department of Environmental Affairs and Development Planning. Cape Town.

DFFE. 2020. Status of the South African marine fishery resources 2020. Department of Environment, Forestry andFisheries. Cape Town: DEFF. ISBN: 978-0-621-48557-8.

DFFE. 2021. South African National Land-Cover 2020 Computer Automated Land-Cover (CALC). Version v1.0.4. Department of Environment, Forestry and Fisheries. Cape Town: DEFF. https://egis.environment.gov.za/sa_national_land_cover_datasets

Dilley BJ, Schoombie S, Schoombie J and Ryan PG. 2016. 'Scalping' of albatross fledglings by introduced mice spreads rapidly at Marion Island. Antarctic Science. 28: 73-80.

Donald PF, Buchanan GM, Balmford A, Bingham H, Couturier AR, de la Rosa Jr GE, Gacheru P, Herzog SK, Jathar G and Kingston N. 2019. The prevalence, characteristics and effectiveness of Aichi Target 11' s "other effective area-based conservation measures" (OECMs) in Key Biodiversity Areas. Conservation Letters: e12659.

Ellender BR, Weyl OLF, Alexander ME, Luger AM, Nagelkerke LAJ and Woodford DJ. 2018. Out of the pot and into the fire: Explaining the vulnerability of an endangered small headwater stream fish to black-bass *Micropterus spp.* invasion. Journal of Fish Biology. 92: 1035-1050.

Faulkner KT, Spear D, Robertson MP, Rouget M and Wilson JRU. 2015. An assessment of the information content of South African alien species databases. Bothalia African Biodiversity Conservation. 45: 1103. https://doi.org/10.4102/abc.v45i1.1103

Faulkner KT, Burness A, Byrne MJ, Kumschick S, Peters K, Robertson MP, Saccaggi DL, Weyl OLF and Williams VL. 2020. South Africa's pathways of introduction and dispersal and how they have changed over time. In: van Wilgen BW, Measyey J, Richardson DM, Wilson JR and Zengeya TA. (eds). 2020. Biological Invasions in South Africa. Mar 10:14:313-54.

Geerts S. 2021. *Protea* maturation rates and fire return intervals in a Mediterranean ecosystem: testing the rules of thumb at a local scale. *International Journal of Wildland Fire.* 30. 971-977.

GTI. 2015a. A Natural and Semi-Natural Land-Cover of the Western Cape Province (2013–2014): Data User Report and Metadata. March 2015, version 05b. GeoTerraImage. Western Cape Government License. Pretoria.

GTI. 2015b. Land-Cover of the Western Cape Province (2013–2014): Data User Report and Metadata. March 2015, version 05b. GeoTerraImage. Western Cape Government License. Pretoria.

Gouws EJ and Gordon A. 2017. Status of Freshwater Ecosystems. In: Turner AA (ed) 2017. Western Cape State of Biodiversity 2017. CapeNature Scientific Services. Stellenbosch. ISBN: 978-0-621-45962-3.

Government of South Africa. 2009. National Protected Area Expansion Strategy for South Africa 2008. Department of Environmental Affairs. Pretoria.

Gozlan RE, Karimov BK, Zadeerev E, Kuznetsova D and Brucet S. 2018. Status, trends, and future dynamics of freshwater ecosystems in Europe and Central Asia. Inland Waters. January 2018. DOI: 10.1080/20442041.2018.1510271.

Grundling PL, Grundling AT, Pretorius L, Mulders J and Mitchell S. 2017. South African Peatlands: Ecohydrological Characteristics and Socio-economic Value. Report No. 2346/1/17, Water Research Commission (WRC), Pretoria, South Africa, 147 pp.

Habibullah MS, Din BH, Tan SH and Zahid H. 2022. Impact of climate change on biodiversity loss: global evidence. Environmental Science and Pollution Research. 29(1):1073-86.

