Eastern Cape
PARKS & TOURISM AGENCY

DRAFT ELEPHANT MANAGEMENT PLAN FOR THE GREAT FISH RIVER NATURE RESERVE

2021 – 2031

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With input and assistance from L Gerber, S Mack, S Mkhulise

January 2021

Authorisation

This management plan for the GFRNR is recommended by:

Name and Title	Signature	Date
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Mxolisi Ngesi Chairperson Likhayalethu CPA		
Wayne Erlank Regional Manager		
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Dean Peinke Chief Operations Officer (acting)		
Vuyani Dayimani Chief Executive Officer		

Executive Summary

The Great Fish River Nature Reserve (GFRNR) is located in the Eastern Cape Province, approximately 35 km North East of Grahamstown. The reserve is approximately 45 000 ha in size and is managed by the Eastern Cape Parks and Tourism Agency (ECPTA). The primary purpose of the reserve, as defined in the Protected Area Management Plan, is the conservation of the unique biodiversity, ecological processes, and associated heritage features of the Albany Thicket.

The ECPTA plans to reintroduce elephant to the GFRNR, primarily to reinstate the ecological processes associated with this keystone species, but also to support other objectives, such as tourism development. The reintroduction will comprise two family groups from the Addo Elephant National Park and two adult bulls (possibly from Kruger National Park or from private reserves) and is envisaged to occur between 2021 and 2022.

The purpose of the current document is to provide a framework for the management of elephant in GFRNR and to meet government's legislative and policy requirements for keeping elephant. This plan was produced through a consultative process that involved neighbours, community groups and elephant specialists.

Elephants are a keystone species (i.e. their interactions with other species generate effects that are large relative to their abundance; Selier *et al.* 2016) in Albany thicket, playing a role in 14 of the 19 broad ecological processes important to this biome (Boshoff et al. 2001). At high densities, elephant can also be destructive to ecosystems. Selective feeding by elephants on preferred plant species can lead to changes in plant population structure and, in some cases, lead to local extinctions (Parker & Bernard 2009). High elephant densities can also impact on the richness and abundance of a range of animal species, mostly through changes in habitat structure (Maciejewski & Kerley 2014).

In order to limit elephant impacts, the population will be kept at low densities in the GFRNR through the use of immunocontraceptives. The population, and their impact on habitats, will also be closely monitored. It is thought that the combination of low elephant densities, the presence of topographical refugia, and a strategic adaptive management approach, will allow for the persistence of sensitive species while also reinstating this charismatic, important component of naturally functioning Albany Thicket ecosystems.

The main objectives of this plan are to:

- Minimize risks to biodiversity – by facilitating opportunities for refuges from elephant impacts and limiting elephant densities;
- Manage expectations – to avoid unrealistic expectations of the benefits to people from the presence of elephants by co-developing a realistic model of tourism revenue and other benefits for the CPA, neighbours and the ECPTA;
- Minimize risks to the organisation and other stakeholders – by minimizing impacts on neighbours, complying with legislation, securing infrastructure and heritage assets and ensuring that mechanisms are in place to address liabilities;
- Promote tourism – to provide opportunities for revenue generation through the potential for elephants to improve the tourism experience; and
- Create an enabling environment for the implementation of this plan – by securing adequate resources and capacity to manage elephant and their effects.

An action plan is provided at the end of this document that outlines sub-objectives, actions, responsible parties and timeframes.

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Introduction and Strategic Context

The Great Fish River Nature Reserve (GFRNR) is in the Eastern Cape Province, approximately 35 km North East of Grahamstown (Figure 1-1). The reserve is approximately 45 000 ha in size and is managed by the Eastern Cape Parks and Tourism Agency (ECPTA). It straddles the Great Fish River and can be accessed from the R67, the R63, or the N2 (Figure 1-1). The geographic coordinates for the approximate centre of the reserve are -33.050° S and 26.828° E.

The ECPTA plans to reintroduce elephant to the GFRNR, primarily to reinstate the ecological processes associated with this keystone species, but also to support other objectives, such as tourism development. The reintroduction will comprise two family groups from the Addo Elephant National Park and two adult bulls (possibly from Kruger National Park or from private reserves) and is envisaged to occur between 2021 and 2022.

There are currently two female elephant, both approximately 25-30 years old on the reserve. These animals were introduced in 1995 and were part of a group of five orphan calves introduced from the Kruger National Park.

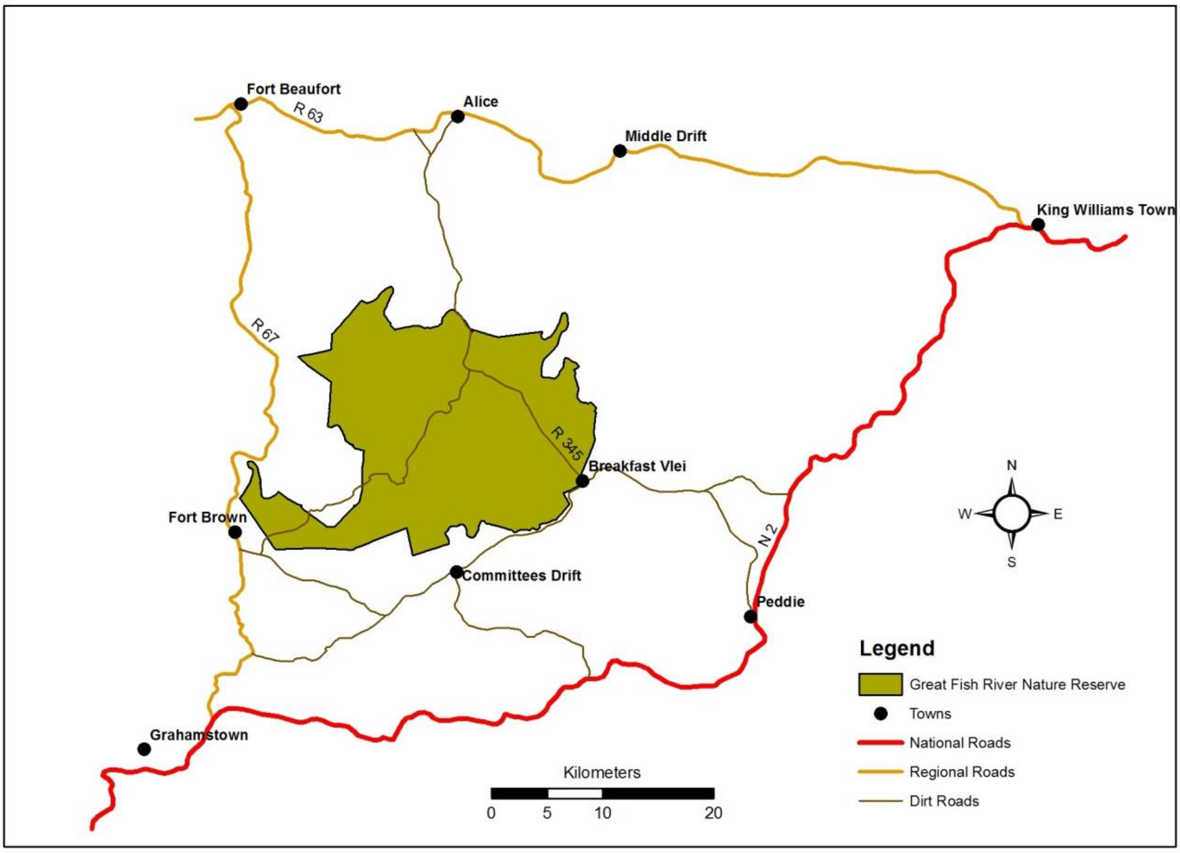

Figure 1-1: Location of the Great Fish River Nature Reserve

The purpose of the current document is to provide a framework for the management of elephant in GFRNR and to meet government's legislative and policy requirements for keeping elephant. The primary purpose of the reserve, as defined in the Protected Area Management Plan (PAMP; see ECPTA 2019), is the conservation of the unique biodiversity, ecological processes, and associated heritage features of the Albany Thicket.

In conserving this biodiversity and its associated heritage resources, the ECPTA seeks to sustainably use the biodiversity and heritage features of the reserve to:

- Develop, and ensure equitable access to, high quality nature-based tourism infrastructure, facilities and services;
- Optimize the delivery of socio-economic benefits to local communities on communal landholdings immediately adjoining the reserve;

- Better integrate the reserve into adjacent land use planning and development; and
- Develop opportunities to increase income generation without compromising the integrity of the area's biodiversity and heritage resources.

The reserve's purpose is encapsulated its vision which is:

To be a co-managed biodiversity and heritage destination of excellence.

To give effect to this vision five high level objectives have been identified in the PAMP. These are:

- To conserve and rehabilitate representative samples of the Albany Thicket Biome and heritage through management actions;
- To develop and market responsible tourism products within the GFRNR;
- To enhance cooperative management and socio-economic beneficiation through job creation as well as regular interaction with key stakeholders;
- To ensure effective and efficient management of the GFRNR; and
- To grow black rhino numbers by effectively implementing the RII Theory of Change.

The proposed introduction of elephant can, however, not be seen in isolation and will also contribute to the achievement of the reserve's other Strategic Goals:

- Reserve Planning and Expansion - Through the development of key subsidiary management plans to provide program-specific information on the broad objectives and activities identified in the PAMP;
- Stakeholder Involvement - Strengthening co-management and stakeholder relationships by involving stakeholders in the development of the elephant management plan; creating research opportunities, and by identifying and enabling access to employment, empowerment and capacity-building opportunities;
- Infrastructure and Equipment - Development and maintenance of management and tourism infrastructure and the elephant-proofing of signage and facilities;
- Visitor Services - Provide a range of tourism and recreation products;
- Improve Commercial Opportunities - to develop a diverse and sustainable income base for the reserve;
- Reserve Administration; and
- Knowledge Management - Develop and maintain targeted research and monitoring programmes and ensure that biodiversity data required to inform management decisions are effectively integrated and accessible.

In addition to the above, the proposed introduction is also in line with the ECPTA's Large Mammal Re-introduction Plan (2013-2018) and will also ensure that the ECPTA becomes compliant with the National Norms and Standards for the Management of Elephants in South Africa (2008). Currently the ECPTA is not compliant with the Norms and Standards as it is keeping two elephants under abnormal social conditions and also because it does not currently have an approved elephant management plan

This management plan complies with the structure, guiding principles and provisions laid out in 2019 Norms and Standards and is based on the principles of Strategic Adaptive Management of complex socio-ecological systems (Biggs and Rogers 2003; Rogers 2003). Strategic Adaptive Management is widely recognised as the most effective means of managing such complex systems (Rogers and Bestbier 1997).

Development of the plan

Two stakeholder engagement workshops were held. The purpose of the first was to workshop the high-level objectives for the plan with neighbours and community representatives. The second workshop was more focussed and mostly attended by elephant specialists and its purpose was to take the high-level objectives and, from them, to develop an objectives hierarchy. In addition, a field trip was arranged for members the Likhayalethu CPA to the Addo Elephant National Park, in order to discuss aspects of elephant conservation and management and the implications of having elephant on the reserve. A draft plan was produced by the ECPTA Scientific Services division, with support from Dr. Angela Gaylard (SANParks) and made available to stakeholders for comment, before being finalised.

Section A: General Information and Inventory

1. General

1.1 Names of management authority and reserve manager

Management Authority: Eastern Cape Parks and Tourism Agency

Reserve Manager: Sizwe Mkhulise – Senior Reserve Manager

1.2 Postal address

Management Authority
The CEO – Eastern Cape Parks and Tourism Agency
17-25 Oxford Street
East London
5201

Reserve Manager
Sizwe Mkhulise
Private Bag x1006
Grahamstown
6140

1.3 Telephone and fax numbers

Reserve Manager:

Phone: 046 622 7909

Cell Phone: 079 496 7883

E-mail: Sizwe.mkhulise@ecpta.co.za

1.4 Farm name(s)

Details of all the properties that make up the reserve are given in Table 1.

Table 1: Schedule of the properties that make up the GFRNR

Farm Description	Title Deed No	Registered Owner	Size (ha)
The farm Kentucky, farm number/portion 107.	Alb.Q.11-19	Republic of South Africa	2648.3969
The farm Dassies Scheur, farm number/portion 110.	1973. .22223	T M Knott	1881.8008
The farm Carrig Na Gunniel, farm number/portion 111.	Aly. Q.11-36	W F of South Africa	1204.2840
The farm Ballysaggart, farm number/portion RE/112.	Aly. Q.13-38	W W F of South Africa	686.5775
The farm Waterford, farm number/portion 112/1.	1914. 1357	W W F of South Africa	1092.4395
The farm Tanderajee, farm number/portion RE/113.	Aly.Q13-39	Republic of South Africa	561.6641
The farm Vorentoe, farm number/portion 113/1.	1961. .13116	Republic of South Africa	540.2508
The farm Ballinafad, farm number/portion 114.	Aly.Q.13-40	W W F of South Africa	1616.2759
The farm Lowestof, farm number/portion 115.	Aly.Q.14-1	Republic of South Africa	1219.7013
The farm Outspanning, farm number/portion RE/116.	Aly.Q.14-3	Republic of South Africa	655.6082
The farm Outspanning, farm number/portion 116/1.	1896. .470	M T Knott	91.2878
The farm Grasslands, farm number/portion 117.	Aly.Q.9(3)-83	Republic of South Africa	1969.1671
The farm Wirrasthrew, farm number/portion 118.	Aly.Q.13-1	W W F of South Africa	801.7140
The farm Onverwagt, farm number/portion RE/194.	FB.Q.1-29	W W F of South Africa	359.7434
The farm Onverwagt, farm number/portion RE/194/1.	1864.3.243	W W F of South Africa	993.5571
The farm Breede Drift, farm number/portion 199.	1924. 9379	T.R. Bosman	2951.0000
The farm Lemoen Kraal, farm number/portion 200.	1954. .7061	C M Gampu	2951.0000
The farm Kat River Mouth, farm number/portion 201.	FB.Q.1(1) - 10	F.B. Agricultutal Soc.	2.8282

Farm Description	Title Deed No	Registered Owner	Size (ha)
The farm Unknown, farm number/portion RE/1.	V.E.Q.17-47	Republic of South Africa	132.2642
The farm Unknown, farm number/portion RE/205.	V.E.Fr.4-68	Unknown	Not available
The farm Unknown, farm number/portion 205/1.	1868-7-82	Republic of Ciskei	Not available
The farm Unknown, farm number/portion 205/2.	Unknown	Unknown	0.0643
The farm Unknown, farm number/portion 208.	V.E.Fr.4-75	Unknown	Not available
The farm Bothas Kloof, farm number/portion RE/209.	V.E.Q. 2-2	Republic of Ciskei	723.4113
The farm Bothas Kloof, farm number/portion 209/1.	1861.24.111	SA Nature Foundation	96.3599
The farm Bothas Kloof, farm number/portion 209/2.	1934. .10207	Republic of Ciskei	387.3150
The farm Bothas Kloof, farm number/portion 209/3.	1934. .10207	Republic of Ciskei	52.0159
The farm Unknown, farm number/portion 209/4.	Unknown	Unknown	Not available
The farm Unknown, farm number/portion 210.	V.E.Fr. 4-73	Republic of Ciskei	492.4203
The farm Nottingham, farm number/portion 215.	V.E.F. 7-18	Republic of Ciskei	2011.9937
The farm Brake Fontein, farm number/portion RE/216.	Vic E Q.1-8	P. P. Jacobs	641.1007
The farm Branksome, farm number/portion 216/1.	1982. .23652	P. P. Jacobs	638.8679
The farm Brake Fontein, farm number/portion 216/4.	Unknown	Probably P.P. Jacobs	386.5784
The farm Branksome, farm number/portion 216/5.	Unknown	Unknown	99.9177
The farm Fort Willshire, farm number/portion RE/217.	V.E.Q.1-9	Republic of Ciskei	791.3018
The farm Fort Willshire, farm number/portion 217/1.	1860.42.216	Republic of Ciskei	613.4097
The farm Kodoos Kloof, farm number/portion 218.	V.E.Q.1-10	Republic of Ciskei	923.3415
The farm Brakfontein, farm number/portion RE/219.	V.E.Q.12-32	Republic of Ciskei	888.2237
The farm Brakfontein, farm number/portion 219/1.	1868.6.243	Republic of Ciskei	466.8728
The farm Brakfontein, farm number/portion 219/2.	1868.20.81	Republic of Ciskei	580.7287
The farm Welcome Rock, farm number/portion 220/1.	1860. .73	Republic of Ciskei	52.8880
The farm Welcome Rook, farm number/portion 220/2.	1873.57.388	Republic of Ciskei	342.6128
The farm Welcome Rock, farm number/portion 220/4.	1966. .17262	Republic of Ciskei	66.4841
The farm Welcome Rock, farm number/portion 221.	1966. .17264	Republic of Ciskei	295.7112
The farm Lekfontein, farm number/portion RE/222.	V.E.Q.1-12	Republic of Ciskei	357.8933
The farm Lekfontein, farm number/portion 222/1.	1865. .277	Republic of Ciskei	265.2637
The farm Unknown, farm number/portion 223.	1878.11.122	Republic of Ciskei	457.3182
The farm Naudes Hoek, farm number/portion 224.	V.E.Q.1-13	Republic of Ciskei	1003.8555
The farm Calmoes Fontein, farm number/portion RE/225.	V.E.Q.1-14	Republic of Ciskei	220.8782
The farm Calmoesfontein, farm number/portion 225/1.	1948. .15696	Republic of Ciskei	334.0475
The farm Calmoesfontein, farm number/portion 225/2.	1948. .15697	Republic of Ciskei	216.8097
The farm Groot Hoek, farm number/portion 226/1.	1941. .12036	Republic of Ciskei	285.1724
The farm Fort Montgomery, farm number/portion RE/227.	V.E.Q.1-15	Republic of Ciskei	720.5604
The farm Wilge Fontein, farm number/portion 228.	V.E.Q.1-59	Republic of Ciskei	882.2280
The farm Bloem Fontein, farm number/portion RE/229.	V.E.Q.1-58	Republic of Ciskei	407.1382
The farm Bloem Fontein, farm number/portion 229/1.	1916. .9661	Republic of Ciskei	425.4109
The farm Nooitgedacht, farm number/portion RE/230.	V.E.Q.1-61	Republic of Ciskei	1002.9990
The farm Nooitgedacht, farm number/portion 230/1.	1859.23.501	Republic of Ciskei	401.7135
The farm Double Drift, farm number/portion 231.	V.E.Q.1-62	Republic of Ciskei	541.7757
The farm Groot Draai, farm number/portion 232.	V.E.Q.17-49	Republic of Ciskei	854.8189
The farm Inkerman, farm number/portion 233.	V.E.Q.1-60	Republic of Ciskei	1242.8279
The farm Breakfast Vlei, farm number/portion 234.	V.E.Q.9-20	Republic of Ciskei	695.5040
The farm Drie Fontein, farm number/portion 235.	V.E.Q.1-63	Republic of Ciskei	1346.4683
The farm Bosch Place, farm number/portion 236.	V.E.Q.17-27	Republic of South Africa	1287.3676
The farm Unknown, farm number/portion 413.	Unknown	Unknown	Not available
The farm Unknown, farm number/portion 424/1.	Unknown	Unknown	Not available
The farm Breakfast Vlei, farm number/portion 42736.	Unknown	Eskom Holdings LTD	0.6408

1.5 Precise extent of the property and the specific enclosure where the elephants will be kept

The total size of the GFRNR is 45 016 ha or approximately 450 km^2. The elephant area constitutes the bulk of this (42 877 ha) and only small sections, totalling 2 139 ha, will not be available to elephant (Figure 1-1). The elephant area is adequately fenced for elephant and currently has elephant on the Certificate of Adequate Enclosure that has been issued by the Eastern Cape Department of Economic Development, Environmental Affairs and Tourism. The smaller areas that are currently excluded are not adequately fenced for elephant and have thus not been incorporated into the main reserve.

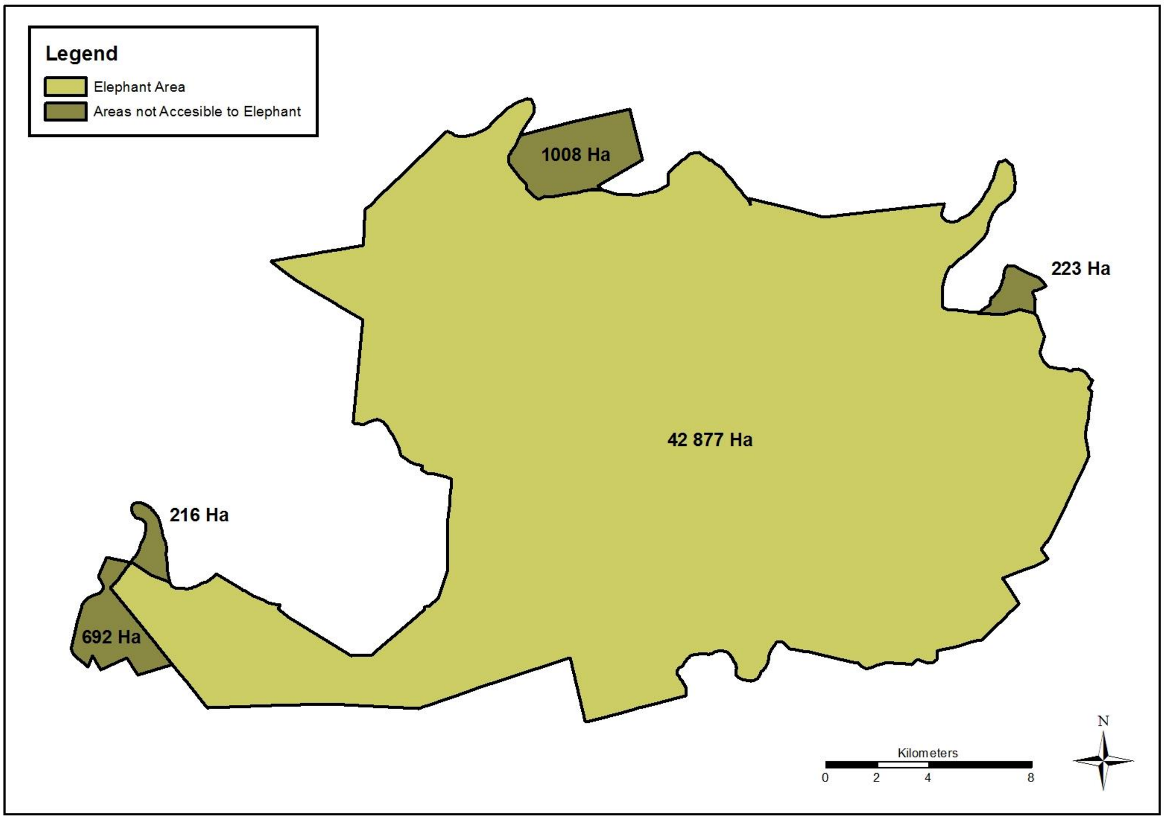

Figure 1-1: Map showing the area available to elephants

1.6 Description of the land uses and activities on all the neighbouring properties

The reserve is surrounded by both community- and privately-owned land. Most of the land to the north and east of the reserve (i.e. from the Kat River in the north, clockwise to the Great Fish River in the south) is community-owned land that was formerly part of the Ciskei homeland (Figure 1-2). This land is predominantly used for grazing by cattle, sheep and goats. The land to the west and south (i.e. from the Kat River anticlockwise to the Great Fish River in the south) of the reserve is all privately-owned, and the predominant land use is extensive game ranching (Figure 1-2). Some cultivation of crops and pastures occurs within a five kilometre radius of the reserve but this is largely restricted to the fairly narrow floodplains along the Great Fish and Keiskamma Rivers in the Fort Brown and Committees Drift areas. This land is used mainly for pastures but some crops and fruit, including pomegranates, from orchids are occasionally grown. In the Naudeshoek area, to the east of the reserve, citrus cultivation is the predominant activity. The Kwandwe Private Game Reserve, located immediately to the west of the GFRNR, is the only other property in the immediate vicinity of the reserve that has elephants.

If elephant were to escape from the reserve there is a risk that they could:

- Come into contact with people, particularly in the more densely-populated communally-owned areas to the north and east of the reserve. This is discussed in more detail in Section 1.8;
- Damage crops, but this risk is relatively low given the low incidence of intensive agriculture and particularly crop farming within a five kilometre radius of the reserve. The citrus that is grown to the east of the reserve may attract elephants but, provided that elephant are not conditioned or accustomed to citrus, this should not be a problem; and

- Damage game fences, particularly in the privately-owned game farms. Many of these farmers have invested in high value species and their security and breeding programmes may be compromised if fences are damaged.

There are nevertheless also potential benefits to introducing additional elephants. The introduction of additional elephants is an important step not only in the in the development of the reserve itself but also in the development a larger tourism node that is emerging in this area. This node includes several high-end privately owned tourism enterprises that are adjacent to the reserve. Together these enterprises have a diverse ecotourism offering and the potential to stimulate growth in the greater area. This in turn is likely to translate into important socio-economic benefits to the broader community.

More specifically the potential benefits that could accrue to the communities neighbouring the reserve, as a result of the introduction of additional elephant, are as follows:

- Elephants are an important tourist attraction and will allow the reserve to be more competitive in the market. This could lead to improved tourism value, which in turn could lead to improved visitor and occupancy rates. This has direct financial benefits for the Likhayalethu CPA, who own part of the reserve, and also indirect benefits to the surrounding communities who stand to benefit through job creation.
- Elephants are likely to improve the value of concessions, which will directly benefit the Likhayalethu CPA and can also lead to new job opportunities
- The presence of more elephant could create new opportunities for the development of local SMME's i.e. as guides, to assist with fence repairs and maintenance, catering, laundry, general maintenance, and other value adding activities.
- Opportunities for local communities to tap into the tourism market by developing off-reserve support services such as tourist shops, opportunities for the sale of locally produced goods, cultural experiences and tourism accommodation.

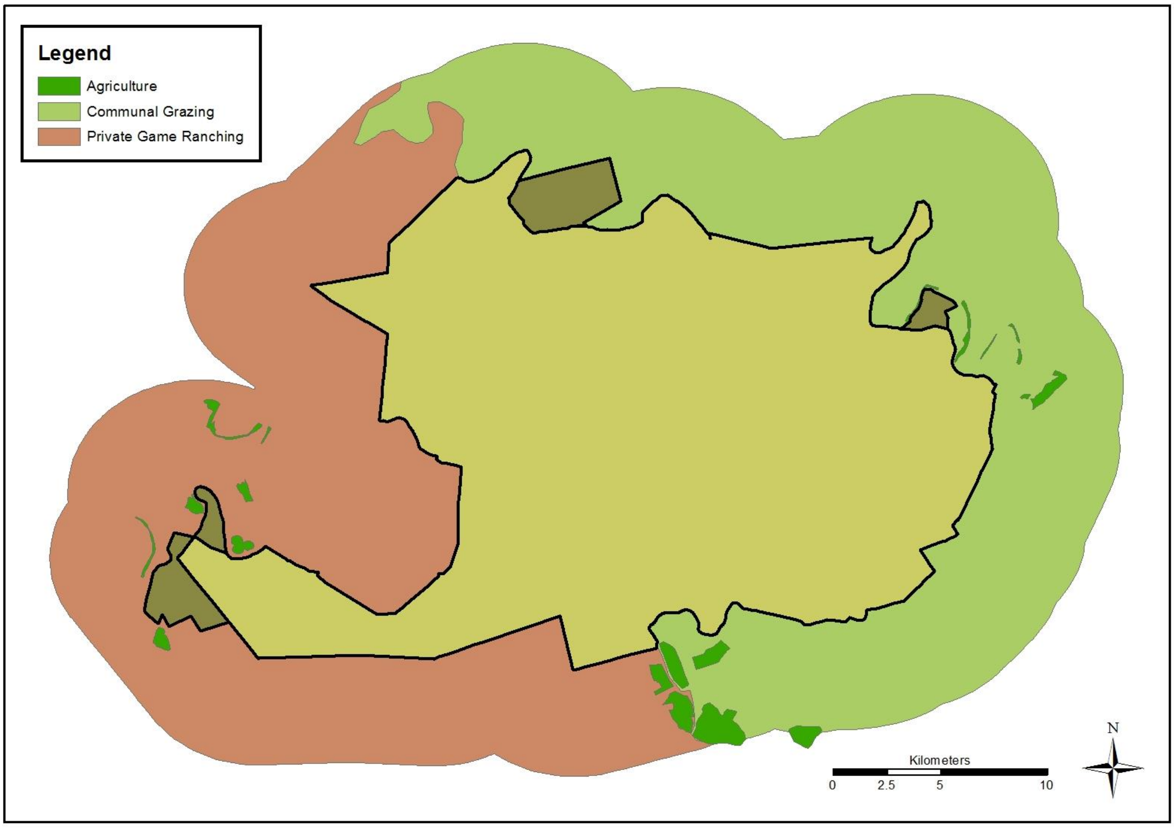

Figure 1-2: Map of surrounding land use

1.7 Name, contact details and qualifications of the compiler of the plan

This management plan was compiled by a team consisting of the following people:

- Dr Angela Gaylard

Current Position	Regional Ecologist with South African National Parks
Qualifications	PhD in elephant ecology
Role	Facilitated the public participation and expert workshops and helped to compile the plan
Contact Details	Tel: 044 3025611 E-mail: angela.gaylard@sanparks.co.za

- Dr Dean Peinke

Current Position	Senior Manager: Scientific Services at Eastern Cape Parks and Tourism Agency
Qualifications	Pr.Sci.Nat. PhD in Zoology; Registered with the South African Council for Natural Scientific Professions, in the fields of Ecological and Zoological Science
Role	Overall project coordinator and helped compile the plan
Contact Details	Tel: 082 416 2563 E-mail: dean.peinke@ecpta.co.za

- Mr Brian Reeves

Current Position	Ecologist at Eastern Cape Parks and Tourism Agency
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1.8 Proximity to settlements, rural communities and tribal land

As previously indicated the reserve is surrounded by both communal- and privately-owned land (Figure 1-3). In total 21 rural communities, distributed in 36 spatially distinct areas, are located within a five kilometre buffer of the reserve (Figure 1-3). The majority of these are located in the communal-owned land and only two occur in the privately-owned areas. In addition to this some scattered farmsteads and farm labourer homes occur throughout the privately-owned land. Although fairly numerous, the villages are relatively small and population densities are still relatively low. Population density in the communal land areas is approximately 72 people/km^2 and in the private owned land about seven people per square kilometre. The people living in these villages are relatively poor are there are high levels of unemployment. The communities to the north fall under the traditional leadership of Chief Zulu while those to the east and south fall under Chief Tyali.

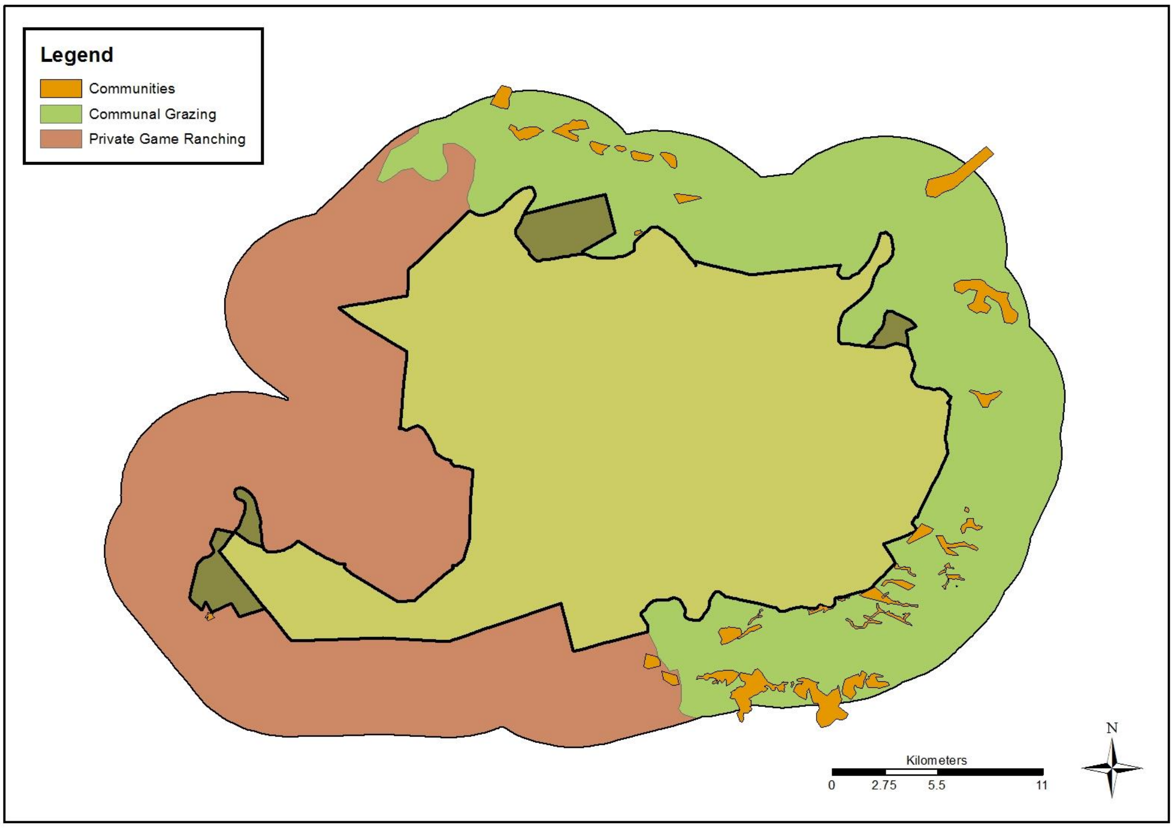

Figure 1-3: Location of rural communities in the area adjacent to Great Fish River Nature Reserve

1.9 Information as to whether there is potential for enlarging the property

Much of the land adjacent to the reserve lies within focus areas identified for protected area expansion in the both the Eastern Cape (Skowno *et al.* 2012) and National (Jackelman *et al.* 2007) Protected Areas Expansion Strategies. In reality, however, opportunities for expansion of the reserve into the communal-owned areas that border the eastern half of the reserve are very limited. This is largely due to the relatively high density of rural settlements in this area but also the complexity of the communal land ownership and management systems in these areas.

