HEXRIVER COMPLEX

PART OF THE
CAPE FLORAL REGION PROTECTED AREAS WORLD HERITAGE SITE
Western Cape, South Africa

Protected Area Management Plan 2021 – 2031

DATE APPROVED: [Date]

MOST RECENT UPDATE: 19 February 2021

CapeNature

Western Cape Government
Environmental Affairs and Development Planning

environment, forestry & fisheries
Department:
Environment, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

United Nations Educational, Scientific and Cultural Organization

World Heritage Convention

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CITATION
CapeNature. 2021. Hexriver Complex: Protected Area Management Plan 2021-2031. Internal Report, CapeNature. Cape Town.

AUTHORISATIONS

In terms of section 41(4) the Minister hereby approves part of the Protected Area Management Plan for the Hexriver Complex designated as World Heritage Sites (See Table 2.1).

TITLE	NAME	SIGNATURE	DATE
NATIONAL MINISTER: Environment, Forestry and Fisheries	Ms Barbara Creecy		

In terms of section 41(4) the MEC hereby approves part of the Protected Area Management Plan for the Hexriver Complex designated as state forest managed by CapeNature as protected areas (everything not included above – see Table 2.2).

TITLE	NAME	SIGNATURE	DATE
PROVINCIAL MINISTER: Department of Environmental Affairs and Development Planning	Mr Anton Bredell	Anton Bredell Digitally signed by Anton Bredell Date: 2021.07.29 10:02:40 +02'00'	

Recommended:

TITLE	NAME	SIGNATURE	DATE
CHAIRPERSON OF THE BOARD: Western Cape Nature Conservation Board	Assoc Prof Denver Hendricks		6 March 2021
CHIEF EXECUTIVE OFFICER: CapeNature	Dr Razeena Omar		5 March 2021

Review Date: 10 years from the date of approval by the MEC or Minister.

ACKNOWLEDGEMENTS

Stakeholders are thanked for their participation and contribution to the development of this management plan.

The reserve management committee, comprising of Rika du Plessis, Antoinette Veldtman, Alana Duffell-Canham, Martin Albertus, Arnelle Collison and Michael Lewis, with significant inputs from the following persons and components, prepared this management plan:

- Amukelani Nkuna (support in drafting the document as former Landscape Manager)
- Ruida Pool-Stanvliet (vegetation)
- AnneLise Schutte-Vlok (Fire)
- Jeanne Gouws (freshwater ecosystems)
- Andrew Turner and Atherton de Villiers (amphibians and reptiles)
- Martine Jordaan (freshwater fish; mammals)
- Kevin Shaw (avifauna)
- Melanie Esterhuyse (CEO, Hex Valley Tourism Association) and Bertdene Laubscher (Togryers Museum, Ceres) (Heritage context)
- Arnelle Collison and Garth Mortimer (expansion strategy)
- Therese Forsyth (sensitivity, zonation and zone of influence)
- Sheila Henning (maps and GIS support)
- Ramese Williams (Concept Development Plan)
- Dian Dreyer (Invasive alien plants)
- Peter Viljoen (Fire operations)
- All contributors of photos

Rika du Plessis (CapeNature – Conservation Manager - On Reserve) is thanked for internal review.

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Cover page image courtesy of the field rangers of the Hexriver Complex. Insert: *Leucadendron rubrum* - Rika du Plessis.

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GLOSSARY

Derived from: Conservation Measures Partnership (CMP) 2020.

Term	Explanation
Adaptive Management	The incorporation of a formal learning process into conservation action to reduce uncertainty in decision-making. Specifically, it is the integration of knowledge, management, and monitoring, to provide a framework to systematically and efficiently test assumptions, promote learning, and supply timely information for management to make decisions and adjust actions based on outcomes of monitoring. The *Conservation Standards* explicitly bring adaptive management principles into conservation practice.
Factor	A generic term for an element of a conceptual model including direct and indirect threats, opportunities, and associated stakeholders. It is often advantageous to use this generic term since many factors – for example tourism – could be both a threat and an opportunity. Also known as root causes or drivers.
Conservation Target	An element of biodiversity (natural value) or heritage (cultural value) of the Complex, which can be a species, habitat, ecological system, or heritage feature, that management strives to protect, and threats towards which management should strive to minimise. All focal conservation targets at a site should collectively represent the biodiversity and heritage features of concern at the site.
Human Well-being Value	In the context of a conservation project, human well-being values are those components of human well-being affected by the status of conservation targets. All human well-being values at a site should collectively represent the array of human well-being needs dependent on the conservation targets.
Goal	A formal statement detailing a desired impact of a project, such as the desired future status of a target. A good goal meets the criteria of being *linked to targets*, *impact oriented*, *measurable*, *time limited*, and *specific*.
Indicator	A measurable entity related to a specific information need such as the status of a value / factor, change in a threat, or progress toward an objective, or association between one or more variables. A good indicator meets the criteria of being: *measurable*, *precise*, *consistent*, and *sensitive*.
Key (Ecological) Attribute	An aspect of a focal target's biology or ecology that if present, define a healthy focal target and if missing or altered, would lead to the outright loss or extreme degradation of that focal target over time.
Objective	A formal statement detailing a desired outcome of a project such as reducing a critical threat. A good objective meets the criteria of being: *results oriented*, *measurable*, *time limited*, *specific*, and *practical*. If the project is well conceptualized and designed, realization of a project's objectives should lead to the fulfilment of the project's goals and ultimately its vision. Compare to vision and goal.
Results Chain	A visual diagram of management's theory of change. A results chain includes core assumptions and the logical sequence linking interventions to one or more values. In scientific terms, it lays out hypothesized relationships or theories of change.
Vision	A description of the desired long-term future or ultimate condition that stakeholders see, and management strives to achieve for the Complex.
Heritage Resources	Means any place or object of cultural significance as per the National Heritage Resources Act, 1999 (Act No. 25 of 1999).

Term	Explanation
Living Heritage	Means the intangible aspects of inherited culture, and may include— (a) cultural tradition; (b) oral history; (c) performance; (d) ritual; (e) popular memory; (f) skills and techniques; (g) indigenous knowledge systems; and (h) the holistic approach to nature, society and social relationships; in terms of the Heritage Resources Act, 1999 (Act No. 25 of 1999).
Situation Analysis	The purpose of a situation analysis is to understand the relationships between the biological environment and the social, economic, political, and institutional systems, associated stakeholders and drivers that affect the Focal conservation targets of the Complex.

ACRONYMS AND ABBREVIATIONS

ASPT	Average Score Per Taxon
BVLM	Breede Valley Local Municipality
CBA	Critical Biodiversity Area
CCNET	Conservation Coaches Network
CFR	Cape Floristic Region
CFRPA	Cape Floristic Region Protected Areas
CITES	The Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMP	Conservation Measures Partnership
CSIR	Council for Scientific and Industrial Research
CWDM	Cape Winelands District Municipality
DEA	Department of Environmental Affairs (Old National)
DEAT	Department of Environmental Affairs and Tourism (Old National)
DEFF	Department of Environment, Forestry and Fisheries (New National)
DTPW	Department of Transport and Public Works (Provincial)
EPWP	Expanded Public Works Programme
ESA	Ecological Support Area
FEPA	Freshwater Ecosystem Priority Area
GIS	Geographical Information System
ICM	Integrated Catchment Management
IDP	Integrated Development Plan
IUCN	International Union for Conservation of Nature
MEC	Member of Executive Council
METT-SA	Management Effectiveness Tracking Tool - South Africa
MTEF	Medium Term Expenditure Framework
NEMA	National Environmental Management Act
NEM: BA	National Environmental Management: Biodiversity Act
NEM: PAA	National Environmental Management: Protected Areas Act
NFEPA	National Freshwater Ecosystem Priority Area
NPAES	National Protected Area Expansion Strategy
NRM	Natural Resource Management
PAAC	Protected Area Advisory Committee

PAES	Protected Areas Expansion Strategy
SANBI	South Africa National Biodiversity Institute
SANSA	South African National Survey of Arachnida
SDF	Spatial Development Framework
SG	Surveyor-General
UAMP	User Asset Management Plan
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WCPAES	Western Cape Protected Area Expansion Strategy
WLM	Witzenberg Local Municipality

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EXECUTIVE SUMMARY

In compliance with the National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003) and Chapter 4 of the World Heritage Convention Act, 1999 (Act No. 49 of 1999), the management authority of a protected area is required to develop management plans for each of its protected areas. The National Minister is authorised under section 25(1) of the World Heritage Convention Act, 1999 (Act No. 49 of 1999) to approve the management plan for a protected area so nominated, or declared under the World Heritage Convention Act, 1999 (Act No. 49 of 1999). Both the National Minister and MEC in a particular province has concurrent jurisdiction to approve a management plan for a protected area submitted under section 39(2) of the National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003). In developing the management plan for the Hexriver Complex, CapeNature as the management authority strives to establish biodiversity conservation as a foundation for a sustainable economy, providing ecosystem services, access and opportunities for all.

An overview of the Hexriver Complex

The Hexriver Complex is situated in the Western Cape, South Africa and is approximately 19 301 hectares. The Complex comprises five protected areas, namely the Bokkeriviere Nature Reserve in the east, the Ben-Etive- and Fonteintjiesberg Nature Reserves in the central and the Wittebrug Nature Reserve and Witzenberg Nature Reserve in the west of the Hexriver Mountain range. It forms part of the North-western and Karoo Mountain phytogeographical centres of endemism, each of which is delimited by high numbers of plant species endemic to each centre (Goldblatt & Manning 2000).

The Hexriver Complex was inscribed by the World Heritage Convention, United Nations Educational, Scientific and Cultural Organisation (UNESCO) in 2015 as a part of the Cape Floristic Region Protected Areas World Heritage Site extension. The latter comprises a serial property of 13 protected areas covering a total area of 1 135 486.46 hectares. Several additional properties have since been acquired for conservation purposes in order to expand and consolidate the protected area network. A buffer zone of approximately 1 315 000 hectares designed to facilitate functional connectivity and provide resilience to global climate change effects and other anthropogenic influences has also been identified. The Hexriver Complex is supported and buffered by a network of adjacent or nearby conserved areas ranging from Provincial Nature Reserves to Private Nature Reserves, local authority nature reserves, stewardship sites and Mountain Catchment Areas.

The Hexriver Complex represents outstanding examples of significant ongoing ecological and biological processes in the evolution of terrestrial ecosystems and plant communities such as a natural fire regime, and natural flow of water through the area supporting unique indigenous freshwater fish assemblages and agricultural sectors, and connectivity for species migration, gene flow, dispersal, etc. In addition, the Complex contains important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value.

Moreover, the Hexriver Mountain Catchment Areas spans three discrete catchments and is identified as one of South Africa's national Strategic Water Source Areas. These catchments provide water for the City of Cape Town and most of the towns and settlements of the surrounding Overberg, Bergrivier, Drakenstein, Witzenberg and West Coast municipalities.

Planning, Policy, Implementation and Review

The Open Standards for the Practice of Conservation is a Strategic Adaptive Management framework that is robust, yet flexible, multi-disciplinary in approach, and inclusive of internal and external stakeholders, as well as the public at large. It enables management teams to develop effective conservation plans, based on the best available traditional, expert and scientific information. Furthermore, it promotes stakeholder and public engagement throughout the planning and implementation phase of the management plan. Key to this process is identifying the ecological and human well-being values representative of the protected area, determining what state they are in, and what threats they face. This forms the basis for establishing clear goals, strategies and objectives that are time bound.

This management plan provides the basis for the management, development and operation of the Hexriver Complex over a timeframe of 10 years. The implementation of the management plan is subject to available resources, legislation, regulations, policies and guidelines to ensure and promote sound financial and biodiversity management, effective compliance, safety and good neighbour relations to promote sustainable access to the reserve.

Fundamental to implementation is pursuing the achievement of conservation outcomes and regular review thereof. Strategic Adaptive Management integrates planning, management and monitoring, and is used to systematically evaluate results, thus enabling management to "change direction" when required. Key to this process is the sharing of results, respectfully, honestly and transparently to facilitate learning through critical appraisal of conservation efforts. CapeNature uses an internationally recognised review system - The Management Effectiveness Tracking Tool for South Africa, adopted by the National Department of Environment, Forestry and Fisheries, to assess the management effectiveness of all its protected areas at a strategic level. Additionally, mechanisms for monitoring and evaluation are built into each aspect highlighted in the strategic plan.

Purpose, Vision and Desired State

CapeNature manages the Hexriver Complex in accordance with its organisational vision, and in agreement with the vision, goals and strategies derived through the planning process. The vision of the Complex is:

"The Hexriver Complex is a montane World Heritage Site, supporting landscape connectivity, where ecological resilience is achieved through catchment management in collaboration with stakeholders."

Protected area values include healthy catchments, providing ecosystem services and human well-being benefits. Two focal conservation targets that incorporate several nested aspects have been selected for the Hexriver Complex. These include

Freshwater Ecosystems and Terrestrial Ecosystems. Freshwater Ecosystems comprise of all natural, seasonal rivers and riparian zones, streams, lowland and high-altitude wetlands (including wetland buffers), seeps and groundwater. It further includes freshwater invertebrate and fish communities (especially *Galaxias* sp. nov. 'breede' (Endangered)), and priority small mammal species (e.g. the Laminate vlei rat (Near Threatened) and the Cape march rat (Vulnerable)). Terrestrial Ecosystems comprises the terrestrial vegetation that consists of nine distinct vegetation types of which two are of conservation concern, namely Breede Alluvium Fynbos (Endangered) and Ceres Shale Renosterveld (Vulnerable). Furthermore, it contains all associated priority faunal species like small mammal-, bird- and insect species (e.g. the Spectacled dormouse (Near Threatened) and White-tailed mouse (Vulnerable), Verreaux's Eagle, *Colophon* beetles (specifically *Colophon haughtoni* (Endangered), *C. cameroni* (VU) and *C. kawaii* (not listed)).

As the public entity responsible for biodiversity conservation in the Western Cape Province, CapeNature delivers a suite of core services to the public in support of the following outcomes: resilient ecosystems; the promotion of local economic development; job creation and skills development; growing diversified nature-based revenue streams; access to environmental education, advocacy and education; and access to natural and cultural heritage. Three focal human well-being values have been identified for the Hexriver Complex. These include:

- Water security and environmental resilience;
- Responsible utilisation of natural resources; and
- Respect and care for the natural environment.

Six goals have been formulated to maintain or enhance the focal conservation targets and human well-being values of the Hexriver Complex. These are:

1. By 2031, the upper and middle river reaches in the Hexriver Complex support macro invertebrate species communities with an ASPT of 6 - ≥8, and viable indigenous fish communities are present in on-reserve rivers identified for fish conservation.
2. By 2031, the health of the wetland ecosystems in the Hexriver Complex will be in at least a near-natural condition, and riparian zones and wetland buffers will have an indigenous vegetation cover of at least 75-89%.
3. By 2031, the terrestrial ecosystems in the Hexriver Complex have an ecologically healthy fire regime and comprises >85% indigenous species.
4. By 2031 the Hexriver Complex will, through integrated catchment management, protect and enhance the provision of water quality and quantity contributing to the water resilience for the Berg, Breede and Gouritz catchment areas.
5. By 2031, access to, and utilisation of, natural resources within the Hexriver Complex are in accordance with CapeNature policy and procedures.
6. By 2031, the Hexriver Complex environmental education, awareness and interpretation programme will promote all ecological and human well-being values.

Threats

Threats that contribute towards degradation or destruction of the Hexriver Complex focal conservation targets were identified and unpacked in a conceptual model to illustrate the current conservation situation and to guide the formulation of mitigating strategies. The main threats to the focal biodiversity values of the Hexriver Complex were identified as:

- Inappropriate fire regime;
- Invasive alien plants;
- Unauthorised access;
- Illegal utilisation of natural resources;
- Inappropriate practices on adjacent properties;
- Invasive alien fish;
- Instream structures;
- Over abstraction of surface water; and
- Climate change.

To assist the Hexriver Complex to mitigate and manage threats and contributing factors effectively, both inside and outside the reserve boundaries, the reserve will incorporate spatial planning tools that include the **Sensitivity, Zonation and Zone of Influence.**

Strategic Plan

A thorough analysis of the Hexriver Complex's conservation situation, inclusive of the biological, social, economic, cultural and institutional systems that affect the protected area's focal conservation targets, formed the basis for developing conservation strategies and action plans. The aim was to identify opportunities and strategic points where intervention is feasible and likely to have the biggest positive impact towards achieving goals. CapeNature will lead the implementation of the management plan, although achieving the Complex's vision requires coordinated effort between various key external stakeholders. Four key strategies have been identified to assist the Hexriver Complex. These are:

Strategy 1: Implement fire and invasive alien species management in the Hexriver Complex to abate the negative impact that invasive alien species has on fire regime, biodiversity and water availability.

Strategy 2: Address illegal and un-sustainable resource utilisation (unauthorised access and poaching) within the Hexriver Complex.

Strategy 3: Enhance and raise awareness of ecological targets of the Hexriver Complex.

Strategy 4: Support sustainable tourism-based livelihoods in partnership with role players in the Hexriver Complex.

1 INTRODUCTION

In working towards CapeNature's vision of conserving nature for a sustainable future, CapeNature's protected area management, in accordance with the purpose of the protected area, strives to:

- Conserve and represent natural habitats and indigenous biodiversity including threatened species for their scientific and conservation value in the Western Cape Province;
- Conserve representative samples of significant ongoing ecological processes in the evolution and development of ecosystems and communities of plants and animals;
- Provide ecosystem services that benefit people of the Western Cape;
- Manage protected areas effectively and efficiently, including the interrelationships between biophysical, social and economic environments;
- Ensure that protected area planning and management is integrated and participatory; and
- Provide for sustainable use and equitable access.

The management plan provides a strategic adaptive management framework for the protected area, guided by the Open Standards for the Practice of Conservation (hereafter referred to as the Conservation Standards) (CMP 2020) adaptive management paradigm. The Conservation Standards is dependent upon and promotes stakeholder engagement and participatory planning in the development of the plan. The framework further stimulates the incorporation of mechanisms to facilitate stakeholder engagement and participation during operationalisation of the plan.

The Hexriver Complex protected area management plan serves as a reference to the management and development of the Complex in its current and envisaged future state. It directs management at all levels. The management plan addresses:

- The mandate, human capacity and financial resources that are required to meet goals and objectives based on the condition of natural and cultural values, and core service areas requiring a focused effort;
- The delivery of socio-economic benefits to neighbouring communities;
- Flexibility of service delivery that encourages innovation and involvement by a wide range of government, community and non-government sectors;
- Performance indicators and accountability measures that provides for regular review and adaptive management.

2 LEGAL STATUS AND BACKGROUND

This section provides a record of the legal status of the protected area, as well as its description, location and includes any areas designated by South Africa in terms of international agreements. Furthermore, it also provides an overview of the biophysical, biodiversity, heritage and socio-economic context.

2.1 Legal Status

2.1.1 Name and legal designations

The Hexriver Complex comprises the following, using the terminology as indicated in the declarations according to the Nature Conservation Ordinance, National Forest Act, 1998 (Act No. 84 of 1998) and National Environmental Management: Protected Areas Act (NEM: PAA), 2003 (Act No. 57 of 2003) and as reflected on the Protected Areas Register held by the Department of Environment, Forestry and Fisheries (DEFF):

- Wittebrug Nature Reserve
- Fonteintjiesberg Nature Reserve
- Bokkeriviere Nature Reserve
- Ben-Etive Nature Reserve
- Witzenberg Nature Reserve

The following components form part of the World Heritage Site and was inscribed by UNESCO as part of the 2015 extension to the Cape Floral Region Protected Areas (CFRPA) World Heritage Site, but not yet declared:

- Wittebrug Nature Reserve
- Fonteintjiesberg Nature Reserve
- Bokkeriviere Nature Reserve
- Ben-Etive Nature Reserve

A full list of the declarations and status of land appears in Table 2.1 and Table 2.2.

2.1.2 Contractual agreements

Hexriver Complex currently do not have land that is contractually included into the Complex.

Land parcels that comprise the Hexriver Complex are listed in Table 2.1 and Table 2.2.

Table 2.1. Land parcels in the Hexriver Complex that comprise World Heritage Sites inscribed by UNESCO, but not proclaimed.

Title Deed	Farm name	Farm No.	Portion No.	Extent (ha)	Registration Division	SG Code	Landowner	Proclamation Date	Proclamation No.	Govt. Gazette	Status
Wittebrug Nature Reserve											
Unregistered State Land	Talls Berg	280	0	26.86	Tulbagh	C07500000000028000000	Republic of South Africa	Not available	Not available	Not available	State Forest Nature Reserve
T9700/1962	Donker Kloof Forest Reserve	293	0	519.65	Tulbagh	C07500000000029300000	Republic of South Africa	11 August 1915	869 of 1915	673	State Forest Nature Reserve
Unregistered State Land	Paarde Kraal Forest Reserve	292	0	590.07	Tulbagh	C07500000000029200000	Republic of South Africa	11 August 1915	869 of 1915	673	State Forest Nature Reserve
T19881/2010	Remainder of Erf 1886, Ceres	1886	0	469.86	Ceres	C01900010000188600000	Republic of South Africa	Not available	Not available	Not available	State land released from state forest on 12 July 2006
Fonteintjiesberg Nature Reserve											
T81726/2007	Fonteintjiesberg	189	0	3982.97	Worcester	C08500000000018900000	Provincial Government of the Western Cape	Not available	Not available	Not available	State land released from state forest on 12 July 2006
Ben-Etive Nature Reserve											
T19881/2010	Ben Etive	385	0	5088.93	Ceres	C01900000000038500000	Republic of South Africa	23 December 1977	2579 of 1977	5837	State land released from state forest on 12 July 2006
Bokkeriviere Nature Reserve											
Unregistered State Land	Farm 346	346	0	1012.43	Ceres	C01900000000034600000	Republic of South Africa	Not available	Not available	Not available	State Forest Nature Reserve
T19881/2010	Farm 354	354	0	427.41	Ceres	C01900000000035400000	Republic of South Africa	Not available	Not available	Not available	State Forest Nature Reserve
T19881/2010	Portion 1 of the farm Karbonaatjes Kraal No. 38	38	1	353.28	Worcester	C08500000000003800001	Republic of South Africa	Not available	Not available	Not available	State land released from

Title Deed	Farm name	Farm No.	Portion No.	Extent (ha)	Registration Division	SG Code	Landowner	Proclamation Date	Proclamation No.	Govt. Gazette	Status
											state forest on 12 July 2006
T19881/2010	Farm 355	355	0	2760.64	Ceres	C01900000000035500000	Republic of South Africa	Not available	Not available	Not available	State land released from state forest on 12 July 2006
T210/1888	Witte Berg	40	0	1568.45	Worcester	C08500000000004000000	Republic of South Africa	4 November 1977	2282 of 1977	5794	State land released from state forest on 12 July 2006
T8488/1896	Bokke Rivier	353	Portion of 353	260.80	Ceres	C01900000000035300000	Republic of South Africa	Not available	Not available	Not available	State land released from state forest on 12 July 2006
T8488/1896	Bokke Rivier	353	Portion of 353	587.41	Ceres	C01900000000035300000	Republic of South Africa	Not available	Not available	Not available	State land released from state forest on 12 July 2006

Table 2.2. Land parcels in the Hexriver Complex that comprise State Forest Nature Reserves not included in the World Heritage Site nomination.

Title Deed	Farm name	Farm No.	Portion No.	Extent (ha)	Registration Division	SG Code	Landowner	Proclamation date	Proclamation No.	Govt. Gazette	Status
Witzenberg Nature Reserve											
Unregistered State Land	Bothass Berg	230	0	386.60	Tulbagh	C07500000000023000000	Republic of South Africa	21 November 1914	1923 of 1914	609	State Forest Nature Reserve
Unregistered State Land	Neethlings Berg	231	0	485.62	Tulbagh	C07500000000023100000	Republic of South Africa	21 November 1914	1923 of 1914	609	State Forest Nature Reserve

Unregistered State Land	Boontjies Riviers Berg	263	0	507.22	Tulbagh	C07500000000026300000	Republic of South Africa	21 November 1914	1923 of 1914	609	State Forest Nature Reserve
Unregistered State Land	Schalken Berg	228	0	267.64	Tulbagh	C07500000000022800000	Republic of South Africa	21 November 1914	1923 of 1914	609	State Forest Nature Reserve

2.1.3 Location, extent and highest point

The Hexriver Complex is situated in the Western Cape Province of South Africa. It lies to the southeast of the Cederberg and Groot Winterhoek Complexes, to the North of the Boland Mountain Complex and to the North-west of the Langeberg Complex. The Hexriver Complex covers an area of approximately 19 301 hectares and comprises five protected areas, namely the Bokkeriviere Nature Reserve in the east (6 975.92 hectares), the Ben-Etive- (6 975.92 hectares) and Fonteintjiesberg (3 982.97 hectares) Nature Reserves in the central and the Wittebrug- (1 606.43 hectares) and Witzenberg Nature Reserves (1 647.08 hectares) in the west of the Hexriver Mountain range.

The area is bordered by the N1 to the Southeast running between Worchester and De Doorns, and the R43 running from Worcester towards the Northwest and then through the northern section of Wittebrug Nature Reserve via Michell's Pass. The R43 continues through Ceres in a north-easterly direction. The Koue Bokkeveld borders the north of the Complex (Appendix 1 Map 1).

Matroosberg Peak is the highest point in the Hexriver Complex at 2 249 meters above sea level. It is also the second highest point in the Western Cape after Seweweekspoort Peak (2 324.9 meters above sea level) in the Swartberg Mountain Range.

The location and extent of the Hexriver Complex is illustrated in Appendix 1 Map 1.

2.1.4 Municipal jurisdiction

The Hexriver Complex is situated within the following district and local municipal boundaries:

- Cape Winelands District Municipality
    - Witzenberg Municipality
    - Breede Valley Municipality

Municipalities within which the Hexriver Complex occurs are illustrated in Appendix 1 Map 1.

2.1.5 International, national and provincial listings

UNESCO World Heritage Site:

The Hexriver Complex is inscribed as part of the proposed extension to the CFRPA World Heritage Site. The CFRPA World Heritage Site comprises a serial property of eight initial protected areas with thirteen in the latest extension, covering a total area of approximately 1 135 486.46 hectares. It includes a buffer zone of 1 315 000 hectares designed to facilitate functional connectivity and provide resilience to global climate change effects and other anthropogenic influences (DEA 2015).

The Hexriver Complex represents outstanding examples of significant ongoing ecological and biological processes in the evolution of terrestrial ecosystems and plant communities (DEAT 2003), a natural fire regime and natural flow of water through the area, supporting unique indigenous freshwater fish assemblages and agricultural sectors, and connectivity for species migration, gene flow, dispersal, etc.

The Hexriver Complex contains important and significant natural habitats for *in-situ* conservation of biological diversity, including those containing threatened species of

outstanding universal value (DEAT 2003). The Complex is a centre of endemism for plants, amphibians, small mammals and importantly, endemic and threatened freshwater fish.

2.2 Biophysical Description

2.2.1 Climate

The Hexriver Complex falls within the winter rainfall region in the Western Cape Province. Precipitation occurs mainly in the form of rainfall and the wettest three consecutive months are June, July and August. The rainfall in the area averages between 200 mm in the eastern parts (Touws River and Worcester) and 1000 mm per annum in the western sections (Ceres and Wolseley). Rainfall is supplemented by fog, mist and snowfall. Mist occurs frequently during winter at approximately 500 meter above sea level. Frequent snowfalls occur on the high peaks in the Hexriver Complex during winter, with Matroosberg Peak often covered by snow in winter (Fig. 2.1).

The Hexriver Complex winter weather is dominated by the arrival of successive low-pressure frontal systems that brings lower temperatures and pressures. These systems are preceded by northwest winds, which bring cold wet weather. High-pressure systems during the summer months cause the dominant southeast winds, which may get to gale force. These southeast winds are dry and influence the fire risk considerably by desiccating the vegetation.

The average maximum temperature ranges from the low forties in February to low thirties in August. The average minimum temperature ranges from low teens in February to just above 0ºC in August. Average yearly temperatures fall below 10ºC on the high lying areas.

The mean annual temperature of the Hexriver Complex is shown in Figure 2.2 and the mean annual rainfall in Figure 2.3.

Figure 2.1. Snow on Matroosberg. (Photo: Arnelle Collison).

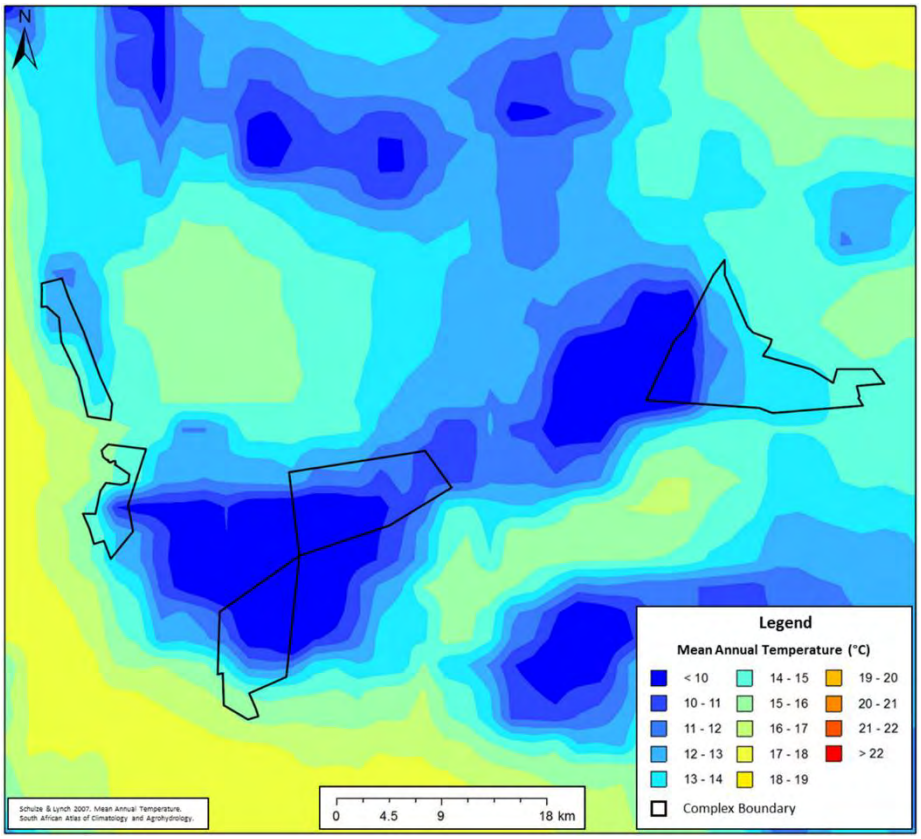


Figure 2.2. Mean annual temperature of the Hexriver Complex.

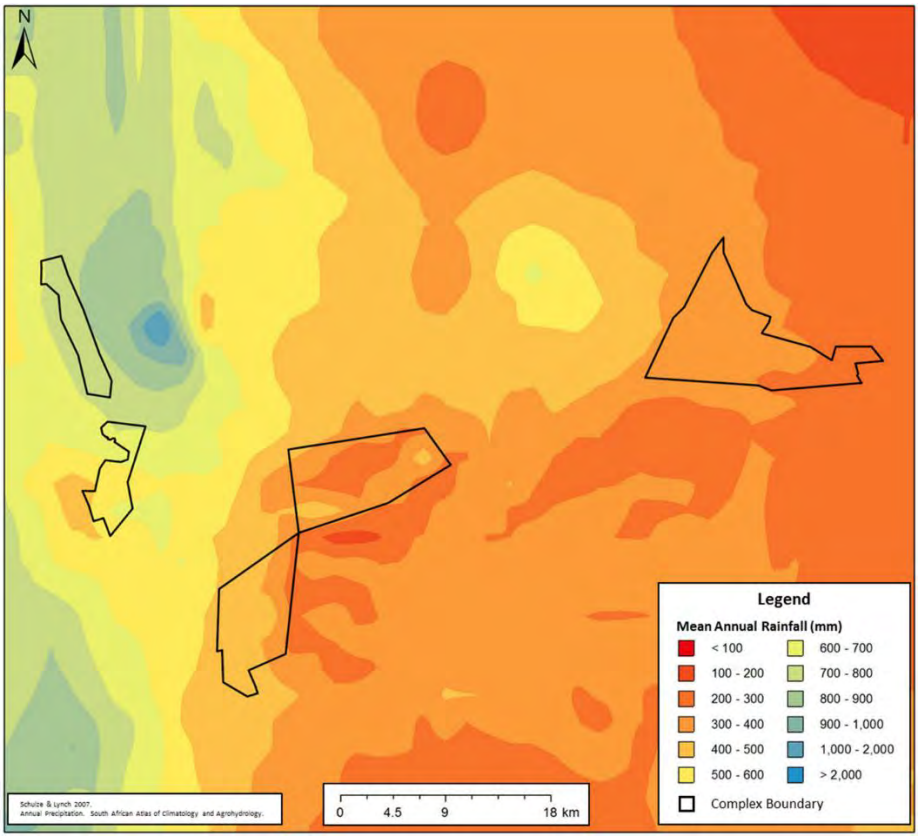


Figure 2.3. Mean annual rainfall of the Hexriver Complex.

2.2.2 Topography

The Hexriver Complex forms part of the Cape fold belt which is an extensive mountain chain of highly folded landforms formed as a result of continental collisions during the assemblage of Gondwana between 280 and 215 million years ago (Bradshaw & Cowling 2014). Denudation of the less erosion-resistant lithology exposed the more erosion-resistant lithology and ultimately shaped the topography of the Hexriver Complex through the formation of a rugged mountain terrain characterised by incised valleys and elevated mountain peaks (Figure 2.4; Appendix 1 Map 2). The altitude above sea level varies from 285m to 2249m at Matroosberg Peak. Some of the other high points are the Mostertshoek Twins Peak (2 031 m) and Sentinel Peak (2 059 m).

Figure 2.4. Colonial peak at Bokkeriviere Nature Reserve in the Hexriver Complex. (Photo: Hexriver Complex Field Rangers).

2.2.3 Geology and soils

The underlying geology of the Hexriver Complex comprises of quartzitic sandstone from the Table Mountain Group, along with quartzitic sandstone and minor shale from the Nardouw sub-group to the north and phyletic shale, greywacke, limestone and arenite from the Porterville formation in the south and west (Table 2.3, Appendix 1 Map 3). These geological formations result in river systems typical of the Cape region that are characterised by clear water and substrates consisting of sandstone rock, -cobbles and -boulders.

The Breede River biophysiographic region lies south-east of the northern limit of the Cape Fold Belt of mountains that dominate the Capensis Region. The mountains were formed by up thrust and folding of the sedimentary rocks and subsequent extensive faulting. The drainage follows fault lines and angular lines of weakness in the sandstone beds, giving rise to a typical rectangular pattern. The area is formed almost entirely of the sedimentary rocks of the Table Mountain Group within the Ordovician to Devonian Cape Supergroup, with some remnants of the older Malmesbury shale's and a transition to the younger Bokkeveld formations. Four formations of the Cape

Supergroup are represented in the area (Table 2.3, Appendix 1 Map 3). The dominant lithological class in the biophysiographic region is Quartzitic sandstone with minor shale and conglomerate lenses (Appendix 1 Map 3). The quartzitic sandstones are relatively resistant to weathering, the shales of the shale bands less so. The Bokkeveld group, another group of the Cape Supergroup, is again rich in nutrients and fossils and occurs from place to place at the foot of the Hex River Mountain.

Table 2.3 and Appendix 1 Map 3 shows the lithostratigraphy of the Hexriver Complex.

Table 2.3. Lithostratigraphy of the Hexriver Complex.

Supergroup / age	Group/age	Subgroup	Formation	Description	Map code
Palaeozoic	Bokkeveld	Ceres		Three sandstone and three shale units.	Dc
		Biedouw		Three shale units separated by two sandstone units.	Dbi
	Malmesbury	Boland	Brandwacht	Greywacke, pelite, conglomerate, volcanic rocks.	Nbr
			Porterville	Phyllitic shale, greywacke, limestone, arenite.	Npt
			Norree	Phyllite, greywacke quartzite, limestone, dolomite, "grit".	Nnr
	Table Mountain Group			Quartzitic sandstone.	O-Dt1
		Nardouw		Quartzitic sandstone, minor shale.	S-Dn

2.3 Biodiversity Context: Ecosystems

The Hexriver Complex is situated in the Greater Cape Floristic Region and forms part of the CFRPA World Heritage Site. The Hexriver Complex is part of the North-western and Karoo Mountain phytogeographical centres of endemism, each of which is delimited by high numbers of plant species endemic to each centre (Goldblatt & Manning 2000).

2.3.1 Vegetation

The Core Cape Subregion (previously termed the Cape Floristic Kingdom) has a flora that differs sharply from the immediate surrounds (Manning & Goldblatt 2012). The Hexriver Complex falls fully within the Core Cape Subregion (Manning & Goldblatt 2012). This Subregion is one of the world's smallest but richest floral kingdoms, encompassing a land area of approximately 90 760 km² (less than 4% of the southern African subcontinent). An estimated 9 383 species of vascular plants (ferns and other spore-bearing vascular plants, gymnosperms, and flowering plants) are known to occur here, of which just over 68% are endemic. The majority of these species are flowering plants. The Core Cape Flora of the Greater Cape Floristic Region is characterised by six endemic or near-endemic families and by the conspicuous

presence of Asteraceae and Fabaceae (two largest families), and the Iridaceae, Aizoaceae, Ericaceae, Proteaceae, and Restionaceae (Manning & Goldblatt 2012). The Core Cape Subregion is notable for its range of ecosystems ranging from coastal foredunes through strandveld, lowland and mountain fynbos.

The vegetation of the area has been mapped nationally at a 1:1 000 000 scale (Mucina & Rutherford 2006; SANBI 2006). The original 2006 national vegetation map (Mucina & Rutherford 2006) was recently updated with substantive changes to vegetation units in the Namaqualand area and the Subtropical Thicket vegetation units in the Western Cape and Eastern Cape Provinces (SANBI 2006). According to this map a total of ten different vegetation units occurs within the Hexriver Complex. These are listed in Table 2.4 and illustrated in Appendix 1 Map 4.

South Africa recognises that different ecosystems have differing species compositions and to effectively conserve biodiversity, the country has set targets for each ecosystem (see Table 2.4). The biodiversity target is the minimum proportion of each ecosystem type that needs to be kept in a natural or near-natural state over the long term to maintain viable representative samples of all ecosystem types and the majority of species associated with those ecosystems. The biodiversity target is calculated based on species richness, using species–area relationships, and varies between 16% and 36% of the original extent of each ecosystem type (Desmet & Cowling 2004).

Threat status is provided for each ecosystem (see Table 2.4). Ecosystem threat statuses are provided in the most recent National Biodiversity Assessment (SANBI 2019). Following the completion of the National Biodiversity Assessment in 2018 the red list of terrestrial ecosystems was updated in early 2020 based on updated national and provincial land cover data and updated threatened species data (SANBI 2020).

Table 2.4. Vegetation units conserved by the Hexriver Complex (SANBI 2019). LT = Least Threatened; VU = Vulnerable; EN = Endangered).