Harris LR, Sink KJ, Skowno AL, Van Niekerk L, Holness S and Sibanda SM. 2019. Chapter 6: Ecosystem assessments. In: Harris LR, Sink KJ, Skowno AL, Van Niekerk L (eds). 2019. South African National Biodiversity Assessment 2018: Technical Report. Volume 5: Coast. South African National Biodiversity Institute, Pretoria. http://hdl.handle.net/20.500.12143/6374 https://acesse.dev/YVm5H

Hofmeyr MD, Vamberger M, Branch W, Schleicher A and Daniels S. 2016. Tortoise (*Reptilia, Testudinidae*) radiations in Southern Africa from the Eocene to the present. *Zoologica Scripta* 46(4): 389-400.

Hofmeyer MD, Leuteritz T and Baard EHW. 2018. *Psammobates tentorius ssp. trimeni,* Western Tent Tortoise. The IUCN Red List of Threatened Species 2018: e.T121936835A121936853. The IUCN Red List of Threatened Species. https://www.iucnredlist.org/species/121936835/121936853

Holden PB, Rebelo AJ and New MG. 2021. Mapping invasive alien trees in water towers: A combined approach using satellite data fusion, drone technology and expert engagement. Remote Sensing Applications: Society and Environment. 21:100448.

Holmes PM. 2022. Report on the installation of permanent vegetation survey plots and baseline terrestrial monitoring for the Greater Cape Town Water Fund (GCTWF). Unpublished report. The Nature Conservancy. Cape Town.

Hrabar H, Birss C, Peinke D, King S, Novellie P, Kerley G and Child MF. 2016. A conservation assessment of *Equus zebra zebra*. In: Child MF, Roxburgh L, Do Linh San E, Raimondo D and Davies-Mostert H (eds). 2016. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust. South Africa.

Huntjens P. and Nachbar K. 2015. Climate change as a threat multiplier for human disaster and conflict. The Hague Institute for Global Justice. The Hague Institute for Global Justice Working Papers No. 9. IPBES. 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services (summary for policy makers). IPBES Plenary at its seventh session (IPBES 7, Paris, 2019). Zenodo. https://doi.org/10.5281/zenodo.3553579

IPBES. 2023. Summary for Policymakers of the Thematic Assessment Report on Invasive Alien Species and their Control of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Roy HE, Pauchard A, Stoett, P, Renard Truong T, Bacher, S, Galil BS, Hulme PE, Ikeda T, Sankaran KV, McGeoch MA, Meyerson LA, Nuñez MA, Ordonez A, Rahlao, SJ, Schwindt E, Seebens H, Sheppard AW and Vandvik V. (eds.).

IPBES secretariat. Bonn. Germany. https://doi.org/10.5281/zenodo.7430692

IPCC. 2023: Sections. In: Climate Change. 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Core Writing Team, Lee H and Romero J (eds.) IPCC. Geneva. Switzerland.35-115. DOI: 10.59327/IPCC/AR6-9789.

IUCN. 2014. Interpreting the RLI. https://archive.nationalredlist.org/support-information/red-list-indices/how-to-create-a-national-red-list-index/interpreting-the-red-list-index/

IUCN. 2022. Summary Statistics. https://www.iucnredlist.org/resources/summary-statistics

Job, N. 2014. Geomorphic origin and dynamics of deep, peat-filled, valley bottom wetlands dominated by palmiet (*Prionium serratum*) – a case study based on the Goukou Wetland, Western Cape. Rhodes University. Eastern Cape.

Jones MGW and Ryan PG. 2010. Evidence of mouse attacks on albatross chicks on sub-Antarctic Marion Island. Antarctic Science. 22: 39-42.

Jordaan MS, Chakona A and van der Colff D. 2020. Protected Areas and Endemic Freshwater Fishes of the Cape Fold Ecoregion: Missing the Boat for Fish Conservation? *Frontiers in Environmental Science* 8: 502042. https://doi.org/10.3389/fenvs.2020.502042

Jubase N, Shackleton RT and Measey J. 2021. Motivations and contributions of volunteer groups in the management of invasive alien plants in South Africa's Western Cape province. Bothalia-African Biodiversity & Conservation. 51:1-3.

Kambikambi M, Kadye W and Chakona A. 2021. Allopatric differentiation in the *Enteromius anoplus* complex in South Africa, with the revalidation of *E. cernuus* and *E. oraniensis*, and description of a new species, *E. mandelai* (Teleostei: Cyprinidae). *Journal of Fish Biology*. 99 (3): 931-954. https://11nq.com/OJIUQ

Kirkwood D, Pence GQ and von Hase A. 2010. Western Cape Biodiversity Framework: Critical Biodiversity Areas and Ecological Support Areas of the Western Cape. A C.A.P.E. Land-use planning project. CapeNature Unpublished Project Report CBD. 2010. Global Biodiversity Outlook 3. Montréal.