There are opportunities for expansion into the privately-owned properties that border onto the western half of the reserve but there are currently no plans to purchase additional land in this area. Any expansion in the future is more likely to happen through a public private partnership. There are, however, currently no such plans. Kwandwe Private Nature Reserve which borders onto the GFRNR in the west is currently considering declaration as a Protected Environment but there is currently no intention to remove fences between these two areas. Differences in management objectives as well a public road that separate the two properties currently preclude any possibility of this happening.

The only short-term opportunity for expansion is the incorporation of the Kingston properties in the north. This land currently belongs to ECPTA but has not yet been properly fenced. If this land were to be fenced it could lead to the incorporation of a further 1 008 ha of land into the elephant area. The incorporation of other ECPTA-owned land (Figure 1-1) in the Fort Brown area is unlikely, as these areas have been severely degraded and are currently being rehabilitated, and also because they form an important security buffer for black rhino in this area. Similarly the land in the Naudeshoek area is unlikely to be incorporated in the immediate future due to the fact that this land is currently utilised for livestock grazing by the neighbouring community.

1.10 Specifications of the perimeter fence

The boundary fence consists of a 22-strand high-strain fence that is 2.4 m high with steel inline poles at 20 m intervals (Figure 1-4). The poles are concreted into 800 mm x 600 mm deep pits and are 100 mm thick. Steel Y-standard poles are placed at four metre intervals between the poles and steel droppers at one metre intervals between these. There are also five electrified strands that are offset from the main line, with one strand positioned at the forehead height of an adult elephant bull. Where necessary, the areas under the fence have been closed and secured with gabion baskets. The river crossings have all been secured with 16 mm cable.

Figure 1-4: Photograph of the boundary fence.

The reserve currently has a Certificate of Adequate Enclosure for elephant, issued by the Provincial Department of Economic Development, Environmental Affairs and Tourism.

2. Legal, policy and planning framework

2.1 International and regional agreements and plans

Convention on International Trade in Endangered Species

The Convention on International Trade in Endangered Species (CITES) is an international agreement between governments aiming to ensure that international trade of animals and plants does not threaten their survival. South Africa's elephant population was downlisted to Appendix II in 2000. This enables the export of elephants and their derivatives if the CITES Scientific Authority of South Africa deems it to be non-detrimental to the long-term survival of the species. However, ivory is listed in Appendix I and cannot be traded but can be exported as part of a hunting trophy

Southern Africa Regional Elephant Conservation and Management Strategy, 2005

The purpose of this strategy is to facilitate coordination, collaboration and communication for the managers of elephant populations across the region in order to conserve elephants and expand their range within the historical extent, forming a contiguous population as far as possible across southern Africa.

2.2 National laws, policies and plans

National Environmental Management: Protected Areas Act, Act 57 of 2003

The National Environmental Management: Protected Areas Act (Act 57 of 2003) provides for the protection and conservation of ecologically viable areas representative of South Africa's biodiversity and natural landscapes and seascapes in protected areas. Protected areas in South Africa are viable tool for the long-term protection and maintenance of ecologically viable numbers of elephant and their associated habitats. In terms of the act, the GFRNR is declared as a nature reserve in terms of Section 23.

National Environmental Management: Biodiversity Act, Act 10 of 2004

The National Environmental Management: Biodiversity Act (Act No. 10 of 2004) provides for the management of South Africa's biodiversity within the framework of the National Environmental Management Act (Act No. 107 of 1998). The act gives effect to the constitutional commitment to taking reasonable legislative measures that promote conservation by providing for the management and conservation of biological diversity and the sustainable use of indigenous biological resources. Chapter 3 provides for biodiversity planning and monitoring.

Elephants are protected in terms of Section 56 of the Biodiversity Act and through the Threatened and Protected Species Regulations (GNR 29657, 2007) of this act. As such, any activities relating to the direct use of elephants (including translocation, hunting and selling) require a permit, which is issued by the relevant Provincial Authority.

National Environmental Management: Biodiversity Act, Act 10 of 2004: Threatened or Protected Species Regulations (TOPS), 2007

Threatened or Protected Species (TOPS) regulations under the NEM: Biodiversity Act came into force in February 2008 and have subsequently been amended. The regulations provide for the protection of species that are threatened or in need of protection to ensure their survival in the wild. The regulations set out a permit system that applies to restricted activities involving listed threatened or protected species and provides for the registration of captive breeding operations, commercial exhibition facilities, game farms, nurseries, scientific institutions, sanctuaries, rehabilitation facilities and wildlife traders.

Elephant is listed as a protected species under TOPS. It is therefore compulsory for elephant conservation sanctuary owners, rehabilitation facility owners, wildlife traders, captive breeders or zoo owners to register their facilities for operation. Game farmers with elephant can voluntarily apply for registration and obtain a standing permit, which is valid for three years. The regulations require a permit to be issued for a person to carry out a listed restricted activity concerning elephant. This includes hunting, capturing, killing, cutting parts off or importing or exporting into or from South Africa. It also includes possessing or exercising physical control over any elephant, breeding, translocating, moving, selling, donating or accepting any elephant or any of its products or derivatives as a gift. The regulations set out provisions for permits authorising the possession of elephant ivory, which include provisions for marking ivory and registration on the national database.

Norms and Standards for the Management of Elephants in South Africa, 2019

Elephants in South Africa are managed in accordance with the 2019 Norms and Standards for the Management of Elephants in South Africa. The purpose of this policy is to ensure that elephants are managed so that their long-term survival is secured, together with the ecosystems in which they occur. The Norms and Standards state that elephant management must be informed by the best available scientific information and that adaptive management should be adopted where information is lacking. The Norms and Standards identify lethal measures as a last resort to controlling elephant populations, after all other alternatives have been exhausted. Culling will not be permitted without an approved culling plan.

The Norms and Standards require that an elephant management plan be produced and approved for properties, whether state-, private- or communally-owned, that house free-ranging elephant. The structure of the plan is outlined in Annexure I of the Norms and Standards and the current document is compliant with this. Elephant management plans must be reviewed every 10 years.

The management plan must comply with the process prescribed in the NEM: Protected Areas Act and include, amongst other, the principles contained within the Norms and Standards, an initial assessment and ongoing assessments of the impact of elephant on vegetation structure and ecological functioning, an assessment of the potential for conflict between people and elephants and provide for emergency plans in the event of the escape of an elephant, and interventions required in terms of adaptive management. In terms of the Norms and Standards, elephant management plans must be approved by the Minister of MEC. The Norms and Standards require that written notification of the intended establishment be provided to adjacent landowners, communities and any other person directly affected.

Before elephant are introduced into an extensive wildlife system, the potential impact of elephants on biodiversity and habitat structure must be considered. The following must be available: adequate food plants, adequate shelter, adequate water for drinking and bathing, and sufficient land area.

When establishing a new elephant population, the Norms and Standards specify that the following must be taken into account with regard to initial population structures: i) the matriarchal society of the animals, ii) the initial population should be a social unit, and iii) adult bulls may be introduced first if a social unit is intended to be introduced later, or they may be introduced once the social unit has become successfully established, or at the same time as the social unit.

The Norms and Standards also outline a duty of care on elephant owners. They must keep up to date with new monitoring and research information, submit information to SANBI to assist in the development of monitoring and research programs, provide for the safety of people interacting with elephants and not allow any neglect or abuse of the elephant.

With regard to extensive wildlife systems with elephant, the responsible person identified in the Norms and Standards, must provide an ongoing assessment of the impact of elephants, report changes beyond acceptable limits, and deploy the necessary management interventions when elephant are altering habitat beyond acceptable limits. The ongoing assessment of elephant impacts must be reported on to the relevant issuing authority every five years, while the number of elephant kept must be reported on every three years.

According to the Norms and Standards, elephant must be kept in an area that is adequately enclosed. The minimum standard for a perimeter fence is 1.8 m in height and electrified on the side occupied by the elephant.

The Norms and Standards state that elephant may only be sedated as an extraordinary measure (and not repeatedly) and only to carry out disease control procedures, scientific research, management functions, for treatment by a veterinarian or to translocate or transport the animal.

2.3 Provincial laws, policies and plans

Eastern Cape Parks & Tourism Agency Act, Act 2 of 2010, Eastern Cape

The Eastern Cape Parks & Tourism Agency Act, Act 2 of 2010, Eastern Cape, provides for the establishment of the ECPTA in order to develop and manage protected areas and to promote and facilitate the development of tourism in the Province.

Section 12 of the act outlines the powers of the ECPTA in relation to protected area management. In terms of this section, the ECPTA must:

- Control, manage and maintain the protected areas;
- Make inventories, assess, monitor and protect natural resources in the protected areas;
- Take the necessary steps to ensure the security of animal and plant life in the protected areas;
- Take the necessary steps to ensure appropriate ecological management of the protected areas;
- Perform the duties and functions required of the management authority of a protected area; and
- Prepare and submit to the MEC management plans for protected areas.

In terms of the Act, the ECPTA is empowered to manage the GFRNR and its elephant population.

Eastern Cape Nature Conservation Ordinance, 19 of 1975

African elephants are classified as protected wild animals in terms Schedule 2 of the Eastern Cape Nature Conservation Ordinance 19 of 1975. As such, a permit was previously required from the Provincial Department of Economic Development, Environmental Affairs & Tourism before elephant were disposed of or moved. However, this is now regulated through permits in terms of the Threatened or Protected Species Regulations.

ECPTA Large Mammal Management Policy, 2009

The ECPTA Large Mammal Policy (2009) outlines the policy framework for managing large mammals within ECPTA reserves. It stipulates that management of large mammals must take place within an adaptive management framework that incorporates natural change and that management interventions must be based on sound ecological or genetic reasoning and must be documented.

With regard to introductions of mammals, the goal is to move towards restoring the natural diversity in all reserves and the best available knowledge will be used to determine what is considered to be indigenous to the various reserves. The removal of animals will be done by the most appropriate method applicable and removals will strive to achieve normal age and sex structure in mammal populations. The policy states that ecosystems will not be specifically managed to benefit a single species. Threatened species may be managed to their benefit, but not to the detriment of the ecosystem.

ECPTA Large Mammal Re-introduction Plan, 2013

This plan identifies a set of priority re-introductions of large mammals onto ECPTA reserves. Its purpose is to provide the ECPTA with strategic direction to allow it to plan, prioritise, budget for, and coordinate large mammal reintroductions. Project 1 of the plan is the reintroduction of brown hyaena, wild dog and elephant into the GFRNR.

ECPTA Artificial Waterholes in Protected Areas Policy, 2013

The ECPTA Artificial Waterholes in Protected Areas Policy (2013) recognises that water is a critical resource for large mammals and one of the major determinants of their distribution. It states that it is important to maintain natural or near-natural distribution of water within ECPTA reserves. As such, the policy discourages the provision of artificial water points for animals, but also recognises that the elimination of artificial water points may not be appropriate of practically possible in all reserves. In protected areas with artificial waterholes, managers should plan to close these over time and as resources allow. In the case of the GFRNR, with its preponderance of dams that were constructed before the area was declared a nature reserve, and considering the influence that these have on large mammal distribution (especially black rhino), it is not feasible or desirable to close most of the artificial waterholes. According to the policy, no new artificial waterholes will be established without having given due consideration to the policy and the implications of such actions.

ECPTA Co-management Policy, 2015

The ECPTA Co-Management Policy (2015) provides a policy framework for the planning, consultation, negotiation and management of co-management agreements between communal landowners of portions of ECPTA-managed reserves and the ECPTA. The legal mechanism underpinning such arrangements is a co-management agreement. The nature of such agreements is outlined in the policy, together with a requirement for management plans for co-managed areas, and consideration of access, use and benefit sharing arrangements.

3. Ecological

3.1 Literature review

Distribution and status of elephant

Elephant were once widely distributed on the African continent. In South Africa, elephants probably occurred over most parts of the country, including in the arid north-western parts (Selier *et al.* 2016). By the end of the 19th century almost all South Africa's elephants had been hunted, and only three, or possibly four, relict populations survived into the 20th century (Lombard *et al.* 2001; Selier *et al*. 2016). By 1920, human population growth and the associated expansion of human settlements and agriculture, combined with the ivory trade had resulted in the elephant population dropping to an estimated 120 individuals in small populations around Knysna, Addo, Tembe and Olifants Gorge (Hall-Martin 1992; cited in Scholes & Mennell 2008). In the past 30 years or so, populations have recovered in this region, which now has the highest numbers in Africa (Blanc 2008). The recovery is due to the establishment of populations in newly proclaimed and fenced private- and state-owned protected areas. This has allowed for a rapid population increase and a substantial range expansion (Selier *et al.* 2016). In 2016, the estimated population in South Africa (including Lesotho and Swaziland) was approximately 27 000 (with about 22 000 elephants on state land and 5 000 on private land; Selier *et al.* 2016). Accordingly, the South African red list assessment classifies elephant as Least Concern (Selier *et al.* 2016). Elsewhere in the continent, the status of the species varies considerably, with regional assessments varying from Least Concern to Endangered (Blanc 2008). The IUCN assessment has classified the species as Vulnerable under Criterion A2a (an observed, estimated, inferred or suspected population size reduction of 30% or more over the past 10 years; Blanc 2008). Elephant now occur in 37 sub-Saharan African countries and have become regionally extinct in five countries since 1913, namely Burundi, Gambia, Mauritania, Swaziland and Sierra Leone (Black 2008; Selier *et al*. 2016). Their status in Senegal, Somalia and Sudan is currently uncertain (Selier *et al.* 2016).

Elephant distribution has become increasingly fragmented across the continent (Blanc 2008). Consequently, the long-term resilience of elephant requires translocations between protected areas and the development of migratory corridors. The species is thus conservation-dependent (Selier *et al.* 2016). In South Africa, most properties holding elephant are fenced and therefore do not allow for their dispersal (Selier *et al.* 2016). Although some cross-border movement occurs in the greater Kruger National Park and Mapungubwe National Park populations, there are currently no migratory populations in South Africa (Selier *et al.* 2016). In the Eastern Cape, there has been a change in land use since the end of the last century, with substantial conversion from agriculture and livestock to wildlife farming and ecotourism (Parker & Bernard 2009). The rise of game-based ecotourism in the Eastern Cape has resulted in elephants being reintroduced to areas, mostly in the Albany Thicket Biome, from which they had been absent for up to a century. Many of these areas are relatively small (10-300 km^2; Roux & Bernard 2007; Parker & Bernard 2009). There are currently no major threats to the species in the region and illegal ivory poaching levels are currently low. However, this threat is anticipated to increase in the future (Selier *et al.* 2016).

Habitat use, home range and density

Boshoff *et al.* (2015) found records of historical elephant occurrence in eight biomes, namely the Fynbos, Succulent Karoo, Desert, Nama-Karoo, Grassland, Savanna, Albany Thicket and Forest Biomes. Historically, the density of elephant was believed to be higher in the coastal zone (where they were present through most of the forest, thicket and savanna mosaics) and relatively lower in the sub-coastal zone (south of the Great Escarpment; where they were mostly present in the wide river valleys vegetated by riverine forest and thicket). Elephant were generally absent or at very low densities in the inland zone (north of the Great Escarpment), and likely occurred only as occasional migrants (Boshoff *et al.* 2015).

Elephant reintroductions in the Eastern Cape have primarily been in the succulent thicket of the Albany Thicket Biome. This habitat type is evergreen and nutritious and, despite low productivity, has a high standing biomass that accumulates over many years. Intact thicket maintains its forage production even during drought and has relatively consistent forage flow between seasons (Gough & Kerley 2006). However, once thicket is degraded through overgrazing, it loses productively in an apparently irreversible positive feedback process (Lechmere-Oertel et al. 2005; cited in Gough & Kerley 2006). Elephant can achieve exceptionally high densities in succulent thicket.

For example, the Addo Elephant National Park has reached densities of greater than three elephant per square kilometre (Parker & Bernard 2009; Roux & Bernard 2007).

Water is the primary environmental factor influencing elephant density (Chamaillé-Jammes *et al.* 2007; Roux & Bernard 2007). Elephants need to drink at least every two to five days and seldom roam far from water (Scholes & Mennell 2008). They tend to have larger home ranges in dry areas, such as the western parts of South Africa, while home ranges are smaller in wetter parts (Selier *et al.* 2003). Major river systems have been an important factor for elephant distribution in the past and elephants show some dependence on these linear habitats (Gaylard *et al.* 2003; cited in Selier 2016). Surface-water management has been suggested as a tool to manage elephant impacts because altering the distribution of water will change ranging behaviour. Elephants in areas with higher water point density are likely to have smaller home ranges (and higher intensity of patch use) than elephants with low water point density (Grainger *et al.* 2005). Seasonal availability of water also plays a role in shaping home ranges. In Kwandwe, the home ranges were larger in the wet summer season than in the drier winter season, when the ranges contracted towards permanent water sources (Roux & Bernard 2007). This contraction of ranges around water points, which are considered key resource areas, during the dry season has also been reported elsewhere (see Scholes & Mennell 2008). In GFRNR, it is thought that elephants will spend most of their time in the *Vachellia karroo* dominated riverine systems, and will only occasionally move off to into the adjacent thicket, but this is something that will need to be monitored.

Elephant home ranges can also be influenced by factors such as sex, seasonal availability of food, food quality, habitat heterogeneity and the amount of space available (Roux & Bernard 2007). Adult bull elephants generally have larger home ranges than animals in breeding herds and, although adult bulls can be fairly sedentary, they also can disperse quite widely during musth. In the Addo Elephant National Park, home ranges of females and non-musth males were of a similar size (Whitehouse & Schoeman 2003; cited in Roux & Bernard 2007). Roux & Bernard (2007) found similar-sized home ranges between bulls and breeding herds in two private reserves in the Eastern Cape, namely Kwandwe and Shamwari, however this may be an artefact of the small sizes of the reserves, which may have limited the upper sizes of home ranges (Roux & Bernard 2007). Primary productivity (often measured by its surrogate, NDVI) appears to influence habitat use, with elephant densities tending to be higher in more productive areas. This relationship appears to be weak though (see Scholes & Mennell 2008). Elephants tend to avoid steep slopes. Therefore, due to the nature of the topography on the GFRNR, there will likely be substantial areas that elephants do not utilise. Elephants also tend to alter their ranges to avoid people (Scholes & Mennell 2008), and this may mean that areas around infrastructure on the GFRNR, such as tourist facilities, staff accommodation and offices, are avoided.

As elephant numbers increase, and if space is available, they can respond by extending their range, leaving local densities constant. If space is limiting (e.g. because of fencing), density may increase within specific areas (Scholes & Mennell 2008). Due to fencing of conservation areas in South Africa, elephants in this country have relatively small home ranges (breeding herds ranging from 21 km^2 to 2 766 km^2, n=51, and bulls ranging from 32 km^2 to 1 707 km^2, n=43) compared to elephants in the rest of the continent, and they likely utilise the land available to them more heavily (Scholes & Mennell 2008). The impact that they have on vegetation may therefore be more severe and may provide vegetation with less chance to recover from elephant damage. Blanc *et al.* (2007; cited in Scholes & Mennell 2008) presented estimated densities of between 0.04 and 2.90 elephants per square kilometre for South African populations. Pentzhorn *et al.* (1974; cited in Maciejewski & Kerley 2014) recommended a maximum stocking rate of 0.4 elephant per square kilometre for the Addo Elephant National Park, while Boshoff *et al* (2002; cited in Maciejewski & Kerley 2014) recommended densities ranging between 0.25 and 0.52 elephant / km^2. The recommended density of elephant within this reserve has been exceeded (by up to eight times) since it was first fenced in 1954.

Behavior

Elephants live in groups that coalesce and divide, and this is thought to be an adaptive response to minimize competition as resources fluctuate. Benefits of forming groups include cooperative defence and offspring care (Archie *et al*. 2005). Elephant groups are 'female-bonded', with females remaining near female relatives throughout their lives and showing extensive affiliative and cooperative behaviour with these individuals (Archie *et al.* 2005). Wittemyer *et al.* (2005) described six tiers of elephant social organisation: mother-calf units, families, bond groups, clans, subpopulations, and populations. Dominance hierarchies among adult female members are transitive and age-ordered but not nepotistic and, consequently, dominance rank does not appear to be a predictor of female fitness. This makes elephants quite different from most female-bonded species, where rank appears to influence fitness (Archie *et al.* 2005).

Reproduction, demographics and population growth

In most elephant populations, females reach sexual maturity at between 11 and 14 years of age, but under optimal conditions ovulation can begin from as early as eight years (Calef 1988). It appears that elephants calve earlier in South Africa than in other parts of the continent (Scholes & Mennell 2008). The gestation period is 22 months (Hodges et al 1994; cited in Scholes & Mennell 2008).

The mean intercalving interval in expanding populations is generally between 3 to 4.5 years (Calef 1988). Elephant conception rate can be influenced by rainfall (Moss 2001, cited in Gough & Kerley 2006). Gough & Kerley (2006) found that elephant birth rate in Addo Elephant National Park was positively correlated with rainfall in the year of conception. They suggest that could be because high rainfall increases plant nutrient levels, which improves condition of breeding females and thereby positively influences birth rates. Although little work has been done on this, age of last calving appears to be between 48 and 60 years and fertility probably begins to decrease as a cow approaches her late forties (Scholes & Mennell 2008).

Calef (1988) calculated the theoretical maximum rate of increase to be 7% - this would be under a normal population age and sex structure. However, estimated growth rates of South African elephant populations have ranged from -0.6 to 25.5% (Scholes & Mennell 2008). When small numbers of elephant are reintroduced into a new area with good habitat, fecundity approaches the physiological maximum and mortality is often extremely low. An elephant population growing at the maximum rate will soon reach a stable age distribution in which about half the animals are older than 11 years and about 7% are calves less than one year old. At the maximum rate of increase, elephant populations will double every 11 years (Calef 1988). Stable elephant populations normally have a 50:50 sex ratio (Calef 1998). Gough & Kerley (2006) found no relationship between calf sex ratio and density or rainfall.

Under natural conditions elephants typically have low mortality rates (Scholes & Mennell 2008). The highest mortality occurs in the first few years of life (Scholes & Mennell 2008). Male mortality is higher than that of females (Gough & Kerley 2006). Droughts, disease and predation can contribute to increased mortality. Elephants appear to be sensitive to droughts and die-offs have been reported during dry times. Lee & Moss (1986; cited in Gough & Kerley 2006) found that calf mortality in males younger than a year was elevated during dry periods. Gough & Kerley (2006) found low calf mortality in Addo Elephant National Park and postulated that, for Addo, year-round access to drinking water and drought resistant vegetation enabled mothers to produce sufficient milk to sustain calves even during poor rainfall conditions. Predation on elephants is low and generally plays an unimportant role in regulating elephant populations (Scholes & Mennell 2008).

There is little literature on immigration and emigration rates for elephants, but elephants are known to immigrate to colonise new areas or re-colonise areas they previously occupied. Elephants may immigrate in response to management interventions (e.g. moving into areas where densities were reduced due to culling). Immigration and emigration rates are likely influenced by density, environmental factors and physical barriers (both man-made and natural; Scholes & Mennell 2008). Fences, particularly in the South African context, block dispersal, immigration and emigration and prevents the limitation of local population growth through dispersal (Scholes & Mennell 2008).

Elephant population regulation

Although models including density dependence as an explanatory variable have best described elephant trends in at least three studies (Scholes & Mennell 2008), Gough & Kerley (2006) found no evidence of density dependence in the Albany Thicket of Addo Elephant National Park. They found that density did not affect growth rate or other demographic rates (juvenile mortality was low, age of first breeding was young, birth rate was high, and adult female mortality rate was low). They hypothesize that elephants are buffered against a decline in nutritional resources due to their broad diets, and that this enables them to degrade a landscape almost to the point of collapse without showing density dependence. An important consequence of this is that elephant demographic data cannot be used to make management decisions in Albany Thicket vegetation about elephant populations until it is too late for plant communities and associated biodiversity.

Ecological processes associated with elephant

Elephants are a keystone species (i.e. their interactions with other species generate effects that are large relative to their abundance; Selier *et al.* 2016) in Albany thicket, playing a role in 14 of the 19 broad ecological processes important to this biome (Boshoff *et al.* 2001). While elephant herbivory is often thought to be the primary mechanism for structuring plant communities, other elephant impacts include trampling, path formation, zoochory and nutrient cycling (Landman *et al.* 2008).

Some of the most important ecological processes associated with elephant are described below:

- Foraging - Being very large, social and equipped with specialised feeding adaptations (trunk and tusks), elephants forage differently to any other large herbivore (Kerley *et al.* 2008; cited Maciejewski & Kerley 2014). Their large body size enables them to digest large volumes of low-quality food and to utilise a broad range of plants including grasses, browse, bark, fruit and bulbs (Kerley & Landman 2006). They are destructive in their foraging and can cause mortality in trees through felling, uprooting and bark removal (Kerley et al 2008; cited in Maciejewski & Kerley 2014). Elephant will also selectively feed on preferred plant species (Parker & Bernard 2009). Due to their broad diet diversity, Kerley & Landman (2006) state that elephant influence the fate of more plant species in Eastern Cape thickets than any other mammalian herbivore.
- Changes in habitat structure - In Albany Thicket, high elephant densities cause a reduction in plant biomass (Pentzhorn *et al.* 1974; cited in Maciejewski & Kerley 2014). An increase in elephant presence results in a decrease in woody, closed habitat and an increase the proportion of path or open habitat (Kerley & Landman 2006). This impacts on browse availability but also probably results in changes in microclimate, with open habitats having more extreme air and soil temperature ranges.
- Litter production - Elephants discard large amounts of plant material during feeding, amounting to approximately 20% of total litter production of succulent thicket without elephants (Kerley & Landman 2006). Litter created by elephants is courser than the normal litter and has a different nutrient composition. Elephants therefore appear to alter the size, nutrient levels and dynamics of litter in thicket.
- Seed dispersal - In terms of species diversity, elephants are relatively poor seed dispersers, with only 21 species recorded to be spread by endozoochory (Kerley & Landman 2006), however due to the large volume of forage intake and faecal output, large numbers of seeds are dispersed. Elephants may be important for seed dispersal for those species for which they do disperse seeds.

Impacts of elephant on plant species

In enclosed systems, that do not allow for natural movements, selective feeding by elephants on preferred plant species can lead to changes in plant population structure and, in some cases, lead to local extinctions (Parker & Bernard 2009).

Midgley & Joubert (cited in Kerley & Landman 2006) found that mistletoes (*Viscum spp*.) were nearly locally extinct within the elephant enclosure at Addo Elephant National Park. *Viscum rotundifolium* and *V. crassulae* are good indicator species of elephant browse intensity (Kerley & Landman 2006).

Aloes are highly preferred by elephant. They either break off the crown (a type of damage exclusively caused by elephants) or push the entire plant over in order to access the succulent meristem (Parker & Bernard 2009). There has been a near disappearance of aloes (*Aloe africana*) in the elephant enclosure at Addo Elephant National Park (Barratt & Hall-Martin, cited in Kerley & Landman 2006). Parker & Bernard (2009) found a higher incidence of aloe mortality in sites that had elephants for more than four years compared to sites where elephant had only recently been introduced (<2 years; Parker & Bernard 2009). It is not clear if the loss of aloes is a cause for concern. Parker & Bernard (2009) suggest that the vegetation might be returning to a more natural state after a long period of mega-herbivore release. The large stands of aloes currently found in the Eastern Cape are derived from a cohort of seedlings that became established about a century ago, during a window of opportunity that arose from low elephant densities due to hunting. Parker & Bernard (2009) state that is not clear to what impact this process will have on the long-term conservation of aloes and associated biodiversity.

In areas newly opened to elephant, *Portulacaria afra* experiences more elephant-induced damage than trees and shrubs such as *Schotia afra, Euclea undulata, Azima tetracantha* and *Capparis sepiaria* (Barratt & Hall-Martin, cited in Kerley & Landman 2006). Moolman & Cowling (cited in Kerley & Landman 2006) found that fewer endemic succulents occurred in elephant browsed sites than in control sites. They also found that species richness, density and cover were lower in these sites. The cover of Crassulaceae was however higher in elephant-browsed sites, probably due to their ability to reproduce vegetatively affording them some resilience to elephant browsing. *Euphorbia mauritanica*, *Rhigozum obovatum* and *Crassula ovata* showed substantial decreases in response to elephant browsing in the study of Stuart Hill (cited in Kerley & Landman 2006).

Lombard *et al.* (2001) found that species richness in Spekboomveld declined exponentially with length of exposure to elephant browsing, halving approximately every seven years. Kerley & Landman (2006) noted that some plants that were previously thought to disappear due to elephant herbivory are not eaten by elephants and suggested that alternative mechanisms are responsible for this.

Impacts on vertebrates

It has been postulated that high elephant densities can impact on the richness and abundance of a range of animal species, mostly through changes in habitat structure (Maciejewski & Kerley 2014). Kerley *et al.* (cited in Kerley & Landman 2006) suggested that elephants may facilitate high tortoise densities due increasing open habitat patches and paths. The decline in geophytes and small succulent shrubs commonly attributed to elephants may actually be due to increased tortoise browsing.

Chabie (cited in Kerley & Landman 2006) reported a shift away from frugivorous birds towards insectivores and granivores in thicket that had been opened, as would be done by elephants.

Sigwela (cited in Kerley & Landman 2006) found that elephants had no effect on kudu diet in areas with elephant, even though kudu and elephant diet overlap substantially. Kerley & Landman (2006) suggest that dietary items are not limiting to either species at the sites studied in the Addo Elephant National Park. Kerley & Landman (2006) note that Cape grysbok, bushbuck and bushpig numbers have declined in the Addo Elephant Park but could not state conclusively that this was due to elephant impact. Elephants have been recorded killing black rhino, and this has occurred in the nearby Addo Elephant National Park, but this has been attributed to aberrant behaviour brought about through abnormal population structures (Kerley & Landman 2006). Kerley & Landman (2006) state that the causes and significance of this need to be further examined. Initially after elephant introduction, the increases in path and open areas may facilitate access to browse by black rhino. However, as elephant paths increase, vegetation cover and density decreases browse availability to black rhino and may result in a loss of forage opportunities (Kerley & Landman 2006). It must be acknowledged that one of the principal objectives of the GFRNR is the conservation of its rhino population and the presence of elephant cannot be allowed to compromise this.

Importance of elephants for tourism

The findings of the study of Kerley *et al.* (2003) suggested that tourists to the Addo Elephant National Park were mostly interested in seeing elephants and made little effort to observe other species. They argued that elephants act as an ‘umbrella’ species, i.e. that their conservation serves to also conserve other species that occur within their habitat. Umbrella species are often large species that have large home ranges and low densities (and therefore require large areas for their effective conservation). Elephants also act as a ‘flagship’ species, i.e. they generate public support for their conservation and, in doing so, indirectly support conservation efforts that protect a wider suite of biodiversity.

Although there may be pressure to maintain high densities of elephant to increase viewing opportunities for tourists (Kerley et al. 2003), Maciejewski & Kerley (2014) found no relationship between elephant density and elephant-viewing success in six private reserves and the Addo Elephant National Park. They suggested that elephant density was not a driver of tourist numbers.

Elephant management philosophy for Great Fish River Nature Reserve

The recognition that ecosystem heterogeneity or variability is the source of biodiversity in complex socio-ecological systems (Pickett et al. 2012) has led to a paradigm shift in conservation over the past two decades. Instead of managing for ecosystem stability, it is now accepted that ecosystems require both spatial and temporal heterogeneity in order to maximize biodiversity and maintain resilience (Gaylard et al. 2003). Consequently, leading conservation organisations throughout the world, have shifted their management approach from the previous focus on preserving species, to restoring or mimicking missing ecological processes (Rogers 2003; Gaylard & Ferreira 2011). This approach recognises biodiversity in terms of compositional, structural and functional components, across a wide range of scales and levels of organisation (Noss 1990). It also emphasizes the concept of complementarity, which accepts that ecological integrity can be maintained even if certain species are lost from a system under particular conditions, as long as their ecological function is retained by other species in the system, and that these species are conserved elsewhere (Gaylard 2015). As such, the focus for elephant management on the reserve is on managing elephant impacts on vegetation, and associated biodiversity, by ensuring that impacts are patchily distributed across the landscape (Kerley et al 2008). Patchy impacts enable species that are intolerant of elephant impact to persist in the refuge areas between patches of even severe elephant impact (Owen-Smith *et al*. 2006; Gaylard 2015). This approach maximizes biodiversity at the landscape scale by allowing for different suites of species to establish in the varying habitats that they prefer (Gaylard 2015).