Vegetation unit	WC Provincial Protection Target (ha)	% of WC target conserved in Hexriver Complex	Ha conserved in Hexriver Complex	Ecosystem Status (2020)
Fynbos Biome				
Fynbos Vegetation Complex				
Winterhoek Sandstone Fynbos	113 467.13	1.31	1491.4	LC
North Hex Sandstone Fynbos	39 396.64	24.64	9 706.05	LC
South Hex Sandstone Fynbos	31 964.09	16.12	5 153.38	LC
Western Altimontane Sandstone Fynbos	3 751.03	21.27	797.77	LC
Breede Shale Fynbos	31 805.89	1.58	502.24	EN
Northern Inland Shale Band Vegetation	27 269.95	1.21	331.12	LC
Breede Alluvium Fynbos	50 155.75	0.12	59.63	EN
Renosterveld Vegetation Complex				
Ceres Shale Renosterveld	49 161.7	0.09	49.05	VU
Matjiesfontein Shale Renosterveld	209 453.65	0.57	1 188.04	LC

Vegetation unit	WC Provincial Protection Target (ha)	% of WC target conserved in Hexriver Complex	Ha conserved in Hexriver Complex	Ecosystem Status (2020)
Forest Biome				
Southern Afrotemperate Forest	64 048.5	0.03	22.74	LC

Of the ten fynbos vegetation units found in the Hexriver Complex, nine falls within the Fynbos Biome (seven in the Fynbos Vegetation Complex and two in the Renosterveld Vegetation Complex) and one within the Forest Biome (Table 2.4). Threatened vegetation units present within the Hexriver Complex include Breede Alluvium Fynbos (Endangered), Breede Shale Fynbos (Endangered) and Ceres Shale Renosterveld (Vulnerable). The landscape transitions and floral diversity in the Hexriver Complex provide physical and climatic diversity in an area of transition between montane and lowland habitats, and juxtaposed Fynbos and Succulent Karoo Biomes. There are 39 endemic fynbos species within the Hexriver Complex (DEA 2015).

2.3.1.1 Vegetation Unit Descriptions

The following is a description of the various vegetation units occurring in the Hexriver Complex as shown in Table 2.4 and Appendix 1 Map 4.

Winterhoek Sandstone Fynbos: This vegetation unit is listed as Least Concern with only 5% transformed and is considered as well protected. It occurs in Witzenberg- and Wittebrug Nature Reserves. The vegetation is mostly closed restioland in deeper moister sands, with low, sparse shrubs that become denser and restios less dominant in the drier habitats. Proteoid and ericaceous fynbos are found on higher slopes while asteraceous fynbos is more common on lower slopes (Rebelo *et al.* 2006). The conservation target for this vegetation unit is 30% (Mucina *et al.* 2007).

North Hex Sandstone Fynbos: This vegetation unit is listed as Least Concern with only 6% transformed, mostly due to cultivation, and very low erosion. It is considered to the well protected. Sections are statutorily conserved in Fonteintjiesberg-, Wittebrug-, Ben-Etive-, and Bokkeriviere Nature Reserves. It occurs on north-facing steep and gentle slopes from foothills to high mountain peaks. The dominant restiolands often have a proteoid overstorey and asteraceous fynbos is found on lower slopes. Some blocks of Western Altimontane Sandstone Fynbos are embedded within North Hex Sandstone Fynbos (Rebelo *et al.* 2006). The conservation target for this vegetation unit is 29% (Mucina *et al.* 2007).

South Hex Sandstone Fynbos: This vegetation unit is listed as Least Concern with low erosion and only a very small portion transformed. Alien invasive vegetation is rare and the vegetation unit is considered to be well protected. Sections of this vegetation unit are statutorily conserved in Ben-Etive-, Fonteintjiesberg-, Wittebrug-, and Bokkeriviere Nature Reserves. It occurs on rugged mountainous terrain with steep, high cliffs and steep slopes facing south to valley floors, creating some of the most dramatic relief in the country. Vegetation is restioid shubland with proteoid overstorey. Structurally it is mainly proteoid and restioid fynbos, with some asteraceous fynbos. Ericaceous fynbos becomes prominent at higher slopes. Specific species include small trees, tall and low shrubs, as well as geophytic herbs and graminoids. Some blocks of Western Altimontane Sandstone Fynbos are embedded within South Hex

Sandstone Fynbos (Rebelo *et al.* 2006). The conservation target for this vegetation unit is 29% (Mucina *et al.* 2007).

Figure 2.5. *Syncarpha speciosissima* occurring in the Hexriver Complex. (Photo: Rika du Plessis).

Western Altimontane Sandstone Fynbos: This vegetation unit is listed as Least Concern with almost no signs of transformation and low erosion and is considered to be well protected although its extent is very small. Sections of this vegetation unit are statutorily conserved in Fonteintjiesberg-, Ben-Etive, Wittebrug-, and Bokkeriviere Nature Reserves. It occurs on summits and top ridges from around 1 800 m upwards including Fonteintjiesberg at 1 989 m. The landscape features high altitude summit peaks, generally fragmented and localised. Vegetation in these high-altitude positions is low, open to medium dense restioid fynbos, with ericaceous and asteraceous fynbos occurring locally. Proteoid fynbos is generally absent (Rebelo *et al.* 2006). The conservation target for this vegetation unit is 29% (Mucina *et al.* 2007).

Breede Shale Fynbos: This vegetation unit is listed as Endangered with about 30% conserved, including in Fonteintjiesberg-, Wittebrug-, and Witzenberg Nature Reserves. About 30% is transformed, mostly due to cultivation. The vegetation unit is considered to be moderately protected. Erosion varies from very low to moderate. It occurs at altitudes of 150 to 700 m, with pockets up to 900 m. The landscape features steep upper slopes below mountains grading to slightly undulating plains, well dissected by rivers. Vegetation is a moderately tall and dense shrubland – mostly restioid, proteoid and asteraceous fynbos (Rebelo *et al*. 2006). The conservation target for this vegetation unit is 30% (Mucina *et al.* 2007).

Northern Inland Shale Band Vegetation: This vegetation unit is listed as Least Concern with more than 80% statutorily conserved, which includes sections in Bokkeriviere-, Witzenberg-, Ben-Etive and Fonteintjiesberg Nature Reserves. Only 4% is transformed due to cultivation and erosion is very low. The vegetation unit is

considered to be well protected. It occurs at altitudes of 400 to 1 650 m. The landscape features a narrow linear area, smooth and flat in profile and thus favoured for paths and roads. The vegetation encompasses diverse shrublands ranging from karoo at lower altitudes and northerly aspects, renosterveld at low and medium altitudes on various aspects, to fynbos at higher altitudes and much lower on southern aspects. Fynbos includes all structural types; it is often quite grassy in character, and usually waboomveld occurs at the lowest altitudes. Heuweltjies are prominent in some areas (Rebelo *et al.* 2006). The conservation target for this vegetation unit is 29% (Mucina *et al.* 2007).

Breede Alluvium Fynbos: This vegetation unit is listed as Endangered with only small patches conserved in Fonteintjiesberg- and Wittebrug Nature Reserves. It is considered as only partially protected. Almost 60% of the vegetation unit is already transformed due to cultivation, road building and urban sprawl. It is also susceptible to increasing transformation through long-term continuous grazing and repeated short interval burning. Such disturbance would eliminate palatable grasses and increase unpalatable shrubs that have a short life cycle. Erosion, however, is very low. It occurs at altitudes of 200 to 350 m, with few patches reaching as high as 600 m. The landscape features slightly undulating plains and adjacent high mountains, with numerous alluvial fans and streams. Vegetation is open, emergent tall proteoids in a moderately tall shrub matrix with a graminoid understorey. Asteraceous and proteoid fynbos are dominant, with localised restioid and ericaceous fynbos (Rebelo *et al.* 2006). The conservation target for this vegetation unit is 30% (Mucina *et al.* 2007).

Ceres Shale Renosterveld: This vegetation unit is listed as Vulnerable with a few patches conserved in Ben-Etive Nature Reserve. About 36% is transformed, mainly due to cultivation, but also threatened by short interval burning and overgrazing. It is considered to be only partially protected. Erosion varies from high to very low. It occurs at altitudes of 500 to 1 300 m. The landscape features moderately undulating plains and lower mountain slopes. Vegetation is medium tall cupressoid-leaved shrubland dominated by renosterbos. Heuweltjies are prominent in places (Rebelo *et al.* 2006). The conservation target for this vegetation unit is 27% (Mucina *et al.* 2007).

Matjiesfontein Shale Renosterveld: This vegetation unit is listed as Least Concern with about 7% statutorily conserved, including in Bokkeriviere Nature Reserve. Some 9% is totally transformed, mainly due to cultivation. It is considered as only partially protected. Erosion is moderate to very low, but very high in some places. It occurs at altitudes of 750 to 1 300 m. The landscape features low mountains, parallel hills and mid-altitude plateaus supporting low, open to medium dense, leptophyllous shrubland with a medium dense matrix of short, divaricate shrubs dominated by renosterbos. Heuweltjies are present at low densities in places (Rebelo *et al.* 2006). The conservation target for this vegetation unit is 27% (Mucina *et al.* 2007).

Southern Afrotemperate Forest: This vegetation unit is listed as Least Concern and a small portion is statutorily conserved in Wittebrug Nature Reserve which forms part of the northernmost localities of the vegetation unit. It is considered as well protected and occurs on altitudes ranging up to 600 m, with notable outliers occurring as high as 1 060 m. The vegetation includes tall, multi-layered afrotemperate forests dominated by tall trees, including some woody endemic elements, with a well-developed shrub understorey and herb layers, especially in mesic and wet habitats (Mucina *et al.* 2006). The conservation target for this vegetation unit is 22% (Mucina *et al.* 2007).

2.3.1.2 Flora species of conservation Concern

A list of 15 known flora species of conservation concern that occur in the Hexriver Complex is given in Table 2.5 (Raimondo *et al.* 2009).

Table 2.5. List of Highly Restricted Species for the Hexriver Complex obtained from the SANBI Threatened Species Programme.

Nature Reserve	Species	Family	Threatened Status according to Raimondo *et al.* (2009); http://redlist.sanbi.org
Wittebrug	*Brunia myrtoides* (Vahl) Class. - Bockh. & E.G.H.Oliv.	Bruniaceae	Vulnerable
	Leucadendron lanigerum H.Buek ex Meisn. var. *laevigatum* Meisn.	Proteaceae	Critically Endangered
	Protea burchellii Stapf	Proteaceae	Vulnerable
Witzenberg	*Protea burchellii* Stapf	Proteaceae	Vulnerable
	Protea scorzonerifolia (Salisb. ex Knight) Rycroft	Proteaceae	Vulnerable
	Sparaxis grandiflora (D.Delaroche) Ker Gawl. subsp. *grandiflora*	Iridaceae	Endangered
	Spatalla tulbaghensis (E.Phillips) Rourke	Proteaceae	Endangered
Ben-Etive	*Anthochortus insignis* (Mast.) H.P.Linder	Restionaceae	Vulnerable
	Askidiosperma insigne (Pillans) H.P.Linder	Restionaceae	Vulnerable
	Brunia myrtoides (Vahl) Class. - Bockh. & E.G.H.Oliv.	Bruniaceae	Vulnerable
	Disa longifolia Lindl.	Orchidaceae	Vulnerable
	Erica atrovinosa E.G.H.Oliv.	Ericaceae	Vulnerable
Fonteintjiesberg	*Leucadendron gydoense* I.Williams	Proteaceae	Endangered
	Leucospermum tottum (L.) R.Br. var. *glabrum* E.Phillips	Proteaceae	Critically Endangered
	Protea rupicola Mund ex Meisn.	Proteaceae	Endangered
	Protea scorzonerifolia (Salisb. Ex Knight) Rycroft	Proteaceae	Vulnerable
	Restio aridus Pillans	Restionaceae	Vulnerable
Bokkeriviere	*Leucospermum catherinae* Compton	Proteaceae	Endangered
	Disa longifolia Lindl.	Orchidaceae	Vulnerable
	Disparago barbata Koekemoer	Asteraceae	Vulnerable

Functional ecological connectivity between the separate sections of the Hexriver Complex is needed in order to provide resilience to global climate change effects and other anthropogenic influences. Landscape level ecological connectivity also ensures the persistence of habitats and species, as well as ecological and evolutionary processes. Climate change is therefore only one of the reasons for pursuing connectivity across the landscape. In the case of the Hexriver Complex, connectivity is affected through extensive buffering mechanisms including adjacent formally

conserved areas ranging from Provincial Nature Reserves to Mountain Catchment Areas, as well as Private Nature Reserves and Stewardship sites. Most of the buffer is Mountain Catchment Area (DEA 2015).

Figure 2.6. Plant species occurring in the Hexriver Complex. a) *Leucospermum catherinae* (EN); b) *Crassula fascicularis*; c) *Protea witzenbergiana*; d) *Erika breviflora*; e) *Indigofera matroosbergensis*; f) *Erica atrovinosa*; g) *Serruria dodii*; h) *Leucadendron rubrum*. (Photos: a–e and g – Arnelle Collison; f – Earl Rhode; h – Rika du Plessis).

2.3.1.3 Fire regime

Fynbos is a fire-driven ecosystem and all Fynbos species require periodic fires to stimulate regeneration and maintain species richness (Van Wilgen & Forsyth 2008; Forsyth *et al*. 2010; Holmes *et al.* 2016). However, in an increasingly fragmented, transformed and risk-averse landscape, natural fire cycles are becoming rare (Holmes *et al.* 2016). Research indicates that globally and within the Cape Floristic Region, many areas have experienced increases in fire frequency and size (Kraaij & van Wilgen 2014). Ecologically sound fire management is thus imperative and involves managing fire regimes, which includes varying the frequency, season, intensity and size of fires, and reconciling ecological and practical requirements. According to the CapeNature fire management guideline (CapeNature 2016a), fire management practices (such as prescribed burning, adaptive intervention management and natural burning zones) can be collapsed into a single model that simply varies with regard to the degree to which intervention (in the form of fire suppression, containment or prescribed burning) is practiced. Fire management should be adapted more to the circumstances a protected area finds itself in than the eco-zone (Van Wilgen & Forsyth 2008) in which it is situated. Van Wilgen and Forsyth (2008) divided the Western Cape into five fire eco-zones based on the fire potential as defined by climate (Van Wilgen 1984). The Hexriver Complex falls within the western inland zone, which is characterized by strong seasonal variation in fire potential and a high mean fire potential in summer (Van Wilgen & Forsyth 2008).

During a facilitated stakeholder workshop, it was highlighted that the fire regime of the Hexriver Complex is a landscape level attribute and should be analysed across the Mountain Catchment Area due to the fragmented nature of the Complex. Therefore, the fire data of the Hexriver Complex and the surrounding Mountain Catchment Area was used to determine the Hexriver Complex Catchment area over which the analysis of the fire regime was done (see Appendix 1 Map 5).

Fire season

Fynbos in the Hexriver Complex is adapted to a fire regime of fires in the dry summer and autumn. Winter fires are possible under exceptional, rare circumstances, but rarely occur (Van Wilgen & Forsyth 2008). Maximum flowering activity occurs in late winter and spring (Van Wilgen *et al.* 1992), and optimal seedling regeneration of serotinous Proteaceae is achieved after fires that occur between December and early April (Bond *et al*. 1984). Furthermore, research has shown that even the fynbos fauna species are adapted to late summer - early autumn fires (Viviers 1983) and that their breeding habits are generally synchronised with the non-fire season. For example, fynbos birds (*e.g.* sugar birds and sunbirds) generally breed in winter (May to November), so winter fires would wipe out a whole year's breeding attempt (Winterbottom 1968). Adults of the typical fynbos reptiles survive summer fires by variably hiding in deep crevices, under rocks, boulders and rock slabs, in the ground, or in deep plant litter. Most of these species lay eggs in summer that hatch in early autumn, or are viviparous, with the young being produced in early autumn (Broadley 1983; Branch 1998). With both these reproductive strategies the young have the winter months to grow and become mobile before the fires of the next summer.

The proportion of area in the Hexriver Complex catchment area that burns in summer should be >80% (*i.e.* less than 20% of the area should burn in winter fires) (Van Wilgen & Forsyth 2008). According to the data from the last 40 years approximately 79% of the area has burnt in the summer and most of the fires occur in the summer months

(see Figure 2.7) (Veldtman 2020). Approximately 10% of the area burnt in October, which may affect breeding success of certain bird species in the area. Birds breed largely during the winter and spring months (July – October), suggesting that spring burns will adversely affect breeding bird populations (van Wilgen & Viviers 1985).

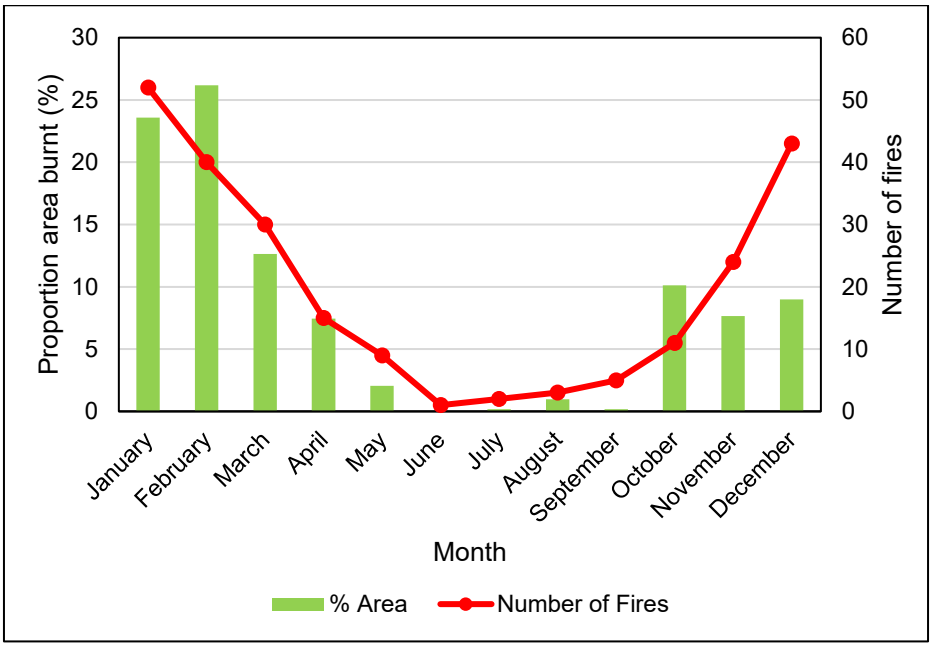


Figure 2.7. Proportion of the area and number of fires in the Hexriver Complex Catchment that burnt in each month between 1980 and 2020.

Fire size

Areas burning in quick succession, a few large fires, or many small fires will both have undesired effects. Too many small fires are difficult and costly to manage and will result in greater edge effects (*e.g.* predation of seed by rodents) and very large fires will upset the desired goal of maintaining an even distribution of veld ages (Van Wilgen & Forsyth 2008). Fire size is also important to the faunal elements of the fynbos. Large fires that result in vast areas of young veld can reduce food availability and pose a problem to the dispersal of animals if the distance between older veld becomes too large. It is therefore critical to have a size mosaic of young and old veld (De Klerk *et al.* 2009). Large fire size and a lack of mosaics also create difficulties for seed dispersal into the burnt area and may leave large areas vulnerable to seed production collapse. Consequently, it would be imperative to keep fire out of such an area (De Klerk *et al.* 2009).

Large fires became increasing common in recent times with Fynbos fire regimes typically dominated by a few, very large fires (Kraaij & van Wilgen 2014). According to Van Wilgen and Forsyth (2008) the proportion of area that burnt in fires larger than 1000 hectares should constitute more than 75% of the total area. Since 1980 most of the fires in the Hexriver Complex were small to medium with approximately 84% of the catchment burnt in fires larger than 1 000 ha (Veldtman 2020). The latter constituted 43 fires (18% of all fires between 1980 and 2020). However, it was also suggested that no fires should exceed 5 000 hectares (Van Wilgen & Forsyth 2008). The catchment area has experienced 11 fires larger than this since 1980. This is especially true for 2016 where 36% of the catchment burnt in two fires burning at the same time

in the same area. These large fires typically burn during December to February (Veldtman 2020).

Veld age

The 2020 veld age map for the Hexriver Complex is shown in Appendix 1 Map 5 and the proportions of veld in different veld age classes in Figure 2.7. CapeNature uses seven veld age categories (1-2 years, 3-4 years, 5-6 years, 7-10 years, 11-15 years, 16-25 years and >25 years) and the desired state is an even distribution of area in the different veld age classes. The proportion of area in each veld age category should be greater than 5% but less than 20% (van Wilgen & Forsyth 2008). This should provide sufficient habitat for a full range of species requiring access to vegetation of different ages. However, 49% the catchment has a veld age of six years and younger (Fig. 2.8) (Veldtman 2020). It has been shown that fynbos can burn from three to five years of age under suitable conditions (Van Wilgen *et al.* 1990; Brown *et al.* 1991), which means that only 0.91% of the catchment area is too young to burn.

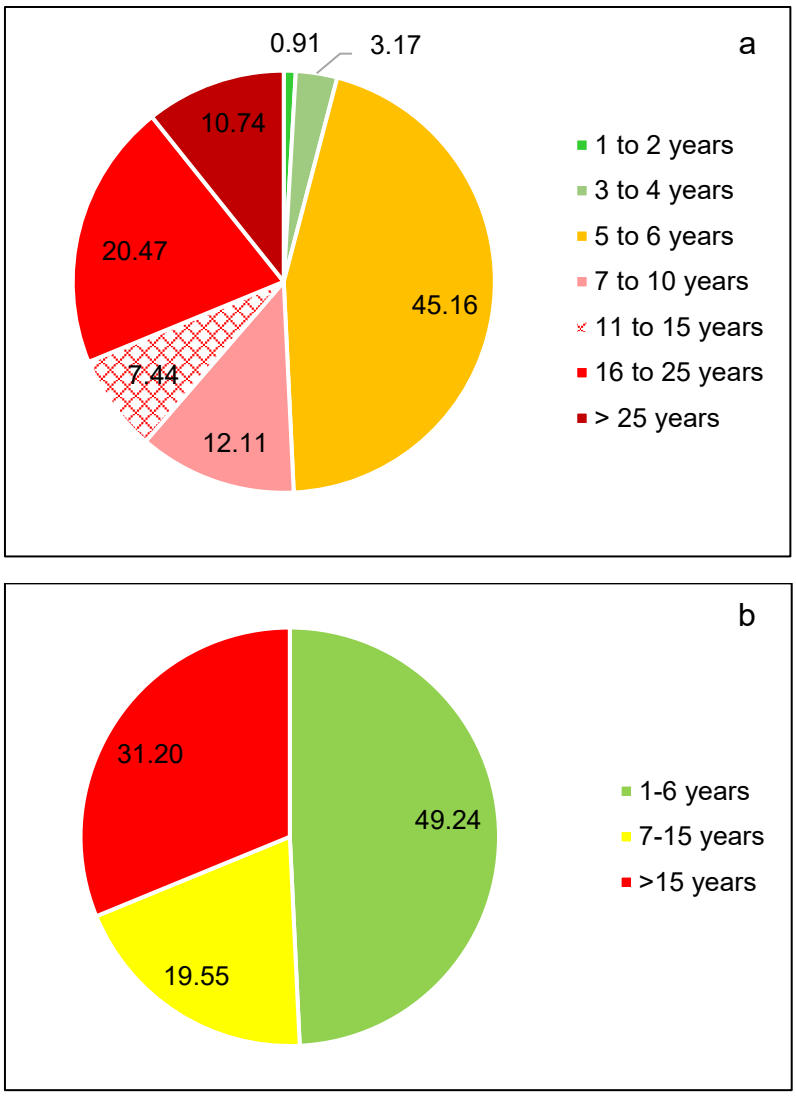


Figure 2.8. Veld age distribution in the Hexriver Complex (1980 – 2020). a) Distribution between the seven CapeNature veld age categories and b) Proportion of veld classified as young (1-6 years), medium (7-15 years) and old (>15 years).

Fire Frequency and return interval

Fire return intervals should neither be too long nor too short (Holmes *et al.* 2016). Slow maturing, serotinous Proteaceae species are used as indicator species to determine acceptable fire return intervals (Van Wilgen *et al.* 1992). These species have been shown to be good indicators for total ecosystem diversity (Vlok & Yeaton 1999, 2000). The minimum fire return period is dependent on the time it takes before 100% of the slowest maturing non-sprouting Proteaceae species in the population have flowered at least once, or when 50% of the slowest maturing non-sprouting Proteaceae species in the population have flowered at least three times (Kruger & Lamb 1978; Kruger 1983, Le Maitre & Midgley 1992).

On the rare occasion when the fire return periods become too long, populations of serotinous Proteaceae will reach senescence, which result in declines in seed production. Short return interval fires that occur before insufficient numbers of serotinous Proteaceae have reached maturity and set seed can lead to population declines or local extinction and cause dramatic structural changes in communities (Van Wilgen 1984; Van Wilgen & Forsyth 2008). It has also been shown that increased fire frequency can benefit sprouting species and that increases in sprouters lead to overall decreases in plant diversity (Vlok & Yeaton 1999).

Many areas have experienced recent increases in fire frequency (Keeley *et al.* 1999, Forsyth & Van Wilgen 2007, 2008; Seydack *et al.* 2007; Kraaij *et al.* 2013). Within the Hexriver Complex the required fire return interval is estimated at 15 years based on flowering of the slowest growing *Protea* species. This should provide sufficient habitat for a full range of species requiring access to vegetation of different ages. Approximately 70% of the complex has burnt less frequently than twice in 17 years. The fire frequency across the Hexriver Complex Catchment is shown in Figure 2.9 and Appendix 1 Map 5 (insert).

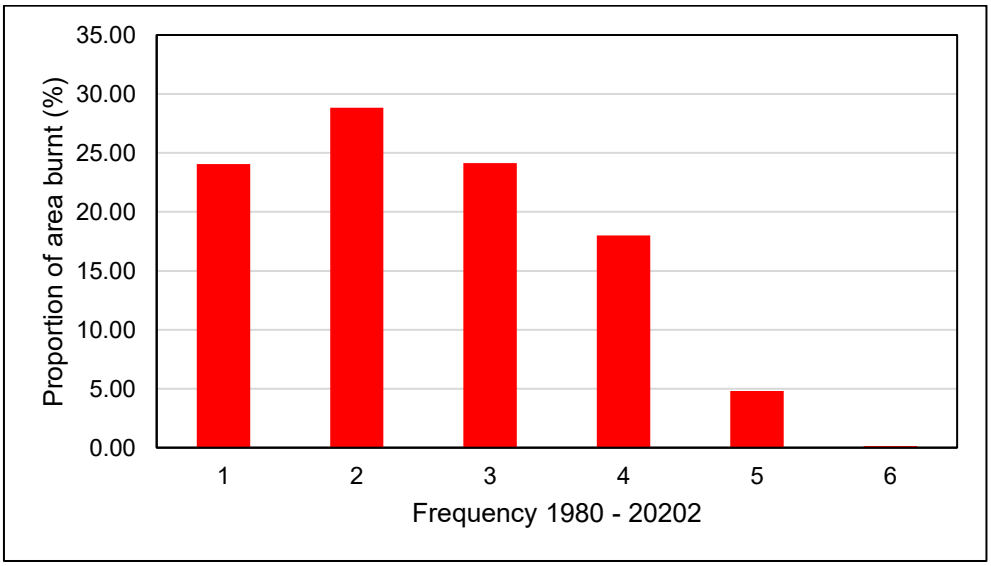


Figure 2.9. Proportion of the Hexriver Complex Catchment with a fire frequency of 1 - 6 for the period 1980 - 2020.

The way in which species regenerate after fire, determines the composition of fynbos vegetation after a fire. Post-fire regeneration success of fynbos species can vary a lot and is dependent on a number of factors. These include *inter alia* fire intensity, seed viability, water availability. In order to improve and refine the fire control measures and

management techniques for each protected area in the Hexriver Complex, data collection on post-fire recruitment of re-seeding Proteaceae is important. The recruitment success of serotinous Proteaceae species which do not re-sprout after fire is used as the indicator of post-fire regeneration success of fynbos vegetation. Only non-sprouting Protea and Leucadendron species are used in these surveys. The ratio of seedlings to re-seeding parent plants measured 12 – 18 months after a fire should be more than 1:5 (Van Wilgen & Forsyth 2008).

The management of fire in fynbos habitats has two main goals: 1) to ensure ecosystem health to conserve biodiversity and deliver vital ecosystem services; and 2) to ensure safety and security in this fire-prone environment (Kraaij & van Wilgen 2014). However, several challenges exist in maintaining a healthy fire regime in fynbos habitats. These include the presence of fire-adapted invasive alien plants, the widespread dominance of unplanned fires, conflict between ecological and safety requirements, altered patterns of ignition and fire spread and global climate change (Kraaij & van Wilgen 2014). Therefore, an adaptive fire management approach is imperative.

2.3.1.4 Invasive Alien Plants

The most problematic invasive alien plants present in the Hexriver Complex and surrounding catchment area are European *Pinus* species, Australian *Acacia* species and *Hakea*. Invasive tree species had invaded an estimated 10 million hectares in South Africa by 1997 with the fynbos biome being the worst affected (Le Maitre *et al.* 2000; Van Wilgen *et al.* 2001). Furthermore, invasive alien trees have a major negative impact on our limited water resources and it is estimated that 6.7% of the water runoff of the entire country is used by these plants (Le Maitre *et al.* 2000; Van Wilgen *et al.* 2008; Van Wilgen & De Lange 2011). Moreover, it has been argued that the future impacts of invasive alien species may be much higher than anticipated, especially on surface water runoff, groundwater recharge and biodiversity (Van Wilgen *et al.* 2008), and will in all likelihood continue to spread faster than they can be cleared (Van Wilgen *et al.* 2016). The water yield from mountain catchments invaded by invasive alien species may reduce by more than 30% over 20 years of invasion (Van Wilgen *et al.* 2001). Furthermore, invasive alien plants also increase fire frequency and fire intensity.

The presence of invasive alien plant species within the riparian zones and wetland buffers has also been identified as a threat to freshwater ecosystems in the Hexriver Complex. The removal of invasive alien trees should be prioritised for maintenance of these areas, especially for rivers in the high-water yield catchments within the Hexriver Complex. Not only will this improve the health of the freshwater ecosystems, but it will also allow for the release of more good quality water. Moreover, the establishment of indigenous vegetation after alien clearing should also be encouraged to enable the re-establishment of faunal groups, such as for aquatic macro-invertebrates for example (Samways *et al*. 2010).

Alien vegetation densities in the Hexriver Complex are classified as mainly scattered (5 – 25 % invaded with areas of medium densities (25 – 50%) (Appendix 1 Map 6). The predominant invasive plant species on Witzenberg- and Ben-Etive Nature Reserves are pines and *Hakea*. Wittebrug Nature Reserve is mainly invaded by Australian *Acacia* species (especially black wattle) and Fonteintjiesberg Nature Reserve by Australian *Acacia* species and *Hakea*. The main species invading

Bokkeriviere Nature Reserve are pines, poplar (*Populus canescens*) and eucalyptus (*Eucalyptus diversicolor*).

The spread of most invasive alien plant species is affected by fire, which in turn influences clearing activities and prioritisation thereof. Clearing and controlling invasive alien plant species is costly and given the limited funding available, prioritisation of areas to be cleared must be undertaken to maximise benefit. Invasive alien plant clearing prioritisation maps are generated annually to support the compilation of annual plans of operation for clearing. These maps are generated annually using the annual updated invasive alien plant densities map and the annual veld age map.

2.3.2 Freshwater ecosystems

The Hexriver Mountain Catchment Areas collectively provide water to the Breede-, Berg- and Olifants/Doring catchments, which in turn provide water for the City of Cape Town and most of the towns and settlements of the surrounding Overberg, Bergrivier, Drakenstein, Witzenberg and West Coast municipalities. These mountain catchment areas and their long-term conservation are thus critical for economic- and agricultural development, especially given the potential and predicted effects of climate change.

2.3.2.1 Groundwater

Most of the Hexriver Complex is underlain by the Table Mountain Group rock structures and associated aquifers and sub-aquifers. The eastern section of the underlying geology of the Bokkeriviere Nature Reserve consists of the Bokkeveld Group, which overlays the Table Mountain Group. This group mainly consists of fine sandstone and mudstones, unlike the hard erosion resistant quartzite sandstone nature of the Table Mountain Group. The aquifers of this group generally contain lower quality water, due to the higher saline properties of the shale-based mudstones. There is also some variance in the western sections of the Wittebrug Nature Reserves, which are underlain to some degree by Malmesbury Group sedimentary units. The rock types contained in this group are fractured and weathered sedimentary rock and the water bearing fractures are mostly restricted to the shallow zone, below the groundwater level.

2.3.2.2 Rivers

The Hexriver Complex span three river systems, namely the Breede River system (Wittebrug-, Fonteintjiesberg- and Ben-Etive Nature Reserves), Berg River system (Witzenberg Nature Reserve) and Gouritz river system (Bokkeriviere Nature Reserve). The rivers of the Hexriver Complex mainly fall into the Breede River catchment, with some tributaries running into the Klein-Berg River and the middle reaches of the Berg River (see Appendix 1 Map 7). A section of the upper Breede River runs through the Wittebrug Nature Reserve in Mitchells pass near Ceres. This is the only major river on this reserve. The Witels River, a major tributary of the Breede River, originates off reserve. Ben-Etive Nature Reserve encompass the headwater of the Titus River and its main tributary the Vals River. Tributaries of the Titus River runs through Ceres before they join the upper Breede. The Bothaspruit river originate on the southern slopes of this catchment divide (Fonteintjiesberg Nature Reserve) and drains into the Breede River near the Brandvlei Dam. Fonteintjiesberg Nature Reserve is located on the headwaters of the Jan du Toits River (Fig. 2.10) and the upper reaches of the Amandel River, a tributary of the Hex River.

Witzenberg Nature Reserve is the only protected area located in the Berg River system. This reserve is located on the catchment boundary and the headwaters of several small tributaries of the Boontjies River originate here and feeds into the Voëlvlei dam.

Figure 2.10. The Jan du Toits River in the Fonteintjiesberg Nature Reserve. (Photo: Martine Jordaan).

Figure 2.11. *Drosera capensis* occurring next to a river in Ben-Etive Nature Reserve. (Photo: Rika du Plessis).

At the furthest eastern extent of the Complex, the Smalblaar and Bok Rivers run along the boundary and then from the Bokkeriviere Nature Reserve. At their confluence downstream of the lower reserve boundary, they form the Donkies River, which flows into the upper Touws River, a tributary of the Groot River in the Gouritz Water Management Association.

Table 2.6 gives the NFEPA and condition status of these main stem rivers and their tributaries in the Hexriver Complex.

Table 2.6. The NFEPA status and estimated health condition of the rivers of the Hexriver Complex. Health scores are defined as follows; natural (A), good to natural (AB), good (B), fair (C), degraded (D).

Nature Reserve	River	Condition*	FEPA status	*River reach/type
Wittebrug	Breede	D	Migration corridor	Foothills
	(Tierkloof)	C	Unknown	Foothills
Fonteintjiesberg	Jan du Toit	AB	FEPA sub-catchment	Mountain stream
	Hartbees	C (AB)	Upstream area	Mountain stream
	Amandel	AB	Fish sanctuary	Mountain stream
Ben-Etive	Titus western tributary	AB	Fish sanctuary	Mountain stream
	Titus eastern tributary	C (AB)	Fish support area	Mountain stream
	Vals	AB	Migration corridor	Mountain stream
Bokkeriviere	Bokke	AB	No FEPA status	Mountain stream - foothills
	Smalblaar	C	No FEPA status	Middle - lower

**Condition estimated through a combination of real data, desktop study and specialist input.*

2.3.2.3 Wetlands

Few wetlands occur within the Hexriver Complex (Nel *et al.* 2011a, b). However, several of these are National Freshwater Ecosystem Priority Area (NFEPA) wetlands. This includes higher and lower altitude seeps and bench flats located on the Witzenberg Nature Reserve in the east, and a valley-bottom wetland system associated with the Bok and Smalblaar rivers on the Bokkeriviere Nature Reserve. The extent of these particular valley-bottom wetlands has recently been increased following a ground-truthing survey at Bokkeriviere Nature Reserve (Fig. 2.12). The wetland vegetation units vary from being Southwest Sandstone and Southwest Alluvium Fynbos (Wittebrug Nature Reserve) and Southwest Shale Fynbos (Witzenberg Nature Reserve) in the east, to Northwest Sandstone Fynbos (Fonteintjiesberg Nature Reserve) and Western Fynbos-Renosterveld Shale Renosterveld (Bokkeriviere Nature Reserve) in the west. The threat statuses of the mapped wetlands vary from least threatened and well protected to critically endangered and poorly protected (see Table 2.7). According to the NFEPA wetlands map layer data, all of the wetlands mapped in protected areas are in a good to natural condition.

Figure 2.12. A wetland at Bokkeriviere Nature Reserve. (Photo: Jeanne Gouws).

Table 2.7. The threat status, estimated health and protection level of the different wetland types of the Hexriver Complex. Threat status categories are least threatened (LT), vulnerable (VU), endangered (EN) and critically endangered (CR).

Nature Reserve	Wetland type	Threat status	Protection level
Wittebrug	Southwest Sandstone Fynbos seeps	LT	Moderately protected
	Southwest Sandstone Fynbos flats	LT	Well protected
	Southwest Sandstone Fynbos channelled valley bottom	CR	Moderately protected
	Southwest Alluvium Fynbos seeps	EN	Well protected
	Southwest Alluvium Fynbos channelled valley bottom	EN	Moderately protected
Witzenberg	Southwest Shale Fynbos channelled valley bottom	CR	Poorly protected
	Southwest Shale Fynbos seep	LT	Well protected
Fonteintjiesberg	Northwest Sandstone Fynbos seep	LT	Moderately protected
	Northwest Sandstone Fynbos flat	LT	Moderately protected

Nature Reserve	Wetland type	Threat status	Protection level
	Northwest Sandstone Fynbos channelled valley bottom	LT	Moderately protected
	Northwest Sandstone Fynbos unchanneled valley bottom	EN	Poorly protected
Bokkeriviere	Western Fynbos-Renosterveld Shale Renosterveld channelled valley bottom	CR	Moderately protected
	Western Fynbos-Renosterveld Shale Renosterveld channelled flat	CR	Not protected

2.4 Biodiversity Context: Taxa

The Cape Faunal Centre (*sensu* Stuckenberg, 1962) coincides roughly with the Cape Floral Region and contains a distinctive fauna with some invertebrates showing little change over millions of years. These relictual faunas date back to the time of Gondwanaland.

2.4.1 Invertebrates

Invertebrates are a vital component of terrestrial ecosystems and constitute more than 80% of all animal diversity, yet they are grossly under-represented in studies of African diversity. Site biodiversity estimates that do not consider invertebrates not only omit the greatest components of what they are attempting to measure, but also ignore groups that are very significant contributors to terrestrial ecosystem processes.

The core of the CFR represents a distinct zoogeographic zone, the Cape Faunal Centre (Stuckenberg 1962), characterised by the phylogenetic antiquity of much of its invertebrate fauna. The component species of this Centre represent what is probably the richest known assemblage of post-Gondwanan relict species and is a pronounced hotspot for faunal endemism within southern Africa, where high levels of endemism are characterised for virtually all taxa examined.

2.4.1.1 Terrestrial invertebrates

In addition to the vital role invertebrates play in ecosystems (McGeoch 2002, Samways *et al.* 2010, 2012), such as primary production, nutrient recycling, predation, herbivory, competition, the Cape flora is dependent on specialised pollination guilds and insect-driven ecological processes such as myrmecochory (seed dispersal by ants) (Le Maitre & Midgley 1992). In South Africa, myrmecochorous plants are mainly restricted to the Fynbos biome and approximately 20% of the strictly Fynbos plant species are dependent on myrmecochory for their survival (Johnson 1992). A total of 29 families and 78 genera of Fynbos plants have been identified as containing species that are ant-dispersed (see Table 1 in Bond & Slingsby 1983).

The presence of a diversity of *Colophon* beetle species in the Hexriver Complex is indicative of the capacity of this area to provide refuge to biodiversity during periods of climate change. This ancient, flightless group of beetles is endemic to the Cape Floristic Region and geographically restricted to the high mountains of the Western Cape. The high-altitude peaks of the Hexriver Complex provide habitat for three *Colophon* beetle species, including the Vulnerable *Colophon cameroni*, the Endangered *C. haughtoni,* and *C. kawaii*, which is not IUCN listed (Switala *et al.* 2014). *Colophon cameroni* has a wide distribution ranging from the Hexriver Complex northwards to the Groot Winterhoek Wilderness, while *C. haughtoni* and *C. kawaii* (Fig.