Kleinjan CA, Hoffmann JH, Heystek F, Ivey P and Kistensamy Y. 2021. Developments and prospects for biological control of Prosopis (*Leguminosae*) in South Africa. African Entomology. 29:859-74.

Kleynhans, CJ, Thirion, C and Moolman, J. 2005. A Level 1 River Ecoregion classification system for South Africa, Lesotho and Swaziland. Report N. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry. Pretoria. South Africa.

Kotzé A, Smith RM, Moodley Y, Luikart G, Birss C, Van Wyk AM, Grobler JP and Dalton DL. 2019. Lessons for conservation management: Monitoring temporal changes in genetic diversity of Cape mountain zebra (*Equus zebra zebra*). *PLoS ONE* 14(7): e0220331. https://doi.org/10.1371/journal.pone.0220331

Kraaij T, Baard JA, Arndt J, Vhengani L and Van Wilgen BW. 2018. An assessment of climate, weather, and fuel factors influencing a large, destructive wildfire in the Knysna region, South Africa. Fire Ecology 14:1-2.

Kruger FJ. 1977. Ecology of Cape fynbos in relation 10 fire. In: Mooney HA and Condrad CE. (eds). 1977. Environmental Consequences of Fire and Fuel Management in Mediterranean Ecosystems. pp. 230-.244. USDA General Technical Service Report WO-3.

Labuschagne C, Nupen L, Kotzé A, Grobler JP and Dalton DL. 2016. Genetic monitoring of *ex situ African Penguin* (*Spheniscus demersus*) populations in South Africa. *African Zoology* 51(2): 83-90.

Le Maitre DC, Lamb AJ and Jones CA. 1991. Conservation of the Kogelberg State Forest: An assessment of management from 1967 to 1988. Unpublished report, Chief Directorate of Nature and Environmental Conservation. Stellenbosch.

Le Maitre DC, Seyler H, Holland M, Smith-Adao L, Nel JL, Maherry A and Witthüser K. 2018. Identification, delineation and importance of the Strategic Water Source Areas of South Africa, Lesotho and Swaziland for surface and groundwater. Report No. TT 743/1/18, Water Research Commission. Pretoria.

Le Maitre D, Görgens A, Howard G and Walker N. 2019. Impacts of alien plant invasions on water resources and yields from the Western Cape Water Supply System (WCWSS). Water SA. 45: 568-579.

Le Maitre DC, Blignaut JN, Clulow A, Dzikiti S, Everson CS, Görgens AH and Gush MB. 2020. Impacts of plant invasions on terrestrial water flows in South Africa. In: Van Wilgen B, Measey J, Richardson D, Wilson JR and Zengeya

T. (eds). 2020. Biological Invasions in South Africa. pp 431-457. Springer. Cham. Switzerland. https://doi.org/10.1007/978-3-030-32394-3

Lötter MC and Le Maitre D. 2021. Fine-scale delineation of Strategic Water Source Areas for surface water in South Africa using Empirical Bayesian Kriging Regression Prediction: Technical report. Prepared for the South African National Biodiversity Institute (SANBI). Pretoria.

Manning J and Goldblatt P. 2012. Plants of the Greater Cape Floristic Region 1: the Core Cape Flora. *Strelitzia* 29. South African National Biodiversity Institute. Pretoria.

Masotla MM, Visagie L and Makhado AB. 2023. Estimates of trends in numbers of selected seabird species breeding in South Africa. DFFE Report for the March meeting of the Expert Review Panel To Advise On The Proposed Fishing-Area Closures Adjacent To South Africa's African Penguin Breeding Colonies And The Decline In The Penguin Population.

Measy GJ (ed). 2011. Ensuring a future for South Africa's frogs: a strategy for conservation research. *SANBI Biodiversity Series* 19. South African National Biodiversity Institute. Pretoria.