Moreover, while it is accepted that the reintroduction of elephant will have a certain level of impact on plant communities, recent ecological literature informs us that, in areas where elephants previously roamed, these impacts must be evaluated in the context of a reversal of megaherbivore release. This widely-accepted notion posits that plant and animal communities which have been protected from elephant browsing for over 100 years may have developed differently in their absence, and that the observed impacts of elephant on vegetation communities may reflect the reversal of the system back to a state prior to local elephant eradication (Kerley & Landman 2005). Hence these impacts may represent a restoration, rather than a degradation, of ecological processes.

Direct management of elephant typically aims to reduce numbers by decreasing birth rates (e.g. through contraception), increasing death rates (e.g. through culling), or simulating dispersal (e.g. translocation; Scholes & Mennell 2008). The underlying assumption is that lowering elephant numbers will lower the intensity of resource use and will thus reduce elephant impacts on other species. Maciejewski & Kerley (2014) state that it is important to stock elephants at low densities in fenced reserves in order to reduce their impact and to maintain other species. This assumption may however not be valid since elephant impact may not be a function of number alone, but rather may be dependent on intensity of resource utilisation reflected by spatial use patterns (Scholes & Mennell 2008).

Indirect management actions include erecting fences and manipulating water availability (providing additional water or limiting access to certain water points; Scholes & Mennell 2008). Due to the large number of water sources (rivers and dams) in the Great Fish River Nature Reserve, the latter option would be difficult to implement. It would also not be desirable to erect internal fences within the reserve, although barriers that limit only elephant may be a management option to protect vulnerable or sensitive areas.

A challenge facing elephant managers is to limit population growth without having to resort to culling (Gough & Kerley 2006). Birth rates can be reduced by administering hormones or immunocontraceptives to reduce or control fertility (Scholes & Mennell 2008). Contraception does not directly reduce numbers, but rather relies on natural mortality and reduced reproductive output to reduce population size over time.

Given the ECPTA's approach to biodiversity management, the following section describes the biophysical properties of the reserve and evaluates how the introduction of elephants might influence its biodiversity.

3.2 General climatic and hydrological data

Both rainfall and temperature vary markedly across the reserve and are influenced by elevation and aspect. Southern slopes experience cooler more moist conditions, whereas northern facing slopes are characteristically warmer and drier.

Rainfall is highly variable from year to year and in its seasonal distribution. Mean annual rainfall as measured at the Kamadolo gate over the period 1983-2008 is 404 ± 113 mm, with an annual minimum of 179 mm and a maximum of 732 mm recorded over this period. Records collected over a 42 year period on a neighbouring farm, Bucklands, give a mean annual rainfall of 480 ± 137 mm for this period, with an annual minimum of 209 mm and a maximum of 779 mm. Records collected at Double Drift over the period 2004-2008, suggest that the rainfall is slightly higher on this side of the reserve with a mean annual rainfall of 644 ± 166 mm recorded here. Rainfall is seasonal with peaks in early summer (November – December) and late autumn (February to March) and relatively dry winters.

Mean monthly minimum and maximum temperatures as recorded at Kamadolo over the period 1990 to 2008, are given in Figure 3-1. In the summer months maximum daily temperatures often exceeded 35°C, whereas in the winter months of June to August, night temperatures dropped below zero. The major river valleys experienced lower minimum temperature with frost. Altitude and aspect affected temperature and the lower elevation sites experienced a greater degree of variability in temperature and frost in winter. The higher elevation sites and southern slopes were cooler in summer but did not experience frost in winter.

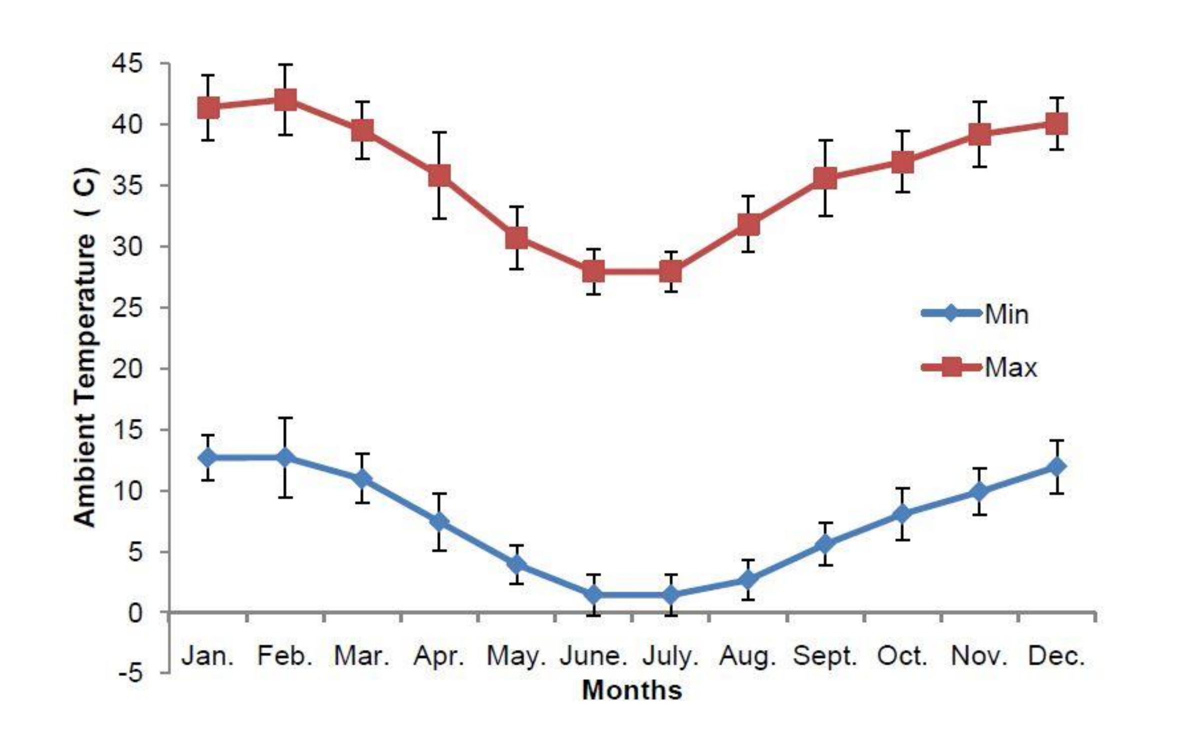

Figure 3-1: Mean Monthly minimum and maximum temperatures

Two major river systems, the Great Fish River and the Kat River, traverse the reserve (Figure 3-2). The Great Fish River flows throughout the year but the Kat River occasionally stops flowing and becomes a series of pools during dry spells. The Keiskamma River runs along a portion of the eastern boundary but is fenced out of the reserve. The bulk of the reserve drains into the Great Fish and Kat River systems and only a small area in the eastern part of the reserve drains towards the Keiskamma River.

In addition to the river systems there are also 529 dams scattered across the area that are available to elephants. These dams were constructed prior to the establishment of the reserve and vary quite considerably in size and water retention capability. The vast majority are relatively small and only hold water temporarily after rains but some of these are also perennial water sources and seldom dry up. Water is not pumped to any of these dams.

The climate and hydrology of the reserve falls within the range required by elephants to meet their physiological and metabolic requirements (Schmidt-Nielsen 1984)

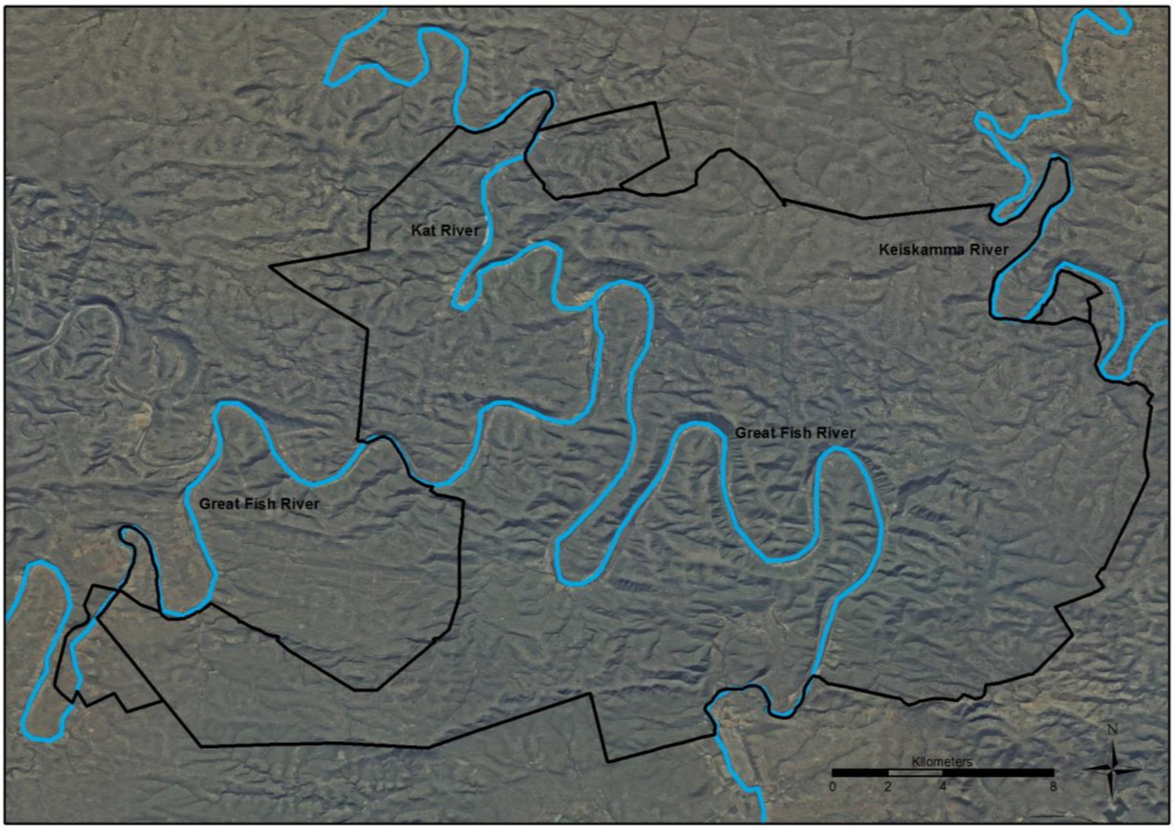

Figure 3-2: Primary river systems

3.3 General description of the geology

The reserve is underlain by rocks of the Beaufort and Ecca Groups, which form part of the Karoo Supergroup. The contact zone between the Ecca and Beaufort Groups runs in an east to west direction through the southern section of the reserve (Figure 3-3; Gow & de Klerk 1997). This zone represents the onset of more terrestrial conditions in the Karoo basin, which was previously a large inland sea (Johnson 1976; Jordaan 1981; Rubidge 1988).

The Beaufort Group rocks consist predominantly of grey/red mudstone and sandstone of the Middleton Formation, and grey mudstones, sandstone and shale of the Koonap Formation (see Figure 3-4). Both formations are part of the Adelaide subgroup of the Beaufort Group, Karoo Supergroup (Johnson & Keyser 1976). The Ecca Group rocks consist primarily of shales of the Fort Brown formation, and the sandstone and shales of the Ripon formation.

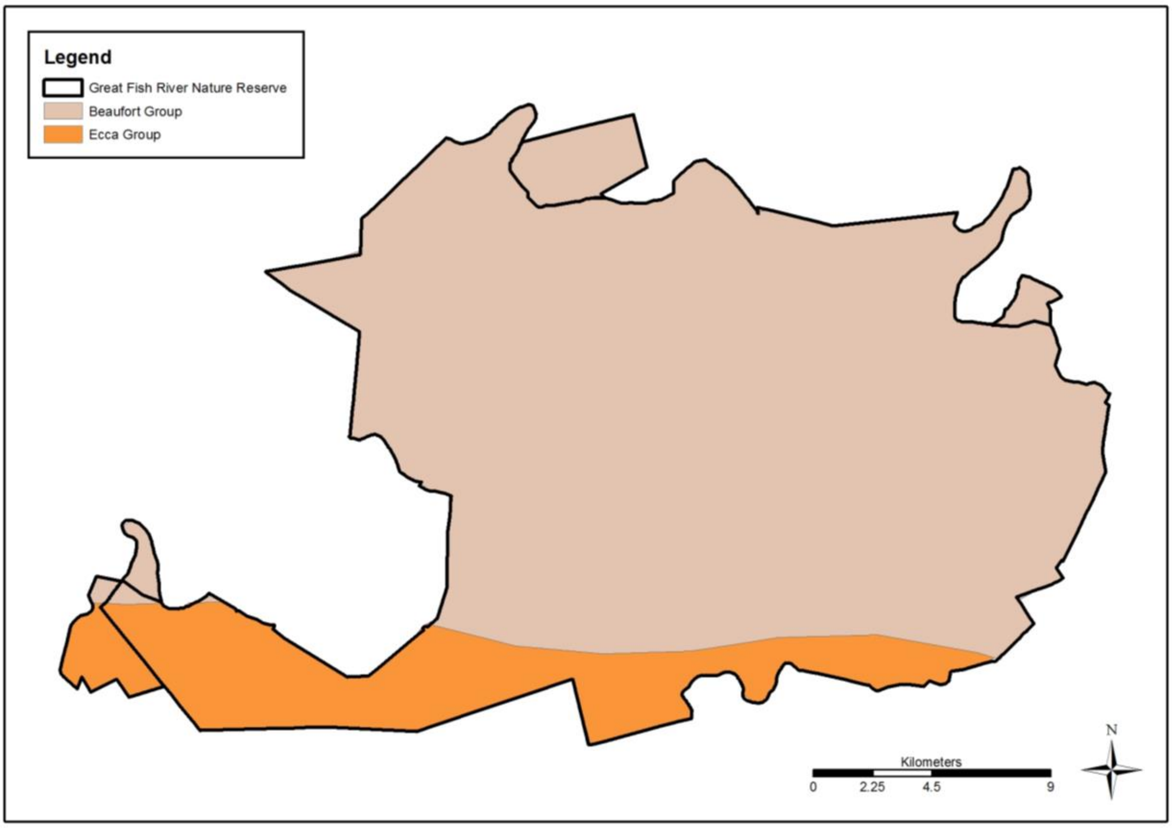

Figure 3-3: Simplified geology

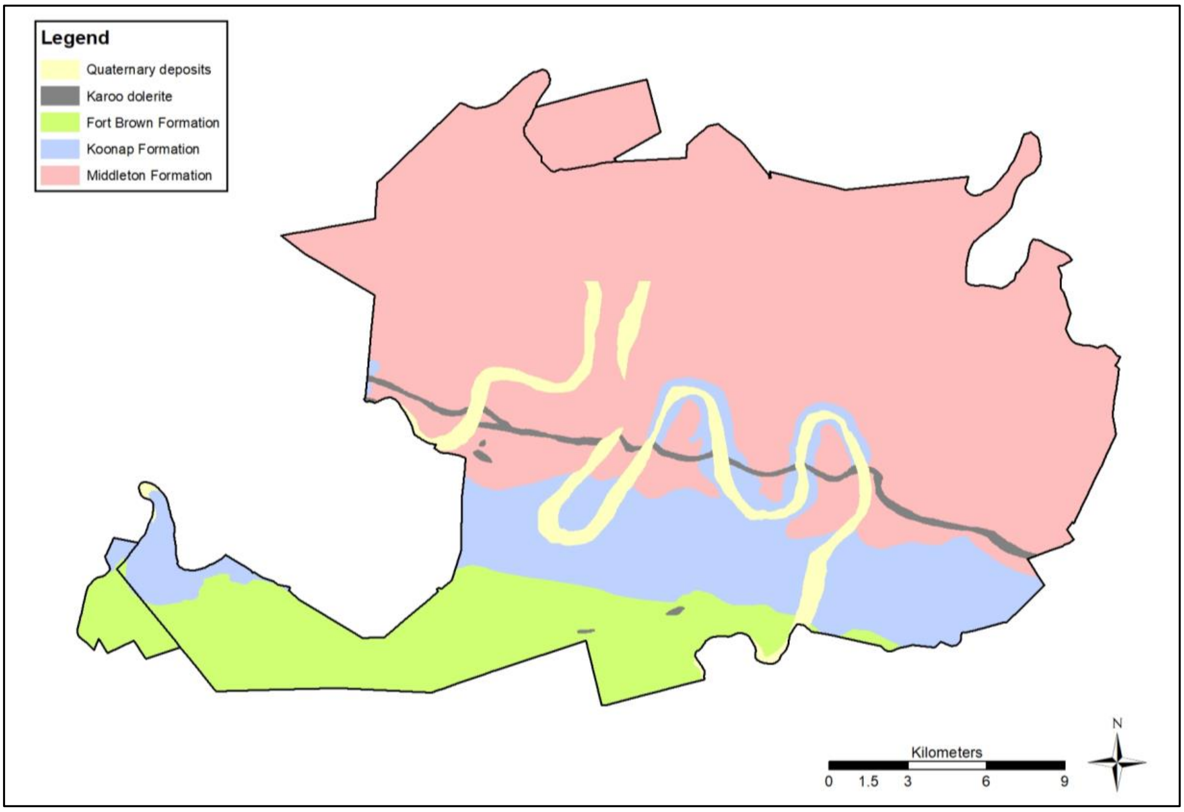

Figure 3-4: Detailed geology

The landscape consists of steep river valleys with inter-basin ridges. The river valleys contain the nutrient-rich mudstones, which are extremely susceptible to erosion, while the more resistant sandstones occur on the inter-basin ridges.

3.4 General description of the soils

Clayey, dystrophic soils occur throughout the reserve and surrounding area, except close to the river where alluvial silt is deposited. Soils in the western sectors of the reserve are underlain by shale and are inclined to be thin and easily eroded. The SOTER maps Eutric Regosols (RGe), Eutric Leptosols (LPe) and Lithic Leptosols (LPq) on the reserve (see Figure 3-5; Batjes 2004).

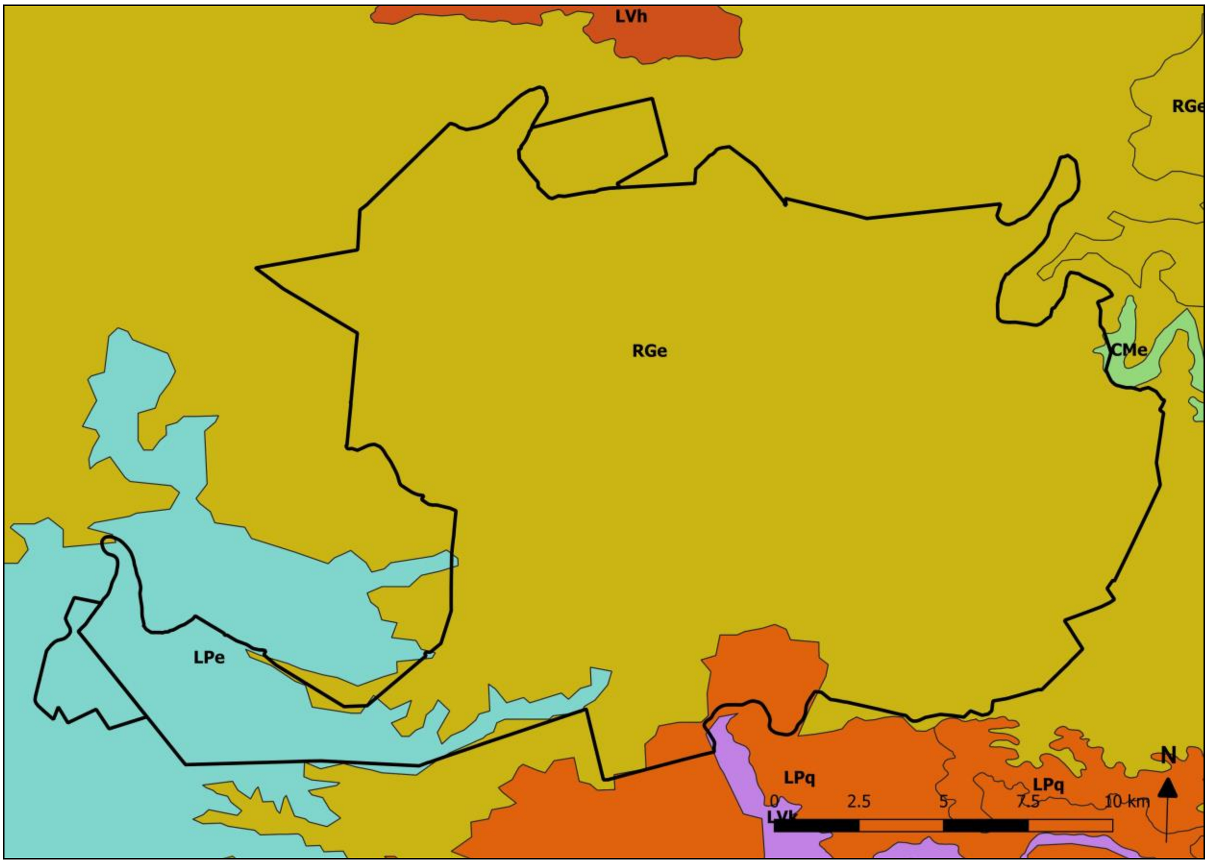

Figure 3-5: Map of the soil types found on the reserve

3.5 Detailed description of the vegetation

The reserve lies primarily within the Albany Thicket Biome and only a small portion of the Savanna Biome intrudes into the northern part (Hoare *et al.* 2006). The Albany Thicket Biome is known for its wide range of growth forms, high levels of plant diversity (including leaf and stem succulents, deciduous and semi deciduous woody shrubs, dwarf shrubs, geophytes, annuals and grasses) and high levels of endemism (Hoare *et al.* 2006). These high levels of diversity and endemism have been attributed to the transitional nature of this vegetation, which is thought to be an interface between various types of forests, sclerophyllous shrublands, Karoo and grasslands.

According to the national vegetation types map (SANBI 2018), five vegetation types occur in the reserve, namely Fish Arid Thicket, Fish Valley Thicket, Crossroads Grasslands Thicket, Doubledrift Karroid Thicket and Fish Mesic Thicket (Figure 3-6). By far the most extensive vegetation type in the reserve is Fish Valley Thicket, while the remaining vegetation types only extend marginally into the reserve. Fish Valley Thicket is a medium to tall (3-5 m) thicket dominated by small trees (including *Euclea undulata*, *Pappea capensis*, *Schotia afra*) and woody shrubs

(*Azima tetracantha*, *Capparis separia* var. *citrifolia*) with tall *Euphorbia curvirama* and *E. tetragona* emerging above the canopy. *Portulacaria afra* occurs in this vegetation type, but its abundance varies from site to site and is locally dominant in some places (see Grobler *et al.* 2018; Hoare *et al*. 2006).

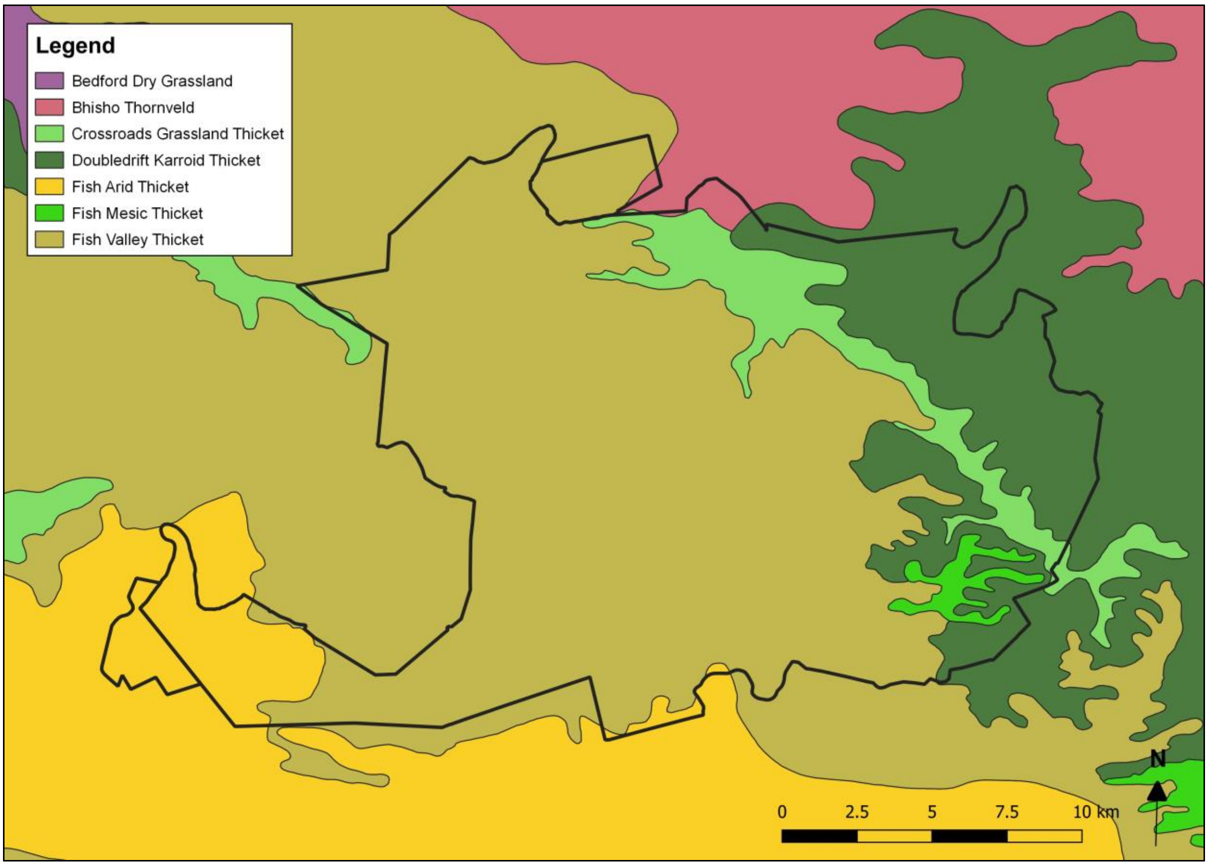

Figure 3-6: National Vegetation Types occurring in the reserve (SANBI 2018)

A finer-scale vegetation map was developed for the reserve in 2015 (Vlok 2015) and, at this scale, eight distinct vegetation types were identified (Figure 3-7). These vegetation types occur in specific habitat units along a clear environmental gradient. In sites where the topography is highly broken, the transition from one vegetation unit to another is abrupt, but along the gradual extended slopes the boundaries are not as distinct. The latter is particularly problematic along gradual east-west slopes, where it is difficult to determine the exact boundary between the lower and upper vegetation types, as there is usually an extended transitional area in which species that are typical of the two vegetation types co-occur. The eight vegetation types are:

- **Doring and Combretum veld:** Occurs along the main bottomland drainage areas. The dominant indicator species are Soetdoring (*Vachellia karoo*) and Fluitjiesriet (*Phragmites australis*), but in the more upland drainage areas, that are less saline, *Combretum caffrum* and *Salix mucronata* usually are the dominant species.
- **Karroid Shrubland:** This occurs along the upper edges of the bottomlands of the Doring and Combretum veld unit **(**related to the Succulent and Nama Karoo). In this unit the vegetation is dominated by short shrublets (e.g. *Pentzia incana* and *Garuleum pinnatum*), with tall shrubs and trees absent, but several interesting succulents (e.g. *Euphorbia gorgonias*, *Pachypodium bispinosum*) are present. After good rain grasses (such as *Aristida diffusa*) can be abundant. Spekboom is rare. This unit is closely related to the Spekboom Noorsveld but differs in the absence of Noors (*Euphorbia bothae*) and the occurrence of species such as *Pachypodium bispinosum* and *Garuleum pinnatum*.
- **Spekboom Noorsveld:** This arid thicket vegetation type occurs on the lower hills just above the Karroid Shrubland. It is equivalent to the Fish Noorsveld of Vlok *et al.* (2003) but differs in having Spekboom present at 30-40% canopy densities. Distinctive of this unit is the occurrence of Noors (*Euphorbia bothae*),

which is currently very rare on the reserve. This vegetation type contains at least one other localised endemic species, *Zaluzianskya vallispiscis*.

- **Fish Spekboom Thicket:** Occurs on the north-facing slopes of the hills above the Spekboom Noorsveld. Typical of this unit is a relative abundance of *Pappea capensis* and *Euclea undulata* trees, with Spekboom occurring at canopy densities of 30-50%, but on steep north-facing slopes sites it can be up to 80%. *Euphorbia tetragona* is also often abundant in this unit, but it is unfortunately rapidly dying back in most parts of the reserve. This vegetation type also occurs along gradual west- and east facing slopes. On these slopes it has a less closed canopy and may resemble some of the mosaic type vegetation types, but it remains distinctive in having Granaatbos (*Rhigozum obovatum*) abundant, which is rare in the mosaic vegetation types that look structurally similar to the more open examples of the Fish Spekboom Thicket.
- **Fish Shrubland Thicket:** Occurs on the south-facing slopes. It differs from the Fish Spekboom Thicket in having *Pappea capensis* and *Euclea undulata* trees absent to rare and Olienhout (*Olea europaea* subsp. *africana*) abundant, often with Kiepersol (*Cussonia spicata*) and *Euphorbia tetragona* and *E. triangularis* emerging above the canopy. Here Spekboom is less abundant with canopy densities of 20-30% along the outer perimeters of this vegetation type. The canopy is often not closed with a grassland/shrubland (often with *Pteronia incana* abundant) in the open areas. In higher rainfall areas the canopy is more closed, with the grass component less abundant and shifting towards more shade tolerant species (e.g. *Panicum* and *Setaria* species).
- **Fish Thicket:** Occurs on the often steep, moist upper south-facing slopes. The canopy is usually closed with Olienhout (*Olea europaea* subsp. *africana*), Kiepersol (*Cussonia spicata*) and *Euphorbia triangularis* abundant in this vegetation type. Distinctive is the presence of other tall trees such as *Calodendrum capense*, *Harpephyllum caffrum* and *Scutia myrtina*. Succulents are uncommon, but *Aloe pluridens* is sometimes present. Spekboom is absent in this unit.
- **Crossroads Spekboom/Grassland Thicket**. Occurs along the upper ridges and is intermediate between the Fish Spekboom Thicket, the Fish Shrubland Thicket and the Crossroads Grassland Thicket. It is an intermediate vegetation type that consists of usually well-defined thicket bush-clumps typical of the Fish Spekboom Thicket or the Fish Shrubland Thicket in a matrix of a karroid shrubland or grassland. In intact examples Spekboom is usually abundant along the outer perimeter of these thicket bush-clumps with Spekboom canopy cover densities of 20-30%. The matrix vegetation is rich in species, including local endemic succulents such as *Euphorbia stellata* and several species of *Crassula, Delosperma, Haworthia* and *Lampranthus*.
- **Crossroads Grassland Thicket:** Occurs at the crest of the highest hills. The matrix vegetation is a species-rich grassland when in a pristine condition but becomes impoverished of species and dominated by *Aristida congesta* when heavily grazed. Small thicket clumps are present, with Spekboom only prominent along the outer perimeter, and especially so on north and west facing slopes. Total Spekboom cover in this unit is not more than 5%. Towards the east this grassland gradually changes into a savannah with a fire-tolerant variant of *Vachellia karoo* present in the matrix vegetation. The latter indicates that fire played a role in the establishment of this unit. Termitaria are usually abundant in the matrix grassland vegetation.