2.13) only occur on Matroosberg (Switala *et al.* 2014). These flightless stag-beetles are relictual fauna with Gondwanaland linkages, since their closest relatives are today found in Brazil and Australia (Endrödy-Younga 1988). The species occurring in the Complex is part of a species group or lineage, the Pleisiomorphic lineage, which is restricted to the Hottentots Holland, Steenbras, Hex River, Stellenbosch and Wellington Mountain ranges. *Colophon* species are under threat due to illegal harvesting by collectors and from climate change. All species are listed on CITES Appendix III (CITES 2019) and the genus was added to the South African Threatened or Protected Species list in 2007.

Figure 2.13. Two species of *Colophon* beetles that occur in the Hexriver Complex. Left: *C. haughtoni*; Right: *C. kawaii*. (Photo: Hennie de Klerk).

The butterflies of South Africa were assessed in 2013 according to the latest IUCN criteria as part of the South African Butterfly Conservation Assessment project (Mecenero *et al.* 2013). There are 38 species of Lepidoptera that are endemic to the Western Cape. No species of conservation concern were identified for the Hexriver Complex during the 2013 South African Red List assessment. Mecenero and others (2013) argued that, in the South African context, it is not just the threatened taxa that are of importance, but also those taxa that are intrinsically rare or localised but not currently threatened. Conservationists should be made aware of these taxa so that future threats can be identified timeously, and the species monitored for change. They assigned conservation statuses to butterfly species that were classified as Least Concern during the 2013 Red Listing but has local rarity (Mecenero *et al.* 2013). These species were either classified as Extremely Rare (known from only one site) or Rare. Rare species were further classified as Rare – Restricted range (those with a range less than 500 km²), Rare – Habitat specialist (species restricted to a specific micro-habitat) or Rare – Low density (species with small subpopulations or single individuals scattered over a wide area). Table 2.8 gives the classification of the five Western Cape species that are likely to occur in the Hexriver Complex that are classified as Least Concern with local rarity.

Table 2.8. Conservation status of butterfly species that are likely to occur in the Hexriver Complex and its zone of influence that were classified as Least Concern during Red Listing in 2013 but are locally rare (Mecenero *et al.* 2013).

Species	Common name	Distribution
Rare – Habitat specialists (restricted to micro-habitat)		
Lycaenidae		
Thestor strutti	Strutt's skollie	Rocky areas in fynbos at the foot of mountain peaks, between Franschhoek and Wolseley, Kluitjieskraal.
Rare – Restricted range (range less than 500 km²)		
Lycaenidae		
Chrysoritis adonis adonis	Adonis opal	Northern slopes of the Gydo mountains and adjacent ranges near Ceres. Winterhoek Sandstone Fynbos.
Lepidochrysops gydoae	Gydo blue	In the mountains around Ceres, on the higher slopes in mountain fynbos.
Rare – Habitat specialists and Low density		
Lycaenidae		
Lepidochrysops bacchus	Wineland blue	Occurs in Fynbos and Albany Thicket localities that receive between 500 mm and 750 mm rainfall per annum.

Further Red List assessments have been conducted since 2013 and several of the species listed in Table 2.8 were assigned higher National Red Listings in 2016 (Red List of South African Species, http://speciesstatus.sanbi.org/taxa/lineage/4/).

The Lepidopterist Society of South Africa only found the range-restricted endemic species *Thestor strutti* and *Chrysoritis adonis adonis* at one location each during the latest surveys. There has been a population decline for *Thestor strutti* over the last 10 years and the Lepidopterist Society has seen no specimens in the last three years despite regular surveys. The taxon thus qualifies globally under the IUCN criteria as Critically Endangered. *Chrysoritis adonis adonis* has not been seen during the normal flight period since 2004 despite regular surveys. The current habitat of this species has shown no signs of degradation, but fruit tree farming has expanded on the lower slopes of the mountain range to the north and may have had an influence on the population through drift of insecticides used for crop spraying. The taxon thus qualifies globally under the IUCN criteria as Critically Endangered. *Lepidochrysops gydoae* is classified as Least Concern, but Rare with a restricted range (Table 2.8). This species is currently only found at single sites in the Gydo Mountains, but it is suspected that it might occur in the Hexriver Complex on higher slopes in mountain fynbos. However, there are no perceived threats to the populations. This species thus qualifies globally under the IUCN criteria as Least Concern but was nationally re-classified in 2016 as Extremely Rare (see classification by Mecenero *et al.* 2013 above).

Another ecologically important invertebrate group is the Arachnida. The South African National Survey of Arachnida (SANSA) was initiated in 1997 (Dippenaar-Schoeman *et al*. 2015) and is an umbrella project that is implemented at a national level in collaboration with researchers and institutions countrywide dedicated to document and unify information on arachnids in South Africa. SANSA is providing essential information needed to address issues concerning the conservation and sustainable use of the arachnid fauna (Dippenaar-Schoeman *et al*. 2013; Dippenaar-Schoeman *et al.* 2015). Presently 71 spider families, 471 genera and 2240 species are known from

South Africa, representing approximately 4.8% of the world fauna. A total of 966 species represented by 365 genera and 68 families have been recorded in the Western Cape (Dippenaar-Schoeman *et al.* 2015) of which 361 species are endemic to the Western Cape (37.4%), with 119 species only known from their type locality. Unfortunately, there is no spider species list available for the Hexriver Complex, but given the information generated by SANSA, it is likely that there might be endemic spider species in the reserve complex.

Main threats to invertebrate populations include habitat destruction and invasive alien plants. This critically important group can be protected by managing ecosystems according to the required fire regimes and by removal of invasive alien plants, especially in river courses.

2.4.1.2 Freshwater Macro-invertebrates

Benthic macro-invertebrates can be used to monitor both water quality and habitat diversity over the long term, using the South African Scoring System version 5 (SASS 5) methodology following standardized protocols (Dickens & Graham 2002). The SASS 5 method is a rapid bio-assessment method and is used to assess the water quality, habitat availability and health of a river system (Dickens & Graham 2002). The method uses the presence/absence of macroinvertebrate families to evaluate water quality, where a sensitivity/tolerance score out of 15 is linked to each taxon. The higher the score, the more sensitive the specific taxon is to pollution. The method also takes invertebrate abundance into account as well as habitat (or biotope) availability, as different taxa prefer different parts of a river system. The SASS score is linked to an ecological category developed by Dallas (2007) (see Table 2.9 and Figure 2.12).

Table 2.9. Ecological categories for interpreting SASS 5 data. Adapted from Dallas (2007).

Ecological Category	Category Name	Description
A	Natural	Unmodified, natural
B	Good	Largely natural with few modifications
C	Fair	Moderately modified
D	Poor	Largely modified
E	Seriously modified	Seriously modified
F	Critically modified	Critically or extremely modified

A baseline freshwater survey was conducted in December 2019 in eight of the rivers in the Hexriver Complex and the zone of influence. SASS scores and Average Score Per Taxon (ASPT) values of these are presented in Figure 2.14. The six sites with the highest SASS scores were all located within or very near to the protected area boundaries and upstream of any modifications such as weirs. They include the Wolwekloof (Wittebrug Nature Reserve), Titus (Ben-Etive Nature Reserve), Vals (Ben-Etive Nature Reserve), Jan du Toits (Fonteintjiesberg Nature Reserve), Bothaspruit (Fonteintjiesberg Nature Reserve) rivers and the Bok River (Bokkeriviere Nature Reserve). At these sites, there was generally a diverse mix of different macro-invertebrate taxa, including both tolerant and more sensitive species (refer to Results Section). The species collected represented individuals from the very sensitive stonefly family Notonemouridae which scores 14 out of 15 (e.g. Titus and Bok rivers),

down to the very tolerant true fly families Chrinomidae (2 out of 15) and Culicidae (1 out of 15). Most of the rivers also contained taxa that are endemic to the South Western Cape (SWC) rivers. These taxa, which include one mayfly family (Ephemeroptera) and several caddisfly families (Trichoptera), are generally also sensitive to pollution (SASS scores range from 11 to 13 out of 15). The endemics present in the Hexriver Complex rivers included species from the mayfly family Teloganodidae (12; Wolwekloof River, Titus River and Bok River) and the cased caddisfly families Barbarochthonidae (13; Titus River, Vals River and Bok River), Glossosomatidae (11; Wolwekloof and Bok rivers), Petrothrincidae (11; Bok River) and Sericostomatidae (13; Titus and Vals rivers). It must be noted here that a fourth SWC endemic caddisfly family might have been present in the samples but were not identified as such. The Hydrosalpingidae family (gold cased caddisflies), which is a rarely sampled taxon, can be mistaken for a family like Barbarocthonidae, based on the physical appearance of the casing. Hydrosalpingidae caddisflies have a score of 15. Other high scoring taxa collected included individuals from the crustacean family Amphipoda (13), the mayfly family Heptageniidae (13), the beetle family Scirtidae (previously named Helodidae) and the true fly family Dixidae.

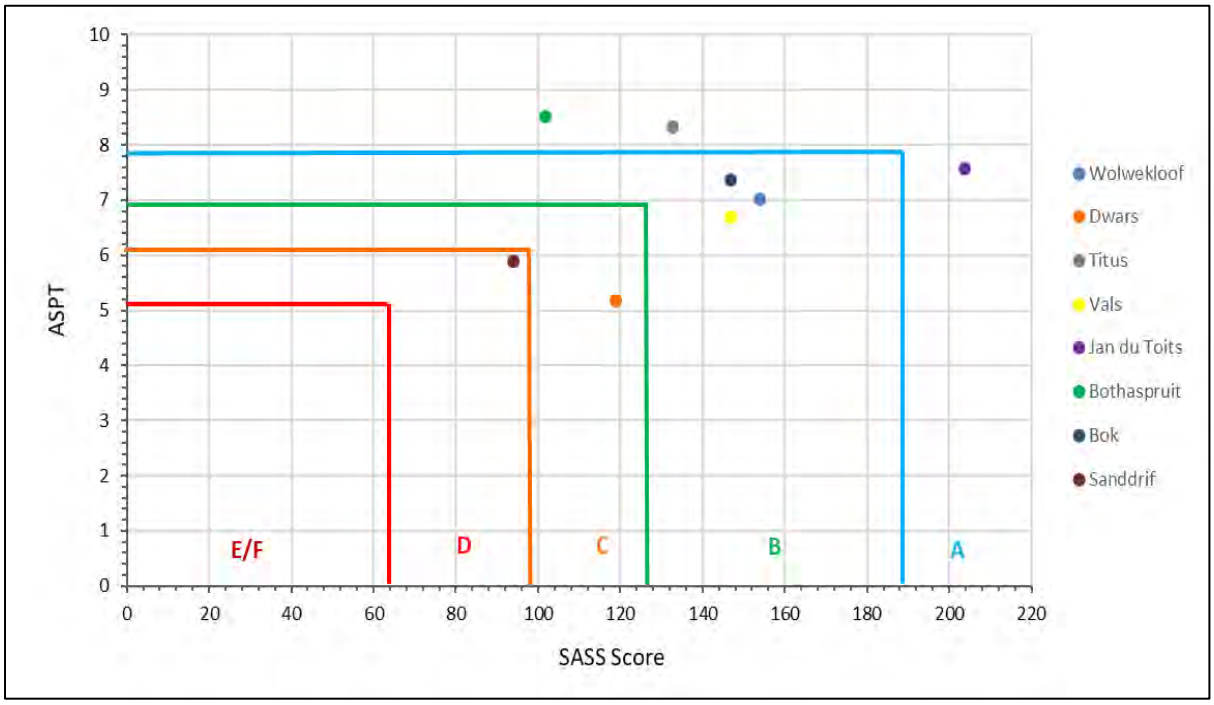


Figure 2.14. The SASS scores and ASPT values at the eight sites at the rivers that were sampled during the Hexriver Complex freshwater survey in December 2019. The different coloured circles depict the different sites located in the upper parts of the rivers of the Hexriver Complex. The coloured biological bands represent the changes in health condition (taken from Dallas 2007).

The SASS 5 data collected here provides only a snapshot of the water quality and biotope/habitat availability at each site of this baseline survey. Seasonal, more in-depth invertebrate surveys are needed to get a complete picture of the species present and community structure and to determine the effects of certain impacts (see Barber-James and Pereira-da-Conceicoa, 2016). Additionally, the initial baseline survey only allows preliminary analyses of the data, and patterns of seasonal, temporal and impact effect variance will only be detected with long term monitoring of selected sites.

Regardless, the SASS 5 data provide valuable information on water quality at the time of sampling and gives an indication of instream habitat availability as depicted by invertebrate taxon diversity and biotopes present. In the case of the Hexriver Complex survey, these initial SASS results can serve as a precursor to potential detailed studies on specifically the benthic macroinvertebrates, in association with indigenous and alien fish species distributions (see for example Bellingan *et al.* 2015). Another focal taxon for measuring the quality of freshwater are the dragonflies and damselflies (Odonata). There is a wide range of sensitivities among South African dragonflies to respond to regional and local events that affect their habitats (Samways & Simaika 2016). A freshwater health index (the Dragonfly Biotic Index) has been developed which places great emphasis on these irreplaceable endemics and is particularly useful for assessing the level of threat to the local dragonfly fauna as well as its recovery when these threats are lifted (Samways & Simaika 2016). By far the biggest threat to Western Cape dragonflies is invasive alien trees. Removal of these trees has resulted in substantial recovery of these irreplaceable dragonfly species, as well as that of other endemic invertebrates, especially in low-elevation mountain rivers.

Recent work on some of the Western Cape dragonflies and damselflies has indicated that they represent ancient lineages. Species in the genus *Syncordulia* (Corduliidae or Emeralds) for example, diverged some 60 million years ago. These species, along with several others, currently survive in small populations and are more resilient than expected, recovering quickly when invasive alien trees are removed. Invasive alien trees shade out the sunny habitat that the dragonflies require for their life activities.

There are three dragonfly species of conservation concern in the Hexriver Complex, namely the Mahogany presba (*Syncordulia venator*), Rock malachite (*Ecchlorolestes peringueyi*) and the Cape thorntail (*Ceratogomphus triceraticus*). These species are all classified as Near Threatened. The Mahogany presba is a Western Cape endemic that is only found at 300 – 1300 m elevation in clear montane streams in bushy areas (Samways & Simaika 2016). The Rock malachite is highly localized in the mountains of the Western Cape and inhabits clear montane streams and rivers with clear pools with lichen-covered boulders that they use as camouflage (Samways & Simaika 2016). The Cape thorntail is a highly localized and rare Western Cape endemic up to about 800m elevation (Samways & Simaika 2016). It occurs along wide and shallow bush-lined and rocky streams and rivers (Samways & Simaika 2016). These species are threatened by invasive alien trees, as are most of the Western Cape freshwater biota.

There is no comprehensive invertebrate species list available for the Hexriver Complex. Such lists are essential as inventories of what occurs in the Reserve Complex, especially in terms of Red Data and endemic species, and as baseline information for long-term monitoring. Some protection might be provided to certain arthropod groups in protected areas given the fact that there are correlations between insect species richness and biomes in the Western Cape (*e.g.* Procheş & Cowling 2006, 2007; Procheş *et al.* 2009). Therefore, the argument can be made that the attention and protection that the area receives in terms of its floral diversity might provide some protection for its insect diversity (Samways *et al.* 2012).

The invertebrate species list of the Hexriver Complex is updated through *ad hoc* baseline data collection. Additional information on the insects of the Cape Floral Region can be obtained from the Iziko Museums of South Africa (www.iziko.org.za).

2.4.2 Amphibians

The Hexriver Complex has five amphibian species recorded. None of these species are evaluated as threatened under the IUCN criteria. The conservation of amphibians in the Complex is reliant on ensuring the persistence of wetland breeding habitat and sufficient surrounding foraging and sheltering habitat for frogs. This will primarily be achieved by the effective control of invasive alien woody plant species and an appropriate fire return interval. These management actions should be sufficiently measured and monitored under the vegetation and fire indicators to ensure persistence of the amphibian diversity in the Hexriver Complex. However, it would be best if this assumption is tested when the resources become available. At this stage only surveillance monitoring for continued presence of amphibians is indicated in this complex.

2.4.3 Fish

The river systems occurring in the Hexriver Complex (see section 2.3.2.2 above) are home to 11 currently described indigenous freshwater fish species from four families, but many of these do not occur within the Complex. These species include six small minnow species of the genera *Enteromius* and *Pseudobarbus*, one species each of the genera *Galaxias* and *Sandelia*, two larger cyprinids of the genera *Labeo* and *Cheilobarbus* and two freshwater eel species of the genus *Anguilla* (Skelton 2001). Local taxonomic research has indicated that many of the currently described indigenous fish species of the CFR consist of a number of genetically unique lineages. In a recent review by Ellender *et al.* (2017), the current taxonomic richness of the CFR is reported to be 42 unique taxa (described species and know unique lineages). Most of these lineages await taxonomic description as new species and should in the meantime be managed and conserved as unique taxa (Swartz 2005; Skelton & Swartz 2011; Chakona *et al*. 2013).

Fish taxa occurring in the Hexriver Complex are shown in Figure 2.15. All expected native freshwater fish species were detected during a recent baseline survey. Fish taxa occurring in the Hexriver Complex include a relatively widespread redfin lineage within the currently described Breede river redfin *Pseudobarbus burchelli* Smith, 1841, namely *Pseudobarbus* sp. nov. “breede” (Vulnerable; Jordaan & Chakona 2017) and at least two undescribed lineages within the Cape galaxias *Galaxias zebratus*. One of these, *Galaxias* sp. nov. ‘nebula’ is widespread within the CFR and the other *Galaxias* sp. nov. ‘breede’ is more range restricted and listed as Endangered (Chakona & Jordaan 2017). The Cape kurper *Sandelia capensis* is widespread within the CFR and is currently listed as Data Deficient due to taxonomic uncertainty (Chakona et al. 2013; Chakona 2018).

No fish records exist for the Witzenberg Nature Reserve, but records exist for *Galaxias* sp. downstream in the Boontjies River. For the three protected areas located in the Breede River system (Wittebrug, Ben-Etive and Fonteintjiesberg), the expected indigenous fish species are *Pseudobarbus* sp. nov. “Breede” (Vulnerable), *S. capensis* and Cape galaxias *Galaxias* sp. (Fig. 2.16). It is likely that indigenous fish would historically have been abundant in the small section of the Breede River running through the Wittebrug Nature Reserve. However, the mainstream Breede River is currently dominated by non-indigenous rainbow trout *Oncorhynchus mykiss*, common carp *Cyprinus carpio*, smallmouth bass *Micropterus dolomieu* and possibly sharptooth catfish *Clarias gariepinus*. The Witels River joins the Dwars River to form the Breede River. This river has an established brown trout *Salmo trutta* population, but it is

unlikely that viable indigenous fish populations will persist in the presence of this non-indigenous species. The Tierhokskloof (Bobbejaans) River, a smaller tributary to the south of the Witels has a population of *Pseudobarbus* sp. nov. 'breede' (Shelton *et al.* 2014).

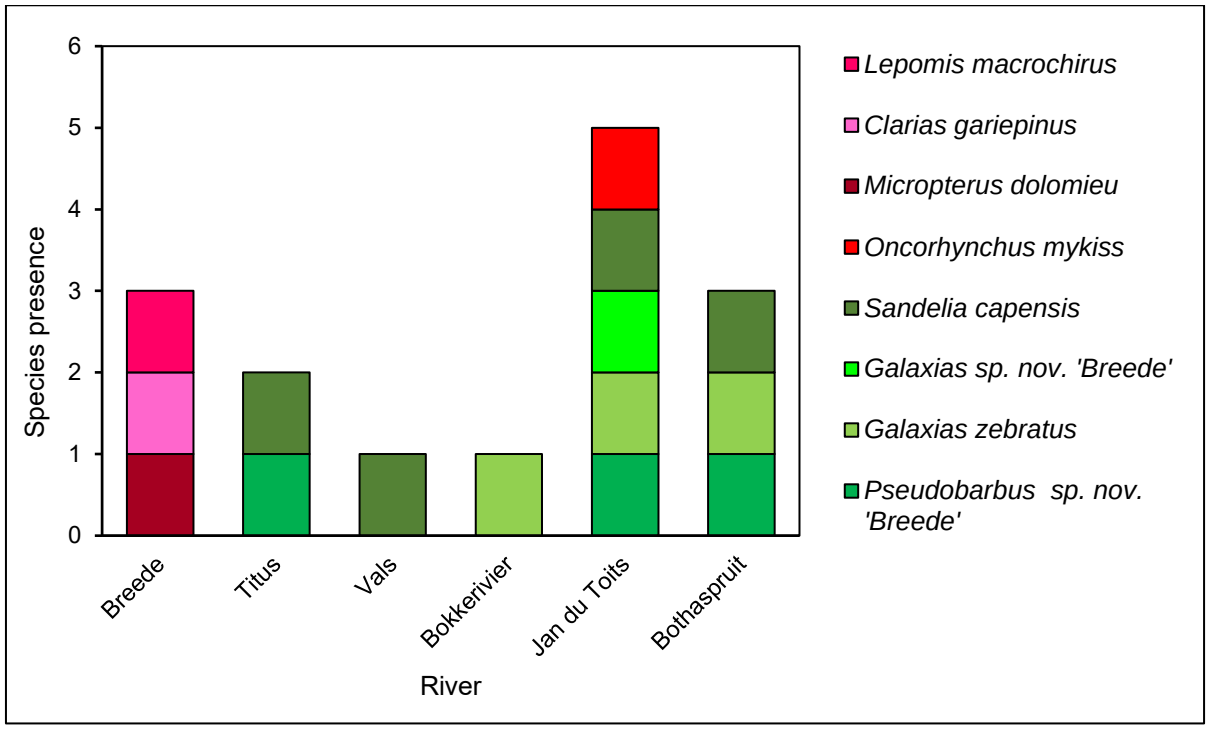


Figure 2.15. Fish species occurrence in the rivers in the Hexriver Complex. Indigenous species are indicated in various shades of green while invasive extralimital and alien species are shown in various shades of red and pink.

Historical records exist for all three expected indigenous taxa in the headwaters of the Titus River and its main tributary the Vals River or in areas downstream of the Ben-Etive Nature Reserve (Chakona *et al*. 2013, Shelton *et al*. 2014). The status of these populations is uncertain as the Titus River catchment is severely impacted by water abstraction and agricultural activities. The Titus River and its headwaters as listed as a fish Critical Biodiversity Area (CBA).

The Jan du Toits River has a large resident population of rainbow trout that dominate the ichthyofauna to the detriment of the indigenous fish community. A survey in 2010 of the lower reaches of the river downstream of the Fonteintjiesberg Nature Reserve yielded records for *Pseudobarbus* sp. nov. 'breede', *S. capensis* and Cape galaxias *Galaxias sp.* (unpublished data, Jordaan & Impson, CapeNature). Based on the work of Chakona *et al.* (2013), the Jan du Toits River is home to two distinct Galaxid lineages, the widespread *Galaxias* sp. nov. 'nebula' is and the threatened *Galaxias* sp. nov. 'breede'.

The Bokkeriviere Nature Reserve occurs within the Gouritz River system that is rich in native fish diversity. However, the only fish record for this reserve is a Galaxias sp. that was collected recently.

Figure 2.16. Fish species occurring in the Hexriver Complex. a) Breede River redfin *Pseudobarbus* sp. '*burchelli* Breede' (Photo: Riaan van der Walt); b) Cape galaxias *Galaxias zebratus* (Photo: Andrew Turner) and c) Cape kurper *Sandelia capensis* (Photo: Unknown).

2.4.4 Reptiles

The Hexriver Complex should have a relatively rich reptile fauna but only six reptile species have been recorded to date. The geometric tortoise (*Psammobates geometricus*) is known from several localities in the Ceres and Tulbagh regions. However, the Hexriver Complex does not have any known suitable habitat for this species. The occurrence of geometric tortoise populations in the Hexriver Complex is unlikely but should always be borne in mind when conducting surveys. If they are found in the Complex they will need to be managed according to the BMP-s that is under development for this species. The conservation of reptiles in the Hexriver Complex is reliant on ensuring the effective control of invasive alien woody plant species, appropriate fire return intervals and preventing too much (>25 %) of the reserve burning in any one fire event.

Figure 2.17. *Agama atra*, one of the reptile species occurring in the Hexriver Complex. (Photo: Koos Steenkamp).

2.4.5 Avifauna

The number of bird species recorded for the Hexriver Complex as derived from species lists recorded during South African Bird Atlas surveys is low (105 species) and are typical of mountain fynbos habitat. The reserve complex is not important in terms of threatened species with only two species of conservation concern recorded. The Verreaux's Eagle *Aquila verreauxii* was recorded from four of the nature reserves (Wittebrug, Ben-Etive, Fonteintjiesberg and Bokkeriviere) at moderate reporting rates (Taylor *et al.* 2015). Although listed regionally as Least Concern the Ground Woodpecker is listed globally as Near Threatened and was therefore included in the list of threatened species. It was, however, only recorded once from the Wittebrug Nature Reserve.

2.4.6 Mammals

The Hexriver Complex has confirmed distribution records for 24 mammal species with rodents (seven species), even-toed ungulates (seven species) and carnivores (four species) dominating the mammal fauna (Table 2.11). Other mammal taxa present include two bat species, one shrew, one hare, one odd-toed ungulate and a single primate species. The only threatened species present is the Cape leopard *Panthera pardus*, which is listed as Vulnerable. Three Near-Threatened taxa are also present, namely the grey rhebuck *Pelea capreolus*, the laminate vlei rat *Otomys laminatus* and the Cape clawless otter *Aonyx capensis*.

The current species list for the reserve complex may be incomplete as mammal distribution records increase substantially (83 species) when considering data obtained from the MammalMap database for the five land parcels that make up the

reserve complex. A possible reason for the large discrepancy in the number of mammal records (24 vs 83 species) between MammalMap and CapeNature records is the scale at which records were considered. CapeNature data was included only if distribution data intersected the reserve polygon but in the case of MammalMap, it is not clear whether datapoints were linked to reserve polygons or to the much larger quarter degree grid squares. From this dataset an additional three priority species of rodents may be present for the reserve complex. These are spectacled African dormouse *Graphiurus ocularis* (Near Threatened), African white-tailed mouse *Mystromys albicaudatus* (Vulnerable) and Cape marsh rat *Dasymys capensis* (Vulnerable). Species that are expected to occur on in the Complex are Cape Fox *Vulpes chama*, caracal *Caracal caracal*, black-backed jackal *Canis* mesomelas, Cape rock hyrax *Procavia capensis*, Cape large-spotted genet *Genetta tigrina* and common genet *Genetta genetta* (all listed as Least Concern). Priority species and actions identified by Birss (2017) for the Western Cape and relevant to the Hexriver Complex is presented in Table 2.10.

Table 2.10. Priority mammal species and actions identified by Birss (2017).

Common name	Species name	Priority actions
Grey rhebuck	*Pelea capreolus*	Collect distribution and population data, develop robust population monitoring methods, maintain registers on protected areas.
Leopard	*Panthera pardus*	Collect distribution and population data.
Cape clawless otter	*Aonyx capensis*	Facilitate continued research.
Small mammals		
Laminate vlei rat	*Otomys laminatus*	Collect distribution data.
Spectacled dormouse	*Graphiurus ocularis*	
White tailed mouse	*Mystromys albicaudatus*	
Cape marsh rat	*Dasymys capensis*	
Ecotypical game species		
Klipspringer	*Oreotragus oreotracus oreotracus*	Collect distribution and population data, develop robust population monitoring methods, maintain registers on protected areas.
Steenbok	*Raphicerus campestris*	
Cape grysbok	*Raphicerus melanotis*	
Common duiker	*Sylvicapra grimmia grimmia*	

Mammal species present on land adjacent to Bokkeriviere Nature Reserve are springbok *Antidorcas marsupialis*, Red hartebeest (*Alcelaphus buselaphus*) and Plains zebra (Burchell's zebra) *Equus quagga burchelli* (all Least Concern). These records were provided by the South African National Defence Force who is the management authority for the property (R. Jeffrey, pers. comm.). Plains zebra pose a hybridization risk to Cape Mountain Zebra and Hartman's zebra and their presence in close contact with these species is highly undesirable. Potential damage causing animals (when present off-reserve on private land) present on the reserve complex are baboons *Papio ursinus* and porcupines *Hystrix africaeautralis*, as well as leopards, caracal and black backed jackal. During the 1990's, a significant feral pig invasion existed on South African National Defence Force property. Feral pigs were subsequently eradicated in a joint CapeNature and South African National Defence Force operation. Feral pigs were also present on properties adjacent to Witzenberg Nature Reserve. Monitoring should continue for re-infestation.

2.5 Heritage Context

Section 5 of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) outlines general principles for heritage resources management while Section 9 of this Act outlines responsibilities of the State and supported bodies.

2.5.1 Heritage resources

2.5.1.1 Paleontological Heritage

Marine sediments in the Hex River Valley region (e.g. Hex River Pass, Matroosberg) contain abundant, well-preserved moulds of the trilobite Metacryphaeus caffer, chonetid brachiopods, molluscs such as the bivalve Janeia and bellerophontid Plectonotus, tentaculitids, and carpoid echinoderms (Almond 2013).

2.5.1.2 Pre-colonial Heritage

The mountains in and surrounding the Hexriver Complex in the Hex River Valley contain rock art painted on the cliffs and caves that are up to 7 000 years old and attests to habitation of the area by the /Xam San, the Southern branch of the San tribe of hunter-gatherers. The rock art of the area includes entoptic images, finger dots and handprints, and reflected their spiritual focus and often depict the people from their group and the animals that lived in the valley (Helm *et al.* 2018). The paintings range from dramatic, robust panels containing many figures to the delicate depiction of single delicate antelope. Some of the paintings depict sheep, which are not known in the archaeological record of southern Africa before approximately 2.0 - 1.6 thousand years ago (Helm et al. 2018). These were probably executed in the final phase of the rock art tradition in the south-western Cape by peoples who occupied the area within the last two thousand years (Helm et al. 2018). Moreover, San rock art of giraffe were discovered in the area. The only other possible San rock art of giraffe in the Cape has been recorded from the Eastern Cape near the Swart Kei River and near Whittlesea in the Queenstown District (Helm et al. 2018).

Based on the similarities between paintings found in the Hex River Valley and surrounding areas and those found in mountains further inland such as the Anysberg near Laingsburg, it is thought that the San moved between these two regions. They used the valley as a migration route, following the herds of antelope into the Karoo during the winter and returning to the permanent rivers in the Western Cape valleys during the summer. During these migrations the Khoisan crossed Bokkeriviere Nature Reserve and paintings are found in rock shelters.

Remnants of fine-line and finger- paintings at Fonteintjiesberg Nature Reserve preserve the historic presence of Khoisan in the kloofs of this area. Surveys of the Hexriver Complex will continue, and records of archaeological site will be submitted and loaded on SAHRIS (South African Heritage Resources Information System). This is an online data capturing database managed by South African Heritage Resources Agency.

Figure 2.18 shows some of the rock art recorded in the Hexriver Complex. Some of these images have been digitally enhanced.

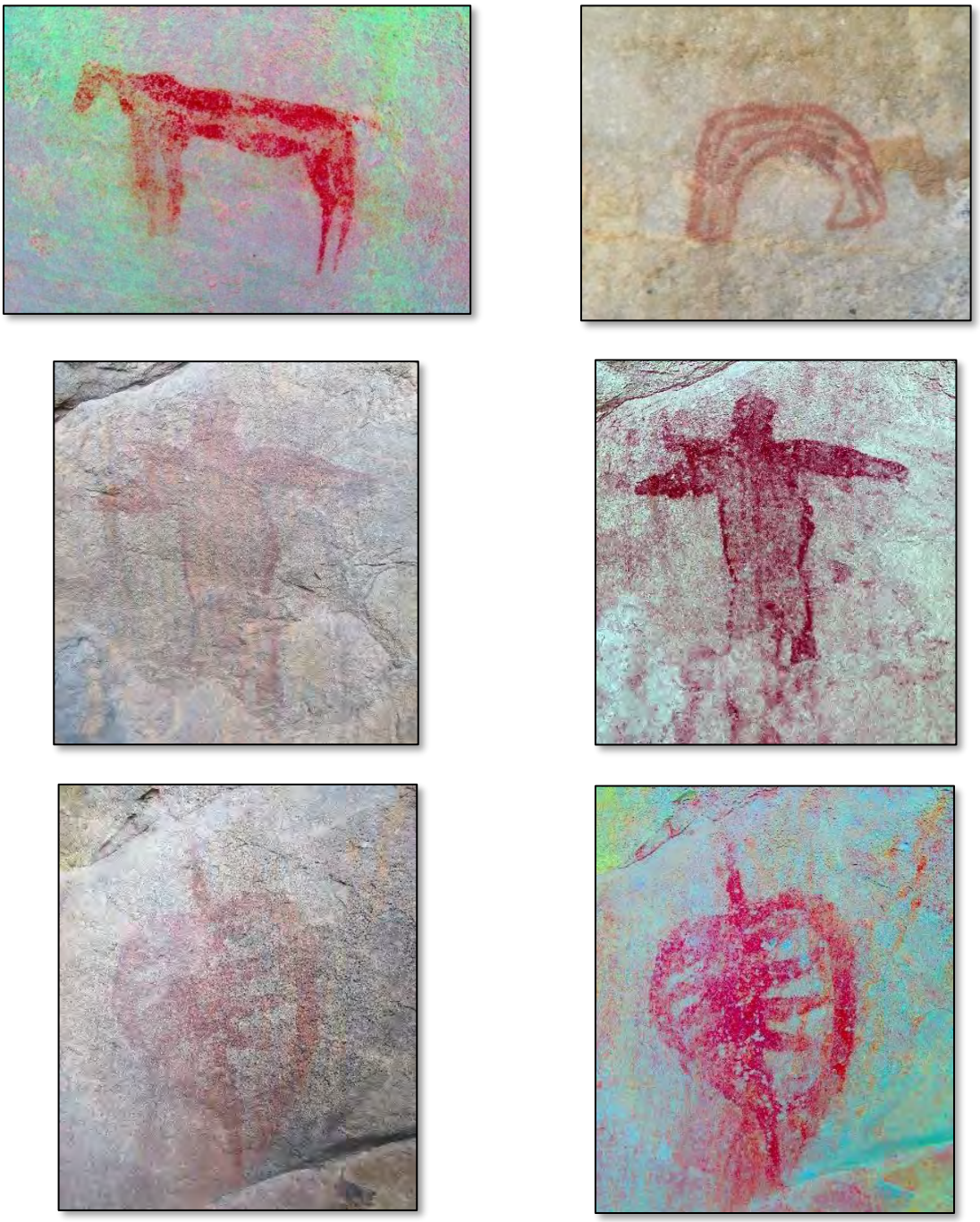


Figure 2.18. Rock art in the Hexriver Complex. (Photos: Earl Roode).

2.5.1.3 Colonial Heritage

As the Cape Colony expanded inland European settlers moved and developed the interior. By 1722 a route through what is known today as Mitchells pass already existed. In 1765 the farmer from Wolwekloof farm developed a wagon trail along the southern banks of the Breede River and constructed a tollhouse to charge toll fees for users of this trail. Approximately 2 kilometres of this historic Mostertshoek pass is in the Wittebrug Nature Reserve. During October 1846, 240 convicts started constructing the new pass under the supervision of Andrew Geddes Bain. The pass was opened on December 1st, 1848 and named after Colonel Charles Mitchell, surveyor-general of the Cape Colony at the time. It is suspected that the unmarked graves located at the

Witels picnic site belongs to many of the convicts who perished while working on this project. Until 1885 Mitchells pass was the main access route into the interior and the diamond-fields in the north. During the 2nd World war, 1946, the pass was widened and upgraded to a cement surfaced road, the earthquake of 1969 caused major damage to the pass and road surface, since then further upgrades and maintenance have been done by the Provincial Roads Department. (Bertdene Laubscher 2020, Togryers Museum, Ceres, pers. comm.)

By the end of the 18th century colonial farmers have moved into the Hex River Valley and constructed dwellings in the Cape Dutch building style (Bertdene Laubscher 2020, Togryers Museum, Ceres, pers. comm.). The construction of the railway track from Worcester to Matjiesfontein via Touwsrivier was completed in 1877 (https://www.karoo-southafrica.com/koup/touws-river/history-of-touws-river/). Water was required for the steam trains a canal was built to take water from the upper ridges of the Bok River some 30 kilometres to Touwsrivier. Today the original canal is still visible and runs across the Bokkeriviere Nature Reserve providing municipal water to the residents of Touwsrivier.

This railway line was a strategic route for the British. During the Boer war British soldiers guarded the bridges, cuttings and tunnel to prevent the Boers sabotaging these structures. During September 1901 British forces pursued a Boer commando of 80 soldiers and horses westward down the little valley between Touwsrivier and the top of the Hex River Pass. The British forces believed that they had the Boer commando cornered and encamped when night fell, thinking that they would continue the pursuit at daybreak. At 1 am on the morning of 23 September 1901 the Boer commando appealed to the owner of the homestead of Karbonatjieskraal to help them find an escape route. He led them to a narrow and treacherous footpath that descends a steep gorge to Kaaimansgat, the farm at the bottom of this descent. From here, the Boer commando could make their escape. The commando then moved on from here to raids and skirmishes in the Ceres Karoo and the Northern Cape. When the British forces learned of the escape and discovered the footpath used for the escape, they dynamited a section of the path to prevent the future use of Kaaimansgat (M. Esterhuize 2020, Hex Valley Tourism Association, pers. comm.). Today Kaaimansgat and Karbonatjieskraal forms part of the Bokkeriviere Nature Reserve.

2.6 Socio-Economic Context

In terms of the Municipal Systems Act (Act No. 32 of 2000), municipalities are required to use integrated development planning to plot future development in their mandated management areas. The municipal Integrated Development Plan (IDP) sets the strategic and budget priorities for development and aims to co-ordinate the work of local and other spheres of government. The IDP should also address how the environment will be managed and protected and is supplemented by a Spatial Development Framework (SDF).

IDPs and SDFs are tools for integrating social, economic, and environmental issues. As biodiversity is a fundamental component of sustainable development, IDPs and SDFs offer an opportunity to ensure that biodiversity priorities are incorporated into municipal planning processes through consultation. In turn, the identification of biodiversity-related projects for the IDP can support local economic development and poverty alleviation. Municipalities within which the Hexriver Complex occurs is illustrated in Appendix 1 Map 1. The Hexriver Complex falls mainly in the Witzenberg Municipality with a small section of Bokkeriviere Nature Reserve falling in the Breede

Valley Municipality. Both these municipalities fall within the Cape Winelands District Municipality (CWDM).

The primary land use adjacent to the boundaries of the protected areas are mainly agriculture. The CWDM is the biggest producer of stone fruit in the Western Cape with the Ceres-Tulbagh area being the most economic functional area. This area produces approximately 40% of stone fruit in the province and more than half of South Africa's pears are produced in Ceres, Tulbagh and Wolseley. Agricultural is mainly taking place in the fertile lowland areas within the wetter valleys in the western parts of the municipal area. This is also the area under most pressure for urban development. The landscape transitions from this highly cultivated and irrigated farming landscape at the foothills of the mountain to the dry and arid Karoo that is largely suitable for grazing. The match between land capacity and the potential of the land has been already been met within the Witzenberg municipality. The balance between conservation and agriculture is thus crucial to maintain the ecosystem and farming productivity of the region.

The Witzenberg Municipality has the fastest growing population rates in in the Cape Winelands District with a population of 140 124 in 2018 and a growth of 7% since 2016 (Witzenberg Municipality 2019). Approximately 60% of its population is under 30. More than half of the population is in urban settlements, with the majority concentrated in Ceres (58.3%, which includes the small settlements of Nduli and Bella Vista). The municipality thus has a rural community consisting of almost 50% of all municipal residents.