Mecenero S, Ball J, Edge D, Hamer M, Henning G, Krüger, M, Pringle E, Terblanche R and Williams M. (eds). 2013. *Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and Atlas*. Saftronics (Pty) Limited and the Animal Demography Unit.

Mecenero S, Edge DA, Staude HS, Coetzer BH, Coetzer AJ, Raimondo DC, Williams MC, Armstrong AJ, Ball JB, Bode JD, Cockburn KNA, Dobson CM, Dobson JCH, Henning GA, Morton AS, Pringle EL, Rautenbach F, Selb HET, Van Der Colff D and Woodhall SE. 2020. Outcomes of the Southern African Lepidoptera Conservation Assessment (SALCA). *Metamorphosis* 31(4): 1-160.

Midgley GF, Hannah L, Millar D, Thuiller W and Booth A. 2003. Developing regional and species-level assessments of climate change impacts on biodiversity in the Cape Floristic Region. Biological conservation. 112:87-97.

Mittermeier RA, Robles GP and Mittermeier CG. 1997. Megadiversity: Earth's Biologically Wealthiest Nations. Conservation International e Agrupación Sierra Madre Cidade do México, 1997.

Moncrieff GR. 2021. Locating and dating land cover change events in the Renosterveld, a Critically Endangered shrubland ecosystem. Remote Sensing. 13:834.

Moodley Y and Harley EH. 2005. Population structuring in mountain zebras (*Equus zebra*): The molecular consequences of divergent demographic histories. *Conservation Genetics* 6: 953-968.

Mtengwana B, Dube T and Mudereri BT. 2021. Modeling the geographic spread and proliferation of invasive alien plants (IAPs) into new ecosystems using multi-source data and multiple predictive models in the Heuningnes catchment. South Africa. GIScience & Remote Sensing. 58:4, 483-500, https://doi.org/10.1080/15481603.2021.1903281

Mucina L and Rutherford MC. 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute. Pretoria. South Africa. Memoirs of the Botanical Survey of South Africa.

Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GAB and Kent J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853-858.

Nel JL, Murray KM, Maherry AM, Peterson CP, Roux DJ, Driver A, Hill L, van Deventer H, Funke N, Swartz ER, Smith-Adao LB, Mbona N, Downsborough L and Nienaber S. 2011. Technical Report for the National freshwater Ecosystem Priority Areas project. Report to the Water Research Commission. WRC Report No. 1801/2/11.

Ollis DJ, Snaddon CD, Job NM and Mbona N. 2013. Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems. SANBI Biodiversity Series 22. South African National Biodiversity Institute. Pretoria.

Petersen CR, van Deventer H, Smith-Adao LB and Nel JL. 2023. Incorporating free-flowing rivers into global biodiversity targets: Prioritization and targeted interventions to maintain ecological integrity. Aquatic Conservation: Marine and Freshwater Ecosystems, 33(1), 115–128. https://doi.org/10.1002/aqc.3898

Pietersen RM. 2021. Investigating the role of groundwater-surface water connectivity in supporting non-perennial river systems, Sandveld, Western Cape, South Africa. Master of Science Thesis. Environmental and Water Science. University of the Western Cape.

Paterson ID, Motitsoe SN, Coetzee JA and Hill MP. 2023. Recent post-release evaluations of weed biocontrol programmes

in South Africa: a summary of what has been achieved and what can be improved. BioControl. Aug 28:1-3.

Pence GQK. 2009. Climate Adaptation Scenarios for the Cape Floristic Region: Technical Report. CapeNature Unpublished Report. Table Mountain Fund. World Wildlife Fund-South Africa. Cape Town.

Pyšek P, Hulme PE, Simberloff D, Bacher S, Blackburn TM, Carlton JT, Dawson W, Essl F, Foxcroft LC, Genovesi P, Jeschke JM, Kühn I, Liebhold AM, Mandrak N, Meyerson LA, Pauchard A, Pergl J, Roy HE, Seebens H, van Kleunen M, Vilà M, Wingfield MJ and Richardson DM. 2020. Scientists' warning on invasive alien species. Biological Reviews. 95:1511–1534.