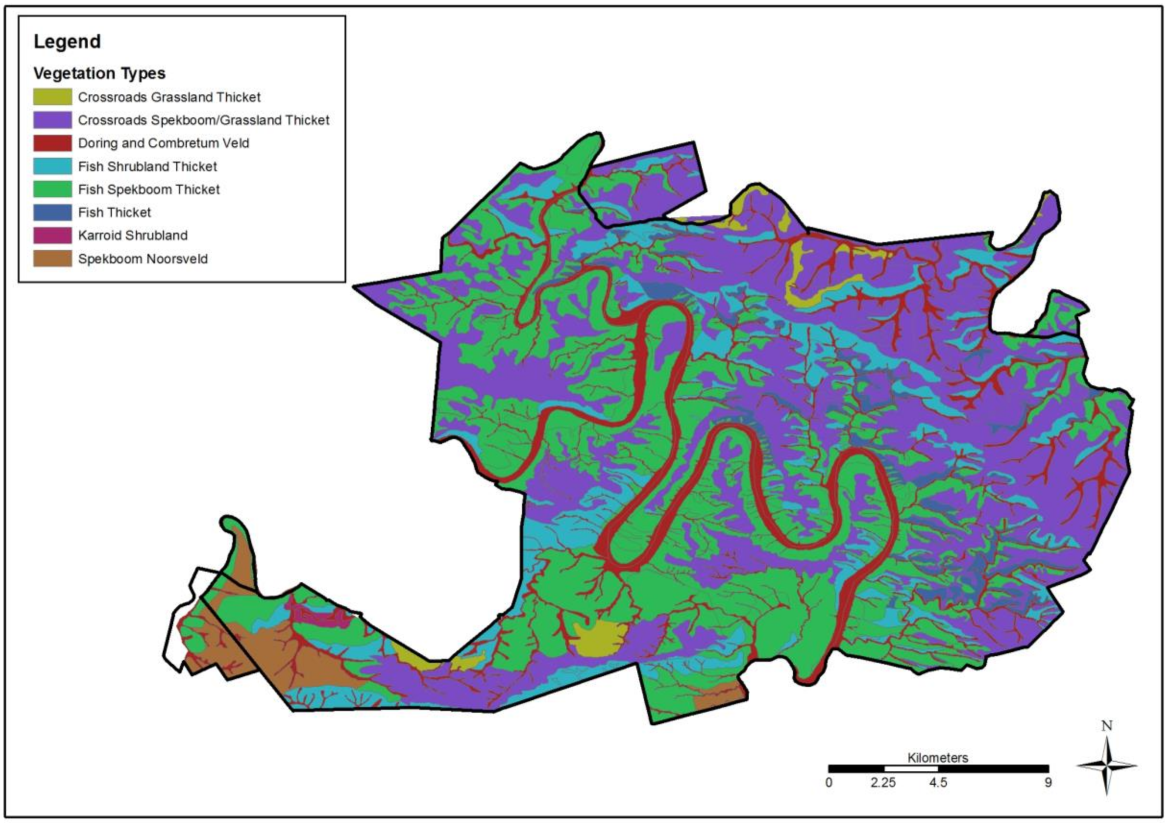

Figure 3-7: Vegetation map of the reserve

Overall, the thicket vegetation that occurs in the reserve is considered to be ideal for elephant and they can be expected to utilise all eight vegetation types described above. The GFRNR provides ideal habitat for elephant and, because of the size of the reserve and the abundance of food throughout the year, it can support a healthy population of wild elephant under relatively natural conditions. This assertion is supported by the fact that historical records indicate that elephant used to be abundant in these parts of the Great Fish River Valley (Skead et al. 2007).

3.6 Preferred management density of elephants

As outlined in the introductory portion of this section, and in keeping with contemporary elephant management approaches (Owen-Smith et al 2006; Kerley et al 2008), decision-making will be based on the intensity and extent of elephant impacts on vegetation, rather than on a particular density of elephants. Nevertheless, we wish to minimize the risks to biodiversity by introducing only two family groups of 6-10 animals each, followed by two bulls of different ages (approximately 40 and 25 years) once the family units have become established. Females will be strategically contracepted to slow population growth rates and to mimic growth rates that are more typical of elephants in larger more natural systems. This is similar to SANParks' approach in its smaller parks such as the Addo Elephant National Park.

Combined with the two existing elephants this would be a combined population of approximately 24 animals, which equates to a density of 0.06 elephants.km^{-2}. This is less than half the previously used "ecological carrying capacity" for elephants (Van Wyk & Fairall 1969).

3.7 Game species and numbers present on the reserve

Estimated population numbers for the large herbivore species that occur on the reserve are given in Table 2. These estimates are derived from replicated aerial counts that are conducted in three-yearly cycles. The data presented here are specifically for the elephant area and are from the most recent counts conducted in 2018. Of these impala, nyala, warthog and waterbuck are alien species and are actively controlled. Larger predators are currently limited to leopard, jackal and caracal.

Table 2: Game estimates from the 2018 aerial census (parentheses indicate known numbers)

Species	Mean ± s
Black Rhino	Numbers withheld for security reasons.
Buffalo	298 ± 21
Bushbuck	165 ± 19
Common Duiker	55 ± 3
Eland	443 ± 12
Elephant	1 ± 1 (2)
Hippo	9 ± 2
Impala	1 ± 1
Kudu	2683 ± 326
Mountain Reedbuck	24 ± 7
Nyala	18 ± 4
Ostrich	148 ± 9
Plains Zebra	265 ± 24
Red Hartebeest	417 ± 19
Steenbok	48 ± 9
Warthog	619 ± 47
Waterbuck	11 ± 3

Of these, the only species that are listed as threatened in the most recent red list assessment of the mammals of South Africa (Child *et al.* 2016) are black rhino and mountain reedbuck, and neither of these species are likely to be significantly impacted by the introduction of additional elephant. Elephant have been known to occasionally kill black rhinoceros but they typically co-occur in many areas without conflict. Leopard as well as a number of other smaller red listed species also occur in the reserve but there are no game or other mammal species that are endemic to the reserve or to the Albany Thicket Biome that would be at risk from the reintroduction of elephant.

3.8 Sensitive habitats and species

O'Connor *et al.* (2007) made predictions on the conditions that render species vulnerable to extirpation by elephants. Although these predictions were made with savanna systems in mind, they remain relevant to Albany Thicket systems. Species are vulnerable if they:

- have limited distributions and are restricted to habitats where elephants forage;
- are highly selected by elephant;
- are subjected to destructive foraging (e.g. pollarding or complete ringbarking) and lack a coppicing ability so foraging results in mortality;
- regenerate infrequently and usually in small numbers;
- grow slowly so that adults are not easily recruited; and
- are long-lived, regenerating only during wetter epochs.

The nature of the elephant reserve also influences vulnerability of species to extirpation, which is increased if:

- the terrain lacks topographic refuges (not the case for the GFRNR, which is topographically complex);
- there are no absolute and only weak partial refuges from elephant because distance from water is not a foraging constraint (with the preponderance of dams, this is generally true of the GFRNR);
- the reserve is in a semi-arid region that experiences variable grass production, hence heightened utilisation of woody material occurs (true for the GFRNR); and
- the reserve is degraded to an extent that suitable grass is infrequently available, hence woody species constitute the mainstay of the diet (not the case for GFRNR, except during exceptionally dry times).

Although further research is required to improve the understanding of the vulnerability of plant species to elephant impacts, some knowledge exists on taxa that should be monitored. Succulents, which are disproportionately represented among the rare and endemic component of the thickets in the region, are especially vulnerable to elephant impacts (Cowling & Kerley 2002; Johnson 1998). Among the possible exceptions to this are some members of the Crassulaceae Family, which are capable of vegetative reproduction and probably more resilient to elephant impacts (Cowling & Phillipson 1999). Moolman & Cowling (1994) found that along with succulents, lower-stratum geophytes are vulnerable to local extinction due to elephant impact.

The following taxa have been recorded as being either possibly or certainly vulnerable to elephant impact: Mistletoes (useful indicators of elephant impact, including *Viscum rotundifolium*, *V. crassulae* and *Moquinella rubra;* Cowling & Kerley 2002), *Aloe spp*. (including *Aloe ferox*, *A. striata*; Cowling & Kerley 2002; however elephant may facilitate *A. africana*; Parker 2017), members of the Apocynaceae Family (Johnson 1998), members of the Euphorbiaceae Family (including *Euphorbia mauritanica*, *Euphorbia tetragona*, *Euphorbia curvirama*, *Euphorbia grandidens, Euphorbia tetragona*; Cowling & Kerley 2002; Johnson 1998; Parker 2017; Cowling *et al.* 2009), succulent members of the Liliaceae Family (Johnson 1998), *Rhigozum obovatum* (Cowling & Kerley 2002), *Lycium oxycarpum* (Cowling & Kerley 2002), *Grewia robusta* (Cowling & Kerley 2002; Parker 2017), *Azima tetracantha* (Parker 2017), *Gymnosporia polycantha* (Parker 2017) and *Schotia afra* (Parker 2017).

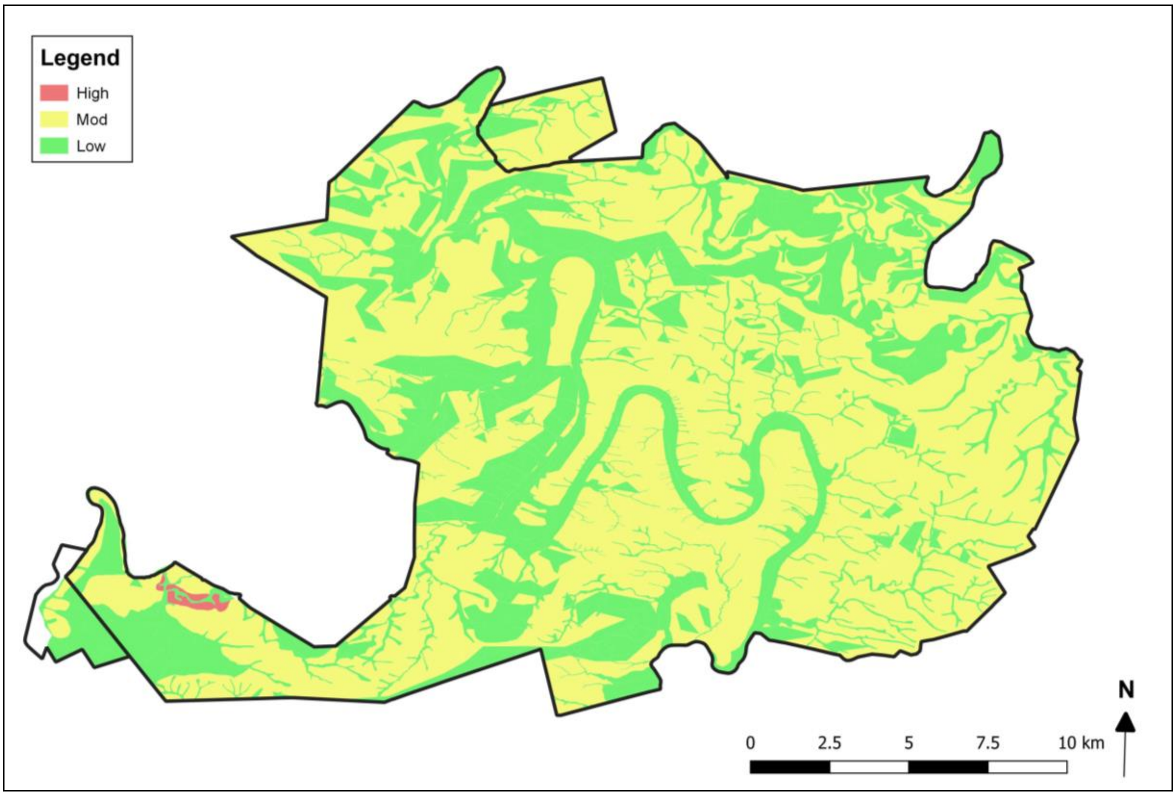

Figure 3-8: Sensitive habitats

A map of the sensitivity of habitats to elephant impacts is presented as Figure 3-8. This was produced by considering the floristic composition of each of the vegetation types mapped by Vlok (2015), with vegetation types with particularly vulnerable taxa being classified as highly sensitive. In addition, areas with steep slopes were considered to have low sensitivity, because elephants tend to have lower impacts on these areas (Cowling *et al.* 2009). Severely degraded vegetation was also considered to have low sensitivity. The vegetation types that were classified as highly sensitive are Spekboom Noorsveld (because of the presence of *Euphorbia bothae*, which is rare on the reserve and vulnerable to elephant impacts) and Karroid Shrubland (because of its diversity of succulents, including *Euphorbia gorgonias* and *Pachypodium bispinosum*). The following vegetation types were classified as moderately sensitive: Fish Thicket (because of the presence of *Euphorbia triangularis* and *Aloe pluridens*), Fish Spekboom Thicket (because of the presence of *Euphorbia tetragona*, which is rapidly dying back in most parts of the reserve), Fish Shrubland Thicket (because of the presence of *Euphorbia tetragona* and *E. triangularis*), and Crossroads Spekboom/Grassland Thicket (because of the presence of local endemic succulents, such as *Euphorbia stellata* and a number of species within the *Delosperma*, *Haworthia* and *Lampranthus* genera). Doring and Combretum Veld (which is dominated by *Vachellia karoo*) was considered to have lower sensitivity. It must be considered though that these vegetation types have experienced megaherbivore release and that the current density of species sensitive to megaherbivores is unlikely natural (Cowling *et al.* 2009).

3.9 Disturbed or degraded areas such as bush encroachment and soil erosion

For many years prior to the formation of the reserve the land was utilised predominantly for livestock farming. This led to the transformation and degradation of the thicket vegetation, particularly in the flatter and more accessible areas. Today the vegetation across large parts of the reserve has been transformed to varying degrees (Figure 3-9). Only small parts of the reserve are considered to be pristine or near-pristine. Large areas are considered to be moderately transformed and there are also fairly extensive areas that are severely transformed. Once thicket vegetation has been severely transformed it does not recover on its own and active intervention is required.

The reserve has an active thicket restoration programme, which aims to stimulate the recovery of the vegetation in the degraded areas by planting spekboom. The areas which have been planted with spekboom are shown in red in Figure 3-9 and the areas where there has been active control of prickly pear are shown in purple.

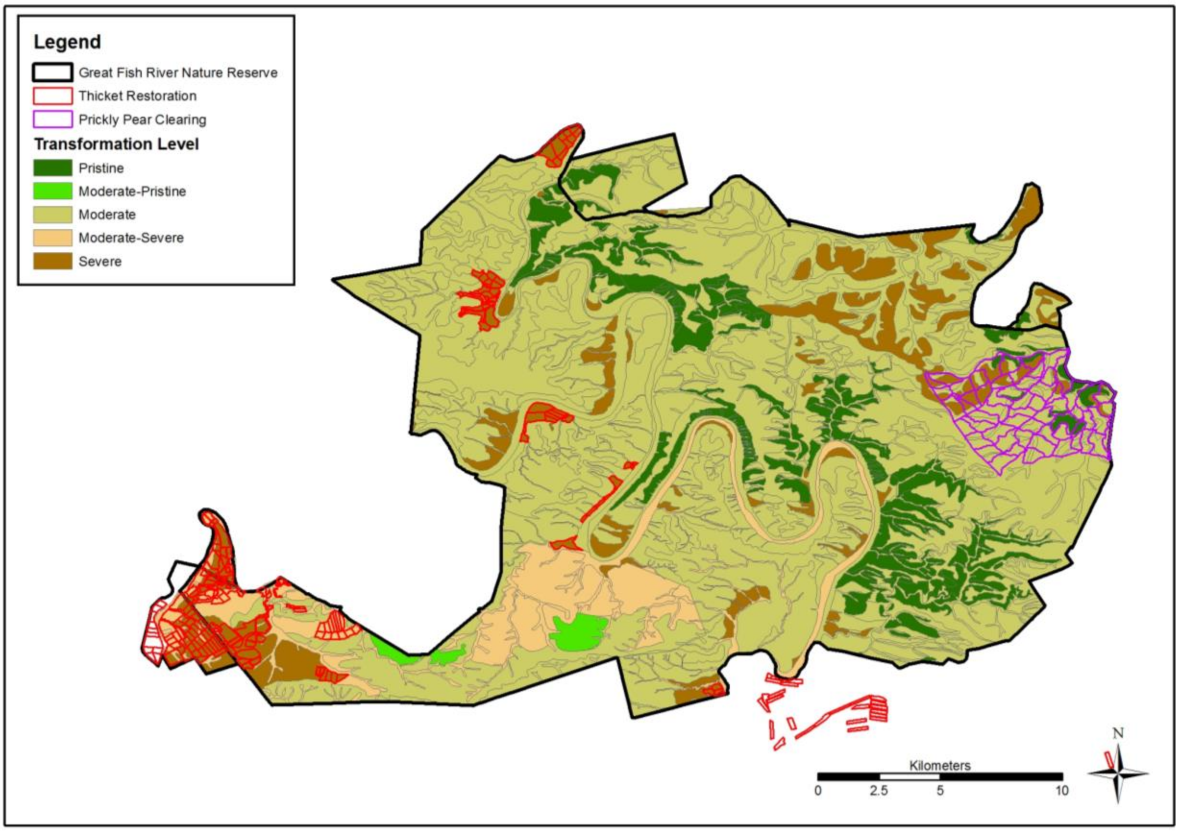

Figure 3-9: Degradation and restoration map

3.10 Description of all available water bodies and distribution thereof

There are two primary river systems in the reserve. The Great Fish River meanders roughly through the centre of the reserve (Figure 3-10). It is perennial and enters in the west and winds through the reserve for 55 km before exiting in the south. The Kat River enters in the north and flows through the reserve for 17 km before merging with the Great Fish River. The Kat River normally flows throughout the year but in dry periods it can be reduced to a series of pools. The Keiskamma River, which runs along the eastern boundary for 20 km, is fenced out of the reserve. Tributaries to these main river systems are ephemeral and drain rapidly after heavy rainfall.

In addition to the river systems described above there are also 574 dams scattered across the elephant area (Figure 3-10). These dams were constructed prior to the establishment of the reserve and vary quite considerably in size and water retention capability. The vast majority are relatively small and only hold water temporarily after rains, but some seldom dry up. Water is not actively provided to any of these dams and water availability thus fluctuates with rainfall and season. There is thus also no way of manipulating water availability for management purposes.

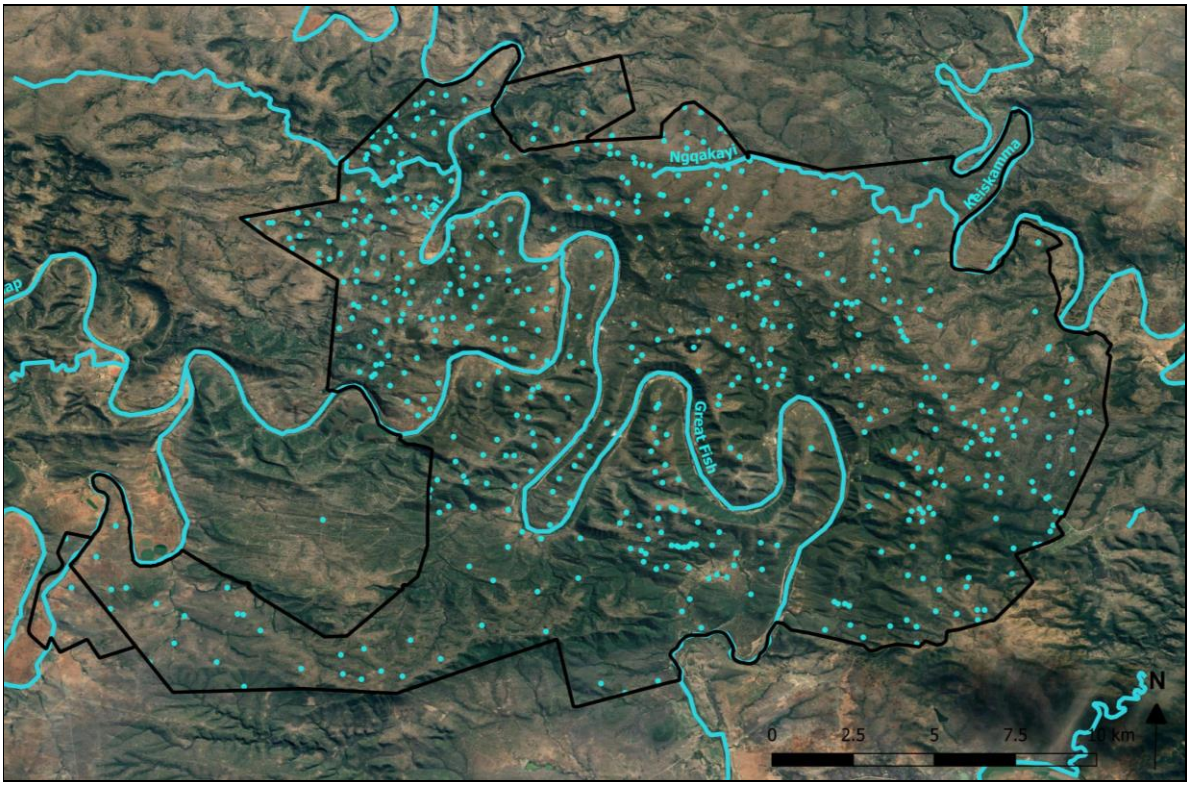

Figure 3-10: The distribution of surface water on the reserve

3.11 Maps

a) Location map

A map showing the location of the reserve in the Eastern Province of South Africa has been included above as Figure 1-1.

b) Topographic map of property

A 1:50 000 scale topographic map showing the property boundaries and key infrastructure is included as Annexure A.

c) Vegetation communities

The vegetation communities found on the reserve are described in detail in *Section 3.5 Detailed description of the vegetation* and maps showing the distribution of these vegetation communities in the reserve has been included above as Figure 3-6 and Figure 3-7.

4. Institutional framework

4.1 Management capacity

The ECPTA is a public entity, established by the Eastern Cape Parks and Tourism Agency Act, Act 2 of 2010. The MEC for the Eastern Cape DEDEAT is the Executive Authority for the ECPTA. By appointment, the ECPTA Board serves as the Accounting Body with the Chief Executive Officer serving as the Accounting Officer. The Chief Operations Officer is the implementer of Protected Area Management Plans through the Regional Managers and the Reserve Managers, with support from all other units of the organisation.

The purpose, vision and management objectives for the GFRNR are outlined in the Protected Area Management Plan (see ECPTA 2019). The management framework for GFRNR comprises four key functions, namely reserve management, conservation, commercial operations and hospitality, and infrastructure maintenance. The four functions fall under the Senior Reserve Manager: GFRNR.

The ECPTA's capacity to manage elephant on the GFRNR is outlined in Figure 4-1. The Regional Manager: Biodiversity & Heritage Cluster is based in Port Elizabeth and provides oversight and coordination, engages with regional stakeholders and communicates with ECPTA senior management. The Senior Reserve Manager is based at the Sam Knott Office on the southern side of the reserve and has the overall responsibility its management. The Senior Reserve Manager is supported by a Conservation Manager and together they coordinate a team of nature conservators, supervisors, rangers and general assistants. The field rangers conduct patrols, which have a monitoring and law enforcement function. A specialist rhino monitoring unit is dedicated to monitoring the black rhino population on the reserve. The supervisors manage the general assistants, who carry out general maintenance of reserve infrastructure and support the field rangers during special operations (such as translocation of game).

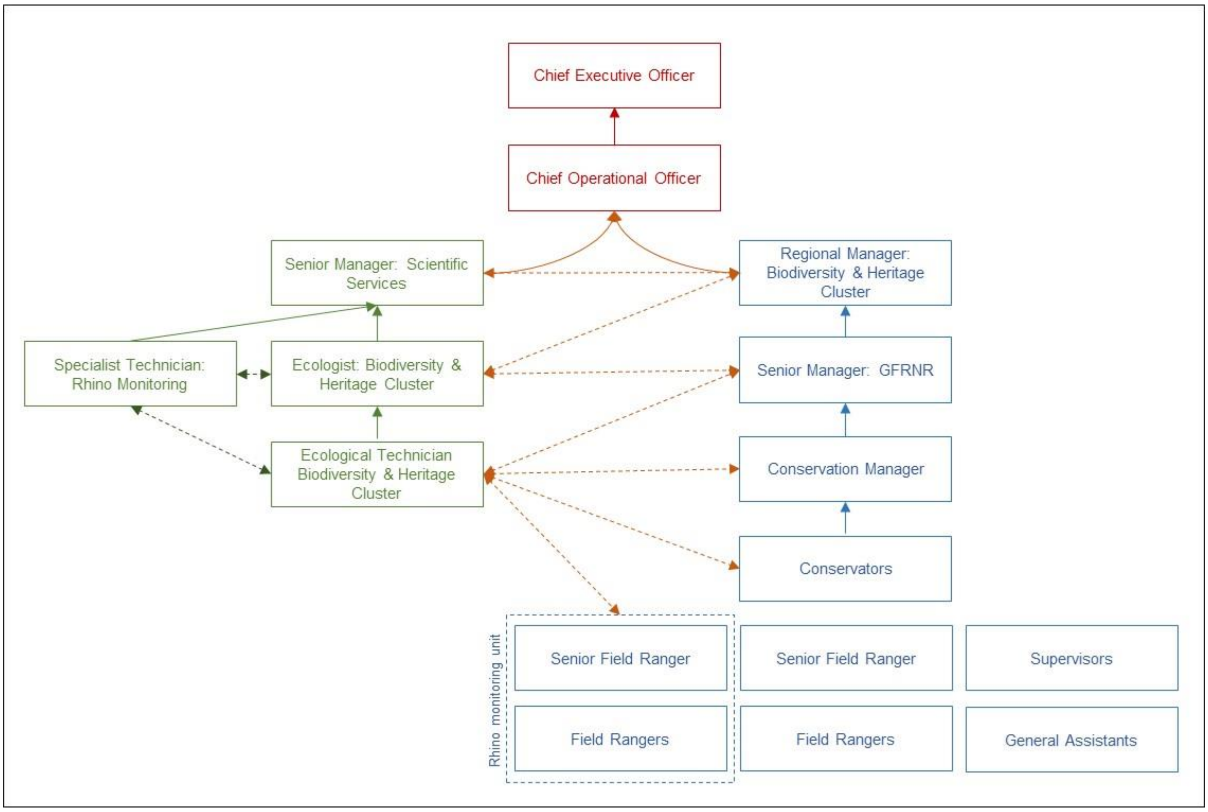

Figure 4-1: Outline of ECPTA capacity to manage GFRNR

The Senior Manager: Scientific Services provides high level scientific advice for the management of ECPTA-managed reserves and also communicates with regional stakeholders. The Ecologist: Biodiversity & Heritage Cluster provides ecological input on the management of the protected area to the reserve management staff described above. For the management of the elephant population, this includes monitoring and development of protocols for monitoring, conducting internal research and directing external research. The Senior Manager Scientific Services and the Ecologist: Biodiversity & Heritage Cluster are based at head office in East London. The Ecologist is supported by an Ecological Technician. The Specialist Technician: Rhino Monitoring is specifically appointed to manage black rhino monitoring.

The roles and responsibilities of key ECPTA staff in implementing this plan are outlined in Table 3.

Table 3: Roles and responsibilities for the implementation of the elephant management plan

ECPTA Official	Roles and responsibilities
Regional Manager (Biodiversity & Heritage)	• Provide strategic oversight for the implementation of this plan; • Ensure that adequate resources are available for the implementation of this plan; • Ensure alignment with corporate policies and strategies; and • Ensure that the relevant activities are incorporated into the annual operational plan for the GFRNR and into the performance agreements of the reserve manager
Senior Reserve Manager (GFRNR)	• Ensure that the activities outlined in this plan are captured in the annual operational plan for the GFRNR; • Ensure that the relevant activities are recorded in the performance management agreements of staff members; • Convene regular meetings to review the implementation of the annual plan of operations. • Convene an annual meeting to review the plan; • Manage staff and finances to achieve the objectives of this plan; • Convene an annual meeting to review and update this plan; • Review and update the plan as required; and • Report on progress in implementing this plan.
Conservation Manager (GFRNR)	• To implement the management plan; • To collate monitoring data, maintain monitoring databases and report to Scientific Services on a monthly basis
Senior Manager (Scientific Services)	• Provide technical support and guidance • Provide direction for the management of the ECPTA managed elephant population • Communicate with key regional and local stakeholders
Ecologist (Biodiversity & Heritage Cluster)	• Provide technical support and guidance in the implementation of this plan; • Analyse and interpret data; • Attend reserve planning meetings; and • Contribute to the ongoing review and revision of this plan.
Ecological Technician (Biodiversity & Heritage Cluster)	• Collate and maintain rhino observation records; • Maintain elephant profiles; • Facilitate correct handling and storage of elephant material; • Provide technical support to the reserve monitoring team; and • Provide support to external researchers and support internal research.
Chief Operational Officer	• Provide critical oversight into the plan and its implementation • Obtain corporate approval and support for the plan; and • Ensure that adequate staff and financial resources are available for the implementation of this plan.

4.2 Management infrastructure

There are office complexes in the Sam Knott section in the south and Double Drift section in the north of the reserve. All roads within the reserve are gravel and require some degree of maintenance. The R345 is a public road that traverses the reserve. Upgrades to the reserve's road network are planned with funding that has been acquired for rhino conservation. The reserve is adequately enclosed by an electrified game fence (see *Section 1.10 Specifications of the perimeter fence*). Funding has been secured to improve accessibility to the perimeter fence.

A boma facility (designed for rhino, but also utilised for buffalo) is situated near the Komadalo Gate, in the Kentucky Section of the reserve.

4.3 Tourist infrastructure

The reserve has several self-catering accommodation facilities, including Mvubu Lodge, Double Drift Lodge, Mbabala Lodge, Nottingham Lodge, Naudeshoek Lodge and the Sam Knott Cabins (see ECPTA 2019). There is also a basic campsite and picnic site at Fort Double Drift. A viewing deck has been built at Adams Krantz.

A Concept Development Plan has been produced to guide the development of tourist facilities and activities on the reserve. This plan includes proposals for the development of new infrastructure, including a campsite at Retreat, a lodge in the Kingston area, and day visitor areas at Double Drift, Nottingham Dam and Adams Krantz. The plan also proposes the opening of several management roads to the public, including the road between the Ndlovu loop and the Fort Wiltshire junction, a link road between Lowestaff and Grasslands, the road between Grasslands and Retreat, management roads at Botha's Post and the Nyathi loop at Fort Wiltshire.

4.4 Research facilities

An old farmhouse at Grasslands has been developed into a research facility, the Basil Kent Research Centre, for use by ECPTA staff and visiting researchers conducting research and monitoring on the reserve.

5. Stakeholders

5.1 Government entities

Department of Environment, Forestry and Fisheries (DEFF)

The Department of Environment, Forestry and Fisheries (DEFF) is the government entity mandated by the Minister of Environmental Affairs to regulate biodiversity conservation matters at a national level. It overseas the implementation of the National Environmental Management: Biodiversity Act (Act No. 10 of 2004) and the Norms and Standards for the Management of Elephants in South Africa (GNR 30833, 2008), which are issued in terms of Section 9 of the Act. In terms of the Norms and Standards, it approves management plans for elephant.

South African National Parks (SANParks)

South African National Parks (SANParks) is mandated to manage the system of national parks in South Africa. With respect to the current reintroduction, SANParks manages potential donor elephant populations (in Kruger and Addo Elephant National Parks). In addition, SANParks has accumulated vast experience in managing elephant and SANParks officials may be a useful resource for input and advice.

Eastern Cape Department of Economic Development, Environmental Affairs & Tourism (DEDEAT)

The Department of Economic Development, Environmental Affairs & Tourism (DEDEAT) is the ECPTA's mother department. The DEDEAT monitors and oversees the activities of the ECPTA, approves the ECPTA's game management recommendations and also issues permits for the transportation and keeping of protected species in terms of the Threatened or Protected Species Regulations (2007) and the provincial nature conservation ordinance. DEDEAT also plays a lead role in terms of the enforcement of environmental legislation.

5.2 Neighbours and community stakeholders

Likhayalethu Community Property Association

Portions of the GFRNR were the subject of a successful land claim. A co-management agreement has been developed, and is currently being implemented, for these portions.

Bucklands Private Game Reserve

Bucklands is a 5 500 ha private reserve that is partly encompassed by the GFRNR. The R345 public road traverses through Bucklands, which shares two common gates with the GFRNR.

Kwandwe Private Game Reserve

Kwandwe, a private game reserve adjacent to the GFRNR, is currently the only neighbouring property with elephant. There already exists cooperation between the managers of Kwandwe and the GFRNR, especially around law enforcement and anti-poaching activities.

5.3 Advisory groups

African Elephant Specialist Group (AfESG)

The African Elephant Specialist Group (AfESG) is a specialist group under the International Union for the Conservation of Nature (IUCN). It consists of technical experts who focus on the conservation and management of African elephant. The aims of the AfESG are to promote the long-term conservation of Africa's elephants and the recovery of their populations to viable levels.

The group is made up of volunteer members from across the continent who are actively involved in some aspect of elephant conservation or management. Membership is reviewed and members are reappointed approximately every four years. Subject to funding availability, the group meets approximately every one to two years to review status and trends of elephant populations and to discuss progress in specific areas related to conservation of the species.

5.4 Universities

Nelson Mandela University

A Memorandum of Understanding (MoU) exists between the ECPTA and the Nelson Mandela University (NMU), which seeks to promote collaborative, applied research on ECPTA protected areas. It is envisaged that a fully-fledged research program will be developed on the elephant in the GFRNR, and that the NMU will be the ECPTA's primary partner in this regard.

University of Fort Hare

The University of Fore Hare has had a long association with the GFRNR and a MoU to promote collaborate research on the GFRNR is also in place. A joint research project on the demographics of the buffalo population in the GFRNR is currently underway and it is foreseeable that projects relating to elephant conservation and management will be developed in future.

Rhodes University

The ECPTA has also entered into a MoU with Rhodes University. There have been initial discussions between the ECPTA and Rhodes University to further develop collaboration, including on aspects such as long-term vegetation monitoring.

5.5 Funders

Rhino Impact Investment

For the past three years the GFRNR has been involved in the Rhino Impact Investment Project, a project funded by the Global Environment Facility (GEF) and implemented by the Zoological Society in London. Out of a possible 50 odd sites, GFRNR was selected as suitable for significant Impact Investment Funding. The goal of the project is to seek innovative ways to finance rhino conservation. A Theory of Change and a budgeted work plan have been developed which will be the guiding operational document over the next five years under the RIB mechanism. The commitments made to this program will need to be considered with the introduction and management of elephant.