The Witzenberg Municipality has a relatively small economy that contributes 13.5% (R8.2 billion) to the economy of the Cape Winelands District (Witzenberg Municipality 2019). It provides employment for just over 60 000 people with the largest economic sectors in 2016 being the wholesale and retail trade, catering and accommodation sector (17.4%); the finance, insurance, real estate and business services sector (15.9%); and the agriculture, forestry and fishing sector (15.2%). These sectors contributed R4 billion to the Witzenberg economy (48.5%) and are thus crucial for the overall stability of the area's economy. In addition, Witzenberg's economy grew faster than that of Breede Valley from 2009 to 2017, indicating the region's resilience to international financial crises (Witzenberg Municipality 2019).

The marginalization of rural communities remains, and is, exacerbated by a general lack of skills and access to opportunities and or services in the areas surrounding the Hexriver Complex. Agriculture remains the largest employment sector, employing approximately 50% of the population in the Witzenberg Municipal area (Witzenberg Municipality 2019). However, the sector is experiencing a high rate of net job losses, and often only provides seasonal opportunities. Unemployment and poverty are a serious concern in the communities adjacent to the Hexriver Complex. The Complex therefore has a role to play with regards to job creation in order to help mitigate the unemployment and poverty rates. This is currently achieved within the Expanded Public Works Programmes (EPWP) (Natural Resource Management (NRM) programmes) and CapeNature Integrated Catchment Management (ICM). These programmes strive to employ a high number of un-skilled and semi-skilled youths (55%), women (55%) and disabled persons (2%). Local economic development is also promoted through the appointment and development of local services providers (Small, Medium and Micro Enterprises) in the conservation field e.g. fire suppression, maintaining firebreaks, roads and other infrastructure.

A further aim of the employment of un-skilled workers is to up-skill participants through specific training sessions for them to be able to be permanently employed within various economic sectors.

3 POLICY FRAMEWORK

CapeNature is subject to the framework of the Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996), national legislation including NEM: PAA, World Heritage Convention Act, 1999 (Act No. 49 of 1999) and all associated regulations and norms and standards for the Management of Protected Areas in South Africa and all other relevant requirements as set out in the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004).

3.1 Purpose of Protected Area Management

The declaration of protected areas is part of a strategy to manage and conserve South Africa's biodiversity. Accordingly, the object of the management plan is to ensure the protection, conservation and management of the natural and cultural historic heritage in a manner that is consistent with the objectives of the NEM: PAA, and for the purpose for which protected areas were declared.

3.2 Guiding Principles

The following guiding principles underpin the management plan for the Hexriver Complex:

- Articulate desired results in terms of conservation outcomes, not actions.
- Articulate how management responses will lead to desired results.
- Monitor progress towards achieving desired results.
- Consider monitoring programme design at the onset of planning.
- Consider expected outcomes of management at the outset of planning.
- Invest in management response appropriate to the risk.
- Adapt strategies based on lessons learnt understanding that measuring effectiveness alone may not resolve uncertainty; data and analyses are necessary to guide management towards doing more of what works and less of what does not work.
- Share results to facilitate learning, acknowledging that although success is not a given, learning can be, through honest appraisal of efforts.

The Hexriver Complex is also subject to the principles and provisions of relevant international treaties and conventions, national and provincial legislation and policy, and any local contractual or co-management agreements.

3.3 Strategic Adaptive Management

Strategic Adaptive Management integrates planning, management and monitoring to provide a framework for:

- testing assumptions;
- learning through monitoring and evaluation; and
- adapting strategies or assumptions.

Strategic adaptive management bridges management and decision science by systematically evaluating results and using this information in a community of practice

(CMP 2020) enabling management to change course when it becomes evident that it is necessary, rather than waiting until the end of a strategy to determine whether an intervention worked (Conservation Coaches Network (CCNet 2012).

CapeNature has adopted, and applies, the Open Standards for the Practice of Conservation adaptive management framework (CMP 2020) as illustrated in Figure 3.1. The Conservation Standards facilitates strategic adaptive management through a systematic evidence based participatory process with stakeholders (CMP 2020). The systematic approach makes explicit the links between goals, focal conservation targets, threats, strategies and actions, enabling management to define and measure success of their actions in the Complex over time.

The Conservation Standards framework is comprised of five stages (Figure 3.1):

- Conceptualising the protected area (i.e. defining the purpose of the protected area, establishing scope and vision; selecting focal conservation targets and assessing threats, and analysing the conservation situation (i.e. assessing contributing factors in terms of opportunities and challenges);
- Planning actions and monitoring (i.e. drafting the plan based on theories of change using results chains);
- Implementing actions and monitoring (i.e. drafting work plans, doing the work and monitoring the work);
- Analysing and using results to adapt (i.e. deciding if what was planned is working); and
- Capturing results, sharing and learning (i.e. learning and sharing what is learned).

The framework works on the rationale that effective conservation of carefully selected focal conservation targets will ensure the conservation of all indigenous biodiversity and cultural historic heritage within the Complex that in turn contributes to a functional landscape. At the same time, the rationale follows that healthy focal conservation targets deliver ecosystem services essential for human well-being. An assessment of the current condition of focal conservation targets serves as a baseline against which to measure condition over the next 10 years and guides the formulation goals and conservation strategies with associated objectives, indicators and work plans.

As such, step one of the adaptive management framework illustrated in Figure 3.1 is foundational to effective management of the area.

Focal conservation targets are classified as follows:

- Natural targets can be species, habitats or ecological systems, which collectively represent and encompass the biodiversity of the Complex. They can include the physical, natural features from which ecosystem services flow, benefitting humans in a variety of ways.
- Cultural historic targets are described in terms of the tangible features that collectively represent and encompass the cultural historic heritage of the Complex. They can also include the physical, cultural and/or historic features from which human well-being values are derived.
- Human well-being values are the intangible or non-material values derived from tangible values, and which collectively represent the array of human well-being needs dependent on natural and cultural features; they can be defined in terms

of the benefits delivered to humans by healthy ecosystems, or by intact cultural or historical features.

Figure 3.1. Strategic Adaptive Management Framework adapted from The Open Standards for the Practice of Conservation (CMP 2020).

3.4 Protected Area Management Effectiveness

Management effectiveness evaluation is the assessment of how well a protected area is being managed, primarily the extent to which management is protecting values and achieving objectives (Hockings *et al*. 2015). The following questions underpin management effectiveness evaluation (Leverington & Hockings 2004):

- Is the protected area effectively conserving the values for which it exists?
- Is management of the area effective and how can it be improved?
- Are specific projects, interventions and management activities achieving their objectives, and how can they be improved?

The monitoring and evaluation framework applied to the Hexriver Complex (illustrated in Figure 3.2 below) measures compliance and management effectiveness of the Complex in terms of the NEM: PAA and associated Norms and Standards for Protected Area Management. Management effectiveness is assessed over time using the Management Effectiveness Tracking Tool – South Africa (METT-SA) which is based on the six elements of good management:

- It begins with understanding the **context** of existing values and threats;
- progresses through **planning**;
- and allocation of resources (**inputs**);
- and as a result of management actions (**processes**);
- eventually produces products and services (**outputs**);
- that result in impacts or **outcomes**.

Management effectiveness is measured at the strategic level as a percentage, drawing upon the results of fine scale monitoring linked to management actions, objectives, goals and focal conservation targets articulated in this plan, see Figure 3.2. Management effectiveness includes the measurement of administrative processes such as capacity and budgets that, when adequate, are likely to result in positive conservation outcomes.

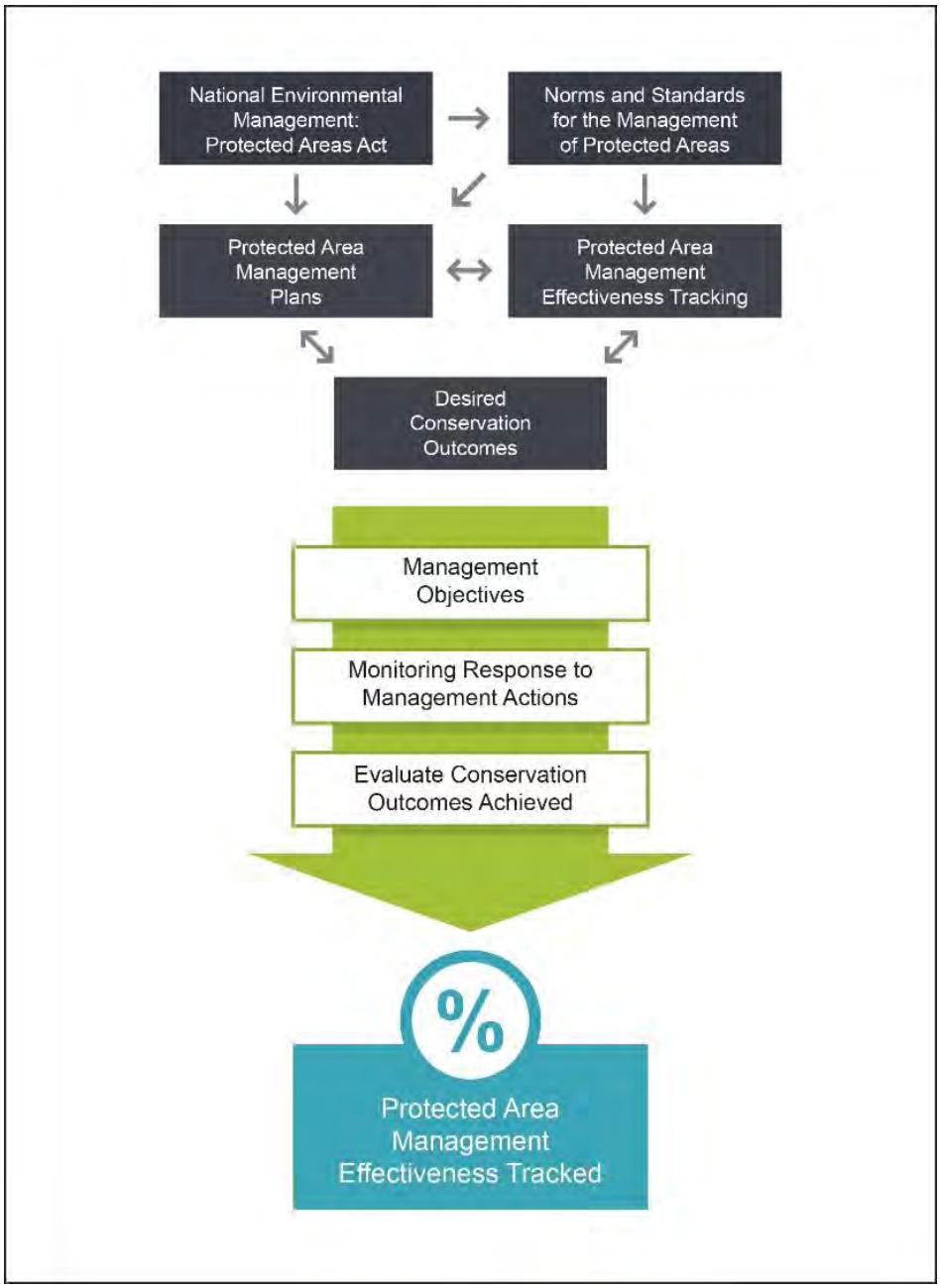


Figure 3.2. Protected Area Monitoring and Evaluation Framework.

Mechanisms for monitoring and evaluation are built into each aspect of the Strategic Plan (see Section 10) through the inclusion of verifiable indicators of progress. The protected area monitoring and evaluation programme, supplementary to the management plan, monitors site level implementation of the plan, status of values and effectiveness of strategies. Results contribute to the Western Cape State of Biodiversity report, produced at five-year intervals.

Furthermore, management reports annually on implementation of the plan through CapeNature's strategic Performance Management System. The Performance Management System ensures that implementation of the management plan is embedded in individual staff performance agreements.

3.5 Policy Frameworks

Protected area management is guided by CapeNature policies, procedures and guidelines for use across all of its components. Policies, procedures and guidelines applicable to this management plan are referenced here and in Section 10 (Strategic Plan).

3.5.1 Internal rules

In terms of Section 52 of NEM: PAA, as amended, the management authority of a nature reserve may, in accordance with prescribed Norms and Standards, make rules for the proper administration of the area.

In addition to the Regulations for the Proper Administration of Nature Reserves, as gazetted on 12 February 2012 in Government Gazette 35021, and Regulations for the Proper Administration of Special Nature Reserves, National Parks and World Heritage Sites, as gazetted on 28 October 2005 in Government Gazette 28181, the Hexriver Complex implements the Nature Conservation Ordinance, 1974 (Ordinance No. 19 of 1974) and Provincial Notice 955 of 1975.

3.5.2 Financial

CapeNature is a schedule 3C public entity responsible for nature conservation in the Western Cape. CapeNature is the executive arm of the Western Cape Nature Conservation Board, established in terms of the Western Cape Nature Conservation Board Act, 1998 (Act No. 15 of 1998) as amended. The objectives of the Board as per the Board Act shall be:

- To promote and ensure nature conservation and deal pro-actively with related matters in the Province,
- To render services and provide facilities for research and training that would inform and contribute to nature conservation and related matters in the Province; and
- To generate income, within the framework of the applicable policy framework.

Funding for the entity comprises three main revenue streams. The majority of funding, which equates to approximately 80% of funding, is received in terms of a provincial allocation received in terms of Vote 9. Secondary funding, which is approximately the further 20%, is received from external donors and own revenue. Own revenue generation consists mainly of tourism income generated through activities and accommodation available on various protected areas managed by the entity.

The entity prides itself on its strong internal controls, sound financial management and practicing of good corporate governance. Corporate governance within the entity embodies sound processes and systems and is guided by the Public Finance Management Act, 1999 (Act No. 1 of 1999) and the principles contained in the King 4 Report of Corporate Governance.

3.5.3 Safety and security

Business Continuity Plan: The CapeNature Business Continuity Plan establishes and provides emergency response procedures and protocols which need to be implemented should an event significantly disrupt the operations of the organisations or an emergency is declared by Management. The plan identifies critical services, how it will be maintained, how to minimise the impact, increase preparedness and initiate an effective response.

Integrated Compliance Plan: The Integrated Compliance Plan for the Hexriver Complex details how compliance and enforcement will be implemented in the Complex in order to:

- Prevent biodiversity loss caused by human activities on the Hexriver Complex through the implementation of active and passive compliance and enforcement operations.
- Ensure compliance with legislation through the monitoring of activities in the Hexriver Complex.
- Address and combat illegal activities through the institution of criminal proceedings.
- Reports illegal activities to the delegated authority where activities have a negative impact on the Hexriver Complex (e.g. listed activities in terms of NEMA).

It is a dynamic reference document that is continually updated and improved, using the data that is gathered during the implementation thereof in order to achieve the management objectives of the Hexriver Complex.

Fire Protection Associations: CapeNature is obliged in terms of the National Veld and Forest Act to be a member of the local Fire Protection Associations. Within the Western Cape, five large Fire Protection Associations have been established that cover the whole area of the Province. The protected areas in the Hexriver Complex are members of the Winelands Fire Protection Association. Fire Protection Associations are the primary partnership tool in veldfire management in South Africa.

Fire Management Plan: The Fire Management Plan is essentially a derivative and part of the Protected Area Management Plan. The latter details the objectives of the Hexriver Complex and the Fire Management Plan use this information to detail how fire will be managed to ensure that the ecological objectives of the Complex are met. This includes the management of both wild and controlled fires.

Fire response plan: The fire response plan forms part of the Fire Management Plan and serves as an operational document for cooperative wildfire management in the Hexriver Complex. This plan is compiled annually at regional level according to the CapeNature fire policy to ensure that there is complete co-operation at higher level. It includes updated names and telephone numbers of all contact persons, radio frequencies and emergency notifications.

3.5.4 Resource use

Resource utilisation is governed by CapeNature's Policy on consumptive use of wild flora from CapeNature-managed protected areas (2019). The policy implementation framework and protocol provide a guideline as to how access to the natural resources should be handled.

According to NEM: PAA, Section 50, the management authorities of protected areas, including World Heritage Sites may, subject to the management plan of the protected area or site, allow or enter into a written agreement with or authorise a local community inside or adjacent to the protected area or site, to allow members of the community to use in a sustainable manner biological resources in the protected area or site. Section 50, however also states that an activity allowed in terms of this section may not negatively affect the survival of any species in, or significantly disrupt the integrity of the ecological systems of the protected area or site.

CapeNature undertakes to build the capacity of Natural Resource Users and other relevant stakeholders on the sustainable utilisation of natural resources and its environmental regulatory framework in and outside protected areas.

3.5.5 Biodiversity management

Integrated Catchment Management Strategy: Integrated Catchment Management is regarded as improving and integrating the management of land, water and related natural biological resources in order to achieve the conservation, and sustainable and balanced use of these resources. The CapeNature Integrated Catchment Strategy focuses on three key areas; including Catchment, Freshwater and Coastal Management. All of these contribute to socio-economic development and are underpinned by key principles including knowledge, advocacy and awareness and an enabling environment.

The Integrated Catchment Management Strategy is aligned to national and provincial priorities and has five strategic objectives to guide implementation namely:

- To integrate the management of the physical, ecological and man-made components of the environment to ensure sustainability and integrity of the ecosystems and the services that they provide in order to ensure long-term climate change resilience.
- Management of biodiversity assets, ensuring their contribution to the economy, rural development, job creation and social well-being is enhanced.
- To enhance biodiversity implementation through the development of strategic tools and knowledge management systems.
- People are mobilised to adopt practices that sustain the long-term benefits of biodiversity.
- The required enabling environment (including institutional and professional capacity, policy and legal framework, partnerships, strategic and operational alignment and stakeholder support) is established and sustained.

Invasive Species Monitoring, Control and Eradication plans: An Invasive Species Monitoring, Control and Eradication plans for the Hexriver Complex is compiled according to the requirements of the National Environmental Management: Biodiversity Act (NEM: BA), 2004 (Act No. 10 of 2004) Alien and Invasive Species Regulations and Lists (Oct 2014). The plans aim to guide management actions to

reduce infestation densities and rates of fauna and flora species through systematic integrated control methods.

Integrated Compliance Plan: The Integrated Compliance Plan for the Hexriver Complex details how compliance and enforcement will be implemented in the Complex in order to achieve the management objectives of the Hexriver Complex and to minimise biodiversity loss due to anthropogenic causes.

Western Cape Protected Area Expansion Strategy: This strategy aims to expand the Western Cape Protected Area network to encompass a more representative and resilient suite of areas that support biodiversity and ecological infrastructure, especially those threatened species and ecosystems that remain yet unprotected. There are several properties adjacent to the various parcels of the Hexriver Complex that are listed as priority sites for protected area expansion.

Fencing and Enclosure of Game and Predators in the Western Cape Province Policy: All protected areas with game species are subject to the management guidelines outlined in the policy.

Game Translocation and Utilization Policy: All protected areas with game species are subject to the management guidelines outlined in the policy.

Management of large game: All large game species on properties adjacent to the Hexriver Complex will be dealt with according to the following principles:

- All game farms bordering the Complex that have extra-limital or historic alien animals, must be enclosed to the standards as stipulated in the CapeNature fencing policy. Protected area personnel must do regular inspections on the reserve side of the fence and escapees must be reported to the owner immediately.
- If the owner is not in possession of a Certificate of Adequate Enclosure, they must be given reasonable time to remove the animals as soon as possible. Game animals escaping from properties without a valid Certificate of Adequate Enclosure are *res nullius* and must be dealt with accordingly. Conservation Managers must stipulate and regulate the actions to remove the animals (*i.e.* flying with a helicopter to recapture or to chase back).
- In cases where *res nullius* game animals enter the Complex, the Conservation Manager must report it immediately and a decision must be taken to have the animals removed, culled or that they may remain on the protected area.
- All protected areas with game animals who wish to remove surplus animals, must follow protocol which includes approval at regional level (*i.e.* ecological meetings) and approval at corporate level through the Wild Animal Advisory Committee.
- Where alien invasive game (*e.g.* fallow deer) are observed in protected areas, Conservation Managers must take immediate action by removing these animals in a humane manner.

Damage-causing wild animals: CapeNature aims to ensure coexistence of humans and indigenous wild animals and considers human-wildlife conflict as situations where artificially induced interactions between humans and wildlife lead to situations requiring mitigation of loss, disturbance or damage. CapeNature requires that human-wildlife conflict be managed, taking into consideration all legal, ethical and welfare

implications and that interventions are carried out within an ecologically sound framework (CapeNature position statement on human–wildlife conflict 2015).

CapeNature advocates the five-step approach to holistic wildlife management of damage causing wildlife namely (1) understanding the origin of the problem; (2) maintaining the correct attitude and respect towards the animal; (3) the responsible species must be identified correctly; (4) implement suitable mitigation measures; and (5) implement effective selective control as per the information contained in the "The Landowner's guide: human-wildlife conflict – sensible solutions to living with wildlife" (CapeNature 2015a). This handbook supplies basic and cost-effective mitigation methods to landowners who report damage caused by wildlife. By implementing the suggested interventions and understanding the ecological role of each species, this will enable the Conservation Manager to deal with wildlife conflict situations both on and off protected areas.

Furthermore, the national predation management manual (The Predation Management Forum 2016) prepared by the predation Management Forum is also available to give management guidance on dealing with predation problems on and off protected areas. CapeNature advocates the following broad best practice guidelines:

- All reports of predators found on protected areas and causing stock losses on neighbouring properties must be reported to and investigated by relevant CapeNature staff who will assist the landowner with mitigation management. All actions against predators must be actioned on the property where the losses occurred and not within the protected area. No hunting or pursuing of predators on any protected area is legally allowed.
- All other wildlife found on protected areas and causing losses or damage on neighbouring properties must be reported to and investigated by relevant CapeNature staff who will assist the landowner with mitigation management.
- Domestic animals (e.g. donkeys, goats, cattle, sheep and pigs) that roam onto protected areas from neighbouring properties must be addressed by relevant staff in conjunction with the local municipal authority through the draft National Animal Pounds Bill and/or any local authority bylaws.
- All feral animals (domestic animals that have become wild and without an owner) found within a protected area must be removed in a humane manner immediately.
- No confiscated, nuisance, damage-causing wildlife or rehabilitated wild animals may be released onto a protected area unconditionally.

3.5.6 Cultural resource management

CapeNature acknowledges that access to protected areas for traditional, spiritual, cultural and historical purposes has major benefits for people and accepts that protected areas have intrinsic and extrinsic use value for the people of the region. CapeNature therefore recognises the need to manage, conserve and promote natural assets for the benefit of all. CapeNature contributes towards the promotion of culture and heritage through the development and conservation of heritage resources as well as the facilitation of access.

3.5.7 Neighbour relations

The National Veld and Forest Fire Act, 1998 (Act No. 101 of 1998) places a duty on landowners to prepare and maintain firebreaks. Chapter 4, Section 12 (7) of the Act states that owners of adjoining land may agree to position a common firebreak away from a boundary. Firebreaks that have been repositioned off CapeNature boundaries must be documented in an official firebreak agreement between CapeNature and the relevant landowner. Firebreak agreements bind all parties over a five-year period (unless otherwise stated) and are renewable upon joint agreement from both parties.

Within the structure of CapeNature, firebreak registers are used as a management tool to assist with the prioritisation and maintenance schedule for each firebreak. The firebreak register is updated annually and indicates whether a firebreak has been realigned to aid with maintenance or fire suppression operations.

Where firebreaks are constructed by the reserve away from the reserve boundary it is required to have mutual agreement in place with the adjacent landowner, the signing of many of these agreements is still in process, or to be renewed.

3.5.8 Research and development

The National Biodiversity Research Development and Evidence Strategy (2015-2025) highlights the increasing demand for knowledge and evidence to support policy and decision making for the protection of biodiversity and the realisation of benefits from our natural resources. In response to this CapeNature developed a biodiversity research and monitoring strategy (CapeNature 2016b). The overall goal of this strategy is to provide reliable data and knowledge to inform and facilitate the conservation of the biodiversity and sustained ecosystem functioning in the Western Cape Province.

Structured monitoring programmes need to be put in place and carried out consistently over time to monitor the state of biodiversity and ecosystem functioning. This allows tracking of ecosystem health and allows critical evaluation of management practices by employing an adaptive management cycle. Therefore, there is a focus on applied scientific research that is driven by management requirements. The strategy emphasises research and monitoring that measures biodiversity outcomes so that management can be clearly linked to the biodiversity and ecosystem function targets.

The guiding principles of the strategy are good science (robust and defensible), alignment with management requirements, taking an integrated management and ecosystems approach, employing a full monitoring lifecycle approach to planning and implementing monitoring programmes and considered (evidence-based) prioritisation of research and monitoring actions.

The CapeNature Biodiversity Research and Monitoring Strategy (CapeNature 2016b) facilitates research that guides management actions in the Hexriver Complex pertaining to the following:

- Priority species (alien invasive, threatened, endemic, keystone and indicator species);
- Damage-causing animals;
- Human-wildlife conflict including social impact;
- Integrated catchment management (fire ecological management, freshwater, alien invasive species);

- Effects of resource use;
- Land-use change in the zone of influence;
- Rehabilitation and restoration, genetic processes supporting conservation;
- Ecosystem services and functioning;
- Climate change (and weather);
- Conservation management effectiveness,
- Cultural, historical and heritage sites;
- Social effects of conservation initiatives (indicators of change, awareness, value of nature as place of learning, healing and self-discovery); and
- The socio-economic effects of implementing EPWP-like work opportunities and resource economics.

3.5.9 Access

CapeNature strives to establish a differentiated and leading brand of products in outdoor nature-based tourism across the Western Cape for all to enjoy. This is achieved by providing opportunities to the public and interacting in an environmentally responsible and sustainable manner specifically to:

- Optimise income generation for biodiversity conservation;
- Optimise shared growth and economic benefits, to contribute to national and provincial tourism strategies and transform the tourism operations within CapeNature; and
- Strengthen existing and developing new products with special attention to the provision of broader access for all people of the Western Cape.

Furthermore, CapeNature strives to increase and improve stakeholder awareness, understanding and participation in environmental conservation through:

- Developing the capacity of local people to meaningfully and responsibly, participate in the management and enjoyment of the protected areas
- Educating relevant stakeholders and creating awareness around key environmental issues to increase knowledge about the environment, develop a deeper understanding about environmental principals and encourage environmentally conscious values that allow for more informed and environmentally responsible decision making

3.5.10 Environmental Education and Awareness

As part of its multi-sectoral approach, CapeNature aims to support the Western Cape Education Departments efforts through presenting curriculum aligned Environmental Education Programmes to schools and will endeavour to collaborate with like-minded partners in pursuit of environmentally sustainable development goals as platforms for involving citizens and groups with the aim of expressing a "call to action". Behaviour change efforts will be optimised through targeting specific audiences with innovative, transformative, quality assured programmes and interventions.

3.5.11 Administrative framework

The Directorate: Conservation Operations is divided into two Regions, namely East and West. The West Region is divided up into two Landscapes, namely West and Central.

The Hexriver Complex is one of seven protected area complexes that occurs within the organisation's West Region. The Complex is supported primarily through the Landscape Office located in Paarl. All Landscape administrative matters that affect the Complex are managed via CapeNature's Head Office.

Conservation Managers report to the Landscape Manager of the Witzenberg Landscape Unit, based at Waterval Nature Reserve near Tulbagh. Protected areas are supported by the Landscape Manager: West Region, based in Paarl. The Complex has one main operational centre, namely Waterval. The staffing structure for the Hexriver Complex is depicted in Figure 3.3.

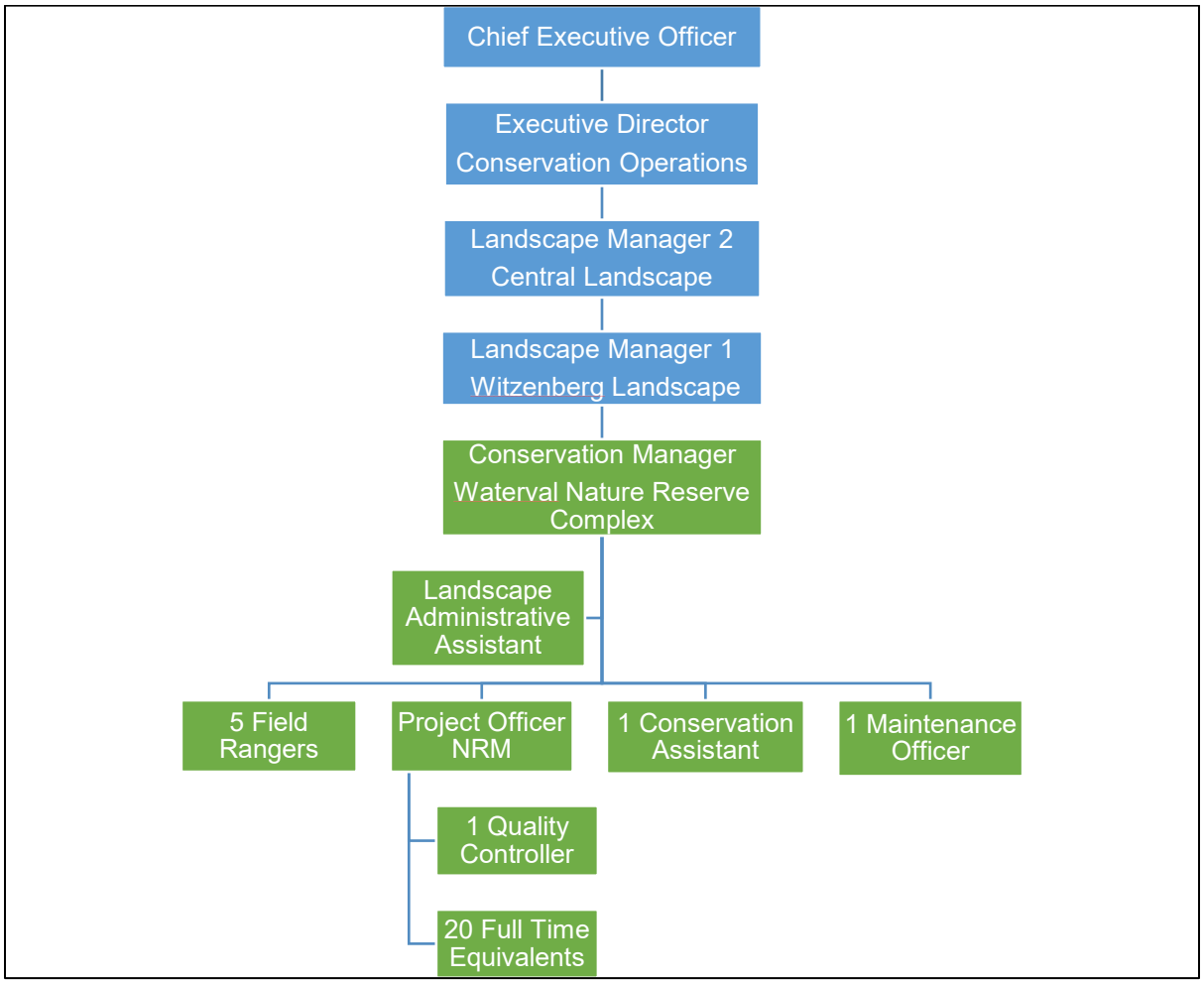


Figure 3.3. Approved organogram for the Hexriver Complex.

4 CONSULTATION

This section outlines procedures for public participation during the development of the management plan, including formal processes for public comment on the draft plan, and establishes procedures for public participation during the implementation phase of this plan (Figure 4.1).

Stakeholder engagement takes place throughout the adaptive management cycle and enables public participation essential for sustainability, builds capacity and enhances responsibility. It promotes communication and the derivation of new information and/or expertise.

At the outset of the planning process for the Hexriver Complex, a stakeholder analysis identified relevant internal and external stakeholders, and defined the scope and purpose of engagement.

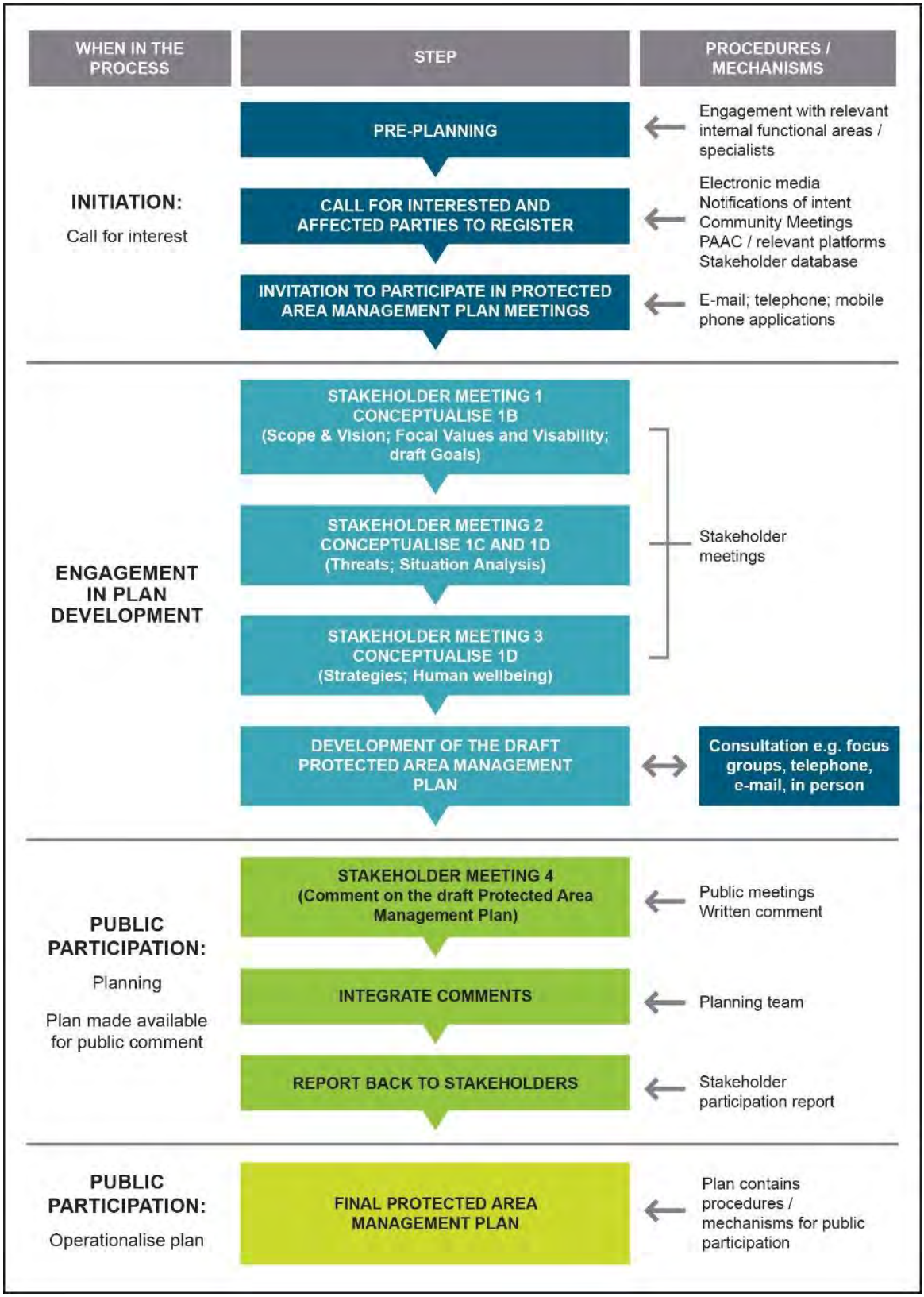


Figure 4.1. Process flow for Protected Area Stakeholder Engagement.

4.1 Stakeholder Engagement

4.1.1 Participatory planning

Several approaches to engaging internally and externally with stakeholders were applied, including structured facilitated workshops, meetings, site visits and the provision and circulation of information for input. Different stakeholders were engaged using varied approaches during the stages of the planning process, from gathering and sharing information, to consultation, dialogue, working groups, and partnerships. The degree of engagement was guided by the stakeholder analysis and in response to the need (i.e. transparency of process / expert opinion / buy-in and support, etc.).

During 2019 and 2020 a series of expert-facilitated stakeholder workshops, coordinated and hosted by CapeNature, were held. Due to the COVID-19 pandemic and the resulting lockdown regulations, some of the stakeholder engagement happened remotely via online meetings. A range of stakeholders representing individuals or agencies with an interest in, and / or knowledge / expertise of the landscape, and individuals or agencies with the capability to support the implementation of the Hexriver Complex management plan were involved. Stakeholders included landowners and land managers (private and communal), and relevant land or resource management authorities. Workshops were aimed at developing a strategic framework for the Complex to help coordinate efforts in the landscape towards a common vision. The desired outcomes were to capacitate stakeholders in the understanding of the natural and cultural focal conservation targets in the Complex landscape and to identify mechanisms to maintain those values over time.

The outcomes of the above-mentioned process were precursors to the site-specific management planning process for the Hexriver Complex and formed the foundation for smaller working groups towards the development of the management plan. The Complex management planning process was further facilitated by the core planning team comprised of CapeNature conservation manager, landscape conservation intelligence manager, landscape ecologist, ecological coordinator, off-reserve conservation manager/officer, stakeholder engagement manager/officer and landscape manager. A series of workshops and core planning team meetings were held with relevant internal and external stakeholders.

4.1.1.1 Key stakeholder groups engaged

- Communities (Ceres, Wolseley, Tulbagh)
- Private landowners;
- Resource managers mandated to manage the land for conservation
    - CapeNature,
    - Breede-Gouritz Catchment Management Agency,
    - private landowners,
    - Witzenberg Fire Protection Agency.
- Government agencies mandated to support and regulate land and water management and other relevant affairs
    - South African national Biodiversity Institute,
    - Department of Water Affairs and Sanitation,
    - Department of Environment, Forestry and Fisheries,
    - South African National Defence Force;

    - Eskom,
    - Transnet;

- Government Agencies mandated to support and regulate heritage management
    - Department of Cultural Affairs and Sport,
    - Hex Valley Tourism Association,
    - Heritage Western Cape;

- Local authorities
    - Cape Winelands District Municipality,
    - Witzenberg Municipality,
    - Breede Valley Municipality,

- Non-government organisations (NGO)
    - Mountain Club of South Africa,
    - Ski Club,
    - Cape Piscatorial Society,
    - Cape WInelands Fire Protection Agency,
    - Wilderness Search and Rescue,
    - Koekedouw Irrigation Board
    - Upper Breede Collaboration Group (UBCEG) – Land care;

- Tertiary Institutions
    - University of Cape Town;

- Other interested and affected parties who support and / or work in the planning domain
    - Matroosberg Nature Reserve,
    - Romansrivier Contract Nature Reserve,
    - Waverley Hills Nature Reserve,
    - Aquila Game Reserve,
    - Schalkenbosch,
    - Fairy Glen Private Nature Reserve,
    - South African Police Service (Worcester).

To date approximately six targeted stakeholder engagements have been initiated and facilitated with the nine above-mentioned stakeholder groupings through the following mechanisms:

4.1.1.2 Workshops

Stakeholder Workshops had the following key themes:

- Planning purpose: introducing stakeholders to planning for adaptive management; planning scope and vision;
- Conceptualisation: capacitating stakeholders in adaptive management planning; selecting focal conservation targets and assessing the condition of Focal conservation targets; threats assessment and conservation situation analysis;
- Planning actions: identifying strategies; developing theories of change and developing objectives and indicators.
- Internal stakeholder engagement: scientific review and component review.

Eleven external organisations (total of 14 people) attended the workshops out of all the organisations invited to attend (Figure 4.2).

Figure 4.2. Stakeholder participation in the Hexriver Complex. (Photo: Martin Albertus).

4.1.1.3 Working groups and other input opportunities

In instances where specific input was required or stakeholders and / or experts were unable to participate in workshops, smaller teams engaged and / or public meetings were facilitated to:

- Share workshop outputs and progress, and test the rationale of situation analyses, for example meetings with internal stakeholders related to taxon and habitat specific planning;
- Address relevant knowledge gaps and test rationale, for example, the Hex Valley Tourism Association was consulted to address knowledge gaps in heritage knowledge highlighted during workshops; internal stakeholders were consulted to address knowledge gaps;
- Provide opportunities for specific community engagements to reach as many individuals as possible via platforms such as the Fonteintjiesberg Nature Reserve Stakeholder Meeting and the Bokkeriviere Advisory Meeting;
- Facilitate information sessions and registration of interest with community members.