R Core Team. 2022. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

Raimondo D, Young BE, Brooks TM, Cardoso P, van der Colff D, de Souza Dias BF, Vercillo U, de Souza E, Juslén A, Hyvarinen E, von Staden L, Tolley K and McGowan PJK. 2023. Using Red List Indices to monitor extinction risk at national scales. *Conservation Science and Practice* 5(1): e12854. DOI: 10.1111/csp2.12854.

Rebelo AJ, Le Maitre DC, Esler KJ and Cowling RM. 2015. Hydrological responses of a valley-bottom wetland to land-use/land-cover change in a South African catchment: Making a case for wetland restoration. Restor. Ecol. 23, 829–841. https://doi.org/10.1111/rec.12251

Rebelo AJ, Gokool S, Holden PB and New MG. 2021. Can Sentinel-2 be used to detect invasive alien trees and shrubs in Savanna and Grassland Biomes? Remote Sensing Applications: Society and Environment. 23:100600.

Republic of South Africa. 2022. The revised national list of ecosystems that are threatened and in need of protection. Government Gazette Vol. 689, Number 47526, 18 November 2022.

Roux DJ, Nel JL, Van Deventer H, Russell I, Van Niekerk L, Simms C, Job N, Baard J, Cole N, Petersen R, Riddell E, Freitag S, Daniels F, Fisher RC, Ebrahim Z and Sithole H. 2023. Mainstreaming freshwater and estuarine ecosystem conservation into South African National Parks: contribution of national parks to freshwater and estuarine conservation targets and strategic options for enhancing this contribution. Scientific Report 01 / 2023. South African National Parks. Skukuza.

Rowntree KM, Wadeson RA, and O'Keeffe J. 2000. The development of geomorphological classification system for the longitudinal zonation of the South African rivers. South African Geographical Journal. 82(3): 163-172.

Samways MJ and Simaika JP. 2016. Manual of Freshwater Assessment for South Africa: Dragonfly Biotic Index. *Suricata* 2. South African National Biodiversity Institute. Pretoria.

SANBI. 2019a. Pressures on biodiversity: Western Cape: Provincial extract from: Skowno AL, Poole CJ, Raimondo DC, Sink KJ, Van Deventer H, Van Niekerk L, Harris LR, Smith-Adao LB, Tolley KA, Zengeya TA, Foden WB, Midgley GF and Driver A. 2019. National Biodiversity Assessment 2018: The status of South Africa's ecosystems and biodiversity. Synthesis Report. South African National Biodiversity Institute. Pretoria. http://hdl.handle.net/20.500.12143/6362 https://www.sanbi.org/wp-content/uploads/2019/10/NBA-Report-2019.pdf

SANBI. 2019b. National Biodiversity Assessment 2018: The status of South Africa's ecosystems and biodiversity. Synthesis Report. South African National Biodiversity Institute. Pretoria. pp. 1–214.

SANBI. 2020. Statistics: Red List of South African Plants version 2020.1. Downloaded from Redlist.sanbi.org on 2023/06/05.

SANBI. 2023a. Strategic Water Source Areas: Vital ecological infrastructure for national water security. SANBI Factsheet Series. South African National Biodiversity Institute. Pretoria.

SANBI. 2023b. Official yearly release of South African national plant checklist for 2023. Western Cape. March 2023.

SANBI. In prep. 2023. A synthesis of freshwater mapping in the Berg and Breede catchments for use in the Ecological Infrastructure for Water Security project. South African National Biodiversity Institute. Pretoria.

SANBI and C•I•B. 2018. The status of biological invasions and their management in South Africa in 2017. South African National Biodiversity Institute, Kirstenbosch and DST-NRF Centre of Excellence for Invasion Biology. Stellenbosch.

SANBI and C•I•B. 2020. The status of biological invasions and their management in South Africa in 2019. pp.71. South African National Biodiversity Institute, Kirstenbosch and DSI-NRF Centre of Excellence for Invasion Biology. Stellenbosch. http://dx.doi.org/10.5281/zenodo.3947613

Sasidharan SP, Ludwig A, Harper C, Moodley Y, Bertschinger HJ and Guthrie AJ. 2011. Comparative genetics of sarcoid tumour-affected and non-affected mountain zebra (*Equus zebra*) populations. *South African Journal of Wildlife Research* 41(1): 36–49.