Section B: Management Goals and Objectives

6. Management Goals and Objectives

6.1 Background and context

The GFRNR's vision and high-level goals are outlined in the reserve's Strategic Management Plan (SMP) and summarised in the introduction to this management plan. The intention to introduce additional elephants into the GFRNR is clearly expressed in the reserve's SMP:

Strategic Goal 2: To promote the long-term conservation, rehabilitation and restoration of the biodiversity, scenic, and heritage features of the GFRNR, and to minimize operational impacts on the environment.

> **Objective 1**: Re-establish, manage, and maintain populations of locally indigenous fauna in the GFRNR.
>
> > **Action b**: Under direction of the Wildlife Management Plan, broad consultation and supplementary specialist scientific and ecological advice, phase in the further introduction of elephant family groups and bulls to the GFRNR.

The proposed introduction is expected to contribute not only to the achievement of this strategic goal but also to contribute towards the achievement of the reserve's other strategic goals, as outlined in the introduction of this plan. In so doing it will be an important contributor to the achievement of the vision outlined in the SMP. The proposed introduction is also in line with the ECPTA's Large Mammal Re-introduction plan (2013-2018) and will also ensure that the ECPTA becomes compliant with the National Norms and Standards for the Management of Elephants in South Africa (2008). The proposed introduction of elephant is therefore well-aligned to the reserve's high-level objectives.

A strategic adaptive management approach has been adopted in the elephant management plan. This approach recognises and considers the uncertainty that is inherent in managing complex socio-ecological systems (Rogers 2003; Gaylard 2015). In accordance with this approach the management objectives are derived from an objectives hierarchy that incorporates high-level values (including those of the ECPTA and broader society), sequentially unpacked to identify the detail required for specific management actions.

6.2 Planning process

The development of the plan was initiated on 29 Jan 2016, when ECPTA advertised its intention to develop an elephant management plan and invited interested and effected parties to register with the Agency. This was advertised in two local newspapers, the Herald and the Daily Dispatch, as well as on the ECPTA's web site. In addition to this, invitations were also e-mailed or handed directly to the Likhayalethu CPA, the Park Forum, Provincial Department, the Friends Group, and immediate neighbours. Stakeholders were asked to complete a registration form and to submit this to the ECPTA. A stakeholder database was developed from this process and all registered stakeholders were invited to a stakeholder engagement workshop that was held at the Knott Memorial church inside the reserve on 17 February 2016. Simultaneously invitations were also sent to several elephant experts from across the country and they were invited to attend both the stakeholder workshop as well as a specialist workshop to be held on 18 February 2016.

In total 43 people attended the stakeholder workshop, which was chaired by Dr. Angela Gaylard. There was good representation from the Likhayalethu CPA, traditional leadership, the park forum, DEDEAT, neighbours and elephant experts and scientists. The meeting was conducted in both English and isiXhosa. Participants were welcomed to the workshop by the then reserve manager, Mr. Gavin Shaw, after which he gave an introductory presentation on the reserve's strategic management plan and how the proposed introduction relates to it. Participants were then given basic background information on the reserve, its biodiversity attributes and the proposed introduction of elephant. This was followed by a session in which Dr. Gaylard outlined the process that would be followed to develop the management plan and highlighted issues that would not be discussed as part of this process. The rest of the meeting was used to jointly develop the high-level objectives. This was done by looking at desired outcomes, special attributes, determinants and threats, and finally the key drivers to achieve the desired outcomes. The key drivers were then clustered to form the elephant management plan's high-level objectives.

The high-level objectives were then taken to the specialist workshop, which was attended by elephant managers and scientists from around the country, as well as two representatives from the Likhayalethu CPA and representatives from DEDEAT. These specialists were asked to provide guidance on how best these objectives could be achieved. This was done by cascading each of the high-level objectives down into sub-objectives so as to develop an objectives hierarchy.

6.3 Elephant management objectives.

The stakeholder consultation process defined the overall purpose of this process as follows:

To re-establish elephant in the Great Fish River Nature Reserve and to use this as a catalyst for realizing the tourism potential of the reserve.

Five high-level objectives were identified by the stakeholders, and these are presented in Figure 6-1 below.

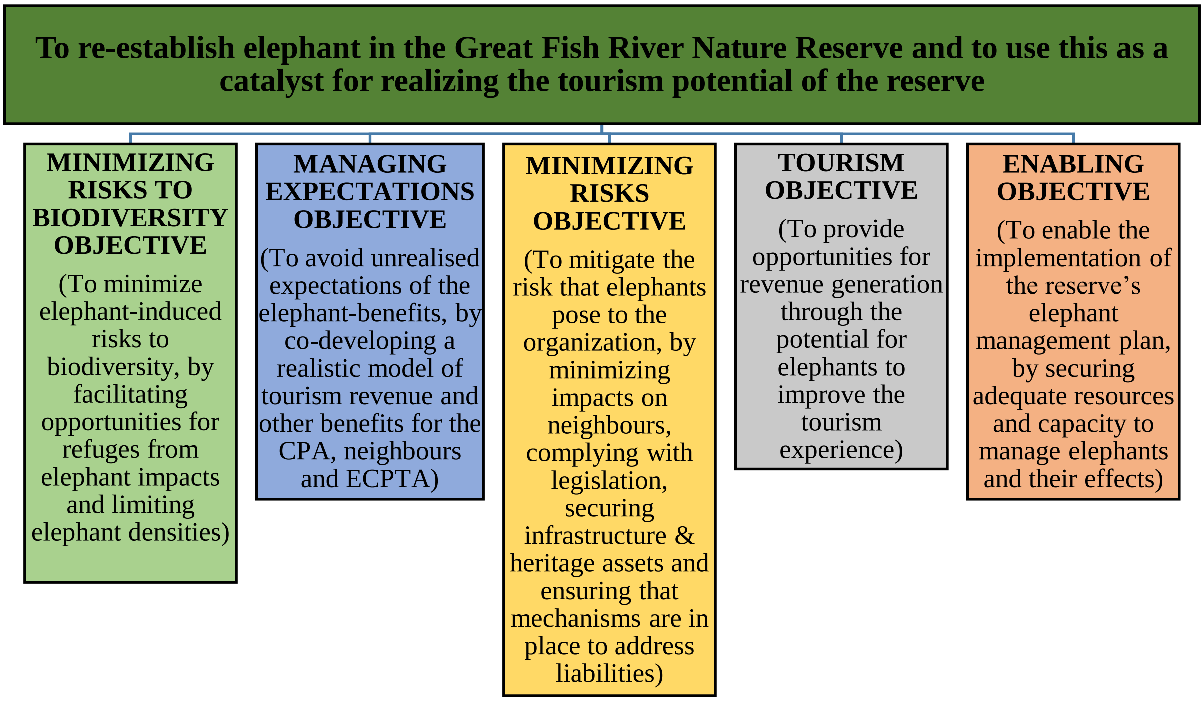

Figure 6-1: High-level elephant management objectives

These five high-level objectives were then broken down further into sub-objectives and the resultant objectives hierarchy is presented in Table 4. As part of the Strategic Adaptive Management cycle, these objectives will be monitored as part of a structured monitoring programme (see the section on monitoring, below). Results of the monitoring will be evaluated annually against the desired outcome and objectives.

Table 4: Elephant management objectives hierarchy

<table>
<tr><td colspan="2">Objective 1: Minimizing Risks to Biodiversity Objective
To minimize elephant-induced risks to biodiversity by facilitating opportunities for refuges from elephant impacts and limiting elephant densities.</td></tr>
<tr><td>Sub-objective A:</td><td>Manage Elephant Population Persistence
To ensure the long-term persistence of a viable elephant population by ensuring appropriate family and social structure, avoiding inbreeding and limiting population growth.</td></tr>
<tr><td>Sub-objective B:</td><td>Landscape Spatial Use Sub-Objective
To strive towards the persistence of impact-intolerant species through the existence of refuges from elephant impact.</td></tr>
<tr><td>Sub-objective C:</td><td>National Rhino Conservation Targets
To maintain the reserve’s contribution to national rhino conservation targets by minimizing elephant effects on rhino population growth.</td></tr>
<tr><td>Sub-objective D:</td><td>Protecting Significant Biodiversity Features
To protect significant biodiversity features from elephant impact through appropriate fencing and other measures.</td></tr>
<tr><td>Sub-objective E:</td><td>Monitoring to Mitigate Risks
To mitigate risks associated with elephant presence on the reserve by monitoring the success of elephant management interventions, understanding patterns of elephant movement impacts, quantifying elephant-induced changes to rhino movement patterns and mortalities, and quantifying elephant impacts on significant biodiversity features.</td></tr>
<tr><td colspan="2">Objective 2: Managing Expectations Objective
To avoid unrealistic expectations of the elephant-benefits by co-developing a realistic model of tourism revenue and other benefits for the CPA, neighbours and ECPTA.</td></tr>
<tr><td>Sub-objective A:</td><td>Ongoing Stakeholder Engagement
To maintain realistic expectations through ongoing stakeholder engagement.</td></tr>
<tr><td>Sub-objective B:</td><td>Co-Developing Realistic Tourism Model
To co-develop a realistic model of tourism revenue and other benefits for the CPA, neighbours and ECPTA.

Cross links to Marketing Strategy</td></tr>
<tr><td colspan="2">Objective 3: Minimizing Risks Objective
To mitigate the risk that elephants pose to the organization by minimizing impacts on neighbours, complying with legislation, securing infrastructure and heritage assets and ensuring that mechanisms are in place to address liabilities.</td></tr>
<tr><td>Sub-objective A:</td><td>Minimize Impacts on Neighbours
To minimize the impacts of elephants on neighbours by adequate fence maintenance and innovative use of technology.

Cross links to early detection of breakouts</td></tr>
<tr><td>Sub-objective B:</td><td>Compliance
To ensure that the organization is compliant with national, provincial and other legislation with regards to having elephants on the reserve by implementing the Ministerially-approved Elephant Management Plan.</td></tr>
<tr><td>Sub-objective C:</td><td>Securing Infrastructure and Heritage
To minimize risks of elephant damage to infrastructure and cultural assets by preventing elephants from accessing these assets.</td></tr>
</table>

Sub-objective D:	**Ensure Mechanisms are in Place to Address Elephant-Induced Liabilities** To minimize liabilities associated with elephants by ensuring that adequate mechanisms are in place to mitigate litigation.
Objective 4: Tourism Objective To provide opportunities for revenue generation through the potential for elephants to improve the tourism experience.	
Sub-objective A:	**Tourism Development Plan** To improve the visitor experience in the reserve by developing a tourism plan that aligns with the organizational tourism strategy and enhances the existing tourism product.
Sub-objective B:	**Marketing Strategy** To realize the potential for elephants to improve the tourism experience through a marketing strategy that sets the reserve's elephant experience apart from others.
Sub-objective C:	**Skills Development** To make use of the opportunities provided by the presence of elephants to develop skills within the reserve and CPA.
Sub-objective D:	**Local Small Business Development** To make use of the presence of elephants in the reserve to develop local small businesses within the CPA and other surrounding communities. *Cross links to skills development*
Objective 5: Enabling Objective To enable the implementation of the reserve's elephant management plan by securing adequate resources and capacity to manage elephants and their effects	
Sub-objective A:	**Resources to Manage Elephants & Their Effects** To secure adequate resources to manage elephants and their effects by incorporating the implementation costs into the organization's budgetary planning and allocation.
Sub-objective B:	**Capacity Development** To enable the implementation of the reserve's elephant management plan by developing the necessary skills and capacity within the reserve and CPA.

7. Habitat

Habitat management is dealt with under Objective 1 in the elephant management objectives hierarchy. The high-level objective is to minimize elephant-induced risks to biodiversity by facilitating opportunities for refuges from elephant impacts and limiting elephant densities.

In accordance with the current best practise the adaptive planning process has identified the spatial distribution of elephant impacts to be the primary factor influencing the persistence of habitats. The objective is therefore to create a situation where elephant impacts are patchily distributed across the landscape and there are adequate refuges for impact intolerant species. Typically, the strategic placement of water is used as a mechanism to ensure that elephant impacts are patchily distributed across the landscape. The distribution of the water, both natural and artificial, in the GFRNR combined with the inability to manipulate the availability of this water means that this is not a useful option in this case. The terrain within the reserve is, however, extremely rugged with deeply incised river valleys and an abundance of steep slopes that are likely to provide natural refuge areas for impact-intolerant species (Gaylard 2015). Moreover, since increasing elephant densities can eventually lead to the distribution of impacts, elephants will be placed on contraception to limit population growth. Both the habitat utilisation and the efficacy of the contraception will be closely monitored as part of the reserve's strategic adaptive management approach.

7.1 Vegetation condition monitoring methods and time schedules

Vegetation condition, as well as structural and compositional changes to the woody vegetation component, will be monitored at varying intervals using a combination of the Point Centred Quarter Method (Trollope *et al*. 2004), fixed point photographs and satellite images.

a) Analysis of satellite imagery to assess changes to woody vegetation cover brought about by elephants

Freely available MODIS or SPOT5 satellite imagery of the reserve will be analysed on a 3-yearly basis to evaluate changes to woody vegetation cover brought about by elephants (see for example Addo Elephant Management Plan, *in press*; Smit *et al*. *in review*). In order to ensure that the effects of elephants can be teased apart from other drivers of woody cover, this data will be analysed in conjunction with habitat use data collected from collars fitted to the elephant. Images taken in mid-summer have been suggested as the best indication of canopy cover changes (Garai 1999).

b) Fixed point photographs to obtain a qualitative assessment of woody vegetation change

Since satellite imagery can only assess vegetation cover or density, fixed point photographs taken every three years will supplement this information by providing a qualitative evaluation of structural (and, to a certain extent, species) changes brought about to woody vegetation. Fixed point photography has been done at sites located on a small portion of the reserve for several years. This programme with be expanded to cover all the vegetation communities across the reserve and initial sampling will be done prior to the introduction of elephant. Four photographs are taken at each site, in north, south, east and westerly directions, and the type of vegetation cover, a species checklist and utilization by herbivores and soil erosion condition recorded at each site at the time of photography.

c) Permanent vegetation plots

Detailed vegetation monitoring is already conducted at 79 sites scattered across the reserve (Dieter van den Broek *pers comm*.). This is an adapted form of the Point Centred Quarter method developed by Cottam & Curtis (1956) and described by Trollope *et al.* (2004). It has been specifically developed for the Albany thicket biome and is utilised to describe the botanical composition, density, biomass, and structure in quantitative terms at each of these sites. Baseline data has already been collected for these sites, but they will be resampled before elephant are introduced and at five year intervals thereafter. In accordance with the adaptive management approach the number of sites at which sampling is conducted may be extended to include additional areas as more information on elephant habitat use becomes available.

d) Rainfall measurement

Rainfall is routinely recorded at several fixed rain gauges on the reserve in order to relate the vegetation survey results to periods of drought and normal rainfall.

7.2 Rehabilitation programme for degraded areas

There are both thicket restoration and invasive alien plant clearing programs active in the reserve (see Figure 3-9). The thicket restoration programs emphasis is on planting spekboom in the severely degraded parts of the reserve. The spekboom acts as a catalyst for the restoration of these areas. This project is part of the greater Expanded Public Works programme and creates several job opportunities for local communities. Large tracts of degraded land have already been replanted and this project is expected to continue.

The invasive alien plant clearing program is similarly managed by the Gamtoos Irrigation Board and is also part of the Expanded Public Works Programme. This project is currently inactive but is expected to resume soon. The emphasis is on clearing Prickly Pear (*Opuntia ficus-indica*), which is a problem across large parts of the reserve.

Both projects are likely to be impacted by the introduction of elephant. Elephants can have a detrimental impact on the survival of spekboom plants and are also known to have a preference for Prickly Pear. Their presence could thus negatively affect the spekboom restoration program and positively affect efforts to control prickly pear, and both could in turn lead to reduced job opportunities. Given the low density of elephant that will be maintained on the reserve, however, it is not expected that these programs will be significantly affected. Elephant habitat use will be monitored and the resultant information will be used to guide and direct these programmes going forward.

7.3 Fire management plan

The reserve does not have a fire management plan as it lies within the arid thicket biome and is not prone to veld fires. A fire management plan is thus not considered necessary.

7.4 Water provision

Water is available from the river network and the many dams and natural pans on the reserve (Figure 3-10). Water is not pumped into the dams. Surface water availability in the dams is therefore dependent on rainfall and fluctuates seasonally. Only a small proportion of the dams indicated in Figure 3-10 retain water throughout the year. The Great Fish River, which winds through the centre of the reserve, receives water from the Orange-Fish-River water transfer scheme and flows throughout the year. There is thus an abundance of water for elephants throughout the year and no addition water provision is required.

7.5 Population management of other wildlife species

The ECPTA has a well-established game management programme and recommendations regarding the management of large herbivores are made annually. This happens through a structured decision-making process that is guided and informed by monitoring.

Replicated aerial counts are conducted on a three-yearly cycle. This not only provides a new estimate that will form the basis for the next three years of management but also allows for an assessment of the management actions implemented over the previous three years. In the same year the predetermined target ranges for each species are re-assessed and if necessary adjusted to achieve the desired management results. These adjustments are informed by vegetation condition, animal condition and management objectives.

In between the aerial counts game numbers are tracked and corrected for growth rate, removals and introductions. An annual estimate of game numbers is prepared in October of every year and these estimates are presented at the annual game management meeting, where ecologists and reserve managers discuss and agree on game management actions for the following year. Decisions regarding removals are based largely on managing species within the predetermined target ranges.

The recommendations formulated at the annual game management meeting are submitted to the ECPTA Board and DEDEAT for approval. Once the recommendations have been approved these animals are then disposed of through live sale, external culling, and internal culling. Currently no hunting is currently permitted in this reserve. The disposal of animals, as outlined above, happens within the context of sustainable utilization and generates much needed revenue for the ECPTA. This revenue generated is reinvested back into the management of these reserves.

7.6 Preferred management density

As expanded upon above, the focus of the reserve's elephant management approach is on the spatial distribution of elephant impacts, rather than on a maintaining a specific elephant density. This is in keeping with contemporary elephant management approaches, including those of the leading conservation authorities in Africa (Gaylard 2015).

However, in order to minimize the risk that elephant impacts will become extensive, elephant densities will be maintained below 0.1 elephant.km^{-2} by administering contraception to increase intercalving intervals. This intervention will also be assessed in terms of its efficacy for limiting extensive elephant impacts.

8. Information pertaining to elephants

8.1 Purpose of introduced elephant

The purpose of introducing additional elephant into the GFRNR is:

a) To re-establish an important indigenous species and the natural ecological processes associated with it. Elephants are important agents of habitat change and have an important effect on the way in which ecosystems function (Kerley 2008);

b) Improve the reserve's tourism appeal and increase the socio-economic benefits to the CPA and local communities; and

c) Rectify and normalise the current elephant population structure to ensure that ECPTA is compliant with the National Norms and Standards.

As highlighted earlier, the introduction of additional elephant will not only contribute to the achievement of the reserve's biodiversity and heritage goals, but will also contribute, to varying degrees, to the achievement of the reserve's other strategic goals. It has also been identified as a high priority project in the ECPTA's Large Mammal Re-introduction Plan.

8.2 Public participation reports, where there are contractual arrangements between the management authority of a protected area and a private land owner(s)

After a successful land claim, large parts of the Double Drift Sector of the Reserve were restituted to the Likhayalethu Communal Property Association. In terms of the settlement agreement the land use of this area may not change, and the land is to be co-managed. A co-management agreement was concluded in March 2017 and this management plan represents the first time that the CPA have been involved in the development of a management plan and the planned introduction of animals into the reserve. The Likhayalethu CPA are represented by a committee of approximately 30 people under the leadership of a chairperson.

Although the co-management agreement was only signed in March 2017, there has been full engagement with the CPA since the start of this project. The proposal to introduce elephant was first discussed with the CPA at a routine meeting held on the reserve. The CPA were then invited to the first stakeholder workshop held on the 17 Feb 2016 and actively participated in the development of the high-level objectives. Two representatives were then nominated by the CPA to attend the specialist workshop, which was held on 18 February 2016. Attendance registers from both meetings are attached. At the request of the CPA a delegation from the CPA were taken on a learning exchange visit to Addo Elephant National Park in February 2017. During this visit they were able to engage with and question the reserve manager and community members from the communities adjacent to Addo and who benefit from the Mayibuya Indluvo Elephant Trust.

A draft elephant plan was in the interim developed by the project team and this plan was presented to the CPA. Feedback from the CPA, as well as other stakeholders, was then incorporated as outlined in the attached stakeholder report. Written notification of the availability of the draft plan for comment was also given to neighbouring landowners, communities and other interested parties.

8.3 Specifications for the release camp

It is not currently envisaged that a release camp will be required. Should it be deemed that a release camp should be used, it will be built with the following specifications:

- It will be a minimum of one hectare in size (for a small family group), and the design (Figure 8-1; from Bothma & Van Rooyen, 2005) will align with the guidelines provided by Garai (1999) and Bothma & Van Rooyen (2005);
- The fence will be built in the configuration of the reserve's perimeter fence, with the addition of two steel cables, and the electric offsets will be at 9 000 V;
- The release camp will be located away from other infrastructure and as far as possible from the reserve boundary, but easily accessible to the large transport vehicles required to bring the animals into the reserve;
- It will include shade trees, and clean drinking water will be available; and
- The site will be well drained and will contain adequate browse and grazing for the confinement period.

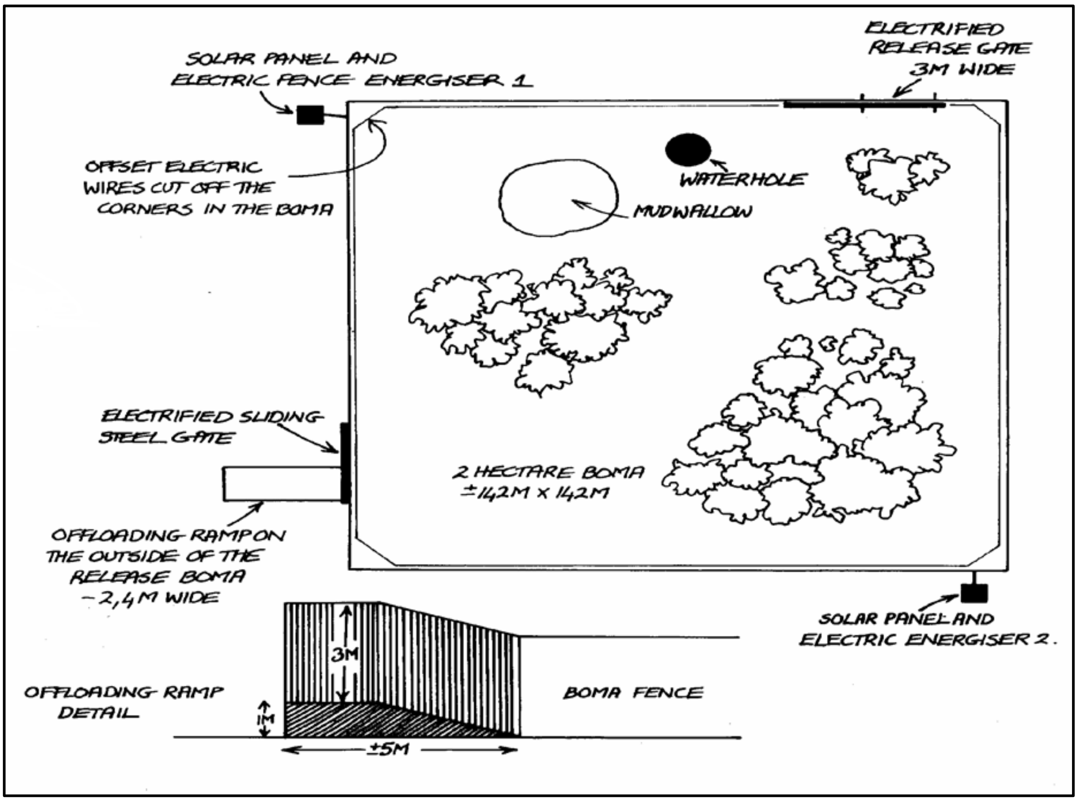

Figure 8-1: Specifications for the elephant release boma (from Bothma & Van Rooyen, 2005)

8.4 Control of elephant population size

As outlined above, the clinically tested PzP immuno-contraceptive vaccine will be administered under the advice of wildlife veterinarians. The main aim of the contraception programme will be to mimic more natural intercalving intervals, where ecological processes (such as drought, migration) are intact. The contraception schedule and details will be finalised once the structure of the herd to be reintroduced is known.

8.5 If, and how, sex and age ratios will be manipulated

The sex and age ratios of introduced elephants will not be manipulated, unless scientific evidence emanating from the monitoring programme suggests that either impacts on vegetation or social aspects are being influenced by a particular age or sex class. The necessity for such manipulation will be minimized by introducing elephants with the following age and sex structure:

- Two cow-calf groups comprising no more than 10 animals each, and organized in a matriarchal system; and
- Two adult bulls, one older than 35 years and one approximately 25 years old, to be introduced only once the cow-calf group has successfully established their range.

The long-term persistence of elephants on the reserve will be maximized through regular monitoring of the social conditioning of the animals. This work will be undertaken by staff from the reserve and Scientific Services. It may be necessary to source new genetic material by swapping out adult elephant bulls from time to time. This will be done through a structured metapopulation management programme in alignment with other small reserves requiring new genetics.

8.6 Measures to prevent poaching

The reserve has stringent security measures in place to protect its black rhino population and these same measures will be employed to protect the elephant. The Senior Reserve Manager has a Conservation Manager and a dedicated, well-trained and equipped ranger force at his disposal. This team is strategically distributed across the reserve and is supplemented by two highly trained tracker dogs, a light aircraft, and various technological options including an unmanned aerial vehicle with night vision capability, and camera traps. In addition to this the reserve has an active community outreach programme, and is in constant communication with neighbours, other game ranchers in the region, the Green Scorpions, SAPS and Hawks. There are clear incident reporting procedures and protocols and these are coordinated through a centralised control room using sophisticated software.

Measures to prevent poaching in the reserve rely primarily on restricting unlawful access by maintaining the integrity of the perimeter fence. Entrance gates are manned and monitored with CCTV cameras and perimeter fences are patrolled regularly by field rangers, who monitor it for breakages and voltage drops. Additional rhino monitoring patrols are constantly conducted across the interior of the reserve.

8.7 Provision for adequate insurance

The ECPTA does not currently have any insurance cover for this, but options will be explored and costed prior to the finalisation of this plan.

8.8 Contingency plans to deal with elephant problems (including contact details of responsible manager veterinary practitioner and capture operator/s)

The ECPTA’s policy in the event of a breakout by elephant will be to recapture the animals and return them to the reserve as soon as possible

a) In the case of the fence being unable to contain the elephants

In the event of a breakout by elephant the following steps will be followed:

- Neighbours and conservation authorities will be informed of the breakout and the suspected or confirmed location of the animal;
- A monitoring team will be dispatched to locate and monitor the animals;
- A recovery team consisting of a wildlife veterinarian, a helicopter service provider and a capture team will be mobilised to recapture the escaped animals;
- The recaptured animals will be inspected by a wildlife veterinarian, and held in the holding boma for any necessary treatment before their release can be confirmed by the veterinarian; and

- Repairs will be made to the perimeter fence immediately.

  Critical contacts are the following:

- Conservation Manager;
- Senior Reserve Manager;
- Regional Manager; and
- Chief Operations Officer.

The ECPTA employs a veterinarian and a helicopter service provider on a three-yearly contract and their contact details therefore change over time. Nevertheless, their contact details must always be available to all the above ECPTA staff. In addition, the ECPTA has a mutual collaboration Memorandum of Understanding (MOU) with SANParks and this should be adapted to include the emergency recovery of any elephants that may escape from the GFRNR.

b) In the case of the alteration of the habitat beyond acceptable limits

The Strategic Adaptive Planning and Management approach is designed to limit unacceptable alteration of habitat by elephants by allowing for refuges from elephant impact and by limiting the size of the elephant population. However, should elephant impacts nevertheless approach unacceptable levels of habitat alteration, the following actions will be taken:

- Alter the contraception schedule to further increase the intercalving intervals, or possibly even halt calving entirely until improvement in habitat alteration is evident (this will be done in consultation with the experts undertaking the contraception research project);
- Erect elephant-proof fences around severely altered habitats, in order to exclude elephants from these areas; and
- Discuss the possibility of entering into biodiversity stewardship or partnership agreements with conservation agencies or neighbouring properties that already have elephant, or whose management objectives are conducive to holding elephant, in order to increase the land available to elephants. Should neighbouring properties be available for purchase, this option will also be explored.

8.9 Feeding scheme in case of a natural food supply shortfall

Given the proposed elephant densities it is highly unlikely that there will ever be any natural food shortage. It is not envisaged that the animals will be required to be provided with supplemental forage.

8.10 Threat analysis and security plan

To be developed in collaboration with the Senior Reserve Manager.