4.1.2 Procedures for Public comment

A process inviting the public, interested and affected parties to register their interest and comment on the draft management plan was initiated via the media (notifications were placed in two local newspapers – Witzenberg Harold and Worcester Standard), electronic media e.g. CapeNature's website, e-mail and telephone.

Furthermore, the draft management plan was placed at public libraries in De Doorns, Ceres, Wolseley and Tulbagh. The draft management plan was also available at CapeNature offices at Waterval Nature Reserve, and available on the CapeNature website. Written comment was invited on the draft management plan for a period of 21 days. The stakeholder participation process was initiated on 30 November 2020 and was concluded on 21 December 2020.

Registered interested and affected parties were invited to a public meeting and provided the opportunity to provide information and express their opinion. Two meetings were held on 14 December 2020 (at Tulbagh City Hall) and 15 December 2020 (webinar). In total seven external stakeholders attended these meetings. Based on a comprehensive stakeholder engagement process report of the outcomes of the public meeting, as well as written comments and responses received, the management plan was amended where relevant, and feedback provided to registered interested and affected parties. A stakeholder register, maintained by the Reserve Management Committee, lists registered interested and affected parties as well as comments received and responses by the reserve management committee.

Please refer to Appendix 2 – Stakeholder Engagement Report for the Hexriver Complex.

4.1.3 Procedures for Participatory Implementation

4.1.3.1 Protected Area Advisory Committee

Participatory management is facilitated through structures such as Protected Area Advisory Committees (PAAC) with the aim of regular interaction with stakeholders and a mechanism to evaluate stakeholder feedback, to promote good neighbour relations and to influence beyond protected area boundaries. The organisation of the Protected Area Advisory Committee for the Complex is as follows:

- Waterval PAAC, established on 23 April 2016. This PAAC service both the Waterval and Hexriver Complex given that both protected areas are managed by the main operational centre.

4.1.3.2 Other mechanisms for stakeholder engagement

Enhancing engagement and participation by relevant stakeholders throughout the Complex is a key focus area going forward. Current structures for stakeholder engagement, additional to the PAAC, include:

- The Western Cape Stewardship Reference Group serve as platform for conservation implementation by partners.
- The Fonteintjiesberg Nature Reserve Stakeholder Meeting and the Bokkeriviere Advisory Meeting serves as other liaison structures for management in the Complex.

5 PURPOSE AND VISION

This section makes provision for CapeNature to manage the Hexriver Complex exclusively for the purpose for which it was declared. It presents the vision, purpose, focal conservation targets and key threats foundational to developing the desired state for the Complex.

The desired state, articulated as goals in this management plan, defines the outcome of management and directs management within and beyond protected area boundaries. This serves as a foundation for appropriate ongoing monitoring and evaluation to assess management effectiveness.

5.1 Management Intent and Desired State

The Hexriver Complex aims to strategically, and adaptively, manage biodiversity towards ensuring the persistence of an intact natural climate change corridor, freshwater ecosystems, and unique cultural and biological diversity of the region through: 1) the prioritised strategic management of threats; 2) improving the condition of terrestrial and freshwater resources through integrated catchment management; 3) improving the condition of natural water supply; 4) ensuring that properties comprising the Complex are legally secured and protected area design is augmented by expansion through stewardship or other effective means; and 5) cooperative governance to overcome regulatory division in the management of freshwater resources.

5.2 Purpose

The Hexriver Complex was nominated as an extension of the CFRPA World Heritage Site in 2015 (DEA 2015). The primary reasons for inclusion of this Complex into the extension nomination for the CFRPA were to improve representation of vegetation units within the CFRPA, as well as to increase and improve the overall size, connectivity and integrity of the CFRPA, thus ensuring protection of an increased land area within the World Heritage Site. The Hexriver Complex improves connectivity between the inscribed Cederberg-, Groot Winterhoek-. and Boland Mountain Complexes. The Complex also provides some initial linkages between these inscribed components and the CFRPA extension of the Riviersonderend- and Langeberg Complexes. The Hexriver Complex thus improves connectivity, resilience and integrity of the surrounding inscribed component properties in the face of global climate change.

The landscape transitions and floral diversity in the Hexriver Complex provide physical and climatic diversity in an area of transition between montane and lowland habitats, and juxtaposed Fynbos and Succulent Karoo Biomes. Of the ten fynbos vegetation units found in the Hexriver Complex, three vegetation units, Ceres Shale Renosterveld, South Hex Sandstone Fynbos and North Hex Sandstone Fynbos, are not formally protected elsewhere. Threatened vegetation units present within the Hexriver Complex include Breede Alluvium Fynbos (Endangered), Breede Shale Fynbos (Vulnerable) and Ceres Shale Renosterveld (Vulnerable).

CapeNature manage the Hexriver Complex in accordance with its organisational vision, and in accordance with the vision, goals and strategies derived in consultation with stakeholders, as set out in this section.

According to Section 17 of the NEM: PAA each protected area in the Hexriver Complex is declared for one or more of the following purposes:

a) to protect ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes in a system of protected areas;
b) to preserve the ecological integrity of those areas;
c) to conserve biodiversity in those areas;
d) to protect areas representative of all ecosystems, habitats and species naturally occurring in South Africa;
e) to protect South Africa's threatened or rare species;
f) to protect an area which is vulnerable or ecologically sensitive;
g) to assist in ensuring the sustained supply of environmental goods and services;
h) to provide for the sustainable use of natural and biological resources;
i) to create or augment destinations for nature-based tourism;
j) to manage the interrelationship between natural environmental biodiversity, human settlement and economic development;
k) generally, to contribute to human, social, cultural, spiritual and economic development; or
l) to rehabilitate and restore degraded ecosystems and promote the recovery of endangered and vulnerable species.

5.3 Vision

The vision for the Hexriver Complex is:

The Hexriver Complex is a montane World Heritage Site, supporting landscape connectivity, where ecological resilience is achieved through catchment management in collaboration with stakeholders.

5.4 Focal Conservation Targets

In consultation with stakeholders, natural and cultural focal conservation targets were identified, explicitly defined, and selected for their ability to represent the full suite of biodiversity and cultural historic heritage within the Hexriver Complex.

Focal conservation targets are summarised in Table 5.1. Features considered to be nested within, or catered for by the conservation of the target, are noted. Key human well-being values derived from the tangible natural and cultural focal conservation targets are also noted. Since human well-being values are those components of well-being affected by the status of tangible natural or cultural targets, their 'health' or status is not assessed separately but seen as contingent upon the status of the natural and cultural focal conservation targets selected.

Table 5.1. Summary of the Hexriver Complex focal conservation target and viability in 2019.

Focal Target	Description, Nested Values, Key Attributes & Associated Human well-being values	Current Status
Freshwater Ecosystems	**Description:** Comprising of all natural, seasonal rivers and riparian zones, streams, seeps and groundwater, wetlands and wetland buffers. **Nested targets of note:** Freshwater invertebrates, freshwater fish communities (especially *Galaxias* sp. nov. 'breede' (Endangered)), riparian zone, lowland and high-altitude wetlands and seeps, rivers,	Fair

Focal Target	Description, Nested Values, Key Attributes & Associated Human well-being values	Current Status
	groundwater, priority small mammal species (Laminate vlei rat (Near Threatened), Cape march rat (Vulnerable)). **Key attributes:** Wetland Ecosystem Health, native vegetation structure and species composition within riparian zone (%), intact wetland buffers, River Health (instream macro-invertebrate species composition, freshwater fish species composition (includes threatened fish species). **Associated human well-being values:** Security from natural disasters; Water Security and environmental resilience; Responsible utilisation of natural resources.	
Terrestrial Ecosystems	**Description:** Comprising the terrestrial vegetation that consists of 9 distinct vegetation units of which two are of conservation concern and the associated flora and fauna species. **Nested targets of note:** Serotinous Proteaceae, Breede Alluvium Fynbos (Endangered), Ceres Shale Renosterveld (Vulnerable), Northern Inland Shale Band Vegetation, Altimontane vegetation, priority small mammal species (Spectacled dormouse (Near Threatened), White-tailed mouse (Vulnerable)), Verreaux's Eagle, *Colophon* beetles (*Colophon haughtoni* (Endangered), *C. cameroni* (VU) and *C. kawaii*), all fauna and flora communities associated with the terrestrial ecosystems, Rock art. **Key attributes:** Fire regime, Indigenous vegetation species composition (%). **Associated human well-being values:** Security from natural disasters; Water Security and environmental resilience; Responsible utilisation of natural resources.	Fair

As the public entity responsible for nature conservation in the Western Cape, CapeNature delivers a suite of core services to the public towards the following outcomes: resilient ecosystems that provide water and other eco-system services; the promotion of local economic development, job creation and skills development; growing diversified nature-based revenue streams; access to environmental education, advocacy and education, and access to natural and cultural heritage. Human well-being is articulated as an outcome of conservation and is illustrated in Table 5.2. These focus areas are essential to the effective execution of this management plan and achievement of goals.

Table 5.2. Human well-being values of the Hexriver Complex.

Human well-being Values	Description and Associated Benefits	Current Status
Water Security and environmental resilience	**Description:** Healthy ecosystems protect and enhance the provision of water quality and quantity and contributes to the water resilience for the Breede-Gouritz water management area. **Key attributes:** Access to clean water in sufficient quantity.	Fair
Responsible utilisation of natural resources	**Description:** Utilisation (consumptive and non-consumptive) of natural resources in a sustainable and non-damaging way. **Key attributes:** Permitted utilisation of resources; access to capacity and skills development opportunities; access to sites for non-consumptive utilisation (e.g. events, filming) and intact ecosystems and abundant wildlife.	Fair
Respect and care for the natural environment	**Description:** Provide an effective environmental education, awareness and interpretation programme that supports the values of	Fair

Human well-being Values	Description and Associated Benefits	Current Status
	the Hexriver Complex and promotes respect and care for the natural environment. **Key attributes:** Intact ecosystems; advocacy; education and awareness.	

5.5 Threats

Protected area management aims to mitigate threats to targets, either through direct threat mitigation, or through mitigation or management of a factor contributing to or driving the threat. Threats to focal conservation targets and the relevant contributing factors of key threats need to be described in sufficient detail to support effective planning and management.

Threats assessment influences the direction and effectiveness of management options. Rating threats according to scope, severity and irreversibility of impact facilitates the allocation of limited resources, simplifies complex scenarios and provides a systematic decision support method to focus efforts.

Table 5.3 provides a summary of focal conservation targets against key threats for the Hexriver Complex.

Table 5.3. A summary rating of critical threats, highlighting the natural and cultural historic focal conservation targets at greatest risk within the Hexriver Complex.

Focal conservation targets	Critical Threats	Threat Rating
Freshwater Ecosystems	Invasive alien fish; invasive alien plants, over abstraction of surface water; instream structures.	High
Terrestrial Ecosystems	Inappropriate fire regime, invasive alien plants; illegal utilisation of natural resources; unregulated access, climate change; Vandalism to heritage.	Very High

The results of the above threat rating highlighted the following key threats affecting the focal conservation targets of the Complex as outlined in Table 5.4 below:

Inappropriate fire regime (High): Too frequent, too large and out of season fires have severe ecological impacts. Most fires are human induced either through accidental ignition or are intentionally set. Over the past 10 years the size of fires has increased significantly (see section 2.3.1.3), resulting in very large proportions of the Hexriver Complex consisting of young veld. In addition, fires have become more frequent with large areas burning at too short return intervals and this is impacting negatively on the Hexriver Complex's ecosystems. Some aquatic systems, such as wetlands, are also affected by an unhealthy fire regime. The Hexriver Complex has many wetlands that are of conservation concern (see Table 2.7). These habitats are sensitive to inappropriate fire regimes with both too short and too long fire-return intervals being problematic. Inappropriate fire regimes also negatively impact indicator species, biodiversity, and potentially also on water supply (Esler *et al.* 2014). There is also a general lack of knowledge about the direct and indirect impacts of uncontrollable fires and enforcement is limited.

Invasive alien plants (Medium): Freshwater and terrestrial ecosystems are threatened by invasive alien flora. *Pinus*, *Hakea* and Australian *Acacia* species are amongst the most problematic woody invasive species in the CapeNature managed protected areas and the surrounding areas, although several other species, such as poplars (*Populus canescens*) and eucalyptus (*Eucalyptus diversicolor*) are also problematic in the low-lying drainage areas (see section 2.3.1.3). A sustained active management intervention is imperative to prevent it from impacting on species diversity and ecosystem services. An integrated approach to clearing invasive alien plants is needed for both aquatic and terrestrial ecosystems.

Unauthorised access (Medium): The privately owned Matroosberg Nature Reserve (adjoining Bokkeriviere Nature Reserve to the West) is managing a 4x4 route (mostly during winter when it is snowing) that runs to a popular look-out point on their property. Access on this route is controlled by a security gate and can only be accessed through prior booking with them. The previous landowner illegally extended the 4x4 route from the look-out point onto the Bokkeriviere Nature Reserve to Matroosberg Peak. Unfortunately, the control of 4x4 tourist is not managed well once they are on the 4x4 route and regularly access Bokkeriviere Nature Reserve illegally, disregarding the CapeNature sign board indicating the boundary. The route from the look-out point to Matroosberg Peak is in a bad condition and must be formally closed and rehabilitated. This illegally created 4x4 track runs through sensitive *Colophon* habitat. The current owner of Matroosberg Nature Reserve has a good relationship with CapeNature and is willing to assist in reporting suspect people for possible colophon beetle smuggling/poaching. In addition, verbal permission was given in the mid-eighties to the Ski Club of South Africa to build a ski hut and a cable network to transport ski equipment up and down the slopes on the mountain section that is now the Bokkeriviere Nature Reserve. The previous owner of Matroosberg Nature Reserve (South African Railway Company) and the South African National Defence Force that owns the property to the East of Bokkeriviere Nature Reserve gave permission. Recently the ski club constructed another ski hut and toilet on Bokkeriviere Nature Reserve. They were unaware that the latest hut and toilet were constructed on CapeNature property. They are willing to remove all the ski huts and re-construct them on the neighbouring property.

Unauthorised access also occurs on the other protected areas in the Complex. Access is uncontrolled and on Ben-Etive Nature Reserve neighbouring landowners made illegal hiking and mountain bike trails and jeep tracks in sensitive habitats that are prone to erosion. Unauthorised access to Fonteintjiesberg Nature Reserve result in open fires and smoke damage to rock art, while unauthorized access at Bokkeriviere Nature Reserve results in associated illegal harvesting of *Proteaceae* species for wood, illegal driving through sensitive vegetation and vandalism to rock art. Unauthorised access at Wittebrug Nature Reserve by members of the public going down to the Breede River to swim and have picnics often result in uncontrolled veld fires that starts from illegal braai fires. This becomes costly for CapeNature.

Illegal utilisation of natural resources (Low): This specifically refers to illegal harvesting of fauna and flora (poaching). Harvesting and utilisation of natural resources without authorisation undermines appropriate resource management. Snaring occurs along the boundaries of the protected areas and might be driven by demand for bush meat (ecotypical game species) due to traditional belief systems and poverty. Informal human settlement surrounding protected areas of the Hexriver Complex are on the increase and correlated with municipal poverty nodes. In addition,

two species of the *Colophon* (stag-beetles) that are endemic to Matroosberg Peak (Bokkeriviere Nature Reserve) are threatened due to international trade amongst beetle enthusiasts and collectors. Colophons are high in demand because of their rarity. In addition, buchu poaching occurs on Witzenberg- and Wittebrug Nature Reserves. Unfortunately, the excessive demand for specific fauna and flora species and / or their by-products is contributing to the loss of species and populations. Ineffective monitoring or the lack of enforcement are contributing factors to indigenous fauna and flora being illegally harvested within the zone of influence (see section 6.3).

Flora and fauna of the fynbos are considered unique, and protected area boundaries may not be well-defined to the public, while major roads intercept protected areas and offer easy access to resources (e.g. Michell's Pass). Environmental Compliance monitoring and enforcement contributes to environmental objectives and protection of ecosystems that in turn support livelihoods and development. Poaching, however, perpetuates a cycle of unfair competitive advantage and financial gain when a state of non-compliance exists. Regulatory divisions and differing priorities of the relevant law enforcement and compliance entities place differing emphasis on compliance monitoring of transport networks. A closer collaboration between conservation and relevant entities along with more effective environmental awareness and compliance monitoring can help alleviate the pressure on ecosystems.

Invasive alien fish (Low): Invasive alien species is a threat to both the Hexriver Complex and the catchment. Most of the indigenous fish species distribution ranges are not restricted to the Hexriver Complex but extend into the wider catchment. Five alien fish species, with the potential of becoming invasive, are present in the Hexriver Complex, namely rainbow trout *Oncorhynchus mykiss*, common carp *Cyprinus carpio*, smallmouth bass *Micropterus dolomieu*, bluegill sunfish *Lepomis macrochirus* and sharptooth catfish *Clarias gariepinus* (the latter species is native to South Africa but alien and invasive in the rivers of the CFR; Skelton 2001). Alien and invasive species are widespread throughout both the Breede and Gouritz systems. Rainbow trout is present in the Jan du Toits River in the Fonteintjiesberg Nature Reserve where the species has negative effects on the Breede River redfin, Cape kurper and a genetically distinct lineage of Cape Galaxias. The indigenous fishes are absent or present in very low numbers. Bluegill sunfish, smallmouth bass and sharptooth catfish are present in the Dwars River. The Tierkloof River has not been surveyed recently, but it is suspected that trout may be present in low numbers (Shelton *et al.* 2014). Invasive alien species affect indigenous fishes through predation, habitat alteration, competition for resources, the introduction of diseases and the disruption of ecological processes (Skelton 1987, De Moor and Bruton 1988). The primary impact is predation on smaller species and on juveniles of larger species and this has resulted in the extirpation of most indigenous species from mainstream rivers and tributaries (Weyl *et al*. 2014). Almost all viable populations of indigenous species are now limited to upper reaches of tributaries above waterfalls and other barriers where alien species cannot invade (Skelton, 2001 Chakona *et al*. 2013). CapeNature has no intention to remove fish listed under category 2 of the NEMBA from the Hexriver Complex for the duration of this PAMP.

Instream structures (Low): Instream structures include weirs, instream dam walls, bridges and causeways. The presence of weirs and other structures also causes upstream inundation (pooling) and alters the natural flow velocity and pattern of the river. In the case of weirs, it seems to be standard practise that rivers are blocked to varying degrees by the presence of diversion weirs just outside of the protected area

boundaries. These weirs tend to block off all the natural flow to downstream areas during the dry months and divert it to for example farm dams. The same would be the case for instream dams.

Over abstraction of surface water (Low): Extensive agricultural development in the region, especially in the catchments of Fonteintjiesberg- and Ben-Etive Nature Reserves within the Breede River system, has resulted in many river reaches outside of protected areas being severely affected by over abstraction of surface water. Water is being abstracted from the Bokke River (Bokkeriviere Nature Reserve) as bulk water supply for Touwsrivier. Severe over abstraction took place during the extensive drought experienced in the Western Cape from 2015 to the present and this resulted in no available water in the downstream sections of the river for ecological processes in summer months. Downstream from the Ben-Etive Nature Reserve the Titus River is also being severely impacted due to surface water abstraction for agriculture. Limited surface water abstraction is also taking place from the Wolwekloof-, Dwars-, Vals-, and Jan du Toits Rivers resulting in limited impact. It is imperative that the ecological reserve for these rivers are determined and taken into account.

Climate change (Very high): Climate change can have significant environmental, social, cultural and economic consequences for natural and social systems. Although the effects of climate change are speculative, it is likely to have major impacts such as an increase in the frequency of extreme weather events (for example droughts, floods and storm surges), habitat shifting and alteration and a hotter and drier climate. Addressing climate change is a global conservation priority and must be considered in the design and management of any conservation plan. The Conservation Standards (CMP 2020) focuses on climate adaptation by identifying threats to conservation targets and developing strategies to abate these threats, and so doing, providing resilience to the impacts of climate change. The Focal conservation targets of the Hexriver Complex link to the landscape being a priority climate change adaptation and mitigation corridor within the Western Cape.

Table 5.4. Rating of key threats applicable to the Hexriver Complex.

Threats	Associated Conservation Targets	Summary Threat rating
Climate change	Terrestrial ecosystems, Freshwater ecosystems	Very High
Inappropriate fire regime	Terrestrial ecosystems	High
Invasive alien plants	Terrestrial ecosystems, Freshwater ecosystems	Medium
Unauthorised access	Terrestrial ecosystems	Medium
Illegal utilisation of natural resources	Terrestrial ecosystems	Low
Invasive alien fish	Freshwater ecosystems	Low
Instream structures	Freshwater ecosystems	Low
Over abstraction of surface water	Freshwater ecosystems	Low

5.6 Goals

Clear and measurable outcome-based goals, strategies and objectives are fundamental for the assessment of protected area management effectiveness and to the whole process of management itself. Based on the viability and threats assessment, a desired future condition was established for Focal conservation targets and core service areas by setting measurable, time-bound goals directly linked to the values and their key attributes.

To maintain the healthy ecological infrastructure that supports life on earth and provides resilience to the impacts of climate change, management needs to achieve the following goals by 2031:

1. By 2031, the upper and middle river reaches in the Hexriver Complex support macro invertebrate species communities with an ASPT of 6 - ≥8*, and viable** indigenous fish communities are present in on-reserve rivers identified for fish conservation.
   *The scores will vary seasonally. Monitoring should always be done at the same time each year (preferably late spring/early summer);
   **Titus - Fair/Good, Vals - Very Good, Bokke - Very Good, Jan du Toits - Fair/Good, Bothaspruit - Very Good.

2. By 2031, the health of the wetland ecosystems in the Hexriver Complex will be in at least a near-natural* condition, and riparian zones and wetland buffers will have an indigenous vegetation cover of at least 75-89%.
   *slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.

3. By 2031, the terrestrial ecosystems in the Hexriver Complex have an ecologically healthy fire regime* and comprises >85% indigenous species.
   *<50% of area is young veld (<6 years old), the proportion of area burnt in fires larger than 1000 ha is more than 75% and single fires does not exceed 5000ha, >80% of the area burns during December-April.

Achieving human well-being, derived from healthy responsibly managed ecological infrastructure and heritage, requires that:

4. By 2031 the Hexriver Complex will, through integrated catchment management, protect and enhance the provision of water quality and quantity contributing to the water resilience for the Berg, Breede and Gouritz catchment areas.

5. By 2031, access to, and sustainable utilisation of, natural resources within the Hexriver Complex are in accordance with CapeNature policy and procedures.

6. By 2031, the Hexriver Complex environmental education and awareness programme will promote ecological targets and human well-being.

5.7 Sensitivity Analysis

Sensitivity analysis based on the Complex's biodiversity, heritage and physical environment is a key informant for spatial planning and decision-making in protected areas. Sensitivity analysis aims to:

- Highlight areas containing sensitive biodiversity and heritage features;
- Inform all infrastructure development *e.g.* location of management and tourism buildings and precincts, roads, trails, firebreaks;
- Facilitate holistic reserve planning and zonation; and

- Support conservation management decisions and prioritisation of management actions.

At the regional scale, sensitivity mapping also allows for direct comparison of sites both within and between protected areas to support organisational planning across CapeNature's protected areas network. The process elevates:

- Sites with the highest regional conservation value;
- Areas where human access or disturbance will have a negative impact on biodiversity or heritage, and specific environmental protection is required;
- Areas where physical disturbance or infrastructure development will cause greater environmental impacts, and / or increasing construction and maintenance costs;
- Areas where there is a significant environmental risk to infrastructure; and
- Areas that are visually sensitive and need to be protected to preserve the aesthetic quality of the visitor's experience.

Sensitivity analysis provides decision support to ensure that the location, nature and required mitigation for access, utilisation and infrastructure development in the Complex are guided by the best possible landscape-level biodiversity and heritage informants. The process is transparent, relying on defensible expert-derived information and scientific data. Sensitivity maps do not replace site-level investigation, although do allow for rapid assessment of known environmental risks, guiding planning to minimise negative impacts.

Sensitivity analysis uses a hierarchical approach. The method uses the premise that if a portion of the landscape is demarcated as highly sensitive in one of the categories considered in analysis then, regardless of the sensitivity in other categories, that portion is elevated as highly sensitive in the overall scoring. The approach thus allocates the highest allocated sensitivity in any of the input categories as the ultimate sensitivity class for that portion. As new and improved data become available, these data can be included.

Biodiversity, heritage and physical features are rated on a standard scale of one to five, where one represents 'no' or 'minimal sensitivity' and five indicates 'maximum sensitivity' (see Figure 5.1). Additional features such as visual sensitivity, fire risk and transport costs can be included. Higher scores represent areas that should be avoided for conventional access and infrastructure development, or where a specific strategy is applicable relative to sensitivity. A score of five typically represents areas where mitigation for conventional access or infrastructure development would be extensive, costly or impractical enough to be avoided at all costs or features so sensitive that they represent a 'no go' area.

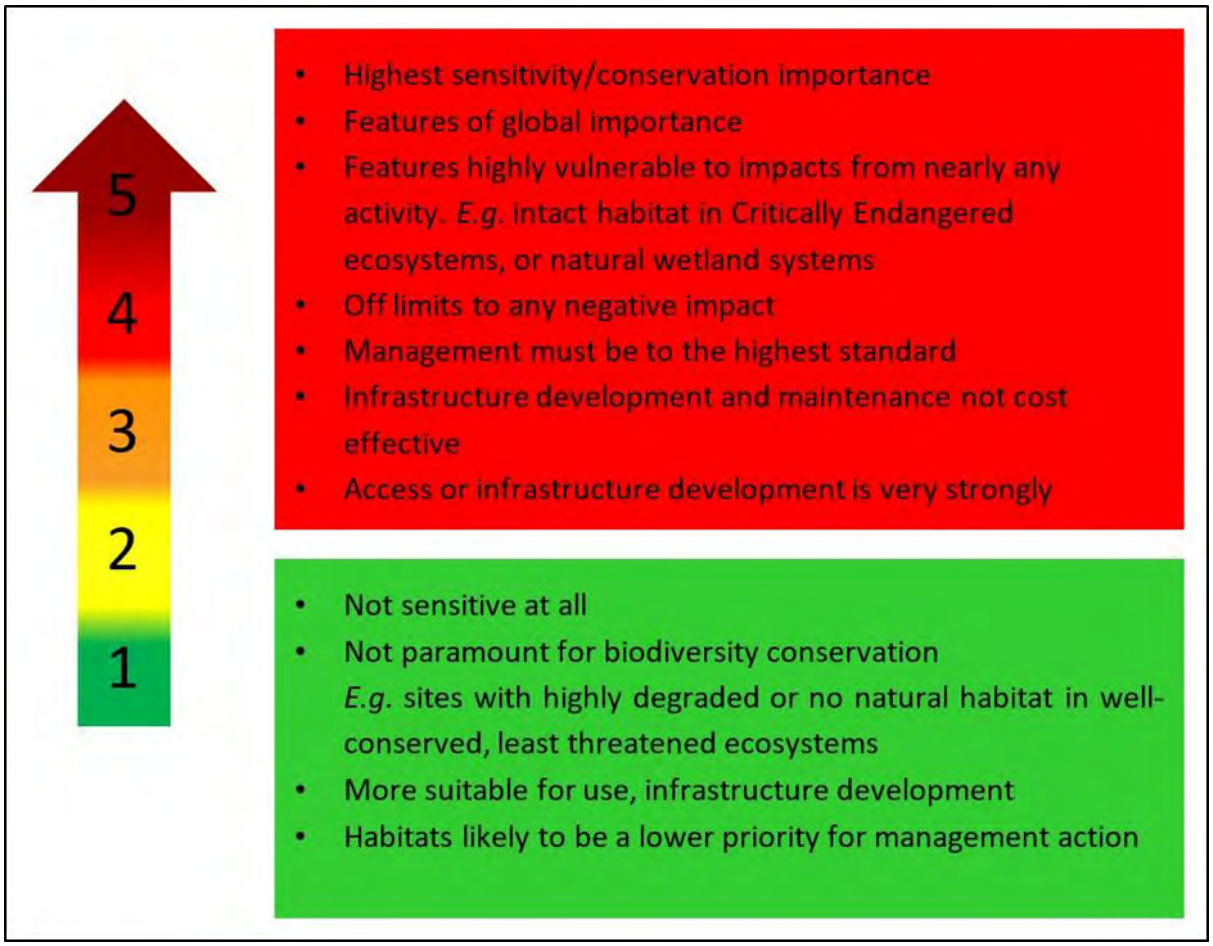


Figure 5.1. CapeNature method for sensitivity scoring and synthesis.

Physical, biodiversity and heritage features included in the sensitivity analysis for the Hexriver Complex is illustrated in Table 5.5 and the sensitivity is shown in Appendix 1, Map 8.

Table 5.5. Physical, biodiversity and heritage sensitivities included in the sensitivity analysis of the Hexriver Complex.

	Category	Dataset	Criteria	Sensitivity score	
Physical	Slope (degrees)	Slope calculated from 20m resolution digital elevation model	>30° Effectively off-limits for infrastructure development due to extreme risk of erosion and instability, or extreme engineering mitigation and associated construction costs required.	Highest sensitivity	**5**
			20°-30° Strongly avoid for infrastructure development – cut and fill or other difficult and expensive construction method required. Appropriate engineering mitigation essential to prevent erosion and slope instability. Highest initial and on-going cost due to slope stabilization and erosion management required.	High sensitivity	4

	Category	Dataset	Criteria	Sensitivity score	
			10°-20° Avoid for road, trail and firebreak construction if possible. Severe erosion will develop on exposed and unprotected substrates. Pave roads and tracks and ensure adequate drainage and erosion management is implemented. May provide good views.	Moderate sensitivity	3
			5°-10° Low topographic sensitivity, likely still suitable for built infrastructure. Use of gentle slopes may provide improved views or allow access to higher areas.	Low sensitivity	2
			0°-5° Preferred areas for any built infrastructure, lowest risk of erosion or instability, lowest construction and on-going maintenance costs.	Lowest sensitivity	1
	Soil edibility / Geology	None included	No special features identified for inclusion.	Highest sensitivity	5
Biodiversity	Rivers	1: 50 000 NGI Rivers	Within 200m of perennial river.	Highest sensitivity	5
			Within 100m of non-perennial river.	High sensitivity	4
	Wetlands and Seeps	Wetlands from SA Inventory of Inland Aquatic Ecosystems (Van Deventer *et al.* 2018)	Wetland and seeps as extracted from the NBA 2018, only the "natural" wetlands" ("artificial" removed).	Highest sensitivity	5
			Within 200m of wetlands and seeps	High sensitivity	4
	Vegetation status / Ecosystem threat status	Red-Listing Ecosystems by Andrew Skowno, done for the NBA per veg type, SA Veg Map 2018 (SANBI 2006-2018)	Critically Endangered – NONE	Highest sensitivity	5
			Endangered – Breede Alluvium Fynbos, Breede Shale Fynbos	High sensitivity	4
			Vulnerable – Ceres Shale Renosterveld	Moderate sensitivity	3
			Threatened – NONE	Low sensitivity	2
			Least Concern – Matjiesfontein Shale Renosterveld, North Hex Sandstone Fynbos, Northern Inland Shale Band Vegetation, South Hex Sandstone Fynbos, Southern Afrotemperate Forest, Western Altimontane Sandstone Fynbos, Winterhoek Sandstone Fynbos	Lowest sensitivity	1
	Protection levels per Vegetation type	Protection Levels by Andrew Skowno, done for the NBA per veg type, SA Veg Map 2018 (SANBI 2006-2018)	Not Protected – NONE	High sensitivity	4
			Poorly Protected – Breede Alluvium Fynbos, Ceres Shale Renosterveld, Matjiesfontein Shale Renosterveld	Moderate sensitivity	3
			Moderately Protected – Breede Shale Fynbos	Low sensitivity	2
			Well Protected – North Hex Sandstone Fynbos, Northern Inland Shale Band Vegetation, South Hex Sandstone Fynbos, Southern Afrotemperate	Lowest sensitivity	1

	Category	Dataset	Criteria	Sensitivity score	
			Forest, Western Altimontane Sandstone Fynbos, Winterhoek Sandstone Fynbos		
	Vegetation status / Ecosystems threat status	Ecosystem Threat Status based on Cape's 2016 assessments per veg type 2012 (Mucina & Rutherford 2006)	Critically Endangered – NONE.	Highest sensitivity	5
			Endangered – Breede Alluvium Fynbos	High sensitivity	4
			Vulnerable – Cere Shale Renosterveld	Moderate sensitivity	3
			Threatened - NONE	Low sensitivity	2
			Least threatened – Breede Shale Fynbos, Matjiesfontein Shale Renosterveld, North Hex Sandstone Fynbos, Northern Inland Shale Band Vegetation, South Hex Sandstone Fynbos, Southern Afrotemperate Forest, Western Altimontane Sandstone Fynbos, Winterhoek Sandstone Fynbos	Lowest sensitivity	1
	Rare and endangered plant species	Rare and endangered plant species extracted from CapeNature Biodiversity Data Base; All threatened Species (SANBI 2015); Altimontane fynbos, extracted from NBA veg map 2018 (SANBI 2006-2018)	All plant species rated as Critically Endangered, Critically Rare, Declining, Endangered, Near Threatened, Rare or Vulnerable. Point localities buffered by 5m. Special habitat – Altimontane fynbos, elevation of 1800m and higher. Highly sensitive for *Colophon* beetle and other endemic species, both flora and fauna.	Highest sensitivity	5
Heritage	Archaeological and cultural sites	Cultural and Heritage Sites (CapeNature Infrastructure register)	Heritage sites as extracted from the reserve's infrastructure register. Files are in point shapefile format and was then buffered by 100m.	Highest sensitivity	5

Sensitivity for the Hexriver Complex is shown in Appendix 1, Map 8. Approximately 42% of the Hexriver Complex is classified as having the highest sensitivity, while 32.6% has a high sensitivity (Table 5.6). The key drivers of sensitivity in the Complex are slope and rivers. Approximately 79% of the Complex has a sensitivity score of moderate to highest sensitivity (Table 5.6), while approximately 36% was classified as having high to highest sensitivity due to rivers.

The vegetation of the Hexriver Complex was not a key driver of sensitivity. The sensitivity based on the protection levels and ecosystem threat status per vegetation type was scored as having the lowest sensitivity. In addition, special habitat only contributed a very small amount to the Complex being scored with the highest sensitivity (Table 5.6). Altimontane fynbos, which only occur at elevations of 1800m and higher, only constitutes a small proportion of the Complex. The very high sensitivity of this habitat is due to its vulnerability to climate change and the fact that

other species that are just as sensitive to climate change (e.g. *Colophon* beetles) occur therein.

Although the sensitivities of most of the parameters scored low, due to the methodology most of the protected area (75%) has been scored as high sensitivity largely because of high sensitivity scorings in the proximity to rivers and the slope categories.

Table 5.6. Summary of total and percentage area captured by the main features contributing to the sensitivity analysis of the Hexriver Complex illustrated in Appendix 2 Map 8.

Score	Total sensitivity score		Main features							
	Area (ha) = **19 308.68**	% of total	**Slope sensitivity** % of total	**Rivers** % of total	**Wetlands and Seeps** % of total	**Ecosystems threat status per vegetation type** % of total	**Protection levels per vegetation type** % of total	**Species of special concern** % of total	**Special habitats** % of total	**Heritage** % of total
1	662.16	3.4	9.6	-	-	96.8	90.7	-	-	-
2	1 144.89	5.9	11.3	-	-	0.0	2.6	-	-	-
3	2 968.32	15.4	24.2	-	-	0.3	6.7	-	-	-
4	6 291.76	32.6	22.2	28.2	6.1	2.9	0.0	-	-	-
5	8 241.54	42.7	32.6	8.1	2.5	0.0	0.0	0.005	4.1	0.1

6 ZONING PLAN

This section outlines the zoning plan for the Hexriver Complex. The Complex forms part of a planning matrix and locating the Complex in terms of the municipal integrated development plan is aimed at minimising conflicting development in either the protected area or the neighbouring municipal area.

The primary objective of the zoning plan is to establish a coherent spatial framework within and around the Hexriver Complex to guide and co-ordinate conservation, tourism and visitor experience, access and utilisation, and stakeholder and neighbour relations.

Zoning is intended to minimise user conflict by separating potentially conflicting activities such as wildlife viewing, recreational activities and tourism accommodation, whilst ensuring that activities and utilisation continues in appropriate areas and do not conflict with the goals and objectives of the Hexriver Complex.

6.1 The Hexriver Complex in the Context of Municipal Integrated Development Planning

The Hexriver Complex is located within the CWDM. It straddles two local municipalities namely Witzenberg and Breede Valley.

SDFs are compiled in order to illustrate current and desired future land uses spatially across the municipality and link in to the IDP in terms of the spatial allocation of the municipal budget. IDPs are compiled annually and for five-year periods by all municipalities in South Africa in order to establish prioritization and allocation of budget expenditure in terms of development priorities.

As such, there are three SDFs and three IDPs, which need to be taken into consideration for the Hexriver Complex, in terms of alignment between statutory initiatives at the three tiers of government and management of protected areas and identification of risks and interventions required. The IDP and SDF should be taken into consideration in determining the zone of influence and establishing potential threats and opportunities in these areas. There is also the opportunity to identify projects and interventions that need to be included in the IDPs and SDFs where appropriate and within the legislated stakeholder engagement processes.

6.1.1 Cape Winelands District Municipality SDF and IDP

The CWDM SDF (2019) has used the 2017 Western Cape Biodiversity Spatial Plan (including the accompanying handbook) as one of its key informants. The CWDM SDF acknowledges formal protected areas, stewardship sites, Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) as being important for the protection of biodiversity and ecosystem services. Wilderness areas, statutory conservation areas and CBAs are listed as falling under the Core Spatial Planning Category where no urban development is permitted.

In terms of impacts on biodiversity the CWDM SDF has identified changes in fire regime, invasive alien species, over-extraction of water sources and loss of ecosystem services as being of major concern. Some of the key strategies that have been identified in the WCDM SDF under the Biodiversity and Ecosystems Focus Area, which are relevant to the Hexriver Complex, include preventing loss and degradation of CBAs and ESAs and to incorporate CBAs into protected area networks; preventing loss of wetlands and increasing the protection of freshwater ecosystems; removal of invasive alien species; and to improve and maintain ecological corridors to facilitate the migration of flora and fauna.

The CWDM SDF indicates that budget has been set aside for EPWP invasive alien vegetation management, river rehabilitation and the service delivery agreement with Cape Winelands Biosphere Reserve for which the Land Use and Spatial Planning Section of the municipality is responsible.

The CWDM IDP includes the Sustainable Development Goals as a basis for its strategy. Objective 9 of the IDP is “To improve and protect the districts natural environment”. The environmental concerns identified include over-utilisation of water, water quality, soil erosion and loss of biodiversity and natural beauty.

The CWDM IDP acknowledges that conserving biodiversity and ecosystem functioning through assigning the correct Core Spatial Planning Category is important. The CWDMs selection of strategies and action was guided by concerns regarding degradation of freshwater ecosystems, absence of any protected status for these

ecosystems, intense development pressure on many vegetation types, poor water quality and absence of adequate buffers to protect core areas, larger conservation areas and intact CBAs.

In terms of projects and programmes across the municipality, the health and air quality programme focus on environmental education and urban greening. Disaster management is of high relevance for the Hexriver Complex, in particular the fire-fighting services, which forms a separate programme. Reference is made to the Council for Scientific and Industrial Research (CSIR) Veld Fire Risk Assessment, as well as the Fire and Rescue Training Academy, co-ordinated planning for the fire season (including CapeNature) and the Fire Protection Association. One of the focus areas for the WCDMs River Rehabilitation Programmes is the Witzenberg Municipal Nature Reserve. The WCDM IDP also has a strong focus on water security, which is of high relevance to the Hexriver Complex which forms a large part of a catchment is considered to be one of the Western Cape's "water factories".