Secretariat of the Convention on Biological Diversity (CBD). 2020. Global Biodiversity Outlook 5. Montreal.

Shelton JM, Day JA and Impson ND. 2014. Preliminary evaluation of the impact of invasive smallmouth bass *Micropterus dolomieu* on native fish abundance in the Witte River, Cape Floristic Region, South Africa. African Zoology. 49: pp.277-282.

Skowno AL and Monyeki MS. 2021. South Africa's Red List of Terrestrial Ecosystems (RLEs). Land. 10: 1048. https://doi.org/10.3390/land10101048

Skowno AL, Poole CJ, Raimondo DC, Sink KJ, Van Deventer H, Van Niekerk L, Harris LR, Smith- Adao LB, Tolley KA, Zengeya TA, Foden WB, Midgley GF and Driver A. 2019a. National Biodiversity Assessment 2018: The status of South Africa's ecosystems and biodiversity. Synthesis Report. South African National Biodiversity Institute, an entity of the Department of Environment, Forestry and Fisheries, Pretoria. pp. 1–214. https://www.researchgate.net/publication/336345987

Skowno AL, Raimondo DC, Poole CJ, Fizzotti B and Slingsby JA (eds). 2019b. *South African National Biodiversity Assessment 2018 Technical Report Volume 1: 3.1 Terrestrial Realm*. South African National Biodiversity Institute. Pretoria. *https://www.sanbi.org/wp-content/uploads/2019/10/NBA-Report-2019.pdf*

Slingsby JA, Merow C, Aiello-Lammens, M, Allsopp N, Hall S, KilroyMollmann H, Turner R, Wilson AM and Silander J.A. 2017. Intensifying postfire weather and biological invasion drive species loss in a Mediterranean-type biodiversity hotspot. Proceedings of the National Academy of Sciences. 114:4697–4702.

Slingsby JA, Moncrieff GR and Wilson AM. 2020. Near-real time forecasting and change detection for an open ecosystem with complex natural dynamics. ISPRS Journal of Photogrammetry and Remote Sensing.166:15- 25.

Snijman DA (ed.). 2013. Plants of the Greater Cape Floristic Region, Vol. 2: the Extra Cape Flora. Strelitzia 30. South African National Biodiversity Institute. Pretoria.

Statistics South Africa. 2016. Community Survey 2016. Statistical release P0301. Pretoria. Statistics South Africa.

Strydom T, Nel JM, Nel, M, Petersen RM and CL Ramjukadh. 2021. The use of Radon (Rn222) isotopes to detect groundwater discharge in streams draining Table Mountain Group (TMG) aquifers. Water SA 47(2) 194–199. https://doi.org/10.17159/wsa/2021.v47.i2.10915

Taft JM, Maritz B and Tolley KA. 2022. Stable climate corridors promote gene flow in the Cape sand snake species complex (Psammophiidae). Zoologica Scripta. 51:58-75.

Tanner J, Mantel S, Paxton B, Slaughter A and Hughes D. 2022. Impacts of climate change on rivers and biodiversity in a water-scarce semi-arid region of the Western Cape, South Africa. Frontiers in Water. 4:949901. https://doi.org/10.3389/frwa.2022.949901

Taylor MR, Peacock F and Wanless RM (eds). 2015. *The 2015 Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland*. BirdLife South Africa, Johannesburg.

Thirion C. and Jafta N (eds). 2019. River Ecostatus Monitoring Programme State of Rivers Report 2017-2018. First version. Department of Water Affairs and Sanitation. RQS Report No N/0000/00/REMP/2019.

Tolley KA, da Silva J and Van Vuuren B. 2019a. Benefits, Trends and Risks to Genetic Diversity. Chapter 10 in National Biodiversity Assessment 2018 Technical Report Volume 1: Terrestrial Realm. Skowno AL, Raimondo DC, Poole CJ, Fizzotti B & Slingsby JA (eds). South African National Biodiversity Institute, Pretoria.

Tolley KA, Weeber J, Maritz B, Verburgt L, Bates MF, Conradie W, Hofmeyr MD, Turner AA, Da Silva JM and Alexander GJ. 2019b. No safe haven: protection levels show imperilled South African reptiles not sufficiently safe-guarded despite low average extinction risk. Biological Conservation. 233:61-72.