Section C: Information to be provided after approval for the introduction of elephants, but before a permit may be issued

9. Details of the elephants

9.1 The complete translocation history of each individual

9.2 Serial numbers of transponders (microchips) to be inserted where appropriate

9.3 The management of the capture, transport and keeping in boma (including sedation) of elephants, as well as the name of the acting veterinary practitioner

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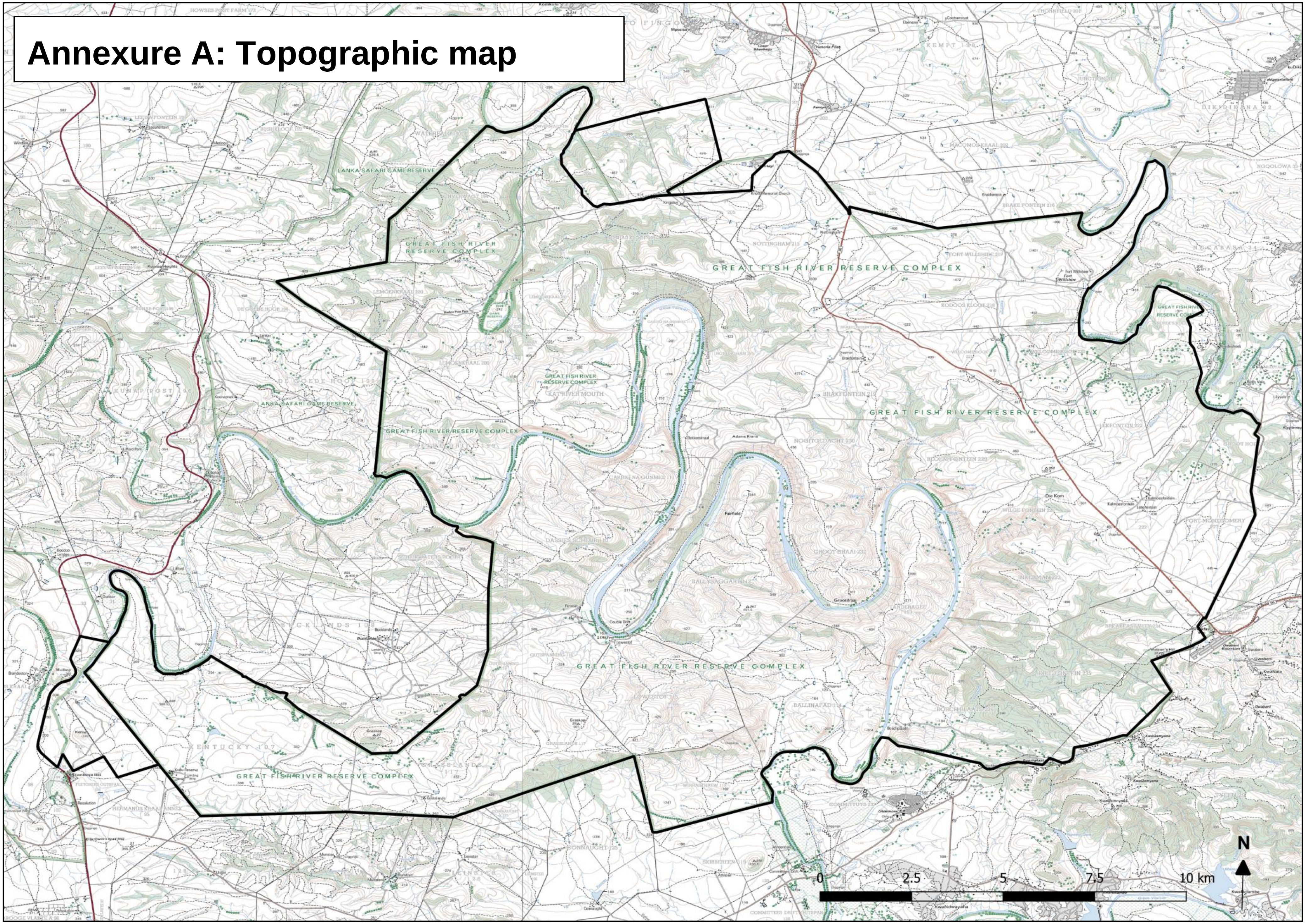
Section E: Annexures

Annexure A: Topographic map



Annexure B: Action Plan

Objective 1: To minimize elephant-induced risks to biodiversity												
Objectives	**Sub-objectives**	**Actions**	**Responsibility**	**Time Frames (Years)**					**Priority**	**Key Outcomes**	**Key Verifiers**	**Target**
				21/ 22	**22/ 23**	**23/ 24**	**24/ 25**	**25/ 26**				
1.1 Manage elephant population persistence	1.1.1 Limit elephant population growth	a) Develop a schedule for administering immuno-contraceptives	Primary Senior Manager: Scientific Services Support Senior Reserve Manager: GFRNR Ecologist: B&H Cluster	✓		✓		✓	High	Plan for the administering of contraceptives	Schedule	First schedule produced by end 2022. Reviewed every two years.
		b) Administer immuno-contraceptives according to schedule	Primary Senior Reserve Manager: GFRNR	✓	✓	✓	✓	✓	High	Growth rate is suppressed	Records of immobilisations	According to schedule
		c) Monitor population growth rate and impacts of contraceptives and adjust schedule accordingly	Primary Ecologist: B&H Cluster Support Ecological Technician: B&H Cluster Senior Manager: Scientific Services Senior Reserve Manager: GFRNR	✓	✓	✓	✓	✓	High	Population demographics are understood. The most effective population reduction actions are implemented.	Monitoring report	Annual

	1.1.2 Ensure appropriate family and social structure	a) Track individual elephants through time and group associations	Primary Ecologist: B&H Cluster Support Ecological Technician: B&H Cluster	✓	✓	✓	✓	✓		All individuals in population are known. Elephant behaviour and associations documented.	Monitoring report	Annual
	1.1.3 Avoid inbreeding	a) Monitor relatedness and associations of animals and determine inbreeding risk.	Primary Ecologist: B&H Cluster Support Ecological Technician: B&H Cluster	✓	✓	✓	✓	✓	High	Relatedness and inbreeding risk are understood	Monitoring report	Annual
		b) Remove or administer contraceptives to animals with high risks of inbreeding	Primary Senior Reserve Manager: GFRNR						High	Inbreeding is prevented	Monitoring report Reports of management actions	As required. (Not required in current plan's cycle)
	1.1.4 Mimic elephant dispersal	Remove animals as required	Primary Senior Reserve Manager: GFRNR						High	Natural processes are simulated	Monitoring report Reports of management actions	As required. (Not required in current plan's cycle)
1.2. Strive towards persistence of impact-intolerant species	1.2.1 Understand elephant response to critical resources	a) Monitor elephant movements and habitat utilisation by fitting satellite collars	Primary Ecologist: B&H Cluster Support Ecological Technician: B&H Cluster	✓	✓	✓	✓	✓	High	Key resource areas are known and elephant movement patterns in relation to them are understood	Monitoring report	Annual
		b) Monitor elephant movements and habitat utilisation	Primary Ecologist: B&H Cluster Support	✓	✓	✓	✓	✓		Key resource areas are known and elephant movement patterns in	Monitoring report	Annual

		through field ranger observations	Ecological Technician: B&H Cluster							relation to them are understood Field rangers become familiar with working with elephants		
	1.2.2 Limit elephant density to maintain composition, structure and function of vegetation	See 1.1.1.										
1.3 Maintain the reserve's contribution to national rhino conservation targets	1.3.1 Minimize the effects on rhino population growth by reducing elephant-induced mortalities	a) Monitor and record elephant-rhino interactions	Primary Ecologist: B&H Cluster Specialist Technician: Rhino Monitoring Support Ecological Technician: B&H Cluster	✓	✓	✓	✓	✓	High	Frequency of interactions recorded and problem individuals identified	Monitoring report	Annual
		b) Convene an emergency meeting on the detection of elephant-induced rhino mortality and determine management response	Primary Senior Reserve Manager: GFRNR Support Regional Manager: B&H Cluster Senior Manager: Scientific Services Ecologist: B&H Cluster Ecological Technician: B&H Cluster	✓	✓	✓	✓	✓	High	Likelihood of rhino mortality reduced	Minutes of meeting	As required

	Reduce elephant-induced mortalities through the selective sourcing of elephants	a) Ensure sourced elephant have no history of conflict with rhino	Primary Senior Manager: Scientific Services Support Ecologist: B&H Cluster	✓					High	Likelihood of rhino mortality reduced	Correspondence / agreements with donor reserves	Before reintroduction
		b) Ensure that single adolescent bulls are not introduced	Primary Senior Manager: Scientific Services Support Ecologist: B&H Cluster	✓					High	Likelihood of rhino mortality reduced	Correspondence / agreements with donor reserves	Before reintroduction
1.4 Protect significant biodiversity features from elephant impact through appropriate fencing and other measures		a) Identify features that need protection from elephant	Primary Senior Manager: Scientific Services Ecologist: B&H Cluster Support Ecological Technician: B&H Cluster	✓				✓	High	Biodiversity features that require protection are identified	Map of location of biodiversity features	Reviewed every 5 years
		b) Erect and maintain fencing, cables or other measures to exclude elephant	Primary Senior Reserve Manager: GFRNR		✓	✓	✓	✓	High	Biodiversity features requiring special protection are secured	Map of installed infrastructure	Infrastructure erected by end 2022 Ongoing assessments of condition of infrastructure. Ongoing maintenance of infrastructure.

1.5 Mitigate risks associated with elephant by monitoring the success of management interventions, understanding patterns of elephant movement, quantifying elephant-induced changes to rhino movement patterns	1.5.1 Evaluate elephant management interventions	1.5.1.1 Monitor social integration between introduced and existing elephants	Primary Ecologist: B&H Cluster Support Ecological Technician: B&H Cluster	✓	✓				High	Impact of the new elephant on the existing elephant is understood	Research report	By end of 2022
		1.5.1.2 Monitor the efficacy of contraception	Primary Ecologist: B&H Cluster Support Ecological Technician: B&H Cluster		✓	✓	✓	✓	High	Efficacy of population control measures understood	Monitoring report	Annual
	1.5.2 Understand patterns of movement and impacts	1.5.2.1 Identify refuges from elephant impact and understand what factors contribute to their existence a) Identify refuge areas based on patterns of space use from collars and ranger sightings b) Understand what factors contribute to an area being a refuge	Primary Ecologist: B&H Cluster Support Senior Manager: Scientific Services Ecological Technician: B&H Cluster			✓			High	Understanding of which areas are unlikely to suffer elephant impact	Research report	By end of 2024
		1.5.2.2 Monitor the impacts on biodiversity to	Primary Ecologist: B&H Cluster Support	✓	✓	✓	✓	✓	High	Impacts of elephant on habitat are understood	Monitoring protocol Monitoring reports	Monitoring protocol finalised by end of 2021/22.

		evaluate elephant impacts on vegetation composition structure and function a) Develop and implement a vegetation monitoring protocol	Senior Manager: Scientific Services Ecological Technician: B&H Cluster									Annual monitoring reports.
	1.5.3 Ensure early detection of breakouts through the use of tracking technology.	a) Ensure that all family groups and lone bulls are collared with satellite collars	Primary Senior Manager: Scientific Services Ecologist: B&H Cluster Support Senior Reserve Manager: GFRNR Ecological Technician: B&H Cluster	✓	✓	✓	✓	✓	High	Elephants are capable of being tracked in near real-time	Records of immobilisations	All groups and lone individuals collared
		b) Monitor elephant movements	Primary Senior Reserve Manager: GFRNR Support Ecological Technician: B&H Cluster	✓	✓	✓	✓	✓	High	The locations of elephant groups and individuals are known in near real-time and excursions through fences are detected.	Maps of elephant locations	Elephant locations are checked daily
	1.5.4 Monitor interspecific competition with rhino	1.5.4.1 Quantify elephant-induced changes to rhino movement patterns and mortality by understanding	Primary Specialist Technician: Rhino Monitoring Support Ecologist: B&H Cluster	✓		✓		✓	High	Impact of elephant on rhino habitat use is understood	Maps of home ranges of elephants and rhino	Every two years

		movements of elephants in relation to rhino a) Analyse the overlap between rhino and elephant home ranges and monitor changes to rhino home ranges	Ecological Technician: B&H Cluster									
		1.5.4.2 Monitor elephant interactions with rhino a) Record incidences of elephant-rhino conflict	Primary Senior Reserve Manager: GFRNR Support Specialist Technician: Rhino Monitoring Ecologist: B&H Cluster Ecological Technician: B&H Cluster	✓	✓	✓	✓	✓	High	Behavioural interactions between elephant and rhino understood	Records of interactions	Ongoing
	1.5.5 Monitor elephant impacts on significant biodiversity features	1.5.5.1 Develop and maintain an inventory of significant biodiversity features a) Taxon inventory surveys conducted	Primary Ecologist: B&H Cluster Support Ecological Technician: B&H Cluster		✓			✓	High	The occurrence and distribution of significant biodiversity features is understood	Inventory reports	One survey conducted in 2022/23. One survey conducted in 2025/26.
		1.5.5.2 Monitor elephant effects on significant biodiversity features	Primary Ecologist: B&H Cluster Support Ecological Technician: B&H Cluster		✓				High	The status of vulnerable biodiversity features is monitored to determine if they are being impacted by elephant.	Monitoring protocols. Monitoring reports.	Monitoring protocols required identified by end 2021/22.

		a) Identify key species or biodiversity features that require monitoring. b) Develop monitoring protocols for these species c) Implement monitoring programs										

Objective 2: To manage expectations of the benefits of elephant reintroduction, by co-developing a realistic model of tourism revenue and other benefits for the CPA, neighbours and ECPTA												
Objectives	**Sub-objectives**	**Actions**	**Responsibility**	**Time Frames (Years)**					**Priority**	**Key Outcomes**	**Key Verifiers**	**Target**
				21/ 22	**22/ 23**	**23/ 24**	**24/ 25**	**25/ 26**				
2.1 To manage realistic expectations through ongoing stakeholder engagement	2.1.1 Discuss the achievement of elephant management objectives at regular meetings with the CPA and with neighbouring	a) Discuss the achievement of elephant management objectives at regular meetings with the CPA	<u>Primary</u> Senior Reserve Manager: GFRNR <u>Support</u> Community Liaison Officer: B&H Cluster	✓	✓	✓	✓	✓	High	CPA is informed of elephant management objectives and activities	Records of meetings	2 meetings per year
		b) Discuss the achievement of	<u>Primary</u>	✓	✓	✓	✓	✓	High	Neighbouring communities and farmers	Records of meetings	2 meetings per year

	communities and farmers	elephant management objectives with neighbouring communities and farmers (through existing structures such as the reserve's liaison forum)	Senior Reserve Manager: GFRNR Support Community Liaison Officer: B&H Cluster							are informed of elephant management objectives and activities		
2.2 To co-develop a realistic model of tourism revenue and other benefits to the CPA, neighbours and ECPTA.	2.2.1 Identify opportunities to maximise the tourism benefits of elephant	a) Review literature and case studies and engage with other elephant managers to understand the influence of elephants on tourism	Primary Tourism Development Manager Support Senior Reserve Manager: GFRNR Community Liaison Officer: B&H Cluster	✓					Mod	The influence of elephants on tourism is understood	Report	By end of 2021/22
		b) Collaboratively identify opportunities for CPA and neighbours to be involved in tourism products	Primary Tourism Development Manager Support Senior Reserve Manager: GFRNR Community Liaison Officer: B&H Cluster		✓				High	Opportunities are identified	Records of engagements	By end of 2022/23
		Update the reserve's tourism plan										

Objective 3: To mitigate the risk that elephants pose to the organisation												
Objectives	**Sub-objectives**	**Actions**	**Responsibility**	**Time Frames (Years)**					**Priority**	**Key Outcomes**	**Key Verifiers**	**Target**
				21/ 22	**22/ 23**	**23/ 24**	**24/ 25**	**25/ 26**				
3.1 To minimize the impacts of elephants on neighbours by adequate fence maintenance and innovative use of technology	3.1.1 Ensure perimeter fence integrity	a) Conduct regular foot patrol fence inspections and identify areas requiring maintenance	Primary Conservation Manager: GFRNR Field Rangers Support Senior Reserve Manager: GFRNR	✓	✓	✓	✓	✓	High	Problem areas along the fence are identified	Field Ranger reports	Entire fence line assessed at least once every two weeks.
		b) Utilise UAVs to support fence inspections in remote and inaccessible areas	Primary Ecologist: B&H Cluster Support Ecological Technician: B&H Cluster	✓	✓	✓	✓	✓	High	Problem areas along the fence are identified	Field Ranger reports	As required
		c) Maintain shapefiles of current fencing condition	Primary Conservation Manager: GFRNR Field Rangers Support Senior Reserve Manager: GFRNR	✓	✓	✓	✓	✓	High	An overview of the current fence condition is available to support prioritisation and planning.	Map of fence condition	Updated annually

		d) Evaluate and implement other technological solutions to prevent and detect elephant excursions	<u>Primary</u> Senior Reserve Manager: GFRNR <u>Support</u> Conservation Manager: GFRNR Senior Manager: Scientific Services Ecologist: B&H Cluster	✓				✓	Mod	An understanding is obtained of technological solutions to support the prevention of elephant excursions.	Review of available technology.	Review conducted by end 2022 and again by end of 2026
		c) Conduct fence maintenance	<u>Primary</u> Conservation Manager: GFRNR General Assistants Field Rangers <u>Support</u> Senior Reserve Manager: GFRNR	✓	✓	✓	✓	✓	High	Problem areas are addressed in time to prevent excursions by elephant.	Reports of fence maintenance activities	Problem areas addressed within 3 days of detection.
3.2 To ensure that the organisation is compliant with national, provincial and other legislation with regard to having elephant on the reserve by implementing the Ministerially-approved elephant management plan.	3.2.1 Integrate legislative and policy requirements into the ECPTA's management of elephant	a) Review and list legislative and policy requirements for keeping elephant.	<u>Primary</u> Ecologist: B&H Cluster <u>Support</u> Senior Manager: GFRNR	✓				✓	High	Legal and policy requirements for keeping elephant are understood	Updates to the elephant management plan	Review conducted by end 2022 and then again by end 2026
		b) Develop Standard Operating Procedures to translate legislative and policy requirements into the ECPTA	<u>Primary</u> Senior Manager: GFRNR <u>Support</u> Conservation Manager: GFRNR	✓				✓	High	Procedures are developed to translate legislative and policy requirements in practice.	SOPs	SOPs developed by end of 2022 and reviewed by end of 2026.

		operational environment	Regional Manager: B&H Cluster									
		c) Obtain the necessary permits for management interventions on elephant.	<u>Primary</u> Senior Manager: GFRNR <u>Support</u> Conservation Manager: GFRNR Regional Manager: B&H Cluster	✓	✓	✓	✓	✓	High	Permits are obtained to enable management interventions as required	Permits	All necessary permits are obtained in advance of any management intervention requiring a permit.
3.3 To minimize risks of elephant damage to infrastructure and cultural assets by preventing elephants from accessing these assets		a) Identify features that need protection from elephant	<u>Primary</u> Senior Manager: GFRNR <u>Support</u> Conservation Manager: GFRNR	✓				✓	High	Infrastructure and cultural assets that require protection are identified	Map of location of infrastructure and cultural assets	Reviewed every 5 years
		b) Erect and maintain fencing, cables or other measures to exclude elephant	<u>Primary</u> Senior Reserve Manager: GFRNR		✓	✓	✓	✓	High	Infrastructure and cultural assets requiring special protection are secured	Map of installed infrastructure	Infrastructure erected by end 2022 Ongoing assessments of condition of infrastructure. Ongoing maintenance of infrastructure.

Objective 4: To provide opportunities for revenue generation through the potential for elephants to improve the tourism experience												
Objectives	**Sub-objectives**	**Actions**	**Responsibility**	**Time Frames (Years)**					**Priority**	**Key Outcomes**	**Key Verifiers**	**Target**
				21/ 22	22/ 23	23/ 24	24/ 25	25/ 26				
4.1 To improve the visitor experience in the reserve by developing a tourism plan that aligns with the organisational tourism strategy and enhances the existing tourism product	4.1.1 To ensure that the reserve's tourism plan is aligned with the organisational tourism strategy	a) Review organisational tourism strategy and reserve's tourism plan and ensure alignment.	Primary Tourism Development Manager Support Senior Manager: GFRNR	✓				✓	High	There is alignment between high-level and reserve-level tourism objectives	Amended reserve tourism plan.	By end of 2022 and reviewed by end of 2026.
		b) Amend reserve's tourism plan to incorporate aspects relating to the presence of elephant.	Primary Tourism Development Manager Support Senior Manager: GFRNR	✓				✓	High	The presence of elephant, and opportunities provided by this, is accounted for in the reserve's tourism development plan.	Amended reserve tourism plan.	By end of 2022 and reviewed by end of 2026.
	4.1.2 To optimise elephant encounters by developing innovative elephant-related tourism experiences and customizing tourism infrastructure for elephant viewing	a) Brainstorm possible elephant-related experiences	Primary Tourism Development Manager Support Senior Manager: GFRNR	✓					High	Opportunities to develop elephant-related tourism experiences are identified.	List of possible opportunities	By end of 2022.
		b) Assess feasibility of various elephant-related experiences,	Primary Tourism Development Manager	✓					High	The feasibility of various opportunities is explored and the way forward to develop these	Action plans	By end of 2022.

		develop action plans and seek partners.	Support Senior Manager: GFRNR							opportunities is understood.		
		c) Develop infrastructure and implement action plans	Primary: Senior Manager: GFRNR		✓	✓	✓		Mod	Reserve is developed to optimise tourism benefits from elephant.	Maps of infrastructure. Reports on the implementation of actions plans.	By end of 2025.
	4.1.3 To enrich the visitor experience by providing interpretative material about elephants and the reserve in general	a) Translate scientific understanding of elephant behaviour and ecology into accessible language.	Primary Ecologist: B&H Cluster Support: Ecological Technician: B&H Cluster		✓				Mod	Information for the use in interpretative material is generated.	Articles, text documents	By end of 2023.
		b) Develop and produce media and interpretive material	Primary: Tourism Development Manager Support: Senior Manager: GFRNR		✓				Mod	Tourists benefit from a greater understanding of the role of elephant in GFRNR	Media and interpretative material	By end of 2023.
4.2 To realise the potential for elephants to improve the tourism experience through a marketing strategy that sets the reserve's elephant experience apart from others	4.2.1 Incorporate the presence of elephant in to the marketing strategy for the reserve	a) Identify unique aspects of the elephant experience in GFRNR	Primary: Tourism Development Manager Support: Senior Manager: GFRNR	✓					Mod	Unique aspects to promote are identified	Report	By end of 2022
		b) Develop marketing material	Primary: Tourism Development Manager	✓	✓				Mod	Resources to support marketing of the presence	Narratives, photographs, brochures, posters, signage	By end of 2023

			Support: Senior Manager: GFRNR							of elephant in the reserve are developed		
		c) Determine appropriate media and target these	Primary: Tourism Development Manager Support: Senior Manager: GFRNR		✓				Mod	Awareness of the presence of elephant in the reserve is increased	Interviews, social media campaigns, additions to ECPTA website	By end of 2023
4.3 To make use of the opportunities provided by the presence of elephant to develop skills within the reserve and CPA 4.4 To make use of the presence of elephant in the reserve to develop local small businesses within the CPA and surrounding communities	4.3.1 Build capacity and an enabling environment for elephant-based guided tours	a) Develop partnerships with individuals and organisations with expertise in elephant guiding	Primary: Senior Manager: GFRNR Support: Community Liaison Officer: B&H Cluster			✓			Mod	Partnerships secured with individuals and organisations which can assist in developing expertise	Memorandum of Understanding	By end of 2024
		b) Develop training programs for the training of elephant guides (internal staff and from the CPA)	Primary: Senior Manager: GFRNR Support: Community Liaison Officer: B&H Cluster			✓			Mod	Internal staff and CPA members trained as elephant guides	Records of training course attendance	By end of 2024
		c) Develop a registration process and standards for operation for external (CPA) elephant guides	Primary: Senior Manager: GFRNR Support: Community Liaison Officer: B&H Cluster			✓			Mod	Standards developed for elephant guides	Standard Operating Procedure Database of registered guides	By end of 2024

Objective 5: To enable the implementation of the reserve's elephant management plan by securing adequate resources and capacity to manage elephant and their effects												
Objectives	**Sub-objectives**	**Actions**	**Responsibility**	**Time Frames (Years)**					**Priority**	**Key Outcomes**	**Key Verifiers**	**Target**
				21/22	22/23	23/24	24/25	25/26				
5.1 To secure adequate resources to manage elephants and their effects by incorporating the implementation costs into the organisation's budgetary planning and allocation.	5.1.1 To incorporate the costs of developing essential infrastructure required for compliance into the organisation's budgetary planning and allocation	a) Update infrastructure plan to include requirements for elephant	Primary: Senior Reserve Manager: GFRNR Support: Regional Manager: B&H Cluster	✓					High	New infrastructure required incorporated into budgetary planning	Infrastructure plan	By end of 2022.
		b) Ensure that budget is allocated according to infrastructure plan	Primary: Senior Reserve Manager: GFRNR Support: Regional Manager: B&H Cluster	✓					High	Budget is allocated to new infrastructure required	Budget	By start of 2022/23
	5.1.2 To incorporate the costs of protecting existing tourism and management infrastructure into the organisation's	a) Ensure that budget is allocated to installation of protection measures	Primary: Senior Reserve Manager: GFRNR Support: Regional Manager: B&H Cluster	✓					High	Budget is allocated for installation of measures to protect infrastructure	Budget	By start of 2022/23

	budgetary planning and allocation											
	5.1.3 To incorporate the costs of protecting special biodiversity features and cultural heritage assets into the organisation's budgetary planning and allocation.	a) Ensure that budget is allocated to installation and maintenance of protection measures	<u>Primary:</u> Senior Reserve Manager: GFRNR <u>Support:</u> Regional Manager: B&H Cluster	✓					High	Budget is allocated for installation of measures to protect special biodiversity and cultural features	Budget	By start of 2022/24 Annually thereafter for maintenance
	5.1.4 To incorporate the costs of identified monitoring of elephant effects and management into the organisation's budgetary planning and allocation.	a) Ensure that funds allocated towards activities outlined in the monitoring program	<u>Primary:</u> Senior Manager: Scientific Services <u>Support:</u> Regional Manager: B&H Cluster	✓	✓	✓	✓	✓	High	Budget is allocated for monitoring activities	Budget	All years, budget secured before the start of each financial year
5.2 To enable the implantation of the reserve's elephant management plan by developing the necessary skills and capacity within the reserve and CPA.	5.2.1 To optimize the skills of existing staff within the reserve through appropriate training.	a) Identify training requirements	<u>Primary:</u> Senior Reserve Manager: GFRNR <u>Support:</u> Human Capital Management division	✓	✓	✓	✓	✓	High	Training needs identified	List of training requirements	By end of 2022 Reviewed annually

		b) Conduct necessary training	<u>Primary:</u> Senior Reserve Manager: GFRNR <u>Support:</u> Human Capital Management division	✓	✓	✓	✓	✓	High	Staff upskilled in functions relating to elephant conservation and management	List of training courses conducted or attended	Initial training conducted in 2021/22 Continuous development thereafter, as required
	5.2.2 To utilise the opportunity presented by elephant on the reserve to contribute towards upskilling CPA members for reserve job opportunities.	a) Investigate opportunities to train and utilise CPA members for various functions required for elephant conservation and management (as field rangers, general assistances, hospitality staff, gate guards)	<u>Primary:</u> Senior Reserve Manager: GFRNR <u>Support:</u> Community Liaison Officer: B&H Cluster		✓	✓	✓	✓	High	CPA capacitated to benefit from job opportunities in the reserve	List of training coursed conducted or attended by CPA members List of CPA members employed by ECPTA	CPA members appointed to ECPTA positions by end of 2023.

Annexure C: Research program

Introduction

The Eastern Cape Parks & Tourism Agency (ECPTA) plans to reintroduce a functional population of African elephant *Loxodonta africana* to the Great Fish River Nature Reserve (GFRNR). Although there are already elephants in the reserve, the population is currently limited to a non-breeding population of only two cows.

The primary objective of the reintroduction is to reinstate the ecological processes associated with elephant, a keystone species in Albany thicket ecosystems. Elephant also have the potential to be destructive to their environments and to negatively impact on other species. In order to limit these impacts, the new elephant population on the GFRNR will be carefully monitored and managed with the objective of keeping densities low.

The impacts of elephant in the GFRNR must be understood within the frame of the system being restored to a more natural state after a long period of megaherbivore release. In this context, the current state of the reserve should be regarded as unnatural. Under the megaherbivore release hypothesis, the long-term absence of megaherbivores has changed the habitat, resulting in the vegetation becoming more closed and allowing for plant species that are vulnerable to megaherbivory or elephant disturbance to expand their distribution. Without an appreciation of this, elephant managers may become overly focused on the observed impacts of elephant and consider these to be forms of ecological degradation, rather than the restoration of historically occurring natural processes.

This document outlines the ECPTA's strategy for promoting research on elephant in the GFRNR, and on their impacts on the reserve. Since the ECPTA's capacity to conduct research is extremely limited, we will need to develop partnerships with universities and non-governmental organizations to fully achieve the GFRNR's elephant research objectives.

In developing the elephant research framework for GFRNR we consulted the South African Elephant Research Strategy. This strategy identifies four research themes for elephant research at a broad scale. These are: 1. Scaling management decisions (relevant scales for managing the effects of elephants); 2. Management interventions (risks associated with techniques, animal health and welfare risks, responses by elephants, risks associated with unintended consequences); 3. Management trade-offs (human perception, appraisal and ethical trade-offs, strategic environmental optimization risk and benefit assessment, policy and regulatory impact assessment); and 4. System integrity (biodiversity outcomes, tourism outcomes, stakeholder outcomes). Many of the themes in the national strategy are appropriate at broader scales and are not necessarily relevant at the scale of the reserve.

Objectives

The broad objectives for elephant research in the GFRNR are to obtain a better understanding of:

1. The historical baseline for megaherbivores in Albany thicket systems and how these systems have experienced megaherbivore release;
2. Elephant behaviour and ecology in enclosed Albany thicket systems;
3. The changes caused by the presence of elephants to animal behaviour, distribution and abundance, and to the plant communities and ecological processes of the GFRNR;
4. The impacts of elephant on people around the reserve, especially on tourism and the opportunities to support livelihoods; and
5. How to best manage the elephant in the GFRNR.

Research priorities

The priorities for research on elephant in the Great Fish River Nature Reserve are outlined in the tables below. Although studies directly pertinent to the management of elephant in the GFRNR are prioritized, research that contributes to the broader understanding of this species and its conservation is also encouraged, despite not necessarily being reflected below.

Research priorities for elephant in Great Fish River Nature Reserve

Objective 1:	**To obtain a better understanding of the historical baseline for megaherbivores in Albany thicket systems and how these systems have experienced megaherbivore release**	
Theme	**Research questions**	**Relevant studies**
Historical baselines for habitat with elephant and reversing megaherbivore release	• What did Albany thicket look like when the three megaherbivores (elephant, rhino and hippo) were present? • How will ecosystems change with the reintroduction of elephant?	Kerley, G. I.H., & Landman, M. (2006). The impacts of elephants on biodiversity in the Eastern Cape Subtropical Thickets: elephant conservation. South African Journal of Science, 102(9-10), 395-402. Kerley, G.I.H., Landman, M., Kruger, L. & Owen-Smith, N. 2007. Effects of elephants on ecosystems and biodiversity. In: Scholes, R.J. & Mennell, K.G. (eds). *Elephant Management: A scientific assessment for South Africa. Wits University* Press, Johannesburg.

Objective 2:	**To obtain a better understanding of elephant behaviour and ecology in enclosed Albany thicket systems**	
Theme	**Research questions**	**Relevant studies**
Population dynamics and regulation	• How will the population grow after reintroduction? • What are historic and appropriate elephant densities in GFRNR?	Gough, K. F., & Kerley, G. I. (2006). Demography and population dynamics in the elephants *Loxodonta africana* of Addo Elephant National Park, South Africa: is there evidence of density dependent regulation? Oryx, 40(4), 434-441. Hanks, J., & McIntosh, J. E. A. (1973). Population dynamics of the African elephant (Loxodonta africana). Journal of Zoology, 169(1), 29-38. Slotow, Rob, et al. (2005). Population dynamics of elephants re-introduced to small fenced reserves in South Africa." South African Journal of Wildlife Research-24-month delayed open access 35.1 23-32.
Diet	• Which species are preferred and which species are utilised by elephant? • Do the different sexes occupy different feeding niches?	Owen-Smith, N., & Chafota, J. (2012). Selective feeding by a megaherbivore, the African elephant (Loxodonta africana). Journal of Mammalogy, 93(3), 698-705. Codron, J., Lee-Thorp, J. A., Sponheimer, M., Codron, D., Grant, R. C., & de Ruiter, D. J. (2006). Elephant (Loxodonta africana) diets in Kruger National Park, South Africa: spatial and landscape differences. Journal of Mammalogy, 87(1), 27-34.
Home range and habitat use	• What are the home ranges of breeding herds and individual bulls? • Which areas of the reserve are elephant using? Which habitats are preferred by elephant and which are avoided? What accounts for habitat preference? • Are there key resource areas used by elephant, and do elephant use these at different times? • Do males and family groups have different requirements at different times (e.g. for water)?	Roux, C., & Bernard, R. T. F. (2009). Home range size, spatial distribution and habitat use of elephants in two enclosed game reserves in the Eastern Cape Province, South Africa. African journal of ecology, 47(2), 146-153. Thomas, B., Holland, J. D., & Minot, E. O. (2008). Elephant (Loxodonta africana) home ranges in Sabi Sand Reserve and Kruger National Park: a five-year satellite tracking study. PLoS One, 3(12), e3902. Matawa, F., Murwira, A., & Schmidt, K. S. (2012). Explaining elephant (Loxodonta africana) and buffalo (Syncerus caffer) spatial distribution in the Zambezi Valley using maximum entropy modelling. Ecological Modelling, 242, 189-197. Dolmia, N. M., Calenge, C., Maillard, D., & Planton, H. (2007). Preliminary observations of elephant (Loxodonta africana, Blumenbach) movements and home range in Zakouma National Park, Chad. African Journal of Ecology, 45(4), 594-598. Thomas, B., Holland, J. D., & Minot, E. O. (2012). Seasonal home ranges of elephants (Loxodonta africana) and their movements between Sabi Sand Reserve and Kruger National Park. African Journal of Ecology, 50(2), 131-139.

	• How do young bulls disperse out of natal groups to establishment new home ranges? • Can we predict which areas of GFRNR will function as refugia for species vulnerable to elephant impacts (e.g. based on distance from water, topography)?	Whitehouse, A. M., & Schoeman, D. S. (2003). Ranging behaviour of elephants within a small, fenced area in Addo Elephant National Park, South Africa. African Zoology, 38(1), 95-108. Druce, H. C., Pretorius, K., & Slotow, R. (2008). The response of an elephant population to conservation area expansion: Phinda Private Game Reserve, South Africa. Biological Conservation, 141(12), 3127-3138. Guldemond, R. A. R., & van Aarde, R. J. (2006). Range constriction and landscape use of elephants in Maputaland, southern Africa. The influence of savannah elephants on vegetation: a case study in the Tembe Elephant Park, South Africa, 54. Nellemann, C., Moe, S. R., & Rutina, L. P. (2002). Links between terrain characteristics and forage patterns of elephants (Loxodonta africana) in northern Botswana. Journal of Tropical Ecology, 18(6), 835-844. Jachowski, D. S., Montgomery, R. A., Slotow, R., & Millspaugh, J. J. (2013). Unravelling complex associations between physiological state and movement of African elephants. Functional Ecology, 27(5), 1166-1175.
Behavioural studies	• What levels of social organisation exist in breeding herds? • How will the existing and newly introduced elephants interact with each other?	Archie, E. A., Morrison, T. A., Foley, C. A., Moss, C. J., & Alberts, S. C. (2006). Dominance rank relationships among wild female African elephants, Loxodonta africana. Animal Behaviour, 71(1), 117-127. Wittemyer, G., & Getz, W. M. (2007). Hierarchical dominance structure and social organization in African elephants, Loxodonta africana. Animal Behaviour, 73(4), 671-681. Charif, R. A., Ramey, R. R., Langbauer, W. R., Payne, K. B., Martin, R. B., & Brown, L. M. (2005). Spatial relationships and matrilineal kinship in African savanna elephant (Loxodonta africana) clans. Behavioral Ecology and Sociobiology, 57(4), 327-338. Wisniewska, M. (2011). Factors Influencing Travel Order as Proxy for Leadership and Trade-offs in Activity Budgets in Lactating and Nonlactating African Savanna Elephants.
	• How do bulls organise themselves into dominance hierarchies? • How does the phenomenon of musth influence elephant behaviour?	Poole, J. H., & Moss, C. J. (1981). Musth in the African elephant, Loxodonta africana. Nature, 292(5826), 830. Hollister-Smith, J. A., Poole, J. H., Archie, E. A., Vance, E. A., Georgiadis, N. J., Moss, C. J., & Alberts, S. C. (2007). Age, musth and paternity success in wild male African elephants, Loxodonta africana. Animal Behaviour, 74(2), 287-296. Evans, K. E., & Harris, S. (2008). Adolescence in male African elephants, Loxodonta africana, and the importance of sociality. Animal Behaviour, 76(3), 779-787. Goldenberg, S. Z., de Silva, S., Rasmussen, H. B., Douglas-Hamilton, I., & Wittemyer, G. (2014). Controlling for behavioural state reveals social dynamics among male African elephants, *Loxodonta africana*. Animal behaviour, 95, 111-119. Santos, T. L. N. D. S. (2017). Genetic characterisation of an African elephant (Loxodonta africana) population: the role of genetic relatedness in male social groups (Doctoral dissertation). Ganswindt, A., Rasmussen, H. B., Heistermann, M., & Hodges, J. K. (2005). The sexually active states of free-ranging male African elephants (Loxodonta africana): defining musth and non-musth using endocrinology, physical signals, and behavior. Hormones and Behavior, 47(1), 83-91.
	• How do elephants communicate and vocalise with each other? • How will elephants (particularly bulls) respond to the presence of elephants in	Soltis, J., Leong, K., & Savage, A. (2005). African elephant vocal communication II: rumble variation reflects the individual identity and emotional state of callers. Animal Behaviour, 70(3), 589-599. Soltis, J. (2010). Vocal communication in African elephants (*Loxodonta africana*). Zoo Biology, 29(2), 192-209.

	neighbouring properties (Kwandwe)?	Soltis, J., King, L. E., Douglas-Hamilton, I., Vollrath, F., & Savage, A. (2014). African elephant alarm calls distinguish between threats from humans and bees. PLoS One, 9(2), e89403. O'Connell-Rodwell, C. E., Wood, J. D., Kinzley, C., Rodwell, T. C., Poole, J. H., & Puria, S. (2007). Wild African elephants (Loxodonta africana) discriminate between familiar and unfamiliar conspecific seismic alarm calls. The Journal of the Acoustical Society of America, 122(2), 823-830.
	• Sex ratios, sexual dimorphism and segregation	Stokke, S., & Du Toit, J. T. (2002). Sexual segregation in habitat use by elephants in Chobe National Park, Botswana. African Journal of Ecology, 40(4), 360-371. Shannon, G., Page, B. R., Duffy, K. J., & Slotow, R. (2006). The role of foraging behaviour in the sexual segregation of the African elephant. Oecologia, 150(2), 344-354. Poole, J. H. (1994). Sex differences in the behaviour of African elephants. The differences between the sexes, 331-346. Shannon, G., Page, B. R., Mackey, R. L., Duffy, K. J., & Slotow, R. (2008). Activity budgets and sexual segregation in African elephants (Loxodonta africana). Journal of Mammalogy, 89(2), 467-476. Visscher, D. R., Van Aarde, R. J., & Whyte, I. (2004). Environmental and maternal correlates of foetal sex ratios in the African buffalo (Syncerus caffer) and savanna elephant (Loxodonta africana). Journal of Zoology, 264(2), 111-116. Saragusty, J., Hermes, R., Göritz, F., Schmitt, D. L., & Hildebrandt, T. B. (2009). Skewed birth sex ratio and premature mortality in elephants. Animal reproduction science, 115(1-4), 247-254.