6.1.2 Witzenberg Local Municipality SDF and IDP

The Witzenberg Local Municipality (WLM) SDF has also used the 2017 Western Cape Biodiversity Spatial Plan as one of its key informants. The SDF has included formal nature reserves, Mountain Catchment Areas, private nature reserves and CBA category 1 under the Core 1 Core Spatial Planning Category and detailed development guidelines have been provided, including a list of undesirable activities. The WLM SDF also includes a Core 2 category under which ESAs have been included.

From a spatial planning and land use management perspective, the following issues have been identified in relation to the biophysical context: Biodiversity and habitat loss are occurring due to agriculture; the southern and western parts of the municipal area are prone to wildfires (and hence are classified as high risk areas); droughts and other climate change related disasters are anticipated to occur with increased frequency; the eastern part of the municipality is predicted to become less productive due to limited water availability and heat-related issues. The WLM SDF states that the match between land capacity and the potential of the land has already been met within the municipality and therefore, the balance between conservation and agriculture is essential to maintain ecosystem functioning and farming productivity of the region.

The WLM SDF has a "Nature" Focus Area, which aims to maintain and expand the continuity of core biodiversity areas, river systems and other landscape elements to establish connected "green networks" across the municipal area and region. Implications of this are that they need to prohibit incompatible activities in CBAs and ESAs and set urban development back from wetlands and floodplains. The SDF also acknowledges the need to prioritise management of alien invasive species in water catchments and river corridors, which is of high relevance to the Hexriver Complex and surrounding catchment. The municipality plans to implement proactive fire and invasive species management on municipal properties; provide active support for stewardship programmes and Land-care programmes; the establishment of conservancies and special management areas to incentivise these programmes and nature reserve declarations on private land.

The WLM IDP refers to managing two nature reserves and several CBAs. It acknowledges that municipal land is vastly infested by aliens. WLM has appointed consultants to draw up the Witzenberg Municipality Invasive Alien Species Monitoring

and Control Plan. This plan will be valid for five years from date of approval after which is will be reviewed to reflect management objectives.

The WLM IDP states that availability of water is the most critical factor in the municipal area. The IDP acknowledges that water resources are crucial to the well-being of humans and that it plays a fundamental role in the continuing existence and health of our ecosystems. Water is also vital for cultivation, processing and manufacturing activities, which drives the economy of Witzenberg. This recognition of the value of water resources is of high relevance to the Hexriver PAMP as it aligns with the management objectives of protecting not only the land parcels making up the Hexriver Complex but also the entire catchment.

Environmental education will be supported by WLM through the "Green Fingers" project in conjunction with Cape Nature with the focus on "learning respect for the nature".

6.1.3 Breede Valley Local Municipality SDF and IDP

The Breede Valley Local Municipality (BVLM) SDF does not have a strong focus on biodiversity conservation. It does acknowledge that the ecological integrity of natural open spaces is important to maintain natural systems and processes. However, there is no mention of the importance of maintaining natural ecosystems, particularly those in protected areas, CBAs and ESAs, in terms of building resilience, climate change adaptation and the need to protect ecological infrastructure, which provides ecosystem services and most importantly water.

The BVLM SDF does however recognise that there is a need for a continuous open space to be developed in the municipality. This would mean that in certain areas where natural open space is currently affected by undesirable activities, the municipality must intervene in order to ensure that these ecological corridors can be created and are able to function appropriately. Focus should be placed on and resources allocated to those consolidated natural open space areas where long term ecological sustainability can be achieved.

The BVLM IDP recognizes that contributions to the green economy must include active and sustained investment in protecting the natural environment and the IDP states that water resources, functional ecosystems and biodiversity have emerged as critical inputs to both rural and urban livelihoods and well-being. The IDP recognises that the EPWP, which encapsulates initiatives such as Working for Water, Working for Wetlands and Working on Fire create significant numbers of jobs and opportunities for skills development. Biodiversity conservation has been identified in the IDP as one of several focus areas to assist with combatting climate change. The Stakeholder Engagement- and Land Use Advice scientists must ensure that the Hexriver Complex goals and objectives are incorporated into the local IDP and SDF documents.

Table 6.1. Aspects of Integrated Municipal Development Plan/s applicable to the Hexriver Complex.

Municipality	Aspect in IDP to be addressed	Proposed Intervention
Cape Winelands IDP	Various fire management interventions and structures.	Integrate with CapeNature operations

Municipality	Aspect in IDP to be addressed	Proposed Intervention
Cape Winelands IDP	Various alien clearing initiatives	Integrate with CapeNature operations
Witzenberg IDP	Invasive alien clearing programme	Assist with identifying priority areas for clearing
Witzenberg IDP	Various fire management interventions and structures.	Integrate with CapeNature operations
Breede Valley IDP	Expanded Public Work Plan	Assist with prioritising action in landscape

6.2 Protected Area Zonation

The primary function of the Hexriver Complex is to conserve biodiversity and support quality water yield. However, other functions such as ensuring access and providing benefits to neighbouring communities and local economies may conflict with this primary function.

The zonation plan is thus a standard framework and set of formal guidelines to balance conservation, access and utilisation within the Hexriver Complex, and is informed by sensitivity analysis. Zonation:

- Is foundational to planning and development within the Complex;
- Provides a framework for development of the Complex;
- Recognises the purpose for which the Complex is established;
- Ensures ecosystem resilience by limiting human intrusion in the landscape;
- Mitigates user conflict and minimises the impact of utilisation on natural and cultural heritage through access and activity management;
- Accommodates a range of activities ensuring that nature-based recreation and experiences for solitude do not conflict with social and environmental requirements or needs; and
- Confines development within the Complex to areas deemed appropriate to tolerate transformation without detracting from sense of place.

CapeNature's zonation categories, illustrated in Table 6.2, are derived from existing protected area zonation schemes worldwide, to develop a coherent scheme that provides for visitor experiences, access and conservation management needs.

Table 6.2. Guide to CapeNature conservation management zones.

Zonation Category	Explanation
Wilderness / Wilderness (declared)	Areas with pristine landscape, sensitive areas or threatened ecosystems. Very limited access.
Primitive	Areas providing natural landscape, solitude and limited access. Normally a buffer area to wilderness zones.
Nature Access	Providing easy access to natural landscape. Includes areas with roads and trails, and access to popular viewing sites and other sites of interest.
Development – Low intensity	Area with existing degraded footprint. Providing primarily self-catering accommodation and camping, environmental education facilities.

Zonation Category	Explanation
Development – High intensity	Area extensively degraded. Providing low and/or higher density accommodation, and maybe some conveniences such as shops and restaurants.
Development – Management	Location of infrastructure and facilities for reserve administration and management.
Development – Production	Commercial or subsistence farming (applicable to privately owned and managed nature reserves).
Development – Private Areas	Private dwellings and surrounds (only applicable to privately owned and managed nature reserve).
Species / Habitat / Cultural Protection	Areas for protection of species or habitats of special conservation concern.
Cultural Species / Habitat Visual Natural Resource Access	Special management overlays for areas requiring specific management interventions within the Species / Habitat / Cultural Protection Zone.

The following underlying decision-making rules are applied in determining zones:

1. Strike a balance between environmental protection and development of the Complex to meet broader economic and social objectives of the protected area.
2. Consider existing development footprints and tourism access routes based on:
    - The principle that all else being equal, an existing transformed site is preferable to a site in a natural condition from a biodiversity perspective;
    - Increasing costs the further developments are from existing infrastructure;
    - The socio-economic benefit of existing tourism nodes and access routes; and
    - Infrastructure design and services with due consideration for focal conservation targets.
3. Where existing development nodes, tourist sites and access routes occur in areas with high sensitivity-value, associated zonation must aim to confine the development footprint as much as possible and preferably within the existing transformed site.
4. Sites with high biodiversity sensitivity value are put into stronger protection zones and peripheral development is favoured.

A summary of the zonation scheme applicable to the Hexriver Complex is depicted in Table 6.3 and illustrated in Appendix 1, Map 9.

Table 6.3. Summary of CapeNature zonation categories applicable to the Hexriver Complex.

Category	Description
Wilderness / Wilderness	Only a portion of the Fonteintjiesberg Nature Reserve was zoned as wilderness. This area has no infrastructure, is very remote and difficult to access.

Category	Description
Primitive	The following protected areas in the Hexriver Complex are zoned as primitive except for the areas zoned for wilderness, nature access, and development areas: Witzenberg Nature Reserve – Entire reserve except for road buffer zoned as Management Development. Wittebrug Nature Reserve – Entire reserve except for road and railway line zoned as nature access. Ben-Etive Nature Reserve – Entire reserve except for dams and road buffers zoned as management - development. Fonteintjiesberg Nature Reserve – The valley of the Jan du Toits river and area not zoned as wilderness. Bokkeriviere Nature Reserve – Entire reserve except for roads, canal, camp area and reservoir zoned as management - development.
Nature Access	For all the reserves within the Hexriver Complex the public roads (such as the Mitchell's Pass) and the Transnet railway line with unrestricted access were buffered by 25m.
Development – Management	The following areas were digitized and zoned as development – management: Witzenberg Nature Reserve – ESKOM jeep track buffered by 2.5m. Ben-Etive Nature Reserve – The two farm dams zoned as management due to agreement with landowners. The access roads to the dams were buffered by 2.5m. Bokkeriviere Nature Reserve –The old reservoir dam and the camp area indicated in south-eastern part of the reserve. Visible gravel roads that have servitudes running between the reservoir and two weirs, and the canal that has a servitude buffered by 2.5m.

6.3 Protected Area Zone of Influence

CapeNature seeks to maximise positive influences and / or minimise direct and indirect negative pressures on values, with the aim of ensuring the persistence of species and biodiversity in general. Activities managed include those that might have direct impacts on values, and those that have only indirect effects, often at considerable distance from the location where the activity takes place.

The zone of influence is a mechanism that recognises and activates the abovementioned principle. Three key informants (Figure 6.1) used to delineate the zone include:

- Viability of Focal conservation targets;
- Threats assessment; and
- Protected area sensitivity and zonation.

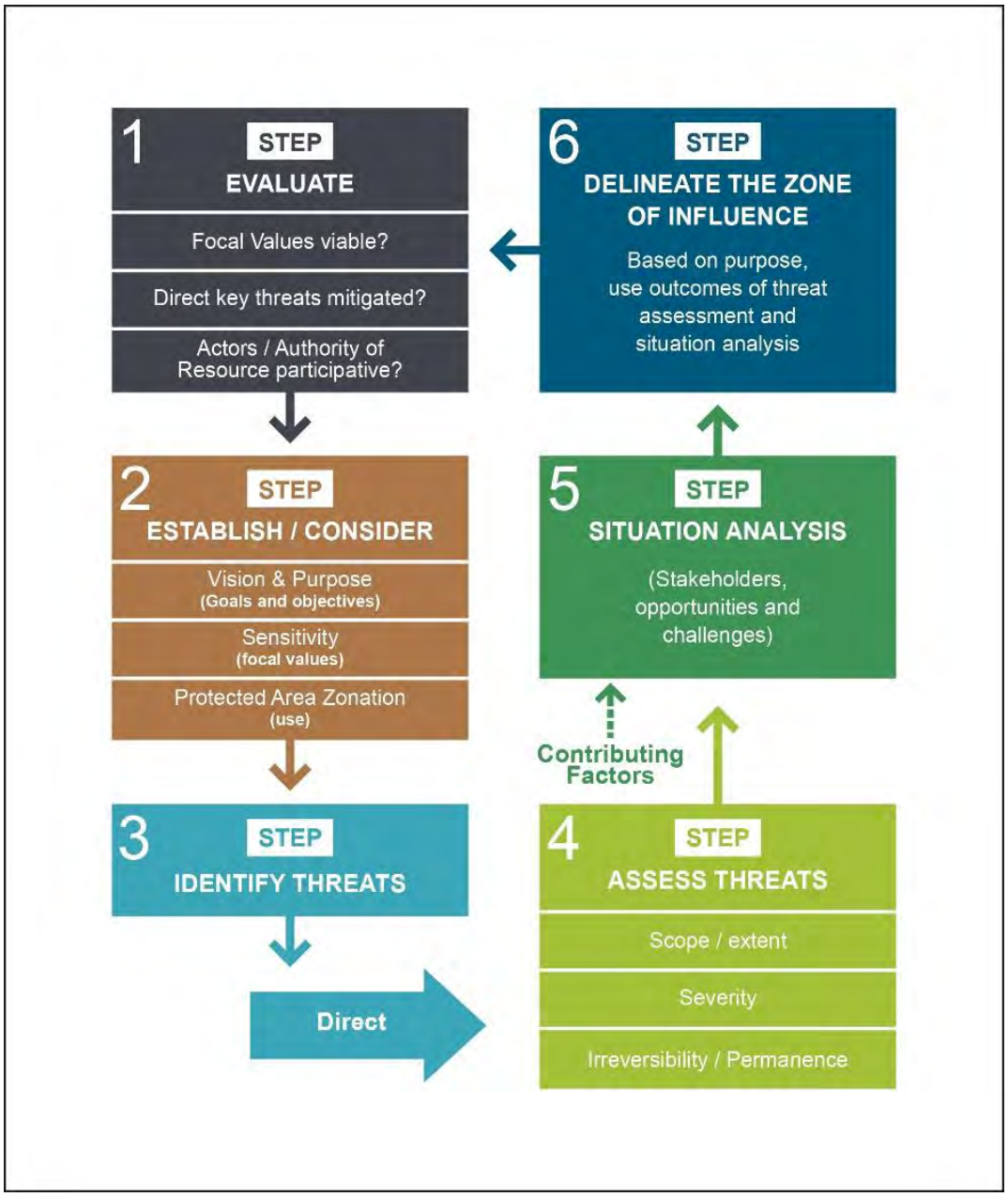


Figure 6.1. Process flow for the delineation of the zone of influence.

The zone of influence is a non-legislated area spatially depicted around the Complex. The zone ultimately aims to facilitate strategic stakeholder engagement by linking key stakeholders to prioritised influences to promote an ecologically functional landscape that supports goals and objectives of the Complex, and enhances the benefits derived from the Complex. The process of delineation helps to identify:

1) Actions to directly restore a value or mitigate a threat;
2) Actions designed for people to continue positive behaviours or halt direct threats; and/or
3) Actions to address enabling conditions.

The zone of influence is thus:

- A tool to guide resource allocation and investment outside of the Complex;
- A tool to marry stakeholder engagement / authorities of resource to activities;

- A spatial prioritisation of where to support compatible land and water use, and positive behaviours;
- A spatial prioritisation of where to collaborate and with whom;
- A mechanism to prioritise support to landowners or managers of priority landscapes; and
- All-encompassing mechanism that includes all or part of a buffer zone as prescribed in terms of legislative frameworks and conventions.

The spatial features used in the zone of influence calculation are rated on a standard scale of one to four: Low (1), Medium (2), High (3), and Very high (4). These ratings are assigned to each input feature within the zone of influence. Higher scores represent areas where many features overlap, elevating the necessity to engage stakeholders and positively influence neighbour relations and / or activities.

Table 6.4 lists the features, criteria and rating applied to delineate the zone of influence of the Hexriver Complex. Appendix 1, Map 10 illustrates the zone of influence for the Complex.

Table 6.4. The criteria used for defining the zone of influence of the Hexriver Complex.

Feature	Criteria	Rating	Zone area (ha)	% of zone
Fire hazards (high fire frequency)	Inappropriate fire frequency due to anthropogenic fires. Areas identified as hotspots for fire risk adjacent to protected areas: 1) areas with a fire frequency of 5 and more since 1980; 2) areas where fires occurred more than once in 15 years; 3) areas where incompatible practices can lead to high fire risks.	Very high (4)	23628.1	17.2
Species of special concern	Known locations of fauna and flora species of special concern occurring outside the protected areas. These species include rare and endangered species, or ecological areas identified where special species occur.	Very high (4)	3 442.9	2.5
New agriculture	Identify areas under threat of potential agriculture in the future due to climate change and CARA regulations. The areas at risk are those in shale substrate and at a gentler slope (up to 20%).	High (3)	12 248.6	8.9
Fish monitoring areas	Rivers identified for low level of conservation intervention, due to the presence of threatened fish species, as a preventative measure (for timeous intervention should invasion occur). Rivers where weirs occur for water abstraction and / or serves as barriers to invasive alien fish.	High (3)	476.0	0.3
Abstraction of surface and ground water	Agricultural fields falling within 10km of the protected areas were used as a surrogate for surface	High (3)	25 859.5	18.8

Feature	Criteria	Rating	Zone area (ha)	% of zone
	water abstraction from the water recharge area.			
Over commercialisation	Areas under threat of over-commercialisation.	High (3)	2 299.7	1.7
Invasive alien plants	No formal plantations have been recorded within the buffer area. The National Invasive Alien Plant Survey, compiled by Kotze *et al.* (2010), was used to extract data.	High (3)	42 687.2	31.1
Illegal resource use	Illegal resource use, including poaching of fauna and flora.	Medium (2)	9 543.3	6.9
Game farming	Extracted all game farms adjacent to the PA boundary from the Western Cape Game Database, last update July 2019.	Low (1)	8 140.1	5.9
Mountain Catchment areas	All adjacent mountain catchment areas were included into the zone of influence.	Low (1)	61 203.3	44.6
Private Nature Reserves	All adjacent private nature reserves were included into the zone of influence.	Low (1)	3 140.3	2.3
Local Authority Nature Reserve	All local authority nature reserves adjacent to the protected areas was included as part of the zone of influence.	Low (1)	6 783.8	4.6
Stewardship sites	Select the stewardship sites that have direct land- and/or water management responsibilities and that contribute to protected area values and appropriate protected area design (connectivity and extent).	Low (1)	1 302.4	0.9
Areas identified in PAES (CAP map)	Include areas identified for conservation action in the Western Cape protected areas expansion strategy. Extracted all the adjacent properties and those connected to them (forming a clump).	Low (1)	3 310.5	2.4
Special projects	For areas where there is no information available, such as listed above, information compiled for special projects can be used to delineate the zone of influence. For the Hexriver Complex, the Western Cape Biodiversity Spatial Plan (WCBSP) project data were used to delineate the zone falling adjacent to the reserves within 100m.	Low (1)	1 648.2	1.2

The zone of influence for the Hexriver Complex has a total extent of 137 360.2 hectares (Appendix 1, Map 10).

Fire hazards and species of special concern were identified as the features that have the highest score in the analysis of the zone of influence (Table 6.4). However, the

areas where the species of special concern occurs only constitute a very small area in the zone of influence. These species are mainly *Colophon* beetles that occur on Matroosberg Peak in Altimontane fynbos, and critically endangered *Protea* species that occur in the Waaihoek valley (see Appendix 1, Map 10). Fire risk affected approximately 17% of the zone of influence. Areas that were identified as high hotspot areas are those that have burnt more than once in the last 15 years and areas with a fire frequency of five or more since 1980 (see also Appendix 1, Map 5 and section 2.3.1).

Invasive alien plants and surface water abstraction were rated as features having a high influence on the zone of influence. Invasive alien plants affected 31% of the zone of influence. Stands of invasive alien plants bordering the protected areas are a major source of re-infestation and will affect clearing effort within the Complex. Surface water abstraction affected approximately 19% of the zone of influence. The Complex is a very important water source area for surrounding areas.

Illegal resource use mainly affects Witzenberg-, Fonteintjiesberg and Bokkeriviere Nature Reserves, constituting approximately 7% of the zone of influence. For example, buchu is poached from Witzenberg Nature Reserve, facilitated by illegal access via Mitchell's Pass, while *Colophon* beetles are illegally collected from habitats on high peaks.

Approximately 45% of the zone of influence is positively impacted on by Mountain Catchment Areas. Three Mountain Catchment Areas (Koue Bokkeveld, Matroosberg and Winterhoek) occur in the protected area network of the Hexriver Complex. These areas are important buffering mechanisms to the Complex.

7 ACCESS AND FACILITIES

This section describes infrastructure and procedures necessary for management of the Hexriver Complex, inclusive of operations and visitors. It provides information on access facilities, operational facilities, control measures as well as commercial and community use.

7.1 Public Access and Management

Access points include controlled and uncontrolled entrances to the protected areas for various activities. Controlled access is through established, manned entrance gates while uncontrolled access is regulated with displayed signage only.

Due to the lay of the land and distance of some protected area from the reserve office it is not possible to have full access control to the entire Hexriver Complex. CapeNature rely on the assistance of partners and neighbours to control illegal access into the Hexriver Complex.

Agreements for access to protected areas are signed with specific clubs and neighbouring landowners. These agreements are reviewed and amended as and when required according to the timeframes linked to agreements. Servitude access for water-users association to dams and pipelines also exist.

Access into Bokkeriviere Nature Reserve from the east is compromised since the property of the South African National Defence Force must be crossed. Public, more specific members of the ski-club access, the reserve from the west to get access to Matroosberg peak during winter for skiing.

Wittebrug Nature Reserve is traversed by a provincial tarred road. This results in easy uncontrolled access at various points into the reserve. During summer the public is drawn to the Breede- and Witels rivers where they picnic, make illegal braai fires and swim in the rivers. Witzenberg Nature Reserve has no hiking trails, a 4x4 track provide access to communication towers and the ESKOM servitude.

Public access points to the Hexriver Complex are listed in Table 7.1 and illustrated in Appendix 1 Map 11.

Table 7.1. Managed public access points to the Hexriver Complex.

Locality	Name	Type of Access	Activity
Fonteintjiesberg Nature reserve	Main Entrance (Somarso Farm)	4x4 vehicle to cross private land and on foot	Fishing and hiking
Ben-Etive Nature Reserve	Main Entrance (Ezelfontein farm)	4x4 vehicle to cross private land and park on reserve and on foot	Hiking

7.2 Administrative and Other Facilities

Infrastructure and associated building maintenance requirements are captured and managed in both the protected area infrastructure register and the CapeNature User Asset Management Plan (UAMP). The UAMP is updated and submitted to Provincial Treasury and the Western Cape Department of Transport and Public Works (DTPW) on an annual basis. DTWP conducted conditional assessments for all protected area Complexes and highlighted priority requirements that informed the UAMP. CapeNature implements and funds scheduled maintenance and emergency repairs. DTPW has allocated funding for road upgrades across all CapeNature protected area Complexes for a period of three years ending in 2022.

Major infrastructure is illustrated in Appendix 1, Map 12.

7.2.1 Roads / Jeep Tracks

Roads and Jeep tracks within the Hexriver Complex are gravel and only accessible with 4x4 vehicles. These roads and jeep tracks are used for management purposes and access to these remote areas of the Hexriver Complex. These roads and tracks are maintained on rotational schedule. Due to the high risk of soil erosion the grading of jeep tracks is not allowed, maintenance work is done with hand tools only.

External partners such as ESKOM and the Witzenberg- and Breede Valley Municipalities use these roads and jeep tracks for maintenance of the power lines, dams and repeaters at Ben-Etive-, Witzenberg-, and Bokkeriviere Nature reserves. Regular assessments and maintenance work is conducted as part of Integrated Catchment Management.

7.2.2 Hiking trails and footbridges

The Hexriver Complex has hiking trails within the Ben-Etive-, Wittebrug- and Fonteintjiesberg Nature Reserves that is used by the University of Cape Town, Cape Piscatorial Society, members of the public and the mountain club of South Africa to access the reserves. These trails are maintained on rotational schedule. A footbridge on the trail leading to Fonteintjiesberg Nature Reserve is maintained by CapeNature although it is located on private land.

7.2.3 Buildings

There are no buildings in the Hexriver Complex that are managed by CapeNature. A small A-frame steel hut at Fonteintjiesberg Nature Reserve, named Perry Refuge, is maintained and managed by the Mountain Club of South Africa. This structure was erected in 1957 by club members in memory of fellow member who passed away on the mountain the year before. The original structure burnt down in 2006 but was rebuilt in 2009 (Fig 7.1).

Figure 7.1. Perry Refuge on Fonteintjiesberg Nature Reserve after it was rebuilt by the Mountain Club of South Africa in 2009. (Photo: Mountain Club of South Africa).

A ski-hut wat constructed on Bokkeriviere Nature Reserve below the Matroosberg peak by members of the ski club, this was done with approval by the former owner of Bokkeriviere in the 1970 when still in private position. The ski-club manage and maintain this structure and no additional structures can be erected.

7.2.4 Fences

The boundaries of the Hexriver Complex remain largely unfenced and occasionally results in tourism, operational or ecological problems. The placement and removal of fences will be closely monitored and evaluated before actions are taken to place or remove structures.

7.2.5 High sites

CapeNature monitors all high sites for negative environmental impacts and illegal structures on an annual basis. High sites impact on the scenic landscape and on rare and threatened plant species found only in high altitude areas. A decision has been taken that no new sites will be considered for communication masts or structures.

There is a high site on Witzenberg Nature Reserve that is used by Witzenberg Municipality/Cape Winelands for radio communications in the area. A locked gate controls access.

7.2.6 Signage

Signage is located at all major entrance points to the protected areas with the Hexriver Complex (Figure 7.2). The primary purpose of signage is to demarcate protected areas, stipulate conditions for access and provide contact details for the management authority. Signboards are placed at the start of all hiking trails.

Figure 7.2. Signage at Bokkeriviere Nature Reserve on Matroosberg Mountain. (Photo: Rika du Plessis).

7.2.7 Utilities

7.2.7.1 Water supply

No facilities within the Hexriver Complex require water. Water from the Hexriver Complex accumulates in farm- and municipal dams (Koekedouw-, Ben-Etive-, Rooikloof- and Bokkerivier dam). The Witzenberg and Breede Valley Municipalities supplies water to the towns of Ceres, Tulbagh, Touwsrivier, De Doorns, Cape Town and surrounding towns from dams located in and around the Hexriver Complex. Water from farm dams and weirs support the agricultural sector within the zone of influence. Associated infrastructure comprises of roads, pipelines, weirs and surface water extraction points in several rivers flowing from the Hexriver Complex.

7.2.7.2 Electricity supply

There are no facilities within the complex that needs electricity. ESKOM servitude traverse sections of the Hexriver Complex as listed in Table 7.

7.2.7.3 Waste management

There are no waste disposal sites within the Hexriver Complex. Waste left behind by irresponsible visitors are collected by rangers when they visit areas and are taken to the Hexriver Complex office for disposal.

7.2.8 Visitor facilities

There are currently no visitor facilities in the Hexriver Complex. Future tourism developments will be done in accordance with environmental legislation.

7.3 Commercial Activities

There are currently no commercial activities within the Hexriver Complex. Applications for events of activities must be submitted according to procedures.

7.4 Community Use

There is currently no community use or agreements with local communities to use biological resources in the Hexriver Complex. Permits are required and application process must be followed as per consumptive use policy.

7.5 Servitudes

Several servitudes exist for the Hexriver Complex where the respective entities are provided access to or through land managed as part of the Complex. Current servitudes are listed in Table 7.4 and mapped in Appendix 1 Map 11. Conditional access is regulated through formal agreements with relevant parties (*e.g.* fire belt maintenance agreements), or servitudes, (*e.g.* water user-rights, rite of passage, power lines, telephone lines, pipelines, service roads). Where there are no agreements in place, these agreements, and development of the associated Maintenance Management Plans, will be negotiated.

Several servitudes exist for the Complex (Table 7.2 and Appendix 1 Map 11).

Table 7.2. Servitudes of the Hexriver Complex.

Date of Agreement	Type of Agreement	Partner	Duration of Agreement (years)	Area Affected	Conditions of use
Unknown	User Rights – Reservoir and pipeline for water usage	Warm Bokkeveld water users Association	Unknown	Ben-Etive 385 Stu dam / Ben-Etive dam	Pipeline for water user's association.
Unknown	User Rights – Reservoir and pipeline for water usage	Warm Bokkeveld water users Association.	Unknown	Ben-Etive 385 Rooi loop dam	Pipeline and reservoir
Unknown	User Rights – access roads for maintenance of a Power lines	ESKOM	Unspecified	Witzenberg 263	Maintenance of power lines.
Unknown	User Rights – power lines	ESKOM Holdings SOC Limited	Unknown	Witzenberg: Boontjies Riviers Berg 263; Tulbagh RD	Power lines
Unknown	User Rights – Reservoir and pipeline for water usage	Breede Valley Municipality	Unknown	Bokke Rivier 353	Water pipeline. Boundary dispute on the eastern Side.
Unknown	Railway line	Transnet	Unknown	Wittebrug Nature Reserve: Erf 1886/0, Ceres	Access over CapeNature land.

Date of Agreement	Type of Agreement	Partner	Duration of Agreement (years)	Area Affected	Conditions of use
Unknown	Water Use – pipeline	Wolseley Water user Association	Unknown	Wittebrug Nature Reserve: Erf 1886/0	Weir
Unknown	Water Use – pipeline	Witzenberg municipality	Unknown	Wittebrug Nature Reserve: Erf 1886/0	Pipeline
Unknown	User Rights – power lines	ESKOM Holdings SOC Limited	Unknown	Wittebrug Nature Reserve: Erf 1886/0	Power lines

8 EXPANSION STRATEGY

Protected area expansion in South Africa is guided by the National Protected Area Expansion Strategy (NPAES) (DEA 2016). In response to the NPAES, CapeNature has produced a Western Cape Protected Area Expansion Strategy (WCPAES) and Implementation Plan 2015-2020 (CapeNature 2015 – 2020).

Mechanisms for protected area expansion include the promotion of stewardship options on private land in collaboration with landowners, regularising existing private nature reserves and Mountain Catchment Areas, and the consolidation of state land managed by municipalities and conservation authorities such as CapeNature as formal protected areas.

Protected area expansion priorities for the Hexriver Complex are highlighted in the 2019 Conservation Action Priority Map. These priority areas focus on the protection of Critically Endangered ecosystems, under-protected ecosystems and strategic landscapes (areas that contribute to meeting multiple conservation objectives through securing one or more sites at the landscape level with the least number of resources) as well as essential habitat for selected species and freshwater ecosystems. In addition, three of the regional Table Mountain Fund climate change corridors identified for the Western Cape should be pursued and supported through protected area expansion in the Hexriver Complex. These include corridors stretching from Elandsberg to Witzenberg Mountains, the Witzenberg - Waboomsberg – Tankwa corridor, and Hex River to Du Toits Kloof Mountains.

Protected area expansion in the Hexriver Complex should aim for the regularisation of the protected area network in the area to ensure compliance with NEM: PAA and the regulations for Nature Reserves. The protected area network consists of State Forest, Forestry exit areas, Private Nature Reserves, Local Authority Nature Reserves and Mountain Catchment Areas. Private Nature Reserves and Local Authority Nature Reserves should be prioritised for regularisation in terms of the PAES objectives, which means a verification and validation process to ensure that they are NEM: PAA compliant. Private Nature Reserves in the protected area network are Boontjiesrivier, Kapklip, Vaalkloof, Wakkerstroom, Whispering Hills and Matroosberg. Two Local Authority Nature Reserves (Ceres Mountain Fynbos and Touw) and three Mountain Catchment Areas (Koue Bokkeveld, Matroosberg and Winterhoek) also occur in the protected area network of the Hexriver Complex. The role of CapeNature in the

regularisation process is to guide, advise and support the management authorities of the respective protected areas.

Post establishment/declaration support to Stewardship Sites adjacent to the Hexriver Complex (in the form of annual audits, management advice and support) is given to six Conservation Areas, namely Altona, Edenhof, Fynbos Vrugte en Wyn, Romansrivier, Waverley Hills and Breede Valley Fynbos Nature Reserve.

The expansion map for the Complex is available in Appendix 1, Map 13.

9 CONCEPT DEVELOPMENT PLAN

The concept development plan sets out the long-term plan for the development of the Complex in keeping with the purpose of the Complex and with due consideration for protected area expansion and the zoning plan.

Tourism products and related infrastructure developments in CapeNature are considered investments and are intended to:

- Harness and enhance the income generation potential of protected areas with a view to achieving long term business sustainability;
- The provision of safe, informative and purpose-built access to protected areas;
- To enhance the operational efficiency and management of the Hexriver Complex.

9.1 Project Selection

From an organisational perspective potential tourism product development are selected based on internal consultation and approval where factors such as environmental impact, appropriateness, environmental authorisation, financial feasibility and the apparent return on investment are considered. Where external approvals for developments are required, these are sought from the relevant authorities prior to the commencement of any development activities (Figure 9.1). CapeNature may elect to operate tourism products and services internally, or via other mechanisms described in the Public Finance Management Act, 1999 (Act No.1 of 1999) such as concessions or public private partnerships.

9.2 Methodology

Tourism products and infrastructure within CapeNature protected areas are designed to be sensitive to their locations and are intended as prime examples of responsible and sustainable commercial developments. These include off-grid bulk water and energy services; passive design efficiencies; enhanced resource utilisation and resource-saving features. Tourism developments aim to comply with prevailing zonation schemes and sensitivity analysis unless approval to the contrary has successfully been sought.

Wherever possible, tourism products, developments and services are intended to provide training and employment opportunities to communities within and surrounding the protected area.

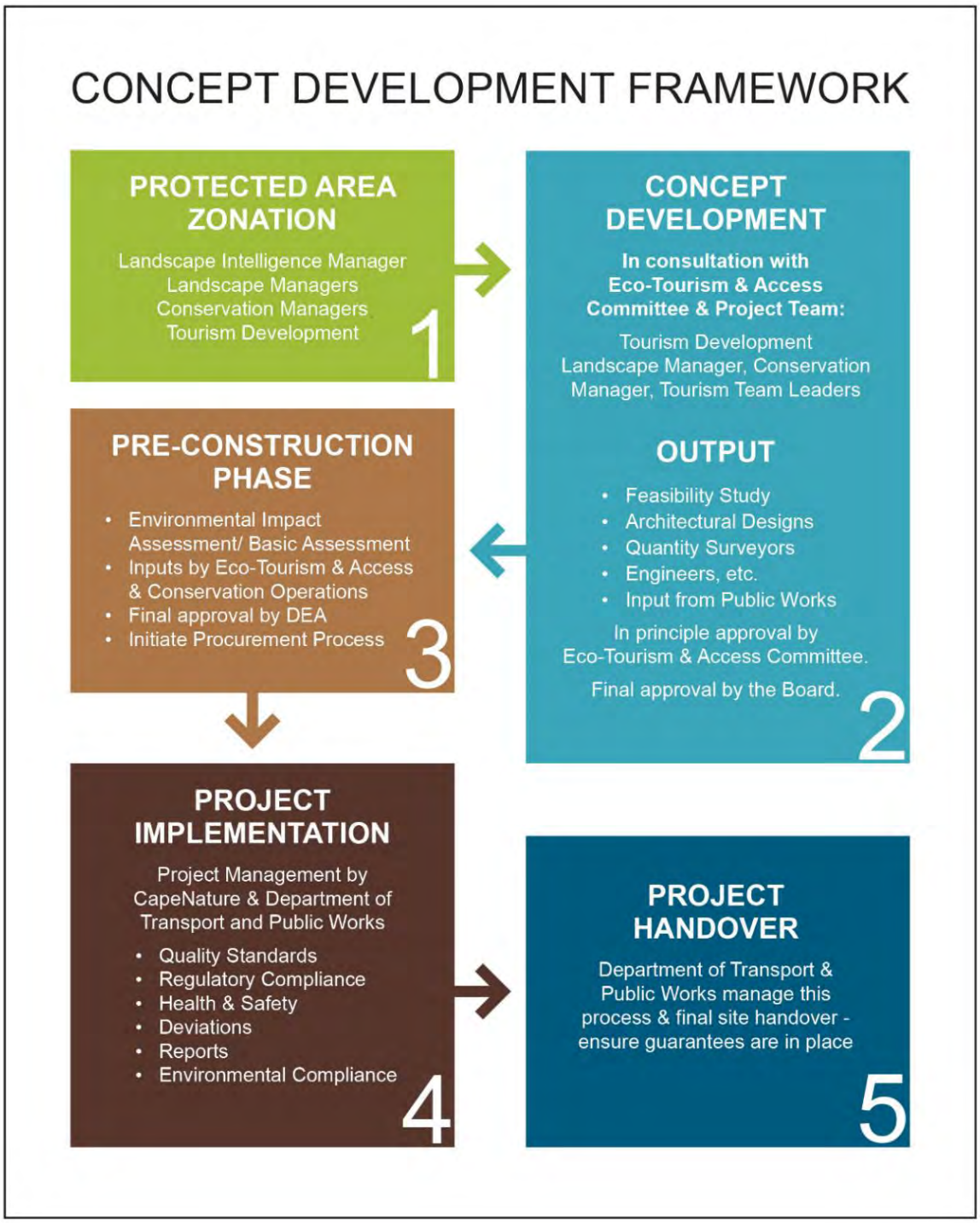


Figure 9.1. Concept Development Plan Framework.

10 STRATEGIC PLAN

This section presents the Strategic Plan for the Hexriver Complex. The strategic plan was derived from an assessment of the conservation situation, inclusive of the biological environment and the social, economic, cultural and institutional systems that influence values. Strategic intervention points formed the basis for developing strategies; using results chains to test theories of change and establish short to medium term objectives. From these, detailed actions with timeframes were developed to guide implementation, monitoring and evaluation.

Strategies are aimed at:

- Focal value restoration / stress reduction;
- Behavioural change / threat reduction; and
- Establishing / promoting enabling conditions.

A summary of selected strategies and objectives for the Hexriver Complex is provided in Table 10.1. Table 10.2 details the actions and associated timeframes for each separate strategy.

CapeNature will lead the implementation of the management plan, although achieving the vision requires coordinated effort. Stakeholder groups and organisations identified in the strategic plan are key role players in successful delivery of this management plan.

Table 10.1. Summary of strategies and objectives for the Hexriver Complex.

Threat(s) abated	Strategy Type	Strategy	Objectives
The negative impact of invasive alien vegetation on fire regime, biodiversity and water availability; Inappropriate fire regime; Invasive alien fish.	Enabling Conditions / Focal Value Restoration / Threat Reduction	**Strategy 1:** Implement fire and invasive alien species management in the Hexriver Complex to abate the negative impact that invasive alien species have on fire regime, biodiversity and water availability.	**Objective 1.1:** By 2022, CapeNature has revised, approved and implemented the Hexriver Complex Invasive Alien Species control plan.
			Objective 1.2: By 2021, the internal efficiency of the implementation of the Fire management policy and procedures have been evaluated and shortcomings have been identified and reported.
			Objective 1.3: By 2022, the identified shortcomings have been addressed.
			Objective 1.4: By 2021 and beyond, the fire regime in the Hexriver Complex is determined in order to support fire management decisions.
			Objective 1.5: By 2025, CapeNature have obtained commitment from partners and neighbours to assist with IAP clearing and compliance on the boundaries of the Hexriver Complex.
Unauthorised access; Illegal utilisation of natural resources; Lack of access to guidelines for responsible and sustainable utilisation; Stakeholders have a lack/insufficient knowledge on the sustainable use of Natural Resources.	Enabling Conditions / Stress Reduction / Threat Reduction	**Strategy 2:** Address illegal and un-sustainable resource utilisation (unauthorised access and poaching) within the Hexriver Complex.	**Objective 2.1:** By 2022 revise and implement the integrated compliance plan for the Hexriver Complex.

Threat(s) abated	Strategy Type	Strategy	Objectives
The negative impact of Invasive alien vegetation on fire regime, biodiversity and water availability, inappropriate fire regime, Unauthorised access, Illegal utilisation of natural resources, invasive alien fish, instream structures, vandalism, over abstraction of surface water, climate change; Stakeholders have a lack/insufficient knowledge on the sustainable use of Natural Resources.	Behavioural change / Threat Reduction	**Strategy 3:** Enhance and raise awareness of ecological targets of the Hexriver Complex.	**Objective 3.1:** By 2022 and beyond CapeNature has developed and implemented the Hexriver Complex environmental education and awareness programme.
Unauthorised access, Illegal utilisation of natural resources, vandalism.	Enabling Conditions / Stress Reduction / Threat Reduction	**Strategy 4:** Support sustainable tourism-based livelihoods in partnership with role players in the Hexriver Complex.	**Objective 4.1:** By 2026 memorandums of understanding have been signed with relevant partners.