UN Environment. 2019. Global Environment Outlook – GEO-6: Healthy Planet, Healthy People. Nairobi. https://doi.org/10.1017/97811086271 46

Underhill LG, Loftie-Eaton M and Navarro R. 2018. Dragonflies and damselflies of the Western Cape – OdonataMap Report, August 2018. *Biodiversity Observations* 9.7: 1-21. https://journals.uct.ac.za/index.php/BO/article/view/643/554

UNODC. 2020. World Wildlife Crime Report. 2020: Trafficking in Protected Species. ISBN: 978-92-1-148349-9. United Nations Publication.

Van Deventer H, Smith-Adao L, Collins NB, Grenfell M, Grundling A, Grundling P-L, Impson D, Job N, Lötter M, Ollis D, Petersen C, Scherman P, Sieben E, Snaddon K, Tererai F and Van der Colff D. 2019. South African National Biodiversity Assessment 2018: Technical Report. Volume 2b: Inland Aquatic (Freshwater) Realm. CSIR report number CSIR/NRE/ECOS/IR/2019/0004/A. South African National Biodiversity Institute. Pretoria. https://www.researchgate.net/publication/339043444

Van Niekerk L, Adams JB, Lamberth SJ, MacKay CF, Taljaard S, Turpie JK, Weerts SP and Raimondo DC. (eds). 2019. South African National Biodiversity Assessment 2018: Technical Report. Volume 3: Estuarine Realm. CSIR report number CSIR/SPLA/EM/EXP/2019/0062/A. South African National Biodiversity Institute. Pretoria. Report Number: SANBI/NAT/NBA2018/2019/Vol3/A. http://hdl.handle.net/20.500.12143/6373. SANBI and C•I•B. 2020. The status of biological invasions and their management in South Africa in 2019. pp.71.

Van Rooyen E, Paap T, Beer WD, Townsend G, Fell S, Nel WJ, Morgan S, Hill M, Gonzalez A and Roets F. 2021. The polyphagous shot hole borer beetle: Current status of a perfect invader in South Africa. South African Journal of Science. 117:1-10.

Van Wilgen BW. 1987. Fire regimes in the Fynbos Biome. In: Cowling Rm, Le Maitre DM, McKenzie B, Prys-Jones RP and van Wilgen BW. (eds). 1987. Disturbance and the dynamics of fynbos biome communities. South African National Scientific Programmes Report no 135, CSIR, Pretoria.

Van Wilgen BW and Richardson DM. 1985. The effects of alien shrub invasions on vegetation structure and fire behaviour in South African fynbos shrublands: a simulation study. Journal of applied Ecology. 1:955-66.

Van Wilgen BW and Scott DF. 2001. Managing fires on the Cape Peninsula, South Africa: dealing with the inevitable. Journal of Mediterranean Ecology. 2:197-208.

Woodford DJ, Impson ND, Day JA and Bills IR. 2005. The predatory impact of invasive alien smallmouth bass, *Micropterus dolomieu* (Teleostei: Centrarchidae), on indigenous fishes in a Cape Floristic Region mountain stream. African Journal of Aquatic Science. 30: 167-173.

WWF. 2019. Understanding groundwater at the Breede River source – information collation towards monitoring and sustainable use around the Titus River. World Wildlife Fund. South Africa. Cape Town.

Zachariades C, Paterson ID, Strathie LW, Van Wilgen BW and Hill MP. 2017. Assessing the status of biological control as a management tool for suppression of invasive alien plants in South Africa. Bothalia-African Biodiversity & Conservation. 47:1-19.

Zengeya TA, Kumschick S, Weyl OLF and van Wilgen BW. 2020. An evaluation of the impacts of alien species on biodiversity. In: van Wilgen BW, Measyey J, Richardson DM, Wilson JR and Zengeya TA. (eds). 2020. South Africa using different assessment methods. Biological invasions in South Africa. Invading Nature. Springer Series in Invasion Ecology 14: 489. https://doi.org/10.1007/978-3-030-32394-3

De Hoop Nature Reserve – Cape mountain zebra
*(Equus zebra zebra)* © Scott Ramsay

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