Objective 3:	**To understand the changes caused by the presence of elephants to animal behaviour, distribution and abundance, and to the plant communities and ecological processes of the GFRNR**	
Theme	**Research questions**	**Relevant studies**
Ecological processes	• What will the impact of elephant be on plant species composition and habitat structure? (e.g. path formation) • What are the mechanisms responsible for the changes to habitat brought about by elephant?	Parker, D. M. (2017) The composition and complexity of the woody and succulent components of Albany thicket with and without elephants. South African Journal of Botany 112 (2017): 19-28. Baxter, P. W. J. (2003). Modeling the impact of the African elephant, Loxodonta africana, on woody vegetation in semi-arid savannas (Doctoral dissertation, University of California, Berkeley). Hayward, M. W., & Zawadzka, B. (2010). Increasing elephant Loxodonta africana density is a more important driver of change in vegetation condition than rainfall. Acta Theriologica, 55(4), 289-298. Landman, M., Schoeman, D. S., Hall-Martin, A. J., & Kerley, G. I. (2014). Long-term monitoring reveals differing impacts of elephants on elements of a canopy shrub community. Ecological Applications, 24(8), 2002-2012. Smith, J. (2012). A spatial and temporal analysis of elephant induced thicket degradation in Addo Elephant National Park (Doctoral dissertation, Nelson Mandela Metropolitan University). Knott, E. J. (2007). The Effect of Elephants (Loxodonta Africana, Blumenbach, 1797) on Xeric Succulent Thicket (Doctoral dissertation, Rhodes University). Parker, D. M. (2008). The effects of elephants at low densities and after short occupation time on the ecosystems of the Eastern Cape Province, South Africa (Doctoral dissertation, Rhodes University). Lagendijk, D. D. G. (2011). The effects of elephant and mesoherbivores on woody vegetation (Doctoral dissertation). Stuart-Hill, G. C. (1992). Effects of elephants and goats on the Kaffrarian succulent thicket of the eastern Cape, South Africa. Journal of Applied Ecology, 699-710.

		Parker, D. M. (2008). The effects of elephants at low densities and after short occupation time on the ecosystems of the Eastern Cape Province, South Africa (Doctoral dissertation, Rhodes University).
	• How will elephant influence browse availability to other species? • What are the consequences of shifting the balance between browser and grazer assemblages (and between hindgut fermenters and ruminants) • Feeding behaviour and mechanics, forage height, overlap and competition with other species	Kohi, E. M., de Boer, W. F., Peel, M. J., Slotow, R., van der Waal, C., Heitkönig, I. M., ... & Prins, H. H. (2011). African elephants Loxodonta africana amplify browse heterogeneity in African savanna. Biotropica, 43(6), 711-721. Rutina, L. P., Moe, S. R., & Swenson, J. E. (2005). Elephant Loxodonta africana driven woodland conversion to shrubland improves dry-season browse availability for impalas Aepyceros melampus. Wildlife Biology, 11(3), 207-214. Wong, J. (2013). Effects of African elephant (Loxodonta africana) on forage opportunities for local ungulates through pushing over trees.
	• What role do elephants play in seed dispersal?	Midgley, J. J., Gallaher, K., & Kruger, L. M. (2012). The role of the elephant (Loxodonta africana) and the tree squirrel (Paraxerus cepapi) in marula (Sclerocarya birrea) seed predation, dispersal and germination. Journal of Tropical Ecology, 28(2), 227-231. Bunney, K. (2014). Seed dispersal in South African trees: with a focus on the megafaunal fruit and their dispersal agents (Doctoral dissertation, University of Cape Town).
	• What role do elephants plan in litter production and nutrient cycling	Kerley, G. I., & Landman, M. (2006). The impacts of elephants on biodiversity in the Eastern Cape Subtropical Thickets: elephant conservation. South African Journal of Science, 102(9-10), 395-402. Lechmere-Oertel, R. G., Kerley, G. I. H., Mills, A. J., & Cowling, R. M. (2008). Litter dynamics across browsing-induced fenceline contrasts in succulent thicket, South Africa. South African Journal of Botany, 74(4), 651-659.
	• What role do elephants play in hydrological functioning (e.g. runoff and run on zones)?	Cowling, R. M., & Mills, A. J. (2011). A preliminary assessment of rain throughfall beneath Portulacaria afra canopy in subtropical thicket and its implications for soil carbon stocks. South African Journal of Botany, 77(1), 236-240. Van Luijk, G., Cowling, R. M., Riksen, M. J. P. M., & Glenday, J. (2013). Hydrological implications of desertification: Degradation of South African semi-arid subtropical thicket. Journal of arid environments, 91, 14-21.
	• Are there species associated with or dependent on elephant (mutualisms)?	Horak, I. G., Heyne, H., Williams, R., Gallivan, G. J., Spickett, A. M., Bezuidenhout, J. D., & Estrada-Peña, A. (2018). Hosts and Host and Vegetation Tick Lists. In The Ixodid Ticks (Acari: Ixodidae) of Southern Africa (pp. 541-634). Springer, Cham.
Impacts on habitat and plant species	• Which plant species are vulnerable to elephant utilisation or disturbance? • Can we identify vulnerable species based on their traits (sprouting ability, restricted range, high selection by elephants, subjected to pollarding or ringbarking, slow regeneration, slow growing, episodic recruitment)? • Which species benefit from elephant presence?	Parker, D. M., & Bernard, R. T. F. (2009). Levels of aloe mortality with and without elephants in the Thicket Biome of South Africa. African journal of ecology, 47(2), 246-251. Cowling, R., & Kerley, G. I. H. (2002). Impacts of elephants on the flora and vegetation of subtropical thicket in the Eastern Cape. In Elephant Conservation and Management in the Eastern Cape. Workshop Proceedings'.(Eds G. Kerley, S. Wilson and A. Massey.) pp (pp. 55-72). Cowling, R. M., Kamineth, A., Difford, M., & Campbell, E. E. (2010). Contemporary and historical impacts of megaherbivores on the population structure of tree euphorbias in South African subtropical thicket. African journal of ecology, 48(1), 135-145. Landman, M., Kerley, G. I. H., & Schoeman, D. S. (2008). Relevance of elephant herbivory as a threat to important plants in the Addo Elephant National Park, South Africa. Journal of Zoology, 274(1), 51-58.

	• What are the mechanisms for disturbance / facilitation?	Johnson, C. F., Cowling, R. M., & Phillipson, P. B. (1999). The flora of the Addo Elephant National Park, South Africa: are threatened species vulnerable to elephant damage?. Biodiversity & Conservation, 8(11), 1447-1456. Lombard, A. T., Johnson, C. F., Cowling, R. M., & Pressey, R. L. (2001). Protecting plants from elephants: botanical reserve scenarios within the Addo Elephant National Park, South Africa. Biological Conservation, 102(2), 191-203. Johnson, C. F. (1998). Vulnerability, irreplaceability and reserve selection for the elephant-impacted flora of the Addo Elephant National Park, Eastern Cape, South Africa. Unpublished MSc thesis, Rhodes University. Ihwagi, F. W., Vollrath, F., Chira, R. M., Douglas-Hamilton, I., & Kironchi, G. (2010). The impact of elephants, Loxodonta africana, on woody vegetation through selective debarking in Samburu and Buffalo Springs National Reserves, Kenya. African Journal of Ecology, 48(1), 87-95. Mtui, D., & Owen-Smith, N. (2006). Impact of elephants (Loxodonta africana) on woody plants in Malolotja Nature Reserve, Swaziland. African Journal of Ecology, 44(3), 407-409. Heilmann, L. C., de Jong, K., Lent, P. C., & de Boer, W. F. (2006). Will tree euphorbias (Euphorbia tetragona and Euphorbia triangularis) survive under the impact of black rhinoceros (Bicornis diceros minor) browsing in the Great Fish River Reserve, South Africa?. African Journal of Ecology, 44(1), 87-94. Lent, P. C., Eshuis, H., Van Krimpen, R., & De Boer, W. F. (2010). Continued decline in tree euphorbias (Euphorbia tetragona and E. triangularis) on the Great Fish River Reserve, Eastern Cape, South Africa. African journal of ecology, 48(4), 923-929. Kakembo, V., Smith, J., & Kerley, G. (2015). A temporal analysis of elephant-induced thicket degradation in Addo Elephant National Park, Eastern Cape, South Africa. Rangeland ecology & management, 68(6), 461-469.
	• What are the impacts of elephant on Albany thicket restoration (Spekboom planting)	Todkill, W. B., Kerley, G. I. H., & Campbell, E. E. (2006). Brushpiles and dung as rehabilitation patches: effect on soil resources in degraded succulent thicket, Eastern Cape, South Africa. African Journal of Range and Forage Science, 23(1), 39-48.
Impacts on animal species and communities	• How will elephant impact on other fauna? Which taxa are vulnerable? • Do elephant facilitate grazers (e.g. buffalo) by opening up habitat? • How will elephant impact on kudu, considering their dietary overlap • What are the mechanisms for elephant impact on animal species (direct conflict, interference competition, competition for food, disturbance, and habitat modification)? • How do elephant facilitate certain taxa (creation of refugia – e.g. under dung)?	Herremans, M. (1995). Effects of woodland modification by African elephant Loxodonta africana on bird diversity in northern Botswana. Ecography, 18(4), 440-454. Nasseri, N. A., McBrayer, L. D., & Schulte, B. A. (2011). The impact of tree modification by African elephant (Loxodonta africana) on herpetofaunal species richness in northern Tanzania. African Journal of Ecology, 49(2), 133-140. Parker, D. M. (2019). The elephant in the 'room': determinants of songbird assemblages in the Thicket Biome, South Africa. Emu-Austral Ornithology, 1-9. Kerley, G. I., & Landman, M. (2006). The impacts of elephants on biodiversity in the Eastern Cape Subtropical Thickets: elephant conservation. South African Journal of Science, 102(9-10), 395-402. Sivewright, S. Bird Community Responses to Elephant-Induced Impacts on the Landscape. Fritz, H., Duncan, P., Gordon, I. J., & Illius, A. W. (2002). Megaherbivores influence trophic guilds structure in African ungulate communities. Oecologia, 131(4), 620-625.
	• How will the presence of elephant impact on rhino behaviour and habitat utilisation?	Landman, M., Schoeman, D. S., & Kerley, G. I. (2013). Shift in black rhinoceros diet in the presence of elephant: evidence for competition?. PLoS One, 8(7), e69771.

		Valeix, M., Chamaillé-Jammes, S., & Fritz, H. (2007). Interference competition and temporal niche shifts: elephants and herbivore communities at waterholes. Oecologia, 153(3), 739-748. Berger, J., & Cunningham, C. (1998). Behavioural ecology in managed reserves: gender-based asymmetries in interspecific dominance in African elephants and rhinos. Animal Conservation, 1(1), 33-38.

Objective 4:	**To understand the impacts of elephant on people around the reserve, especially on tourism and the opportunities to support livelihoods**	
Theme	**Research questions**	**Relevant studies**
Impacts on tourism	• How does having elephants raise the profile of the reserve? • How much of an attraction to tourists is the presence of elephants? • What are tourists' expectations relating to elephant?	Kerley, G. I., Geach, B. G., & Vial, C. (2003). Jumbos or bust: do tourists' perceptions lead to an under-appreciation of biodiversity?. South African Journal of Wildlife Research-24-month delayed open access, 33(1), 13-21. Maciejewski, K., & Kerley, G. I. (2014). Elevated elephant density does not improve ecotourism opportunities: convergence in social and ecological objectives. Ecological Applications, 24(5), 920-926. Maciejewski, K., & Kerley, G. I. (2014). Understanding tourists' preference for mammal species in private protected areas: is there a case for extralimital species for ecotourism?.PLoS One, 9(2), e88192. Geach, B. (2002). The economic value of elephants–with particular reference to the Eastern Cape. In Elephant conservation and management in the Eastern Cape: Workshop proceedings (pp. 32-40). Okello, M. M., Manka, S. G., & D'Amour, D. E. (2008). The relative importance of large mammal species for tourism in Amboseli National Park, Kenya. Tourism Management, 29(4), 751-760.
Impacts on people around the reserve	• What are the local people's perceptions of elephant? • What opportunities exist for people living around the reserve to benefit from elephant?	Twine, W., & Magome, H. (2008). Interactions between elephants and people. Elephant Management: A Scientific Assessment of South Africa. Wits Univ. Press, Johannesburg, South Africa, 206-240. Hill, C. M. (1998). Conflicting attitudes towards elephants around the Budongo Forest Reserve, Uganda. Environmental Conservation, 25(3), 244-250. Kuriyan, R. (2002). Linking local perceptions of elephants and conservation: Samburu pastoralists in northern Kenya. Society &Natural Resources, 15(10), 949-957. Lee, P. C., & Graham, M. D. (2006). African elephants Loxodonta africana and human-elephant interactions: implications for conservation. International Zoo Yearbook, 40(1), 9-19.

Objective 5:	**To learn how to best manage elephant**	
Theme	**Research questions**	**Relevant studies**
Reintroduction	• What is the best way to reintroduce elephant to GFRNR • How will newly reintroduced elephant respond after release?	Burks, K. D., Mellen, J. D., Miller, G. W., Lehnhardt, J., Weiss, A., Figueredo, A. J., & Maple, T. L. (2004). Comparison of two introduction methods for African elephants (Loxodonta africana). Zoo Biology: Published in affiliation with the American Zoo and Aquarium Association, 23(2), 109-126. Pinter-Wollman, Noa. "Spatial behaviour of translocated African elephants (Loxodonta africana) in a novel environment: using behaviour to inform conservation actions." Behaviour (2009): 1171-1192. Pinter-Wollman, N., Isbell, L. A., & Hart, L. A. (2009). Assessing translocation outcome: comparing behavioral and physiological

		aspects of translocated and resident African elephants (Loxodonta africana). Biological Conservation, 142(5), 1116-1124.
Regulating the population and population growth	• Which methods of contraception are most suitable? • How effective is immuno-contraception of elephant on GFRNR? • When should contraception be instituted and at what frequency? • What demographic profile is desirable for GFRNR?	Delsink, A. K., Kirkpatrick, J., Grobler, D., & Fayrer-Hosken, R. A. (2002). Field applications of immunocontraception in African elephants (Loxodonta africana). Reproduction (Cambridge, England) Supplement, 60, 117-124. Valades, G. B., Ganswindt, A., Annandale, H., Schulman, M. L., & Bertschinger, H. J. (2012). Non-invasive assessment of the reproductive cycle in free-ranging female African elephants (Loxodonta africana) treated with a gonadotropin-releasing hormone (GnRH) vaccine for inducing anoestrus. Reproductive Biology and Endocrinology, 10(1), 63. Delsink, A. K., Kirkpatrick, J., Van Altena, J. J., Bertschinger, H. J., Ferreira, S. M., & Slotow, R. (2013). Lack of spatial and behavioral responses to immunocontraception application in African elephants (Loxodonta africana). Journal of Zoo and Wildlife Medicine, 44(4s), S52-S74.
Regulating habitat use	• How feasible is it to manipulate elephant density across the reserve by altering accesses to key resources? • What is the feasibility of other means to manipulate elephant spatial habitat use (noise, chemicals)? • Do we need elephant exclosures / botanical reserves?	Chamaillé-Jammes, S., Valeix, M., & Fritz, H. (2007). Managing heterogeneity in elephant distribution: interactions between elephant population density and surface-water availability. Journal of Applied Ecology, 44(3), 625-633. Purdon, A., & van Aarde, R. J. (2017). Water provisioning in Kruger National Park alters elephant spatial utilisation patterns. Journal of Arid Environments, 141, 45-51. Owen-Smith, N. G. I. H., Slotow, R., Kerley, G. I. H., Van Aarde, R. J., & Page, B. (2006). A scientific perspective on the management of elephants in the Kruger National Park and elsewhere: elephant conservation. South African journal of science, 102(9), 389-394. Wienand, J. J. (2013). Woody vegetation change and elephant water point use in Majete Wildlife Reserve: implications for water management strategies. Balfour, D. (2007). Review of options for managing the impacts of locally overabundant African elephants. IUCN. Knight, M., Castley, G., Moolman, L., & Adendorff, J. (2002). Elephant management in Addo Elephant National Park. GIH Kerley, S Wilson & A Massey (Eds) Elephant Conservation and management in the Eastern Cape. Terrestrial Ecology Research Unit, Nelson Mandela Metropolitan University, Report, 35.
Metapopulation management and genetics	• When do we need to bring new animals in? How should this be done? At which intervals should bulls be cycled? • Which animals should be removed? • Monitoring the phenotypic response to changes in gene frequencies for tusklessness (with addition of non-Addo animals)	Van Jaarsveld, A. S., Nicholls, A. O., & Knight, M. H. (1999). Modelling and assessment of South African elephant Loxodonta africana population persistence. Environmental Modeling & Assessment, 4(2-3), 155-163. Van Aarde, R. J., & Jackson, T. P. (2007). Megaparks for metapopulations: addressing the causes of locally high elephant numbers in southern Africa. Biological conservation, 134(3), 289-297. Roever, C. L., Van Aarde, R. J., & Leggett, K. (2013). Functional connectivity within conservation networks: Delineating corridors for African elephants. Biological Conservation, 157, 128-135. Miller, S. M., Harper, C. K., Bloomer, P., Hofmeyr, J., & Funston, P. J. (2015). Fenced and fragmented: conservation value of managed metapopulations. PloS one, 10(12), e0144605. Lubow, B. C. (1996). Optimal translocation strategies for enhancing stochastic metapopulation viability. Ecological Applications, 6(4), 1268-1280. Whitehouse, A. (2002). Managing small elephant populations: lessons from genetic studies. In Workshop on Elephant Management and Conservation in the Eastern Cape (pp. 41-48).

		Whitehouse, A. M. (2002). Tusklessness in the elephant population of the Addo Elephant National Park, South Africa. Journal of Zoology, 257(2), 249-254. Whitehouse, A. M., & Harley, E. H. (2001). Post-bottleneck genetic diversity of elephant populations in South Africa, revealed using microsatellite analysis. Molecular ecology, 10(9), 2139-2149.
Technologies for monitoring and managing elephant	• What emerging technologies exist for monitoring and managing elephant? • What are the most reliable indicators for monitoring elephant impact? • How do monitoring systems need to be designed to be able to detect actual change rather than natural variation in the system? • Can we utilise the cover values derived by Smit et al. as a proxy for healthy thicket? • Is vegetative cover a good surrogate for biodiversity in Albany thicket systems? • What technologies can we use to limit elephant access to key resources in order to manipulate their spatial use of habitat (e.g. excluding elephant from certain water sources)?	Galanti, V., Tosi, G., Rossi, R., & Foley, C. (2000). The use of GPS radio-collars to track elephants (Loxodonta africana) in the Tarangire National Park (Tanzania). Hystrix-the Italian Journal of Mammalogy, 11(2). Smit, I. P., Landman, M., Cowling, R. M., & Gaylard, A. (2016). Expert-derived monitoring thresholds for impacts of megaherbivores on vegetation cover in a protected area. Journal of environmental management, 177, 298-305. Nkosi, S. E., Adam, E., Barrett, A. S., & Brown, L. R. (2019). A synopsis of field and remote sensing based methods for studying African elephant (Loxodonta africana) impact on woody vegetation in Africa. Applied ecology and environmental research, 17(2), 4045-4066. Knight, M., Castley, G., Moolman, L., & Adendorff, J. (2002). Elephant management in Addo Elephant National Park. GIH Kerley, S Wilson & A Massey (Eds) Elephant Conservation and management in the Eastern Cape. Terrestrial Ecology Research Unit, Nelson Mandela Metropolitan University, Report, 35. Whitehouse, A. M., Hall-Martin, A. J., & Knight, M. H. (2001). A comparison of methods used to count the elephant population of the Addo Elephant National Park, South Africa. African Journal of Ecology, 39(2), 140-145. Morrison, J., Higginbottom, T., Symeonakis, E., Jones, M., Omengo, F., Walker, S., & Cain, B. (2018). Detecting vegetation change in response to confining elephants in forests using MODIS time-series and BFAST. Remote Sensing, 10(7), 1075. Grant, CC, Bengis, R, Balfour, D & Peel, M. Controlling the distribution of elephant. *Assessment of South African Elephant Management* Kakembo, V., Smith, J., & Kerley, G. (2015). A temporal analysis of elephant-induced thicket degradation in Addo Elephant National Park, Eastern Cape, South Africa. Rangeland ecology & management, 68(6), 461-469.
Animal welfare and ethics	• How do management interventions impact on the welfare of elephants? • How do elephants respond to stress?	Ganswindt, A., Münscher, S., Henley, M., Palme, R., Thompson, P., & Bertschinger, H. (2010). Concentrations of faecal glucocorticoid metabolites in physically injured free-ranging African elephants Loxodonta africana. Wildlife Biology, 16(3), 323-333. Tingvold, H. G., Fyumagwa, R., Bech, C., Baardsen, L. F., Rosenlund, H., & Røskaft, E. (2013). Determining adrenocortical activity as a measure of stress in African elephants (Loxodonta africana) in relation to human activities in Serengeti ecosystem. African Journal of Ecology, 51(4), 580-589. Möstl, E., & Palme, R. (2002). Hormones as indicators of stress. Domestic animal endocrinology, 23(1-2), 67-74. Viljoen, J. J., Ganswindt, A., Reynecke, C., Stoeger, A. S., & Langbauer Jr, W. R. (2015). Vocal stress associated with a translocation of a family herd of African elephants (Loxodonta africana) in the Kruger National Park, South Africa. Bioacoustics, 24(1), 1-12.

Internal research

A limited amount of research will be conducted by ECPTA Scientific Services staff. However, given capacity constraints, and a primary focus on monitoring, it is not envisaged that elephant research will be major component of their work plans. Rather, it is expected that Scientific Services staff will play a role in facilitating and supporting external research.

External research and partner organisations

The ECPTA hopes to develop partnerships with several external institutions to further the elephant research agenda of the GFRNR.

It is envisaged that the Centre for African Conservation Ecology (ACE) of the Nelson Mandela University (NMU) will be a particularly important partner, given the experience held by this institution (and its researchers) on elephants in Albany thicket, its proximity to the reserve and previous collaborations between the ECPTA and NMU. A Memorandum of Understanding (MoU) already exists between ECPTA and NMU, and this needs to be enacted.

Memoranda of Understanding have also been signed with Rhodes University and the University of Fort Hare. Both institutions have played important roles in developing our understanding of the social, economic and ecological context of the reserve, and could contribute to elephant related research on the reserve.

The Elephant Reintegration Trust is non-governmental organization that has focused on the reintegration of previously captive elephants with wild populations. This organization has tremendous expertise in understanding elephant behaviour, and could provide invaluable support in understanding the interaction between existing and newly-introduced elephants on the GFRNR (a research project has already been registered with this organization to examine this). In addition, it is hoped the ECPTA staff will benefit from capacity building opportunities provided by this organization.

Research approval process

The ECPTA has a policy for research in its protected areas and an established process for the approval of external research applications. Researchers interested in conducting field work in ECPTA protected areas must submit an application form to Scientific Services. Applications are reviewed by the relevant ecologist and reserve manager before being submitted for approval by the Senior Manager: Scientific Services and the Chief Executive Officer. Once approved, a research agreement is drafted. External researchers are required to liaise with reserve managers for access to the reserves and must submit annual progress reports.

Facilities for researchers

The Basil Kent Research Centre is available for external researchers to use while conducting field work on the GFRNR. In addition, other tourism facilities can be utilised. Facilities may be made available at reduced rates to researchers conducting research that has been identified as a priority by the ECPTA.

Annexure D: Monitoring program

Introduction

Elephant management in the GFRNR will be done with the understanding that both spatial and temporal heterogeneity is desirable in order to maximize biodiversity and maintain resilience (i.e. the intermediate disturbance hypothesis). As such, the focus will be on managing elephant impacts on vegetation, and associated biodiversity, by ensuring that impacts are patchily distributed across the landscape. Patchy impacts enable species that are intolerant of elephant impact to persist in the refuge areas between patches of even severe elephant impact. This approach maximizes biodiversity at the landscape scale by allowing for different suites of species to establish in the varying habitats that they prefer.

Monitoring will be a key component of the adaptive management strategy for elephant in the GFRNR. The interaction between elephant and their environment will be monitored, together with the effectiveness of any management actions. The results will then be reviewed and used to inform the development of subsequent management actions. This document outlines the ECPTA's strategy for monitoring elephant and their impacts on the reserve. Importantly, the ECPTA's capacity to monitor elephant is limited. The ECPTA therefore needs to rely on external partners and the innovative use of technology in order to achieve its monitoring objectives.

Monitoring framework

The monitoring program will involve two phases: an initial phase where we attempt to gain an understanding of how elephant are utilizing the reserve, and a subsequent phase, which will be directed by the initial phase, where we will focus our monitoring efforts on detecting change caused by elephants. This will be done by monitoring against baseline data for areas within elephant home ranges and by comparing heavily utilised areas to areas that elephant do not utilize. We also propose routine monitoring activities that will take place during both the initial and subsequent monitoring phases.

Objectives

The objectives of the elephant monitoring program on the Great Fish River Nature Reserve are to:

1. Monitor the status of the elephant population;
2. Monitor the changes caused by elephant to habitat, ecological processes and the distribution, abundance and behaviour of other species; and
3. Monitor the impact of elephant on reserve management, and tourism and other ecosystem goods and services.

The objectives of the monitoring program are deconstructed into various aspects, indicators and methods in the table below.

Objective	Aspect		Indicator / surrogate	Method
Monitor the status of the elephant population	Population dynamics	Population size	Number of individuals	Aerial game census
		Fecundity	Number of births	Aerial game census, field ranger observations
		Mortality	Number of deaths	Aerial game census, field ranger observations
		Population growth	Rate of increase	Calculation of rate of increase based on increase in known population size (birth rates and death rates)
	Diet		Species recorded being utilised by elephant	Fecal analysis, field ranger observations
	Habitat use and distribution		Home range and density	Satellite / radio collars
	Key resource areas		Concentration of elephant in space and time	Satellite / radio collars

Monitor changes to habitat, ecological processes and the distribution, abundance and behaviour of species	Changes in habitat structure	Changes in cover	Remote sensing of satellite imagery, drone imagery, vegetation surveys
	Changes in other aspects of ecological functioning	Changes in recruitment, seed dispersal, litter production, hydrological functioning	Dedicated research projects
	Changes in plant species composition or abundance	Decrease in indicator species (e.g. mistletoes, aloes) abundance or distribution	Vegetation surveys
	Impacts of elephant on animal taxa	Changes in the distribution, abundance or behaviour in animals species	Census data, camera trap data
	Impacts of elephant on rhino	Changes in rhino number, growth rate, habitat use	Rhino monitoring data
Monitor impacts on reserve management, tourism and ecosystem goods and services	Management interventions	Number of elephants immobilised	Records of immobilisation
	Impacts on tourism	Visitor numbers, visitor expectations and satisfaction	Records of tourism numbers, visitor surveys
	Impacts on infrastructure	Number and location of incidents of elephant damage to infrastructure	Records of elephant damage

Routine monitoring (phase independent)

Individual profiles

Profiles will be maintained of distinguishing characteristics of each individual elephant in order to facilitate individual identification. This will include photographs of any distinctive marks or ear notches, and photographs of the tusks (elephant can often be identified by the size and shape of their tusks). Each individual will be assigned a unique identity code.

Elephant population history database

A population history database will be created for the elephant on the GFRNR. The following information will be maintained for each individual in the database:

- Current status (present, dead (suspected), dead (confirmed)
- Sex
- Date of birth, confidence limits for date of birth and current age
- Mother and father (if known)
- For females, calving history including:
    - Age at first calving
    - Records of each calf and Intercalving interval
    - Contraception schedule
- Herd associations
- Whether the animal was introduced or born on the reserve
- For introduced animals:
    - Donor reserve
    - Age at capture of each individual
    - Release date, release location and herd affiliation
    - Microchip numbers
    - Details of DNA samples collected
- For animals that have died:
    - Date of death and confidence limits for this

    - Age at death
    - Cause of death
- For animals that have been removed:
    - Capture date
    - Age at capture
    - Receiving reserve
    - Method of disposal
- Any additional comments

The population history database will be updated continuously as pertinent information becomes available.

Elephant sightings database

A database will be created to record all elephant sightings, including field ranger sightings, camera trap sightings and aerial sightings, on the reserve.

The sightings database will be updated monthly, and the following information will be logged for each sighting:

- Animal identity code and name
- Date and time of observation
- Which animals or family groups it was seen in association with
- The geographic coordinates for the sighting and the distance at which the animal was observed
- Type of sighting (e.g. ground observation, helicopter sighting, drone sighting)
- Condition of the animal
- The activity that the animal was engaged in at the time of the observation
- Observer details

Contraceptive schedule

A schedule will be developed for the administration of contraceptives to elephant cows. This will be dynamic and will be adapted to allow for cows to conceive, or to prevent conception, based on whether or not the population growth rate is within the target range and on the individual calving history of each of the cows.

Birth records

All elephant births with be recorded within two weeks of the discovery on a standardized form.

Mortality records

All elephant deaths on the reserve will be recorded within two weeks of the discovery on a standardized form.

Immobilisation records

Records will be kept by means of a standardized form of every elephant immobilization on the reserve. The information recorded will include the date, time and purpose of the immobilization, details of the veterinarian performing the immobilization, details of existing microchips detected or new microchips inserted, details of DNA samples collected, details of any medical intervention conducted and elephant body and tusk measurements. Photographs will also be taken from standardized perspectives.

Field ranger sightings of elephant and elephant activity

Field rangers will record all elephant observed during their patrols. Field rangers will also record any worrisome elephant activity (e.g. destruction of sensitive species). Observations will either be recorded on either the CMORE or Cybertracker system, and the records collected for each month will be forwarded to the Ecological Technician for quality control and curation.

Camera trapping

Camera traps are already deployed routinely in the reserve, principally for black rhino monitoring. Camera traps will also be deployed in the area utilised by elephants to record activity patterns, distribution and habitat use. All images obtained of elephant from camera traps will be examined, and entries will be added to the sightings database.

Aerial game census

Aerial game counts of the reserve are conducted every three years. The most recent count took place in 2018 and the next is scheduled for 2021. During the counts, an attempt will be made to do a total count of all the elephant on the reserve. Photographs will be taken of each individual to support the updating of individual profiles.