Table 10.2. Strategic Plan for the Hexriver Complex.

INTEGRATED CATCHMENT MANAGEMENT					
STRATEGY 1:	Implement fire and invasive alien species management in the Hexriver Complex to abate the negative impact that invasive alien species has on fire regime, biodiversity and water availability.				
GOALS:	By 2031, the terrestrial ecosystems in the Hexriver Complex have an ecologically healthy fire regime* and comprises >85% indigenous species. By 2031, the health of the wetland ecosystems in the Hexriver Complex will be in at least a near-natural* condition, and riparian zones and wetland buffers will have an indigenous vegetation cover of at least 75-89%. By 2031, the upper and middle river reaches in the Hexriver Complex support macro invertebrate species communities with an ASPT of 6 - ≥8*, and viable** indigenous fish communities are present in on-reserve rivers identified for fish conservation. By 2031 the Hexriver Complex will, through integrated catchment management, protect and enhance the provision of water quality and quantity contributing to the water resilience for the Berg, Breede and Gouritz catchment areas.				
THREATS:	The negative impact of invasive alien vegetation on fire regime, biodiversity and water availability; Inappropriate fire regime.				
Objectives	**Actions**	**Responsibility**	**Timeframe**	**Measurable Indicators / Outputs**	**References / Existing Procedures**
Objective 1.1: By 2022 CapeNature has revised, approved and implemented the Hexriver Complex Invasive Alien Species control plan.	• Ensure that the NBAL mapping is according to the CapeNature procedure. • Verify NBAL densities and update the NBAL database. • Update invasive alien animal database. • Compile prioritisation maps for the Hexriver Complex. • Revise the Invasive Alien Species control plan and obtain approval.	**Lead:** Conservation Managers (On Reserve) **Enablers:** Program Manager - Natural Resource Management West; Ecologist Fauna; LCI Team; Integrated Catchment Specialist; Landscape Manager (L1)	Annually	Updated Hexriver Complex Invasive Alien Species Control Plan (Reserve specific) which have projected treatment dates, appropriate methodologies and responsibilities and accountabilities identified.	Hexriver Complex Invasive Alien Species Control Plans

	• Used the approved plan to inform IWPs and IAPOs. • Prioritise removal in collaboration with partners (WfW, WoF, HAT, Municipalities and volunteer groups). • Implement APOs. • Monitor costs and effectiveness of implementing APO and control plan.	**Lead:** Conservation Manager (On Reserve) **Enablers** Program Manager - Natural Resource Management West; LCI Team; Ecologist Fauna; Integrated Catchment Specialist.	Year 1 and beyond	Density data spreadsheet, Maps and shape files, Integrated Work Plan and Annual Plan of Operation	Standard annual procedure
Objective 1.2: By 2021 the internal efficiency of the implementation of the Fire management policy and procedures have been evaluated and shortcomings have been identified and reported.	• Identify barriers, limitations and opportunities to improving implementation (SWOT analysis).	**Lead:** Landscape Manager (L1 & L2) **Enablers:** Conservation Manager (on Reserve); Capability Manager: Integrated Catchments; IC Specialist Disaster & Climate Response; IC Specialist	Within first year of implementation	Limitation and Opportunities Report (SWOT analysis)	Fire management policy and procedures
Objective 1.3: By 2021 the identified shortcomings have been addressed.	• In partnership with implementation entities and funders implement identified corrective measures. • Monitor effectiveness of corrective measures implemented. • Implement adaptive management if necessary	**Lead:** Landscape Manager (L1 & L2) **Enablers:** Conservation Manager (on Reserve); Capability Manager: Integrated Catchments; IC Specialist Disaster & Climate Response; IC Specialist	Within third year of implementation	Corrective measures are implemented, and implementation efficiency has improved from 2019 baseline	Fire management policy and procedures
Objective 1.4: By 2021 and beyond, the fire regime in the Hexriver Complex is determined	• Analyses of fire frequency, fire return interval, fire size and season for the Hexriver Complex.	**Lead:** Landscape Ecologist **Enablers:** Conservation	Annually	Post-fire season executive summary	Post-fire season executive summary

to support fire management decisions.	• Produce report on the analysis of the fire regime and Protea monitoring data.	Manager (on Reserve); LCI Team			
	• Conduct post-fire and permanent *Protea* monitoring to determine fire return intervals.	**Lead:** Conservation Manager (on Reserve) **Enablers:** Ecologist Flora; LCI Team	Annually	Report with recommendations	Monitoring protocols
	• Implement fire management policy and procedures and Veldfire Response Plan based on the analysis recommendations for the Hexriver Complex.	**Lead:** Conservation Manager (on Reserve); IC Specialist **Enablers:** Capability Manager: Integrated Catchments; IC Specialist Disaster & Climate Response; Landscape Manager (L1 & L2);	Annually		CapeNature fire policy and procedures
Objective 1.5: By 2025, CapeNature have obtained commitment from partners and neighbours to assist with IAP clearing and compliance on the boundaries of the Hexriver Complex.	• Through environmental education and awareness inform partners and neighbours regarding the relevant legislation and the negative impact of fire and alien invasive species on biodiversity and water production. • Obtain commitment from water users associations and DEFF to do IAP clearing on private properties.	**Lead:** Stakeholder Engagement Officer **Enablers:** Conservation Manager (On and Off Reserve); Compliance and Enforcement Specialist.	Year 1-10	Fence and boundary patrol reports; Copies of directives issued; Biological control release records; PAAC meeting minutes; Records of engagements with landowners (such as firebreak discussions).	Fence and boundary patrols; PAAC meetings; CapeNature Stakeholder interaction register

INTEGRATED COMPLIANCE AND ENFORCEMENT					
STRATEGY 2:	Address illegal and un-sustainable resource utilisation (unauthorised access and poaching) within the Hexriver Complex.				
GOALS:	By 2031, the terrestrial ecosystems in the Hexriver Complex have an ecologically healthy fire regime* and comprises >85% indigenous species. By 2031 the Hexriver Complex will, through integrated catchment management, protect and enhance the provision of water quality and quantity contributing to the water resilience for the Berg, Breede and Gouritz catchment areas. By 2031, access to and sustainable utilisation of natural resources within the Hexriver Complex are in accordance with CapeNature policy and procedures. By 2031, the Hexriver Complex environmental education and awareness programme will promote ecological targets and human well-being				
THREATS:	Unauthorised access; Illegal utilisation of natural resources; Lack of access to guidelines for responsible and sustainable utilisation; Stakeholders have a lack/insufficient knowledge on the sustainable use of Natural Resources.				
Objectives	**Actions**	**Responsibility**	**Timeframe**	**Measurable Indicators**	**Existing Procedures**
Objective 2.1: By 2022 revise and implement the integrated compliance plan for the Hexriver Complex.	• Revise and implement the approved compliance plan. • Provide relevant training to staff applicable to their function and mandate. • Improve and maintain collaboration with relevant law enforcement partners. • Implement the Policy on Consumptive use of Wild Flora from CapeNature Managed Protected Areas. • Sign agreements with relevant land users.	**Lead:** Conservation Manager (On & Off reserves). **Enablers:** Landscape Manager (L1); Capability Manager: Biodiversity Conservation; Compliance and Enforcement Specialist.	Year 1 - 10	Number of EMIs trained and appointed; Number of Peace Officers trained and appointed.	Criminal Procedure Act, 1977 (Act No. 51 of 1977); Bill of Rights; Constitution of SA; NEMA, NEMBA, NEMPAA; Draft Western Cape Biodiversity Bill 2019; Integrated Compliance Plan.

ENVIRONMENTAL EDUCATION AND AWARENESS					
STRATEGY 3:	Enhance and raise awareness of ecological targets of the Hexriver Complex.				
GOALS:	By 2031, the upper and middle river reaches in the Hexriver Complex support macro invertebrate species communities with an ASPT of 6 - ≥8, and viable indigenous fish communities are present in on-reserve rivers identified for fish conservation. By 2031, the health of the wetland ecosystems in the Hexriver Complex will be in at least a near-natural condition, and riparian zones and wetland buffers will have an indigenous vegetation cover of at least 75-89%. By 2031, the terrestrial ecosystems in the Hexriver Complex have an ecologically healthy fire regime and comprises >85% indigenous species. By 2031, sound permanent and post-fire Protea monitoring have been established in the Hexriver Complex according to CapeNature protocol to enable the determination of ecological thresholds of potential concern for fire management in the landscape. By 2031 the Hexriver Complex will, through integrated catchment management, protect and enhance the provision of water quality and quantity contributing to the water resilience for the Berg, Breede and Gouritz catchment areas. By 2031, access to and sustainable utilisation of natural resources within the Hexriver Complex are in accordance with CapeNature policy and procedures. By 2031, the Hexriver Complex environmental education and awareness programme will promote ecological targets and human well-being.				
THREATS:	The negative impact of Invasive alien vegetation on fire regime, biodiversity and water availability, inappropriate fire regime, Unauthorised access, Illegal utilisation of natural resources, invasive alien fish, instream structures, vandalism, over abstraction of surface water, climate change; Stakeholders have a lack/insufficient knowledge on the sustainable use of Natural Resources.				
Objectives	**Actions**	**Responsibility**	**Timeframe**	**Measurable Indicators**	**Existing Procedures**
Objective 3.1: By 2022 and beyond CapeNature has developed and implemented the Hexriver Complex environmental education and awareness programme.	• Identify internal and external stakeholders. • Coordinate and streamline efforts among stakeholders / partners within the agreed hotspots. • Identify specific target groups within the hotspots (*e.g.* communities, landowners, schools *etc.*).	**Lead:** Stakeholder Engagement Officer **Enablers:** Conservation Manager (on and off Reserve)	Within first year of implementation and beyond	Reduction in ignition points; Environmental Awareness Plan; List of target groups	Environmental education, awareness and interpretation programme; Integrated Work Plan

	• Compile or update environmental education and awareness material and information aligned with the school curriculum. • Coordinated, joint implementation of the environmental education and awareness plan.	**Lead:** Stakeholder Engagement Officer; EEO; Media & Marketing; Manager: Advocacy and Awareness Program.	Within second year of implementation, and beyond Within third year of implementation, and beyond	Updated environmental education and awareness material and information aligned with the school curriculum; Implementation of the plan – MoVs from interventions and	Complex-specific Environmental Education and Awareness plan

TOURISM					
STRATEGY 4:	Support sustainable tourism-based livelihoods in partnership with role players in the Hexriver Complex.				
GOALS:	By 2031, access to and sustainable utilisation of natural resources within the Hexriver Complex are in accordance with CapeNature policy and procedures.				
THREATS:	Unauthorised access; Illegal utilisation of natural resources; vandalism				
Objectives	**Actions**	**Responsibility**	**Timeframe**	**Measurable Indicators**	**Existing Procedures**
Objective 4.1: By 2026 memorandums of understanding have been signed with relevant partners.	• Identify opportunities and partners for sustainable tourism. • Improve public access control to the protected areas. • Sign and maintain MoUs with partners.	**Lead:** Conservation Manager (on Reserve); Tourism Officer **Enablers:** Stakeholder Engagement Officer; Tourism Liaison Officer; Tourism Operations Manager	Within five years of implementation	MoUs with relevant partners.	Legal vetting procedures

11 COSTING

This section provides an overview of costing and fund allocation for strategies. It outlines the existing financial resources (current budget), funding shortfalls, sources of alternate funding and future financial projections.

11.1 Finance and Asset Management

In line with the legal requirement, the strategies identified for implementation within the Complex, to achieve the desired state, have been costed below.

The Complex will adhere to the guiding principles listed below:

- Responsibly manage the allocation of budget, revenue raising activities and expenditure;
- Ensure solid financial management supporting the achievement of the objectives of this plan; and
- Compliance with the Public Finance Management Act, 1999 (Act No. 1 of 1999) as well as CapeNature's financial policies and procedures.

A budget was derived based upon the activities in this management plan. When estimating the costing, the following items were considered:

- Those costs and associated resources which could be allocated to specific activities and which were of a recurring nature;
- Those costs and associated resources which could be allocated to specific activities, but which were of a once off nature;
- Unallocated fixed costs (water, electricity, phones, bank fees, *etc*.);
- Maintenance of infrastructure; and
- Provision for replacement of minor assets, (furniture, electronic equipment, vehicles, *etc*.).

11.1.1 Income

CapeNature's budget is funded by the Medium-Term Expenditure Framework (MTEF) allocation, other government grants and generated from own revenue sources derived from commercial activities. Any surplus revenue generated is used to fund shortfalls in management costs across the organisation.

CapeNature has overhead costs relating to support services such as human resources, communications, marketing and learning, finance, biodiversity capabilities, conservation operations, eco-tourism and access, legal services, etc. which is not allocated to individual protected area complexes and must also be funded through grant funding or own revenue generated.

This management plan is a 10-year plan, and thus straddles multiple MTEF periods that impact on actual budget allocation and projection. Due to the challenging fiscal position the country faces and additional strain brought on by the COVID-19 pandemic, the organisation is facing budget cuts and reduced tourism income that will have to be considered during the implementation of this management plan.

Total income projected for 2021/22 is budgeted at R 647 166.

11.1.2 Expenditure

11.1.2.1 Recurring costs

Annual direct costs may include staff, transport and travel, stores and equipment and fixed costs. This expenditure is split according to strategies as illustrated in Figure 11.1.

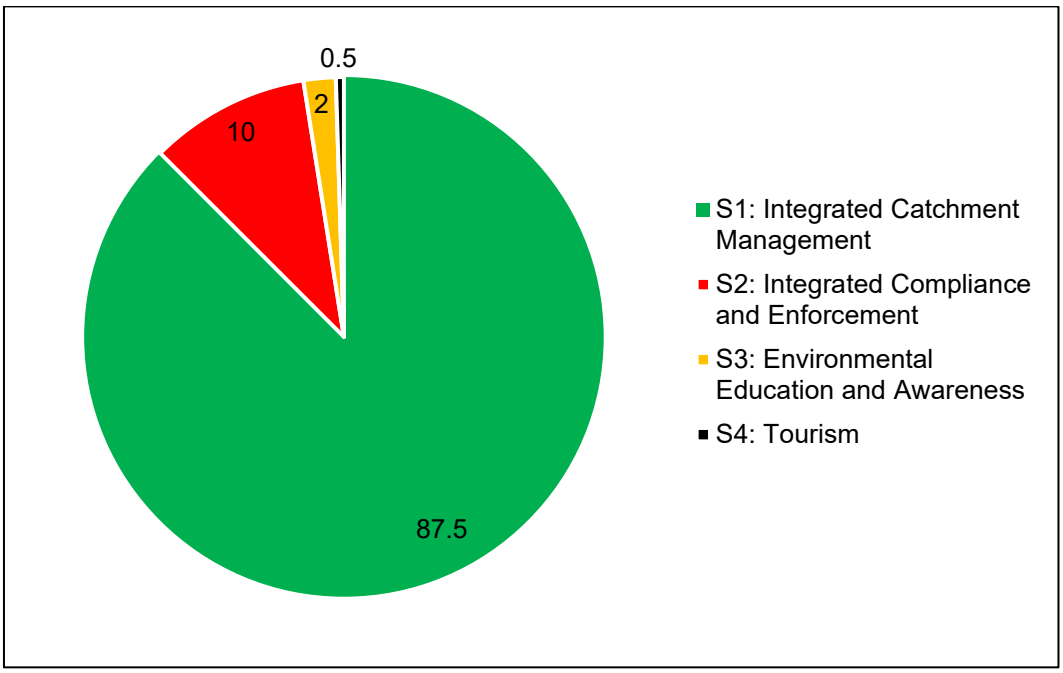


Figure 11.1. The estimated proportion of annual operational costs for the Hexriver Complex for year 2021/22 aligned with the identified and prioritised strategies.

11.1.2.2 Once off costs

In addition to the recurring costs there might be once-off replacement costs of assets, *e.g.* tractor, firefighting equipment, field equipment, *etc*. that are aligned with the life span of the relevant assets being replaced.

11.1.2.3 Maintenance

An annual earmarked allocation is provided for the development of new tourism infrastructure, upgrades and maintenance of existing tourism and management infrastructure. Tourism projects are prioritised across all CapeNature facilities and maintenance is scheduled accordingly.

11.1.2.4 Implications

Unsuccessful securing of external funding and replacement of crucial capital equipment could lead to potential shortfall and will have a negative impact on strategies throughout. Further reductions in organisational budget can be expected during the management plan cycle. The implications of this being that the strategic plan may not be fully achieved. Available funding will have to be prioritised accordingly.

A zero-based budget approach is needed to determine the true financial needs of the complex.

12 REFERENCES

Barber-James, H.M. & Pereira-da-Conceicoa, L.L. 2016. Efficacy and deficiencies of rapid biomonitoring in biodiversity conservation: a case study in South Africa. African Journal of Aquatic Science. 41: 337-343.

Bellingan, T.A., Woodford, D.J., Gouws, J., Villet, M.H. & Weyl, O.L.F. 2015. Rapid bioassessment of the effects of repeated rotenone treatments on invertebrate assemblages in the Rondegat River, South Africa. African Journal of Aquatic Science. 40: 89-94.

Birss, C. 2017. Chapter 9: Mammals. In: Turner A.A., editor. Western Cape Province State of Biodiversity 2017. CapeNature Scientific Services, Stellenbosch. ISBN:

Bond, W.J. & Slingsby, P. 1983. Seed dispersal by ants in shrublands of the Cape Province and its evolutionary implications. South African Journal of Science. 79: 231-233.

Bradshaw, P.L. & Cowling, R.M. 2014. Landscapes, rock types, and climate of the Greater Cape Floristic Region. In: Allsop N., Colville J.F. & Verboom G.A., (eds). Fynbos: Ecology, Evolution, and Conservation of a Megadiverse Region. Oxford University Press, United Kingdom. pp 26-46.

Branch, B. 1998. Field guide to snakes and other reptiles of Southern Africa. Cape Town: Struik.

Breede Valley Municipality. 2020. Review of the Integrated Development Plan – 2020-2021. Third review of the 4th Generation IDP (2017 – 2022) as prescribed by Section 34 of the Municipal Systems Act (2000).

Breede Valley Municipality. 2019. Cape Winelands Spatial Development Framework.

Broadley, D.G. 1983. Fitzsimon's snakes of Southern Africa. Parklands (Johannesburg): Jonathan Ball and Ad. Donkers Publisher. Pp. 322-324.CapeNature. 2015. Five Year Strategic Plan. CapeNature unpublished report.

Burchell, W.J. 1822. Travels in the interior of Southern Africa. Vol 1 (582 pages) London: Longman, Hurst, Orme & Brown.

Brown, P.J., Manders, P.T., Bands, D.P., Kruger, F.J. & Andrag, R.H. 1991. Prescribed burning as a conservation management practice: a case history from the Cederberg Mountains, Cape Province, South Africa. Biological Conservation 56: 133–50.

CapeNature. 2015a. Landowners' Guide: Human-Wildlife Conflict – Sensible solutions to living with wildlife. CapeNature. Cape Town.

CapeNature. 2015b. Western Cape Protected Areas Expansion Strategy: 2015 – 2020. Internal Report. CapeNature, Cape Town.

CapeNature. 2016a. Veldfire management guidelines. Internal report. CapeNature. Cape Town.

CapeNature. 2016b. CapeNature Biodiversity Research & Monitoring Strategy. Internal Report. CapeNature, Cape Town.

Cape Winelands District Municipality. 2017. 4th Generation Integrated Development Plan 2017/18 – 2021/22.

Cape Winelands District Municipality. 2018. Integrated Development Plan 2017/18 – 2021/22. Draft 1st Review.

Chakona, A., Swartz, E.R. & 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: e70953. DOI: 10.1371/journal.pone.0070953.

Chakona, A. & Jordaan, M. 2017. *Galaxias sp. nov. 'Breede'*. The IUCN Red List of Threatened Species 2017. <www.iucnredlist.org>

Chakona, A., Swartz, E.R., 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.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). (2019). CITES Appendices I. URL: II and III. http://www.cites.org/eng/app/appendices.php. Accessed 25 October 2019.

Conservation Coaches Network. 2012. Harmonized Open Standards Presentations. http://cmp-openstandards.org/guidance/basic-open-standards-presentations-ccnet-2012/.

Conservation Measures Partnership. 2020. Open Standards for the Practice of Conservation. Version 4.0 / February 2020.

Dallas, H.F. 2004. Seasonal variability of macroinvertebrate assemblages in two regions of South Africa: implications for aquatic bioassessment. African Journal of Aquatic Science. 29: 173-184.

Dallas, H.F. 2007. The influence of biotope availability on macroinvertebrate assemblages in South African Rivers: implications for aquatic bio-assessment. Freshwater Biology. 52: 370-380.

De Klerk, H., Schutte-Vlok, A., Vlok, J., Shaw, K., Palmer, G., Martens, C., Viljoen, P., Marshall, T., van Ross, G., Forsyth, A.T., Wessels, N., Geldenhuys, D. Wolfaardt, A. and Kirkwood, D. 2009. Ecological Fire Monitoring Manual. CapeNature: Internal Report. pp 47.

De Moor, I.J. & Bruton, M.N. 1988. Atlas of alien and translocated indigenous aquatic animals of southern Africa. South African National Scientific Programmes Report 144.

Department of Environmental Affairs (DEA). 2015. Nomination of the Extension of the Cape Floral Region Protected Areas: World Heritage Site. Compiled for the Department of Environmental Affairs, South African National Parks, Western Cape Nature Conservation Board, Eastern Cape Parks and Tourism Agency and Eastern Cape Economic Development, Environmental Affairs and Tourism. Compiled by Indigenous Vegetation Consultancy. For submission to UNESCO.

Department of Environmental Affairs (DEA). 2016. National Protected Areas Expansion Strategy for South Africa. Department of Environmental Affairs, Pretoria.

Department of Environmental Affairs and Tourism (DEAT). 2003. Nomination of the Cape Floral Region of South Africa for inclusion on the World Heritage List. Compiled for the Department of Environmental Affairs and Tourism, South African National Parks, Western Cape Nature Conservation Board and the Chief Directorate: Environmental Affairs Eastern Cape. For submission to UNESCO.

Desmet, P. & Cowling, R. 2004. Using the species–area relationship to set baseline targets for conservation. Ecology and Society 9(2): 11.

Dickens, C.W.S. & Graham, P.M. 2002. The South African Scoring System (SAS) version 5 rapid bio-assessment method for rivers. African Journal of Aquatic Science. 27: 1-10.

Dippenaar-Schoeman, A.S., Haddad, C.R., Foord, S.H., Lyle, R. Lotz, L.N. & Marais, P. 2015. South African National Survey of Arachnida (SANSA): review of current knowledge, constraints and future needs for documenting spider diversity (Arachnida: Araneae). Transactions of the Royal Society of South Africa 70(3): 245–275.

Dippenaar-Schoeman, A.S., Van Den Berg, A.M., Haddad, C.R. & Lyle, R. 2013. Spiders in South African agroecosystems: a review (Arachnida, Araneae). Transactions of the Royal Society. 68: 57–74.

Ellender, B.R., Wasserman, R.J., Chakona, A., Skelton, P.H. & Weyl, O.L.F. 2017. A review of the biology and status of Cape Fold Ecoregion freshwater fishes. *Aquatic Conservation: Marine and Freshwater Ecosystems* 27(4):867-879.

Endrödy-Younga, S. 1988. Evidence for the low-altitude origin of the Cape Mountain Biome derived from the systematic revision of the genus *Colophon* Gray (Coleoptera: Lucanidae). Annals of the South African Museum 96: 359–424.

Forsyth, G.G. & van Wilgen, B.W. 2007. An analysis of the fire history records from protected areas in the Western Cape. CSIR Report Number CSIR/NRE/ECO/ER/2007/0118/C, Council for Scientific and Industrial Research (prepared for CapeNature), Stellenbosch.

Forsyth, G.G. & van Wilgen, B.W. 2008. The recent fire history of the Table Mountain National Park, and implications for fire management. Koedoe 50: 3–9.

Forsyth, G.G. Kruger, F.J. & Le Maitre, D.C. 2010. National veldfire risk assessment: Analysis of exposure of social, economic and environmental assets to veldfire hazards in South Africa. CSIR Report (CSIR/NRE/ECO/ER/2010/0023/C).

Forsyth, G.G., le Maitre, D.C. & Van Wilgen, B.W. 2009. Prioritizing quaternary catchments for invasive alien plant control within the fynbos and karoo biomes of the Western Cape Province. Stellenbosch, CSIR: 57.

Goldblatt, P. & Manning, J. 2000. Cape plants. A conspectus of the Cape Flora of South Africa. Strelitzia 9. National Botanical Institute, Cape Town and Missouri Botanical Garden.

Hart, T. 1998. Cultural Historical Assessment of the Hex Pass Railway, Worcester to De Doorns. Archaeology Contracts Office, Department of Archaeology, University of Cape Town.

http://www.sahra.org.za/sahris/sites/default/files/heritagereports/9-2-110-0075-19980601-ACO_0.pdf [Google Scholar]

Helm, C., Cawthra, H., Cowling, R., De Vynck, J., Marean, C., McCrea, R. & Rust, R. 2018. Paleoecology of giraffe tracks in Late Pleistocene aeolianites on the Cape south front. South African Journal of Science. 114: 1-8.

Hockings, M., Leverington, F. & Cook, C. 2015. Protected area management effectiveness. In Protected Area Governance and Management. In: Worboys GL, Lockwood M, Kothari A, Feary S & Pulsford I, editors. ANU Press, Canberra, pp. 889–928.

Holmes, P., Dorse, C., Rebelo, T., Helme, N., Wood, J., Palmer, G. & Harrison, J. 2016. Chapter 4: Planning for and managing risk, restoration, *ex situ* conservation and animals. In: Cadman M., editor. Ecosystems Guidelines for Environmental Assessment in the Western Cape - Edition 2. Fynbos Forum, Cape Town.

Johnson, S.D. 1992. Plant-animal relationships. I In: R.M. Cowling (ed.). Fynbos ecology: Nutrients, fire and diversity. pp. 135-174. Oxford University Press, Cape Town.

Jordaan, M. & Chakona, A. 2017. *Pseudobarbus burchelli*. The IUCN Red List of Threatened Species 2017: www.iucnredlist.org

Keeley, J.E., Fotheringham, C.J. & Morais, M. 1999. Re-examining fire suppression impacts on brushland fire regimes. Science 284: 1829–32.

Kraaij, T. & van Wilgen, B.W. 2014. Drivers, ecology, and management of fire in fynbos. In: Allsopp N, Colville JF & Verboom A, editors. Fynbos: Ecology, Evolution, and Conservation of a Megadiverse Region. Oxford University Press, Cape Town.

Kraaij, T., Baard, J.A., Cowling, R.M., van Wilgen, B.W. & Das, S. 2013. Historical fire regimes in a poorly understood, fire-prone ecosystem: eastern coastal fynbos. International Journal of Wildland Fire 22: 277–87.

Kruger, F.J. & Lamb, A.J. 1978. Conservation of the Kogelberg State Forest. Preliminary assessment of the effects of management from 1967 to 1978. Interim report on Project 1/3/11/07, Department of Forestry, Jonkershoek Forestry Research Station.

Kruger, F.J. 1983. Die Hottentots Holland Natuurreservaat. Pamflet 316, South African Forestry Research Institute, Pretoria.

Le Maitre, D.C. & Midgley, J.J. 1992. Plant reproductive ecology. In: Cowling RM, editor. Fynbos ecology: Nutrients, fire and diversity. pp. 135-174. Oxford University Press, Cape Town.

Le Maitre, D.C., Versfeld, D.B. & Chapman, R.A. 2000. The impact of invading alien plants on surface water resources in South Africa: a preliminary assessment. Water SA 26: 397–408.

Le Maitre, D.C. & Midgley, J.J. 1992. Plant reproductive ecology. In: R.M. Cowling (ed.). Fynbos ecology: Nutrients, fire and diversity. pp. 135-174. Oxford University Press, Cape Town.

Leverington, F. & Hockings, M. 2004. Evaluating the effectiveness of protected area management: The challenge of change. In: Barber C.V., Miller K.R. & Boness M., (eds). Securing protected areas in the face of global change: Issues and strategies, IUCN, Gland and Cambridge.

MacKellar, N., New, M. & Jack, C. 2014. Observed and modelled trends in rainfall and temperature for South Africa: 1960-2010. South African Journal of Science 110: 1–13.

Manning, J. & Goldblatt, P. 2012. Plants of the Greater Cape Floristic Region 1: The Core Cape flora, Strelitzia 29. South African National Biodiversity Institute, Pretoria.

McGeoch, M.A. 2002. Insect conservation in South Africa: an overview. African Entomology. 10: 1-10.

Mecenero, S., Ball, J.B., Edge, D.A., Hamer, M.L., Henning, G.A., Krüger, M., Pringle, E.L., Terblanche, R.F. & Williams, M.C. 2013. Conservation assessment of the butterflies of South Africa, Lesotho and Swaziland: Red List and atlas. Pp 676. Saftronics (Pty) Ltd., Johannesburg and Animal Demography Unit, Cape Town.

Mucina, L. & Rutherford, M.C. 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

Mucina, L., Rutherford, M.C. & Powrie, L.W. (eds) 2007.Vegetation Map of South Africa, Lesotho and Swaziland, edn 2, 1:1 000 000 scale sheet maps. South African National Biodiversity Institute, Pretoria. ISBN 978-1-919976-42-6.

Nel, J.L., Driver, A., Strydom, W., Maherry, A., Petersen, C., Hill, L., Roux, D.J., Nienaber, S., Van Deventer, H., Swartz, E. & Smith-Adao, L.B. 2011b. Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources. WRC Report No.TT 500/11, Water Research Commission. Pretoria.

Nel, J.L., Murray, K.M., Maherry, A.M., Peterson, C.P., Roux, D.J., Driver, A., Hill, L., Van Deventer, H., Funke, N., Swartz, E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L. & Nienaber, S. 2011a. Technical Report for the National freshwater Ecosystem Priority Areas project. Report to the Water Research Commission. WRC Report No. 1801/2/11.

Pence, G.Q.K. 2017. The Western Cape Biodiversity Spatial Plan: Technical Report. Internal Report, CapeNature. Cape Town.

Pool-Stanvliet, R., Duffell-Canham, A., Pence, G. & Smart, R. 2017. The Western Cape Biodiversity Spatial Plan Handbook. CapeNature, Stellenbosch.

Procheş, S. & Cowling, R.M. 2006. Insect diversity in Cape fynbos and neighbouring South African vegetation. Global Ecology and Biogeography. 15: 445-451.

Procheş, S. & Cowling, R.M. 2007. Do insect distributions fit our biomes? South African Journal of Science. 103: 258-261.

Procheş, S., Forest, F. Veldtman, R., Chown, S.L., Johnson, S.D., Richardson, D.M. & Savolainen, V. 2009. Dissecting the plant-insect diversity relationship in the Cape. Molecular and Phylogenetic Evolution. 51: 94-99.

Raimondo, D., Von Staden, L., Foden, W., Victor, J.E., Helme, N.A., Turner, R.C., Kamundi, D.A. & Manyama, P.A. (eds). 2009. Red List of South African plants, Strelitzia 25, South African National Biodiversity Institute, Pretoria.

Rebelo, A.G., Boucher, C., Helme, N., Mucina, L., Rutherford, M.C., Smit, W.J., Powrie, L.W., Ellis, F., Lambrechts, J.J., Scott, L., Radloff, F.G.T., Johnson, S.D., Richardson, D.M., Ward, R.A., Procheş, S.M., Oliver, E.G.H., Manning, J.C., Jürgens, N., McDonald, D.J., Janssen, J.A.M., Walton, B.A., Le Roux, A., Skowno, A.L., Todd, S.W. & Hoare, D.B. 2006. Fynbos Biome. In: Mucina, L. & Rutherford, M.C. (Eds). The vegetation of South Africa, Lesotho and Swaziland: 52-219. SANBI, Pretoria.
URL: http://bgis.sanbi.org/vegmap/map2009_2012.asp.

Samways, M.J., Sharratt, N.J. & Simaika, J.P. 2010. Effect of alien riparian vegetation and its removal on a highly endemic river macroinvertebrate community. Boilogical Invasions 13: 1305 – 1324.

Samways, M. J., Hamer, M. and Veldtman, R. 2012. Development and future of insect conservation in South Africa. Pp. 245-278. In: T. R. New (ed.). Insect Conservation: Past, Present and Prospects. Springer, Dordrecht.

Samways, M.J. & Simaika, J.P. 2016. Manual of Freshwater Assessment for South Africa: Dragonfly Biotic Index. Pp. 224. South African National Biodiversity Institute, Pretoria. ISBN 978-1-928224-05-1.

Samways, M.J., Bazelet, C.S. & Pryke, J.S. 2010. Provision of ecosystem services by large-scale corridors and ecological networks. Biodiversity Conservation. 19: 2949-2962.

Seydack, A.H.W., Bekker, S.J., & Marshall, A.H. 2007. Shrubland fire regime scenarios in the Swartberg Mountain Range, South Africa: implications for fire management. International Journal of Wildland Fire 16: 81–95. South African National Biodiversity Institute. 2006- . The Vegetation Map of South Africa, Lesotho and Swaziland. In: Mucina L, Rutherford MC & Powrie LW, editors. Online, http://bgis.sanbi.org/SpatialDataset/Detail/18, Version 2012.

Shelton, J.M., Samways, M.J. & Day, J.A. 2014. Predatory impact of non-native rainbow trout on endemic fish populations in headwater streams in the Cape Floristic Region of South Africa. Biological Invasions 17: 365–379.

Skelton, P.H. 1987. South African red data book – fishes. South African National Scientific Programmes Report 137: 1-199.

Skelton, P.H. 2001. A complete guide to the freshwater fishes of Southern Africa. Struik Publishers, Cape Town.

Skelton, P.H. 2001. A complete guide to the freshwater fishes of Southern Africa. Struik Publishers, Cape Town.

Skelton, P.H., Swartz, E.R. 2011. Walking the tightrope: trends in African freshwater systematic ichthyology. *Journal of Fish Biology* 79: 1413-1435.

South African National Biodiversity Institute (SANBI). 2006-2018. The Vegetation Map of South Africa, Lesotho and Swaziland. Mucina L., Rutherford M.C. & Powrie L.W. (eds). Online: http://bgis.sanbi.org/Projects/Detail/186. Version 2018.

South African National Biodiversity Institute (SANBI). 2019. National Biodiversity Assessment 2018: The state 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.

South African National Biodiversity Institute (SANBI). 2020. The terrestrial Red List of Ecosystems (RLE) South Africa 2020: Technical Report. South African National Biodiversity Institute, an entity of the Department of Environment, Forestry and Fisheries, Pretoria.

Stuckenberg, B.R. 1962. The distribution of the montane palaeogenic element in the South African invertebrate fauna. Annals of the Cape Provincial Museum II.

Swartz, E.R. 2005. Phylogeography, phylogenetics and evolution of the redfins (Teleostei, Cyprinidae, Pseudobarbus) in southern Africa. *PhD Dissertation*, University of Pretoria.

Switala, K.S., Sole, C.L. & Scholtz, C.H. 2014. Phylogeny, historical biogeography and divergence tome estimates of the genus *Colophon* Gray (Coleoptera: Lucanidae. Invertebrate Systematics 28: 326-336.

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

The Predation Management Forum. 2016. The Farmer's one-stop guide to identifying and managing predators. Agri Connect (Pty) Ltd. Pretoria, South Africa.

Treurnicht, M., Pagel, J., Esler, K.J., Schutte-Vlok, A.L., Nottebrock, H., Kraaij, T., Rebelo, A.G. & Schurr, F.M. 2016. Environmental drivers of demographic variation across the global geographical range of 26 plant species. Journal of Ecology 104: 331–342.

Trew, W.I. 1984. Rock paintings and Sandhills in the Hex River Valley, South-Western Cape. The South African Archaeological Bulletin. 39: 130-137.

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. & Snaddon, K. 2018. South African National Biodiversity Assessment 2018: Technical Report. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 October 2019. Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number http://hdl.handle.net/20.500.12143/5847.

Van Wilgen, B.W. & De Lange, W.J. 2011. The costs and benefits of biological control of invasive alien plants in South Africa. African Entomology 19: 504–514.

Van Wilgen, B.W. & Forsyth, G.G. 2008. The historical effects and future management of fire regimes in the Fynbos Protected Areas of the Western Cape Province. CSIR Report prepared for CapeNature (CSIR/NRE/ECO/ER/2008/0078/C).

Van Wilgen, B.W., Fill, J.M., Baard, J., Cheney, C., Forsyth, A.T. & Kraaij, T. 2016. Historical costs and projected future scenarios for the management of invasive

alien plants in protected areas in the Cape Floristic Region. Biological Conservation. 200: 168-177.

Van Wilgen, B.W., Reyers, B., Le Maitre, D.C., Richardson, D.M. & Schonegevel, L. 2008. A biome-scale assessment of the impact of invasive alien plants on ecosystem services in South Africa. Journal of Environmental Management 89: 336-349.

Van Wilgen, B.W., Richardson, D.M., Le Maitre, D.C., Marais, C. & Magadlela, D. 2001. The economic consequences of alien plant invasions: examples of impacts and approaches to sustainable management in South Africa. Environmental Developments in Sustainability 3: 145–168.

Van Wilgen, B.W. & Viviers, M. 1985. The effect of season of fire on serotinous Proteaceae in the Western Cape and the implications for fynbos management. South African Forestry Journal 133: 47–53.

Van Wilgen, B.W., Bond, W.J. & Richardson, D.M. 1992. Ecosystem management. In: Cowling RM, editor. The ecology of Fynbos: Nutrients, fire and diversity. Oxford University Press, Cape Town.

Van Wilgen, B.W., Everson, C.S. & Trollope, W.S.W. 1990. Fire management in Southern Africa: some examples of current objectives, practices, and problems. In Goldammer, J.G, ed. Fire and tropical biota. Ecosystem processes and global challenges. Ecological Studies 84: 179–215. Springer-Verlag, Berlin.

Van Wilgen, B.W. 1984. Fire climates in the southern and Western Cape Province and their potential use in fire control and management. South African Journal of Science 80: 358 362.

Veldtman, A. 2020. Fire regime of the Hexriver Complex (1980 – 2020). Internal report, CapeNature. Cape Town.

Viviers, M. 1983. Practical training in Mountain Catchment Conservation Research in the Western Cape (Fire Season). Unpublished Report. George, Saasveld College.

Vlok, J.H.J. & Yeaton, R.I. 1999. The effect of overstorey proteas on plant species richness in South African mountain fynbos. Diversity and Distributions 6: 233-242.

Vlok, J.H.J. & Yeaton, R.I. 2000. Competitive interactions between overstorey proteas and sprouting understorey species in South African mountain fynbos. Diversity and Distributions 6: 273-281.

Westerling, A.L., Hidalgo, H.G., Cayan, D.R. & Swetnam, T.W. 2006. Warming and earlier spring increase western US forest wildfire activity. Science 313: 940–943.

Weyl, O.L.F., Finlayson, B., Impson, N.D., Woodford, D.J. & Steinkjer, J. 2014. Threatened endemic fishes in South Africa's Cape Floristic Region: A new beginning for the Rondegat River. Fisheries 39: 270–279.

Wilson, A.M., Latimer, A.M., Silander, Jr. J.A., Gelfand, A.E., & De Klerk, H. 2010. A hierarchical Bayesian model of wildfire in a Mediterranean biodiversity hotspot:

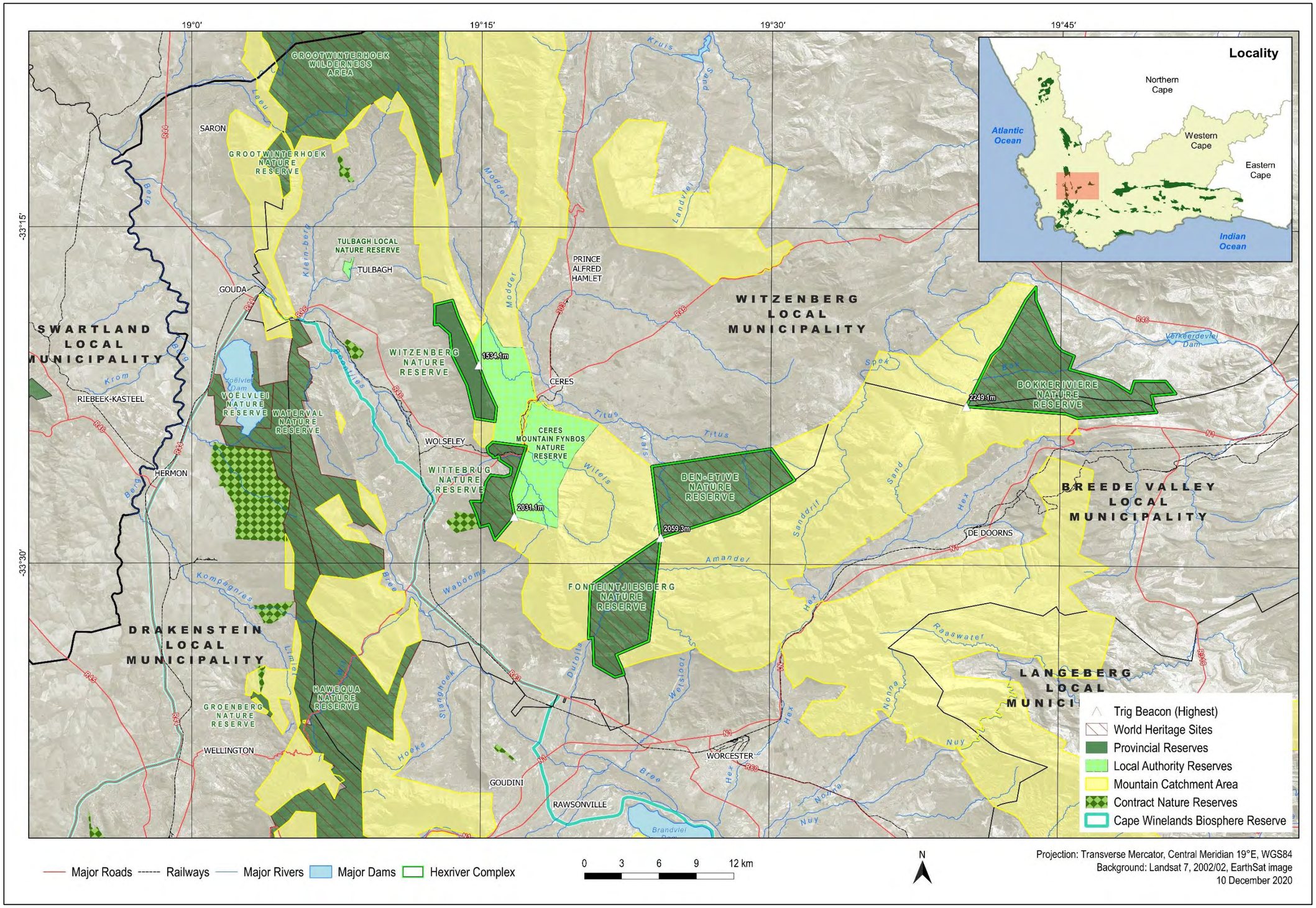
implications of weather variability and global circulation. Ecological Modelling 221: 106–12.

Winterbottom, J.M. 1968. Remarks on the avifauna of the macchia of the southern Cape Province. Revue de Zoologie et de Botanique Africaines 77. World Congress. 2016. Contract Management Education, Engagement and Excellence. Orlando, Florida. July 23 – 26.

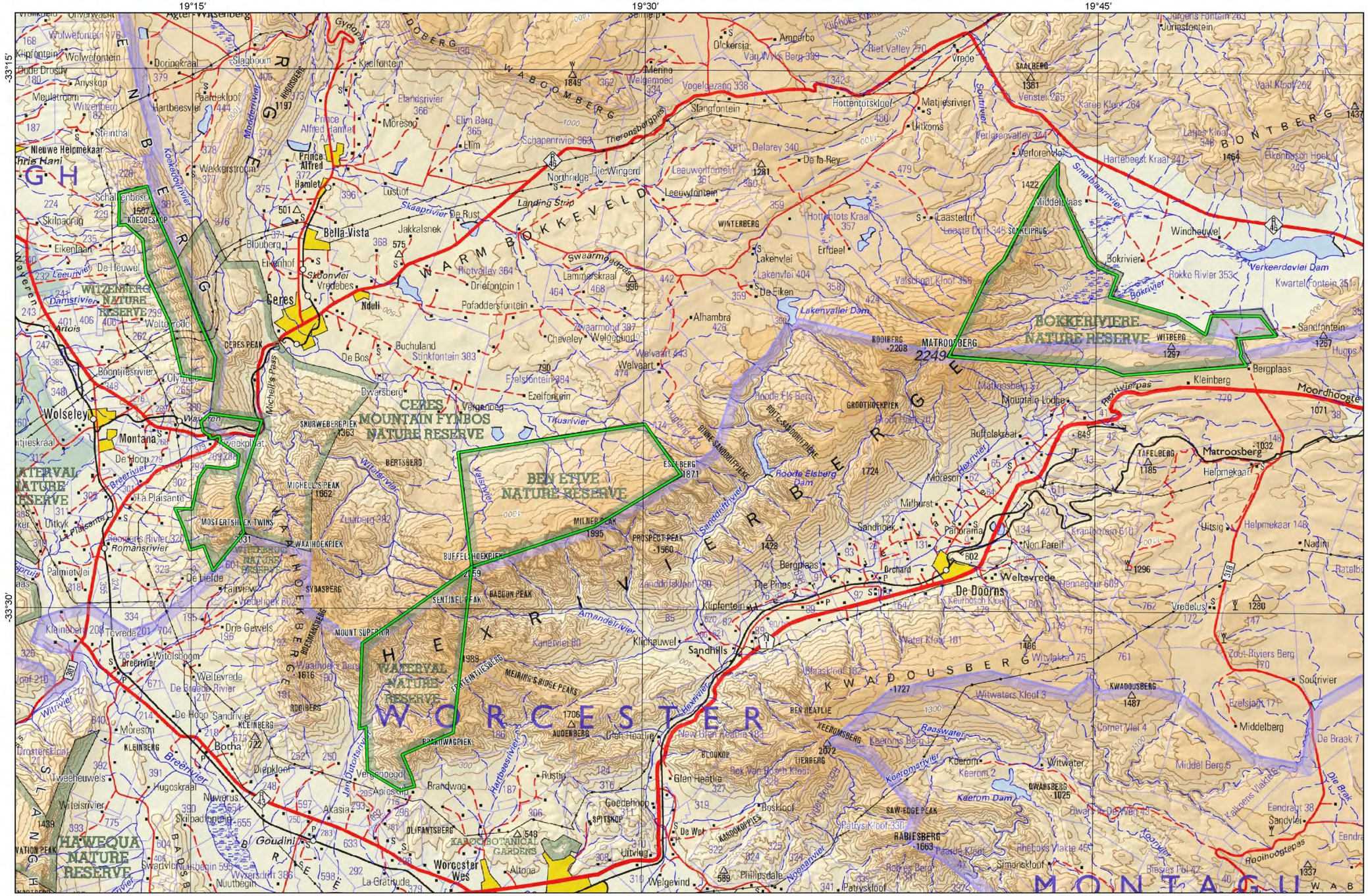
Witzenberg Municipality. 2019. Witzenberg Municipality Spatial Development Framework: Draft for comment.

Witzenberg Municipality. 2019. Witzenberg Municipality Draft Reviewed Integrated Development Plan 2019 -2020.

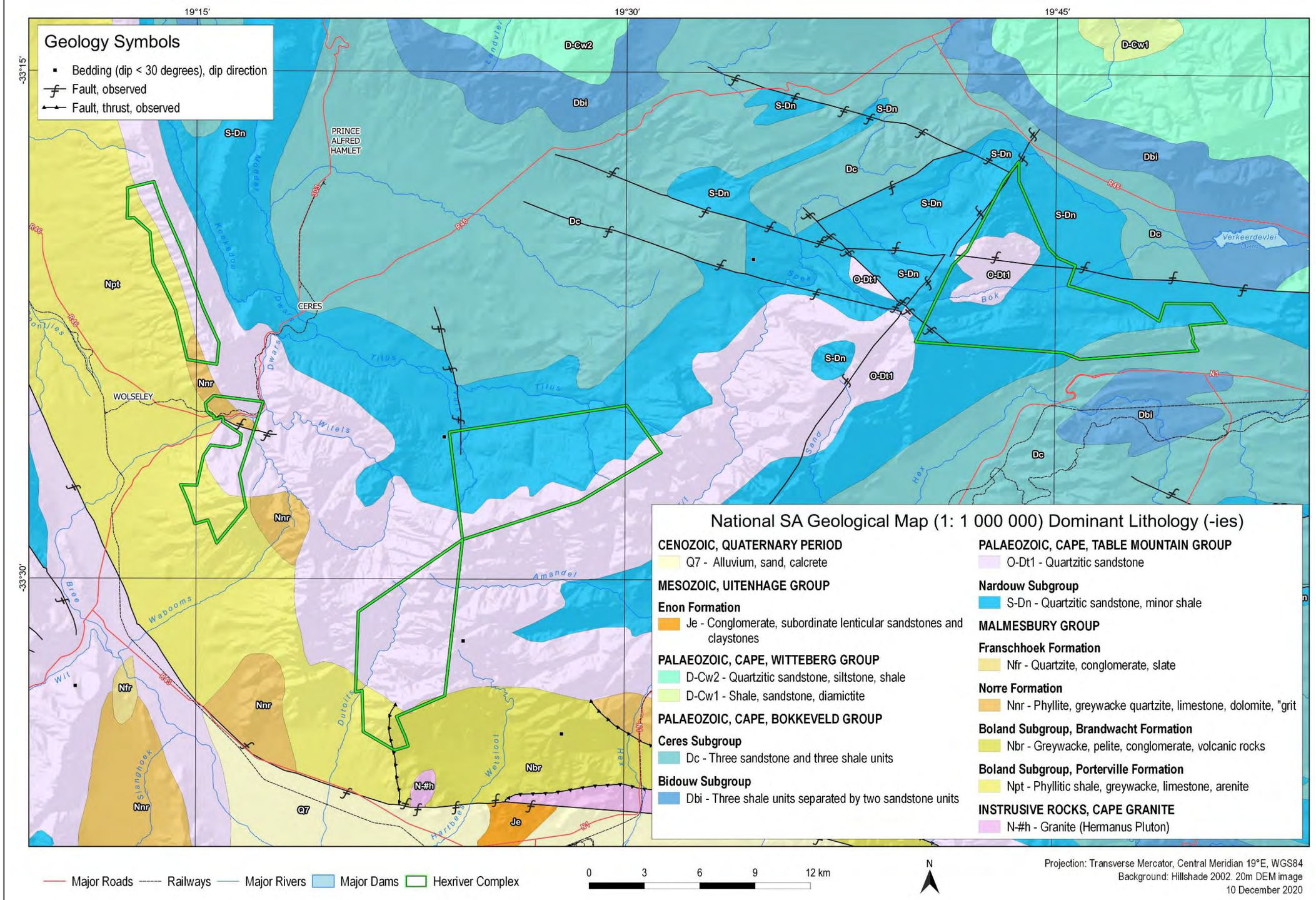
APPENDIX 1 Maps of the Hexriver Complex.



Map 1: Location and extent of the Hexriver Complex.



Map 2: Topography of the Hexriver Complex.



National SA Geological Map (1: 1 000 000) Dominant Lithology (-ies)

CENOZOIC, QUATERNARY PERIOD
- Q7 - Alluvium, sand, calcrete

MESOZOIC, UITENHAGE GROUP

Enon Formation
- Je - Conglomerate, subordinate lenticular sandstones and claystones

PALAEOZOIC, CAPE, WITTEBERG GROUP
- D-Cw2 - Quartzitic sandstone, siltstone, shale
- D-Cw1 - Shale, sandstone, diamictite

PALAEOZOIC, CAPE, BOKKEVELD GROUP

Ceres Subgroup
- Dc - Three sandstone and three shale units

Bidouw Subgroup
- Dbi - Three shale units separated by two sandstone units

PALAEOZOIC, CAPE, TABLE MOUNTAIN GROUP
- O-Dt1 - Quartzitic sandstone

Nardouw Subgroup
- S-Dn - Quartzitic sandstone, minor shale

MALMESBURY GROUP

Franschhoek Formation
- Nfr - Quartzite, conglomerate, slate

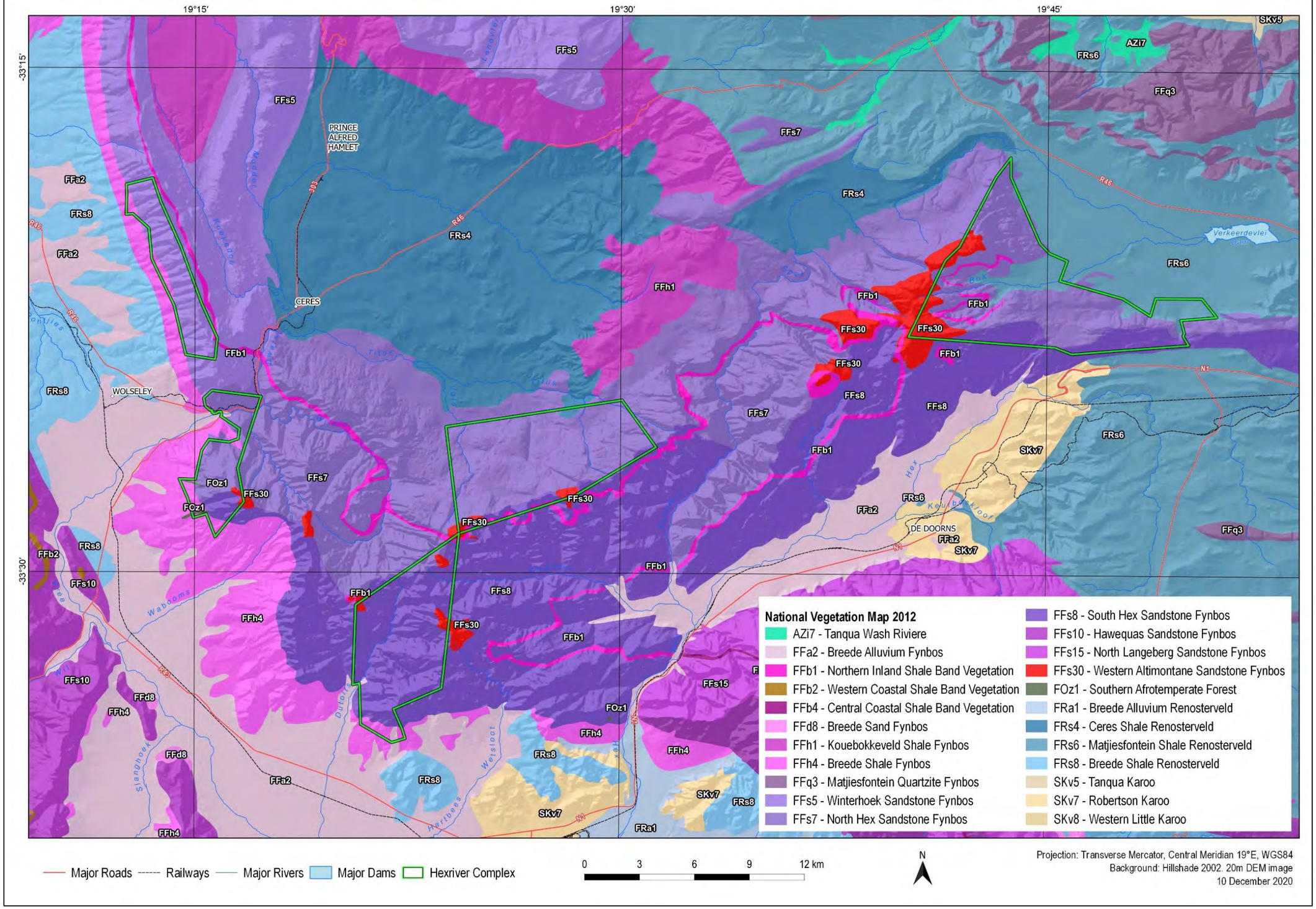
Norre Formation
- Nnr - Phyllite, greywacke quartzite, limestone, dolomite, "grit

Boland Subgroup, Brandwacht Formation
- Nbr - Greywacke, pelite, conglomerate, volcanic rocks

Boland Subgroup, Porterville Formation
- Npt - Phyllitic shale, greywacke, limestone, arenite

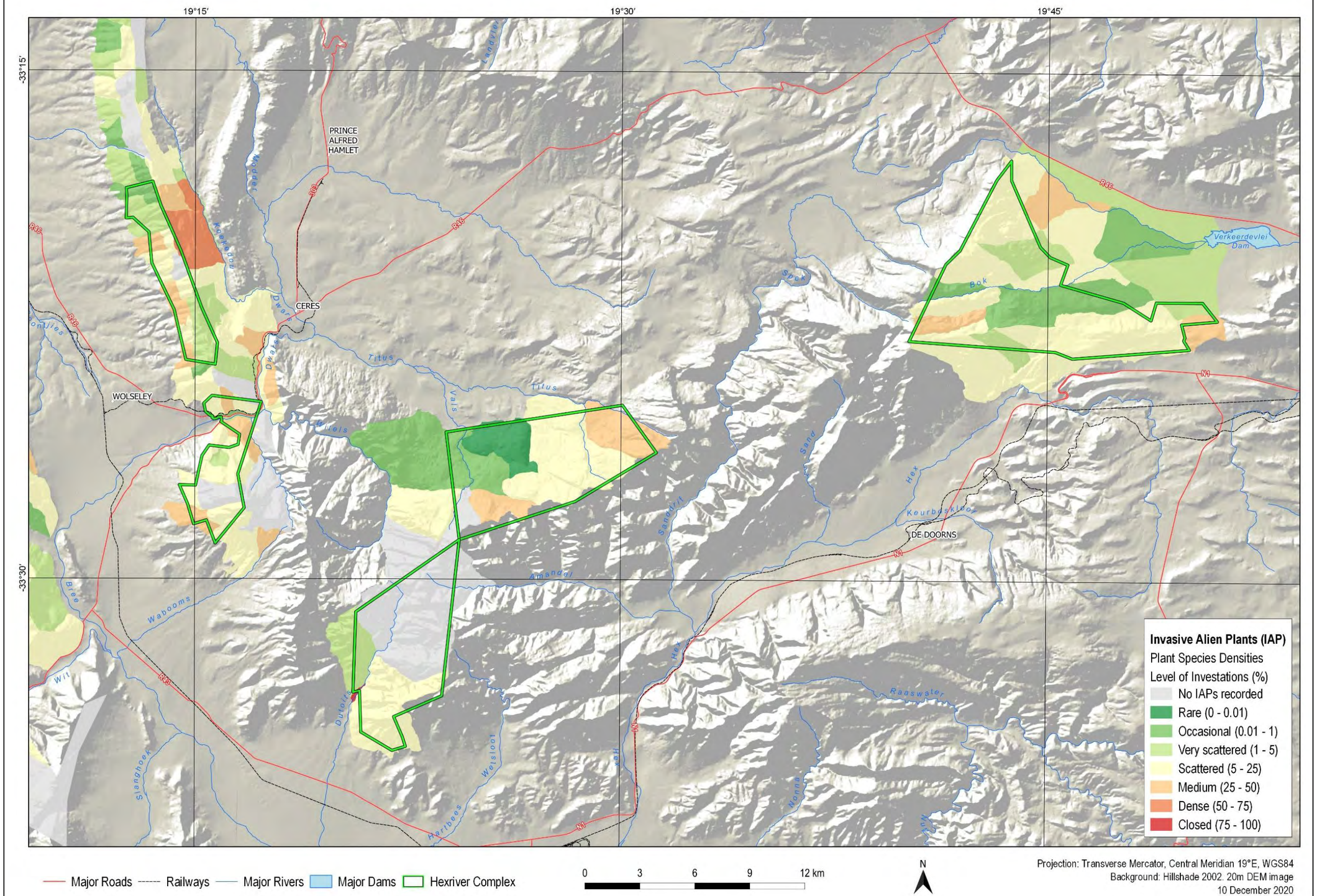
INSTRUSIVE ROCKS, CAPE GRANITE
- N-#h - Granite (Hermanus Pluton)

Map 3: Geology of the Hexriver Complex.

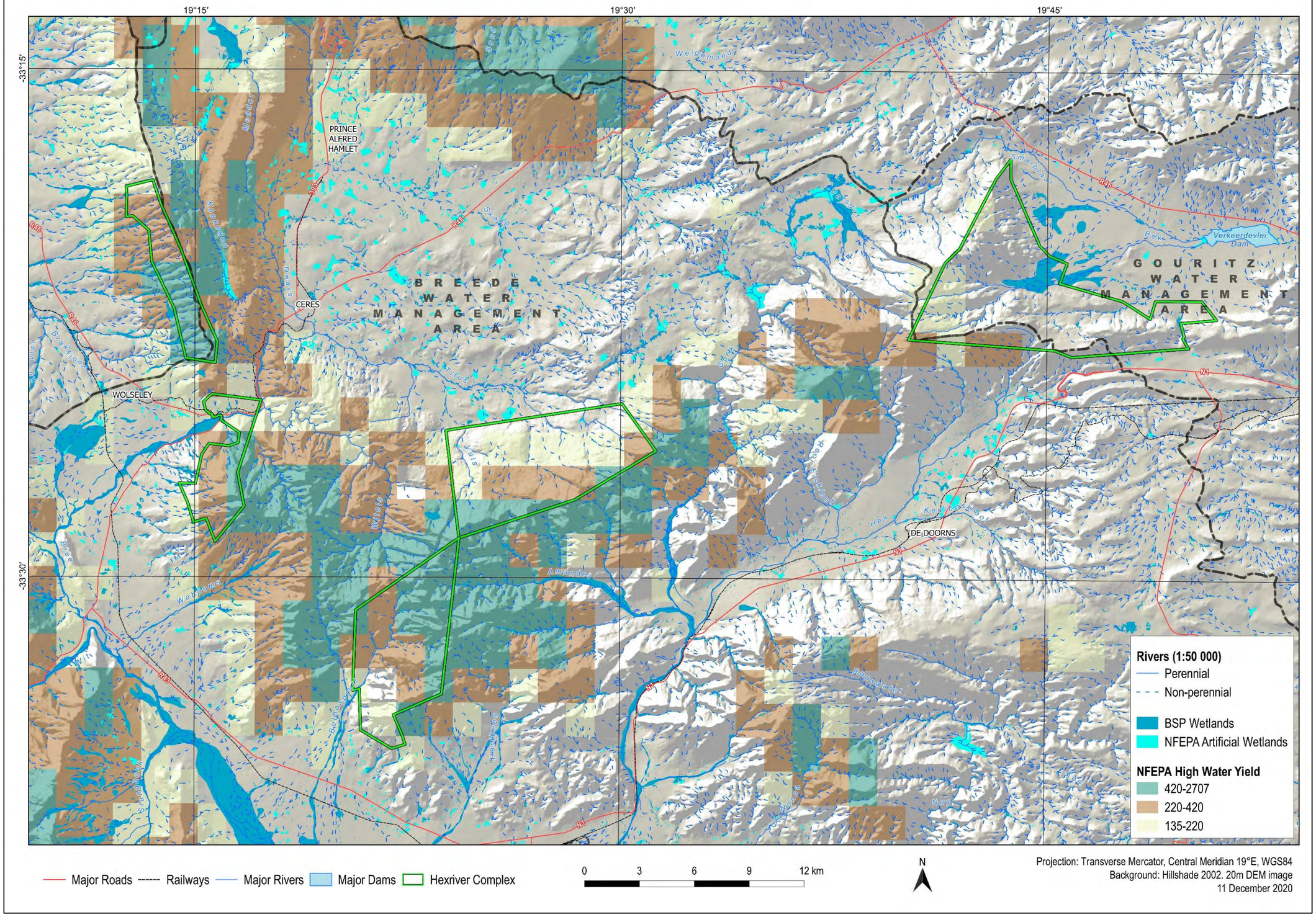


Map 4: Vegetation of the Hexriver Complex.

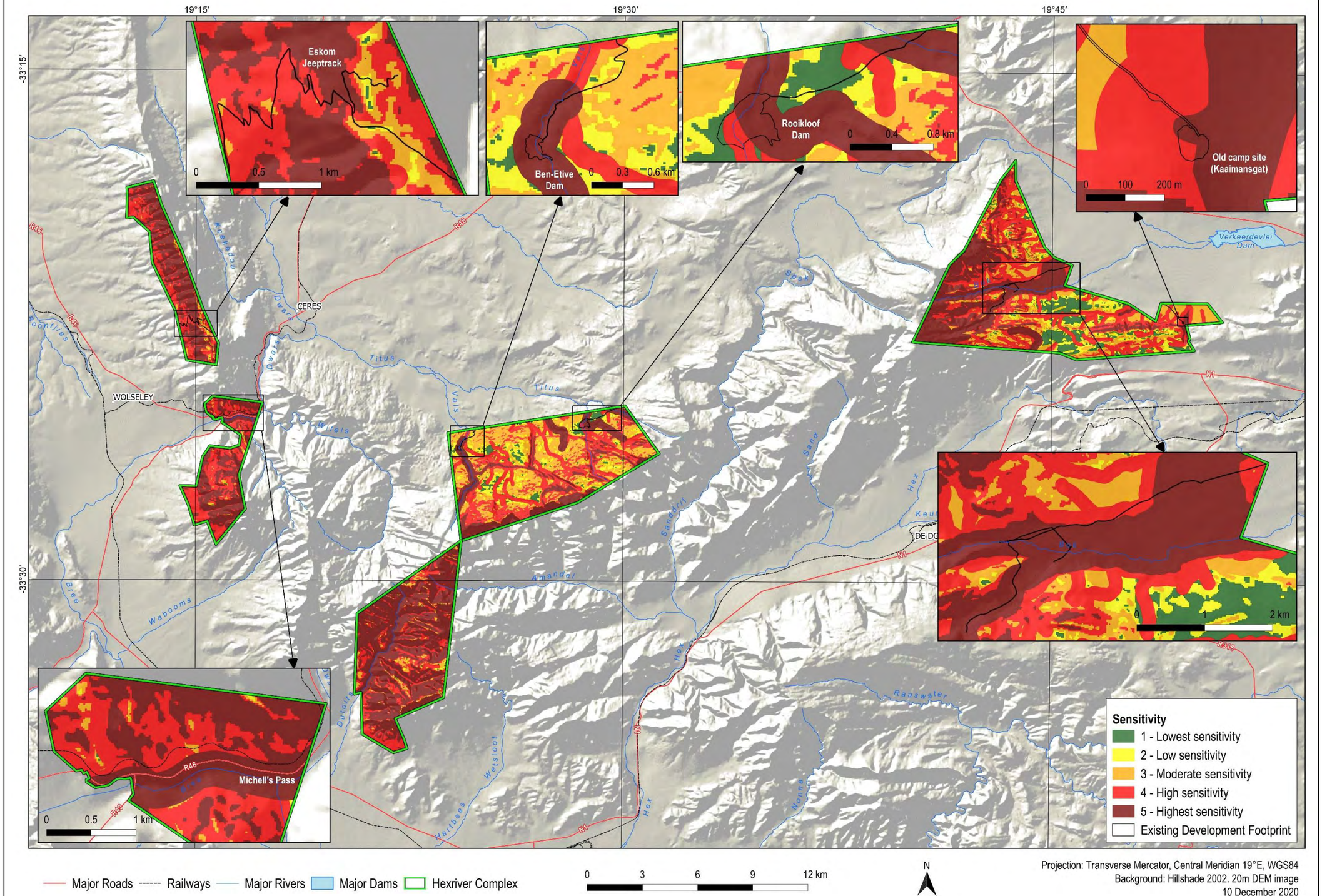
Map 5: Veld age and fire frequency of the Hexriver Complex.



Map 6: Invasive alien plant densities in the Hexriver Complex.



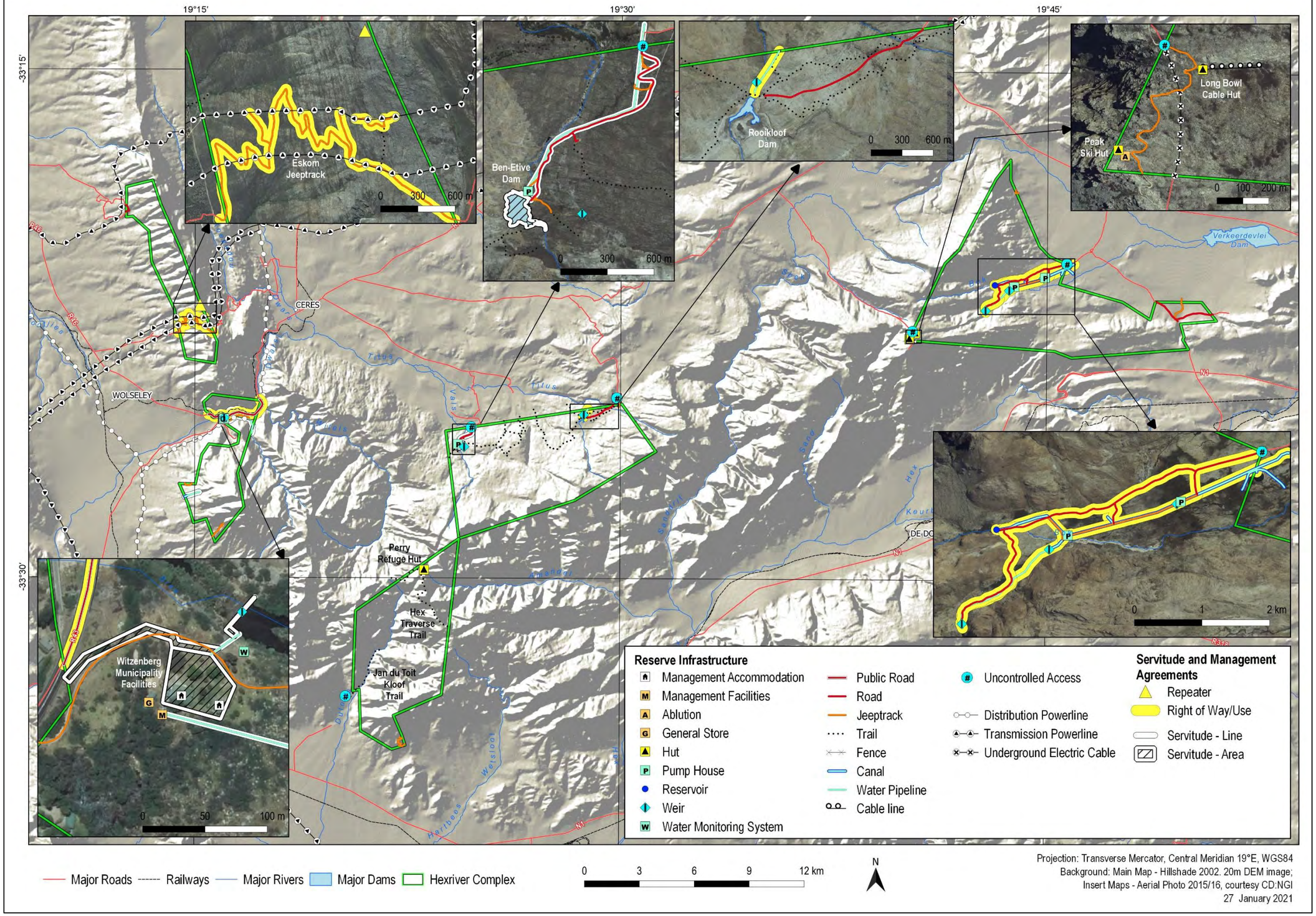
Map 7: Aquatic systems of the Hexriver Complex.



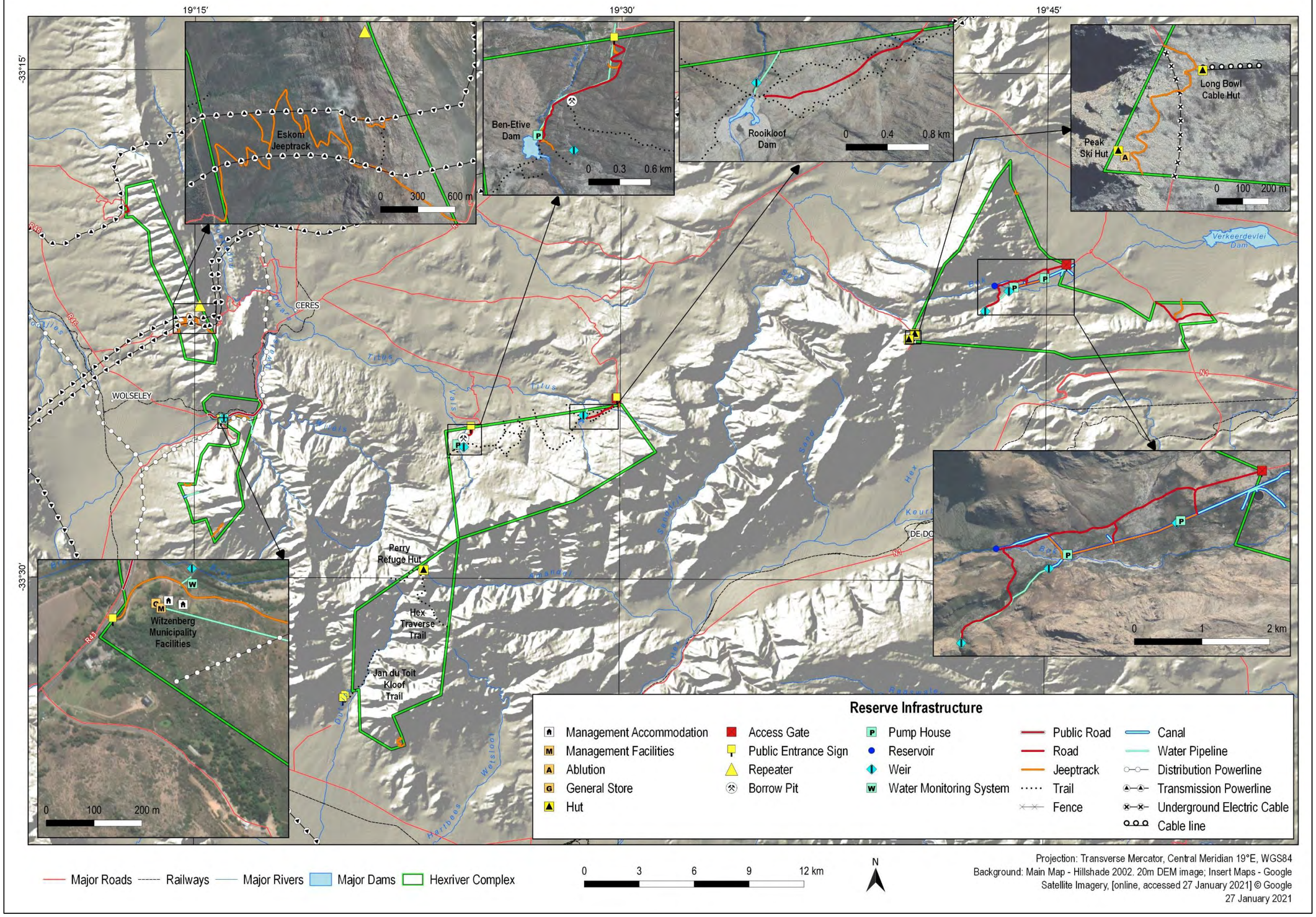
Map 8: Sensitivity of the Hexriver Complex.

Map 9: Zonation of the Hexriver Complex.

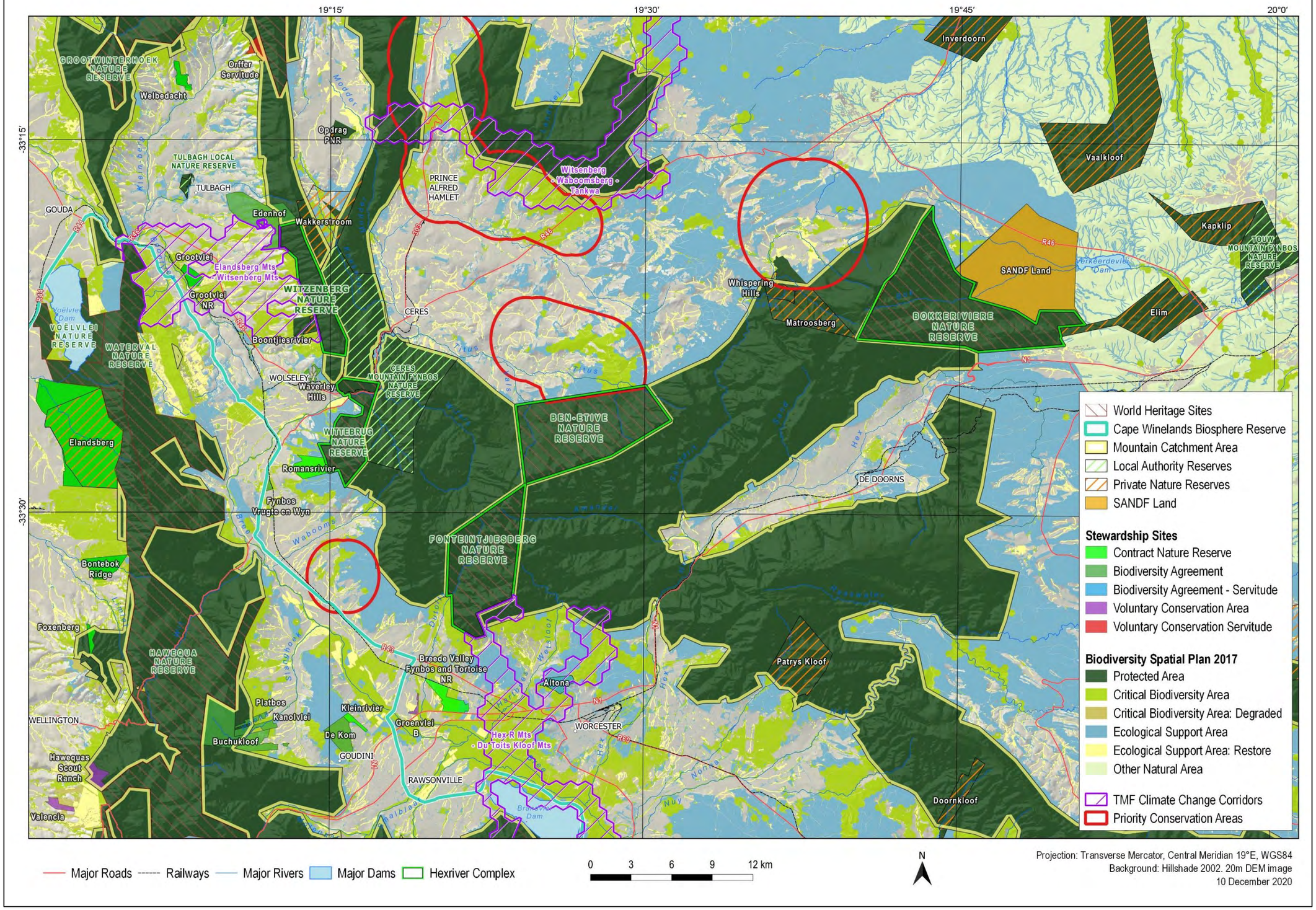
Map 10: Zone of influence around the Hexriver Complex.



Map 11: Access and servitudes on the Hexriver Complex.



Map 12: Infrastructure on the Hexriver Complex.



Map 13: Expansion of the Hexriver Complex.

APPENDIX 2 Stakeholder Engagement Report for the Hexriver Complex.

HEXRIVER COMPLEX

PART OF THE CAPE FLORAL REGION PROTECTED AREAS WORLD HERITAGE SITE

Western Cape, South Africa

STAKEHOLDER ENGAGEMENT PROCESS REPORT

COMPILED BY FOOTPRINT ENVIRONMENTAL SERVICES

DATE: JANUARY 2021

CapeNature