Ad hoc aerial monitoring

Any elephant observed during ad hoc aerial monitoring from fixed wing aircraft or helicopters on the reserve will be recorded in the sightings database. Photographs will be obtained of all observed animals.

Fecal material collection

Field rangers will be encouraged to routinely collect and store elephant fecal material for future research on elephant diet within GFRNR.

Recording of elephant damage to infrastructure

Records will be kept of any elephant damage to infrastructure (in particular to fencing). The following will be recorded:

- Date and time of the observation of damage to infrastructure
- Geographic coordinates of the infrastructure that was damaged
- Type of infrastructure damaged and the nature of the damage
- Management response (repairs conducted).

Initial monitoring phase

The first year of elephant monitoring will be focussed on understanding how elephants are using the reserve. The information gleaned from this phase will be used to design the subsequent phases of the monitoring program.

Baseline vegetation monitoring

The focus of this will be to collect baseline data ahead of the elephant reintroduction. Although future elephant spatial utilization of the reserve will not be known during this phase, monitoring will be focused on the reintroduction sites and on areas deemed likely to be used by elephant. The following methods will be employed: fixed point photography, point centered quarter vegetation monitoring, habitat mapping from drone imagery and remote sensing from satellite imagery. These methods are described in detail in subsequent sections of this document.

Satellite collars

It is anticipated that elephant will utilize discrete sections of the reserve, while the remainder of the reserve will be lightly utilised, if at all. In order to identify heavily-utilised areas, satellite collars will be fitted to the matriarchs of both herds (to provide information on the distribution of family groups) and also to the two mature bulls. Satellite fixes of elephant positions will be analysed and elephant home range, habitat utilization and suspected key resource areas will be defined.

Elephant home range will be estimated using kernel density estimation from satellite fixes of individual collared elephant. Habitat utilization and preference will be estimated by comparing the proportional extents of vegetation types within the kernels to the proportion of satellite fixes within each vegetation type. Vegetation types with a greater number of satellite fixes than what would be expected from their proportion within the home ranges will be classified as preferred. The satellite data will also be scrutinized for concentrations of satellite fixes in relation to particular resources (water points, forage areas) at different temporal scales in order to determine key resource areas.

Subsequent monitoring phase

Once an initial understanding of elephant utilization of the reserve has been obtained, the emphasis of the monitoring program will broaden to include efforts to discern elephant impact on habitat. The two focal areas for this will be: 1) a time series comparison (starting with baseline data) of habitat within heavily utilised areas to determine habitat change due to elephant over time, 2) comparison of heavily utilised areas to areas that are lightly utilised or not utilised to determine the long-term impact of elephant on habitat.

For the first of the above, robust comparison will require that sufficient of the baseline sites are located in areas that are actually utilised by elephant. For the second focal area, the array of monitoring sites will be expanded so that sufficient sites are located in both utilised and unutilized areas.

Habitat monitoring methods to be employed during initial and subsequent monitoring phases

The effort that can be invested in monitoring will be determined by available capacity. We envisage that some components will be conducted internally by ECPTA staff, and other components will require the support of external institutions.

Fixed point photography

This standard monitoring technique is easy and quick to implement, but the disadvantage of it is that only qualitative data are recorded. Nevertheless it is a good indicator of changes to habitat structure and the images recorded by this method can be powerful for demonstrating substantial changes to a variety of audiences.

Fixed pointed photography will be conducted by ECPTA staff at regular (likely annual intervals).

Point centered quarter vegetation sampling

The Adapted Point Centered Quarter (APCQ) vegetation sampling protocol (see Trollope *et al.* 2004, Van den Broeck *et al.* 2008) has been implemented on GFRNR, and this will be employed in order to obtain quantitative data on habitat structure, tree and shrub species composition and density, phytomass, and browse potential.

An outline of the methodology for APCQ surveys is attached as an appendix.

APCQ surveys will be conducted at three-yearly intervals (coinciding with the aerial game census). Since, the ECPTA does not have the capacity to do this internally, we will seek support from external research institutions (possibly from graduate students) for this.

Detecting elephant impact on habitat – remote sensing from satellite and aerial imagery

Landsat images will be retrieved from online portals for the summer and winter period each year. Image classification will be conducted to discriminate between habitat structural units (e.g. woodland, grassland, bare ground). Changes in habitat structure will be quantified and tracked over time. In addition, historic satellite imagery (e.g. going back 20 years) will be analyzed to obtain a baseline of pre-introduction variation in vegetation.

High-resolution imagery may also be obtained from drones flying along predetermined transects. Habitat structural units will either be digitised manually or possibly determined through image classification. Changes in habitat structure will be tracked over time. A comparison between data from satellite and drone imagery will be made to determine which of these methods is the most effective for elephant monitoring in GFRNR. Once this has been completed, a decision will be made on whether to proceed with both or just one of these methods.

Annual elephant monitoring report

An elephant monitoring report will be produced by the Regional Ecologist for each calendar year. The report will describe the monitoring effort (where monitoring effort was focussed and number of observations obtained through the various methods), the population status (demography, behaviour and associations) and distribution and habitat use. It will also record any management interventions recorded for the year and make recommendations for the next management cycle.

Elephant management committee

An elephant management committee will be constituted primarily from ECPTA staff, and will include the following as core members: Regional Manager: Biodiversity & Heritage Cluster, Senior Reserve Manager: GFRNR, Senior Manager: Scientific Services, Regional Ecologist: Biodiversity & Heritage Cluster, Ecological Technician: Biodiversity & Heritage Cluster. Other ECPTA staff members, or representatives from external entities, may be co-opted onto the committee as required. The committee will meet at least annually. During meetings, the results of the previous management cycle's monitoring effort will be presented by the Regional Ecologist. This will be used as the basis for management decisions for the following management cycle.

Schedule and responsibilities

A schedule of monitoring and responsibilities is presented in the table below.

Method	Frequency	Data type	Information obtained	Responsibility
Field ranger observations	Daily / Weekly	Quantitative	Behaviour and association Demographics Distribution (population and individuals) Impacts on habitat and infrastructure Condition	Senior Reserve Manager: GFRNR
Satellite collars	First two years after reintroduction	Quantitative	Distribution of collared animals (surrogate for herds)	Regional Ecologist
Camera trapping	Continuous	Qualitative / Quantitative	Distribution of individuals Condition Behaviour and association	Regional Ecologist Ecological Technician
Aerial game census	Every 3 years	Quantitative	Population size Demographics Distribution Behaviour and association	Senior Manager: Scientific Services
Fixed point photography	Annual	Qualitative	Changes to habitat structure	Ecological Technician

APCQ sampling	Every 3 years	Quantitative	Changes in individual plant species density Changes in phytomass	External researchers
Remote sensing of satellite imagery	Every 3 years	Quantitative	Changes to habitat structure	Regional Ecologist External researchers

References

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Annexure E: Introduction Assessment

Eastern Cape
PARKS & TOURISM AGENCY

Great Fish River Nature Reserve

Elephant Introduction Assessment

January 2020

Brian Reeves & Dean Peinke

INTRODUCTION

The Eastern Cape Parks & Tourism Agency (ECPTA) is the management authority of the Great Fish River Nature Reserve (GFRNR). The ECPTA plans to reintroduce elephant to the GFRNR, primarily to reinstate the ecological processes associated with this keystone species, but also to support other objectives, such as tourism development and the creation of opportunities for adjacent communities. The reintroduction will comprise two family groups (6-10 animals each) from the Addo Elephant National Park and two adult bulls (possibly from Kruger National Park or from private game farms) and is envisaged to occur in 2021.

Section 6(2b) of the National Norms and Standards for the Management of Elephant in South Africa (2019), requires an introduction assessment before elephants can be introduced into an extensive wildlife system. Accordingly, the current document assesses the suitability of the GFRNR for elephant and evaluates the potential impacts of the introduction.

SUITABILITY FOR ELEPHANT

Historical records indicate that elephants were previously abundant in the Great Fish River Valley (Skead 2007). These animals were hunted by early settlers, largely in response to the demand for ivory, and were extirpated in 1852.

Availability of adequate food plants

Elephant are large, social animals that are equipped with specialised feeding adaptations (trunk and tusks). They forage differently to any other large herbivore (Kerley et al. 2008). Their large body size enables them to digest large volumes of low-quality food and to utilise a broad range of plants including grasses, browse, bark, fruit and bulbs (Kerley & Landman 2006).

The habitats available to elephant in the GFRNR are listed below. The information was derived from the fine-scale vegetation map developed for the reserve in 2015 (see Figure 0-1; Vlok 2015):

- Doring and Combretum veld: Occurs along the main bottomland drainage areas. The dominant indicator species are Soetdoring *Vachellia karoo* and Fluitjiesriet *Phragmites australis*, except for in the more upland, less saline drainage areas, where *Combretum caffrum* and *Salix mucronata* are the dominant species.
- Karroid Shrubland: This habitat unit is related to Succulent and Nama Karoo and occurs along the upper edges of the Doring and Combretum veld unit. The vegetation is dominated by short shrublets (e.g. *Pentzia incana* and *Garuleum pinnatum*), with tall shrubs and trees absent, but several interesting succulents (e.g. *Euphorbia gorgonias* and *Pachypodium bispinosum*) are present. After good rain, grasses such as *Aristida diffusa* can be abundant. Spekboom is rare. This unit is closely related to the Spekboom Noorsveld but differs in the absence of Noors *Euphorbia bothae* and the occurrence of species such as *Pachypodium bispinosum* and *Garuleum pinnatum*.
- Spekboom Noorsveld: This arid thicket vegetation type occurs on the lower hills just above the Karroid Shrubland. It is equivalent to the Fish Noorsveld of Vlok *et al* (2003) but differs in having Spekboom present at 30-40% canopy densities. Distinctive of this unit is the occurrence of Noors, which is currently very rare on the reserve. This vegetation type contains at least one other localised endemic species, *Zaluzianskya vallispiscis*.

- Fish Spekboom Thicket: Occurs on the north-facing slopes of the hills above the Spekboom Noorsveld. Typical of this unit is a relative abundance of *Pappea capensis* and *Euclea undulata* trees. Spekboom occurs at canopy densities of 30-50%, but on steep north-facing slopes sites it can be up to 80%. *Euphorbia tetragona* is also often abundant in this unit but appears to be rapidly dying back in most parts of the reserve. This vegetation type also occurs along gradual west- and east facing slopes. On these slopes it has a less closed canopy and may resemble some of the mosaic type vegetation types, but it remains distinctive in having Granaatbos *Rhigozum obovatum* abundant, which is rare in the mosaic vegetation types that look structurally similar to the more open examples of the Fish Spekboom Thicket.
- Fish Shrubland Thicket**:** Occurs on the south-facing slopes. It differs from the Fish Spekboom Thicket in that *Pappea capensis* and *Euclea undulata* trees are rare to absent while Olienhout *Olea europaea* subsp. *Africana* is abundant, often with Kiepersol *Cussonia spicata, Euphorbia tetragona* and *E. triangularis* emerging above the canopy. Here Spekboom is less abundant with canopy densities of 20-30% along the outer perimeter of this vegetation type. The canopy is often not closed and grassland or shrubland (often with *Pteronia incana* abundant) occurs in the open areas. In higher rainfall areas the canopy is more closed, with the grass component less abundant and shifting towards more shade tolerant species (e.g. *Panicum* and *Setaria spp*).
- Fish Thicket: Occurs on the often steep, moist upper south-facing slopes. The canopy is usually closed and Olienhout *Olea europaea* subsp. *africana*, Kiepersol *Cussonia spicata* and *Euphorbia triangularis* are abundant in this vegetation type. The presence of other tall trees such as *Calodendrum capense*, *Harpephyllum caffrum* and *Scutia myrtina* is distinctive of this unit. Succulents are uncommon, but *Aloe pluridens* is sometimes present. Spekboom is absent in this unit.
- Crossroads Spekboom/Grassland Thicket: Occurs along the upper ridges and is intermediate between Fish Spekboom Thicket, Fish Shrubland Thicket and Crossroads Grassland Thicket. It consists of usually well-defined thicket bush-clumps typical of the Fish Spekboom Thicket or the Fish Shrubland Thicket that are located in a matrix of a karroid shrubland or grassland. In intact examples Spekboom is usually abundant along the outer perimeter of these thicket bush-clumps with canopy cover densities of 20-30%. The matrix vegetation is rich in species, including local endemic succulents such as *Euphorbia stellata* and several species of *Crassula, Delosperma, Haworthia* and *Lampranthus*.
- Crossroads Grassland Thicket: Occurs at the crest of the highest hills. The matrix vegetation is a grassland that is rich in species when in a pristine condition, but the grassland is impoverished in species and dominated by *Aristida congesta* when heavily grazed. Small thicket clumps are present, with Spekboom only prominent along the outer perimeter, and especially so on north and west facing slopes. Total Spekboom cover in this unit is not more than 5%. Towards the east this grassland gradually changes into a savanna with a fire-tolerant variant of *Vachellia karoo* present in the matrix vegetation. The latter indicates that fire played a role in the establishment of this unit. Termitaria are usually abundant in the matrix grassland vegetation.

The Albany thicket vegetation that occurs in the reserve is suitable for elephant and they can be expected to utilise all eight vegetation types described above. Due to the size of the reserve and the abundance of food throughout the year, it is expected that the reserve can support a healthy population of wild elephant under relatively natural conditions.

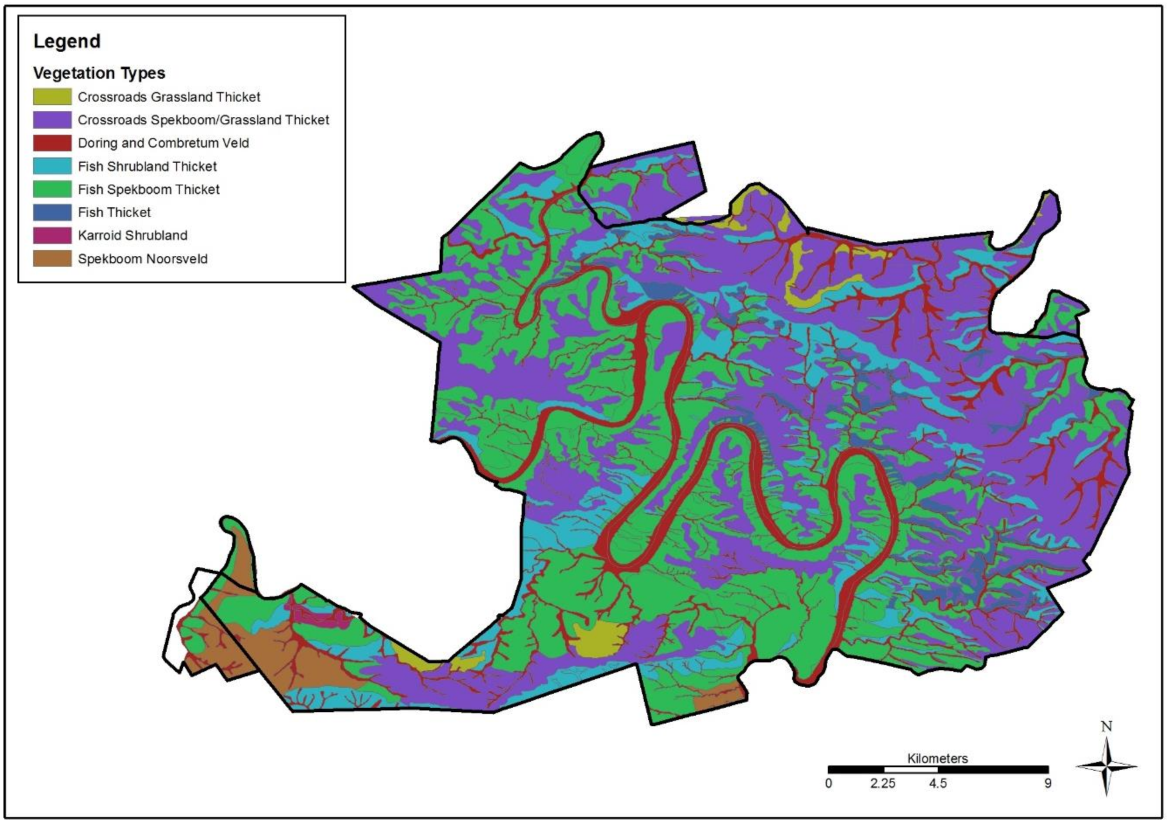

Figure 0-1: Vegetation of the GFRNR

We examined the literature to gain an understanding of the diet composition of elephant in similar Albany thicket systems, and to identify species that would likely be utilised on the GFRNR. Landman *et al.* (2013) compared elephant and black rhino diet in Addo, while Roux (2006) examined the feeding ecology of elephant in Kwandwe and Shamwari. Of the species recorded in these studies to substantially contribute to elephant diet, 86% (32 of 37 species) are present in the GFRNR (see Table 0-1).

Table 0-1: Elephant diet composition (percentage) recorded in reserves in the Eastern Cape (+ indicates preferred, - indicates avoided).

Family	Species	Addo (Landman *et al.* 2013)	Kwandwe (Roux 2006)	Shamwari (Roux 2006)	Average	Occurrence in GFRNR
Grasses						
Poaceae	*Cynodon dactylon*	19.6			6.5	Present
Poaceae	*Panicum deustum*	4.5			1.5	Present
Poaceae	*Eragrostis obtusa*	3.1+			1	Present
Poaceae	*Eragrostis curvula*	2.6			0.9	Present
Poaceae	*Pennisetum clandestinum*	1.9+			0.6	Present
Succulents						
Portulacaceae	*Portulacaria afra*	9.3	18	1-	9.4	Present
Cactaceae	*Opuntia ficus-indica*		5	10	5	Present
Crassulaceae	*Crassula ovata*		3		1	Present
Asphodelaceae	*Aloe ferox*			2-	0.7	Present
Woody shrubs						
Fabaceae	*Vachellia karroo*		15+	36+	17	Present
Salvadoraceae	*Azima tetracantha*	4.4	8	9	7.1	Present

Family	Species	Addo (Landman *et al.* 2013)	Kwandwe (Roux 2006)	Shamwari (Roux 2006)	Average	Occurrence in GFRNR
Sapindaceae	*Pappea capensis*	$^{+}$	18^{+}	3	7	Present
Anacardiaceae	*Searsia spp.*		4	11	5	Present
Anacardiaceae	*Ozoroa mucronata*		13^{+}		4.3	Present
Fabaceae	*Schotia afra*	3.4	4	3^{-}	3.5	Present
Celastraceae	*Gymnosporia spp.*		1^{-}	6^{-}	2.3	Present
Apocynaceae	*Carissa bispinosa*	6.1			2	Present
Ebenaceae	*Euclea undulata*	$^{-}$	2^{-}	2^{-}	1.3	Present
Zygophyllaceae	*Zygophyllum morgsana*			4	1.3	
Anacardiaceae	*Schinus molle*		3		1	
Celastraceae	*Gymnosporia polyacanthus*	3			1	
Combretaceae	*Combretum caffrum*			3	1	Present
Solanaceae	*Lycium ferocissimum*		3		1	Present
Anacardiaceae	*Searsia longispina*	2.9^{+}			1	Present
Capparaceae	*Capparis sepiaria*	2.9			1	Present
Celastraceae	*Putterlickia pyracantha*	2.5^{+}			0.8	Present
Tiliaceae	*Grewia robusta*	2.3^{+}			0.8	Present
Araliaceae	*Cussonia spicata*			2	0.7	Present
Celastraceae	*Gymnosporia capitata*	2^{+}			0.7	Present
Oleaceae	*Olea europaea*	$^{+}$		2	0.7	Present
Rubiaceae	*Gardenia thunbergia*			2	0.7	
Sapotaceae	*Sideroxylon inerme*			2	0.7	Present
Tiliaceae	*Grewia spp.*		1^{-}	1	0.7	Present
Anacardiaceae	*Searsia pterota*	1.9			0.6	
Asteraceae	*Brachylaena spp.*		1		0.3	Present
Rhamnaceae	*Scutia myrtina*	$^{+}$		1	0.3	Present
Vitaceae	*Rhoicissus tridentata*	$^{-}$		1	0.3	Present

Availability of adequate shelter

The GFRNR is an extensive, natural system and the requirements of elephant for shelter are likely to be met. In addition, there are large portions of the reserve that are inaccessible to the public and, should they require this, the elephants will be able to occupy areas devoid of human disturbance.

Availability of adequate water for drinking and bathing

Water is the primary environmental factor influencing elephant density (Chamaillé-Jammes *et al.* 2007; Roux & Bernard 2007). Elephants need to drink at least every two to five days and seldom roam far from water (Scholes & Mennell 2008). Major river systems have been an important factor for elephant distribution in the past and elephants show some dependence on these linear habitats (Gaylard *et al.* 2003). In the GFRNR, it is thought that elephants will spend most of their time in the *Vachellia karroo* dominated riverine systems and will only occasionally move off to into the adjacent thicket, but this is something that will need to be monitored.

Water is unlikely to be a limiting factor for elephant in the GFRNR. Two major river systems, the Great Fish River and the Kat River, traverse the reserve (Figure 3-2). The Great Fish River flows throughout the year but the Kat River occasionally stops flowing and becomes a series of pools during dry spells. The Keiskamma River runs along a portion of the eastern boundary but is fenced out of the reserve. The bulk of the reserve drains into the Great Fish and Kat River systems and only a small area in the eastern part of the reserve drains towards the Keiskamma River. There are 529 dams scattered across the area of the reserve that is available to elephants. These dams were constructed prior to the establishment of the reserve and vary quite considerably in size and water retention capability. The majority of these are relatively small and only hold water temporarily after rains, but many of these are perennial water sources that seldom dry up. Water is not pumped to any of these dams.

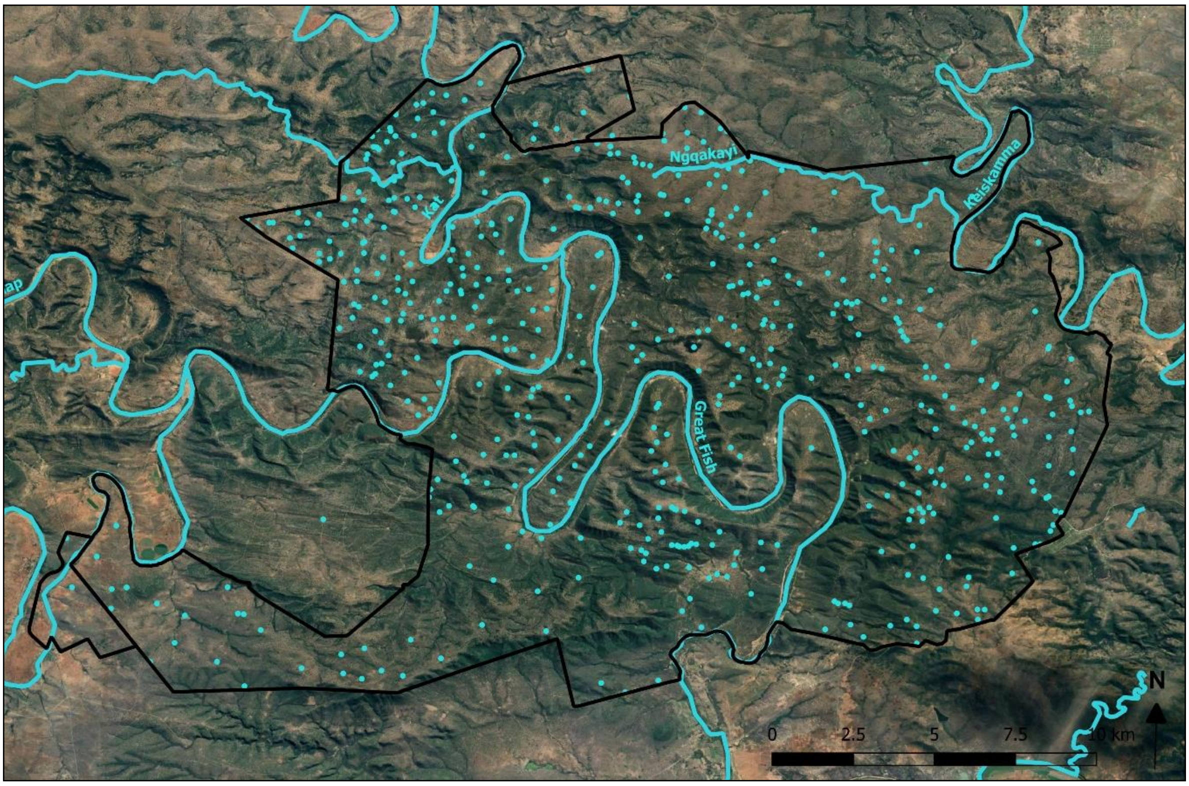

Figure 0-2: The distribution of surface water on the reserve

Size of land available to the population

The total size of the GFRNR is 45 016 ha or approximately 450 km^2. The elephant area constitutes the bulk of this (42 877 ha) and only small sections, totalling 2 139 ha, will not be available to elephant. The elephant area is adequately fenced for elephant and currently has elephant on the Certificate of Adequate Enclosure that has been issued by the Eastern Cape Department of Economic Development, Environmental Affairs and Tourism.

In line with current best practice (Owen-Smith et al 2006; Kerley et al 2008), elephant management decisions will be based on the intensity and extent of elephant impacts on vegetation rather than on managing for a specific elephant density. Nevertheless, to minimize risks to biodiversity, elephant density will be kept low by introducing a small number to the reserve and by limiting population growth. The introduction will comprise two family groups (6-10 animals each), followed by two bulls of different ages (approximately 40 and 25 years) once the family units have established. Contraception of females will be done to reduce population growth rates and to mimic growth rates that are more typical of elephants in larger systems. This is similar to the approach of SANParks in its smaller reserves, such as the Addo Elephant National Park.

Combined with the two existing elephants this would be a population of approximately 24 animals, which equates to a density of 0.06 elephants.km^{-2}. This is less than half the previously used ecological carrying capacity for elephants (Van Wyk & Fairall 1969). This is also on the lower end of the spectrum of elephant density in other reserves in the Albany thicket (see Table 0-2).

Table 0-2: Estimated elephant density on other reserves in the Albany thicket (all estimates from 2005; van Aarde 2008)

Reserve	Density (elephant/km2)	Density category
Addo	2.9	High
Shamwari	0.41	|
Kwandwe	0.17	Mod
Lalibela	0.15	|
Kariega	0.06	Low

The ECPTA will monitor the impact of the elephants as the population grows and should the results indicate a trajectory or rate of habitat change that is not acceptable, the proportion of females under contraception will be increased in order to reduce or stabilise population growth (successful contraception of 80% of breeding-age females would lead to the birth rate approximately matching mortality rate and population stabilisation; Scholes & Mennell 2008).

Social and behavioural impacts on the elephant to be introduced

Elephants are intelligent and occur in highly socialised groups with strong family bonds. The unnecessary disruption of these groups should be minimized. Translocation is a source of stress to elephant and the translocation and introduction will be guided by the current best practice to minimizes this. Two discrete family units will be selected from the donor population (Addo Elephant Park) and these will be given time to establish before the two bulls (possibly sourced from Kruger National Park or from private game farms) will be introduced. Cows will be translocated with all their offspring and kept together during translocation. The bulls will comprise one mature and one young bull to minimize aggression during establishment, and in order to allow for the older bull to moderate the behaviour of the younger bull.

ABILITY TO PROVIDE FOR ELEPHANT NEEDS

The ECPTA's capacity to manage elephant on the GFRNR is outlined in Figure 0-3. The Regional Manager: Biodiversity & Heritage Cluster is based in Port Elizabeth and provides oversight and coordination, engages with regional stakeholders and communicates with ECPTA senior management. The Senior Reserve Manager is based at the Sam Knott Office on the southern side of the reserve and has the overall responsibility its management. The Senior Reserve Manager is supported by a Conservation Manager and together they coordinate a team of nature conservators, supervisors, rangers and general assistants. The field rangers conduct patrols, which have a monitoring and law enforcement function. A specialist rhino monitoring unit is dedicated to monitoring the black rhino population on the reserve. The supervisors manage the general assistants, who carry out general maintenance of reserve infrastructure and support the field rangers during special operations (such as translocation of game).

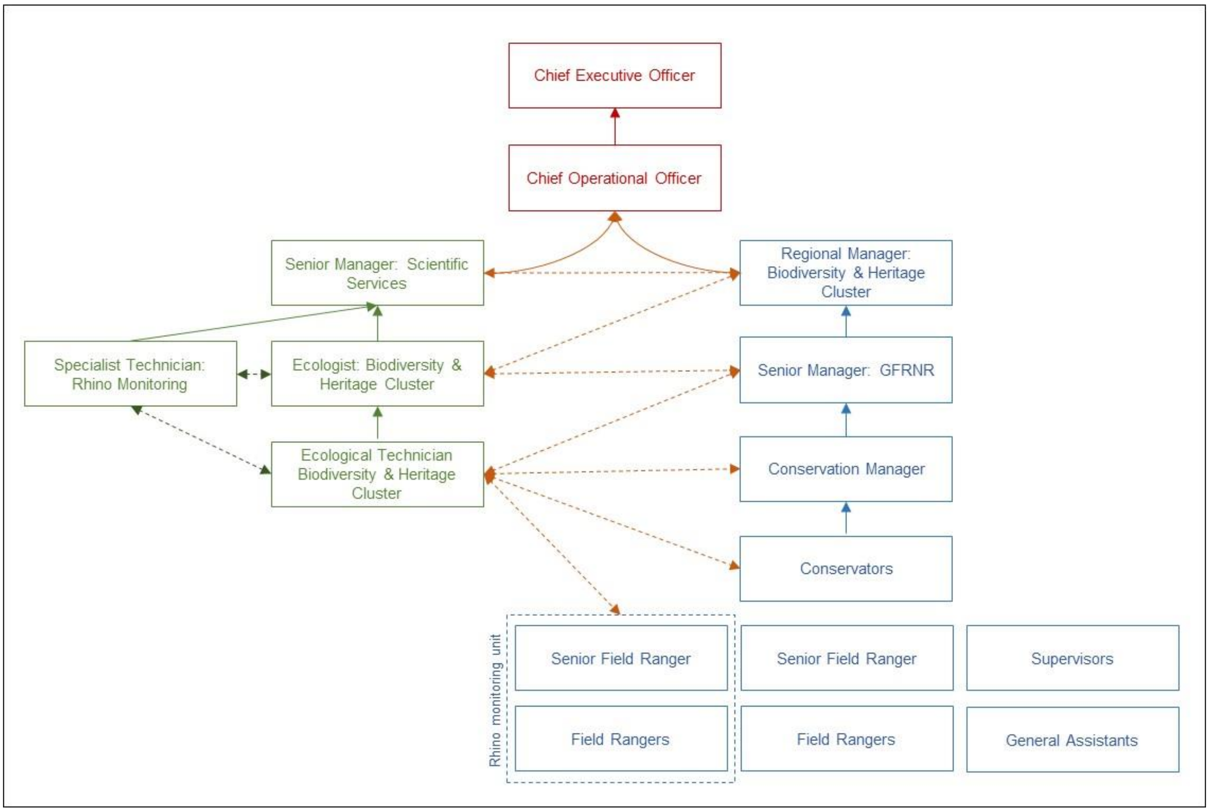

Figure 0-3: Outline of ECPTA capacity to manage GFRNR

The Senior Manager: Scientific Services provides high level scientific advice for the management of ECPTA-managed reserves and communicates with regional stakeholders. The Ecologist: Biodiversity & Heritage Cluster provides ecological input on the management of the protected area to the reserve management staff described above. For the management of the elephant population, this includes monitoring and development of protocols for monitoring, conducting internal research and directing external research. The Senior Manager Scientific Services and the Ecologist: Biodiversity & Heritage Cluster are based at head office in East London. The Ecologist is supported by an Ecological Technician. The Specialist Technician: Rhino Monitoring is specifically appointed to manage black rhino monitoring.

ABILITY TO MEET LONG-TERM FINANCIAL COMMITMENTS FOR ELEPHANT MANAGEMENT

The ECPTA is established as a Schedule 3C Public Entity in terms of the Eastern Cape Parks & Tourism Agency Act (Act 2 of 2010, Eastern Cape). The ECPTA presumes budget sustainability based on the MTEF allocations to ECPTA and that reserves will be funded.

POTENTIAL IMPACTS OF ELEPHANTS

There remains work to be done to fully understand the impact of elephants on the habitats, ecological processes and biota of Albany thicket. Where research on specific aspects is lacking, our assessment of the potential impacts of elephants in the GFRNR is premised on their historical presence in the area (Skead *et al.* 2007) and on the evidence of the system having coevolved with elephant and other megaherbivores (Kerley *et al.* 2004). Therefore, provided that elephants are kept at appropriate densities, they should not have a detrimental effect on the biodiversity of the GFRNR. Indeed, the density of elephant is likely to be the determinant of whether elephant impacts can be broadly classified as enhancing or degrading the system. For example, density will determine whether elephants increase or decrease heterogeneity (a surrogate for biodiversity) in the landscape (Guldemond *et al.* 2017).

Elephants are a keystone species in Albany thicket (their interactions with other species generate effects that are large relative to their abundance; Selier *et al.* 2016) and they play a role in 14 of the 19 critical ecological processes of this biome (Boshoff *et al.* 2001). While elephant herbivory is often thought to be the primary mechanism for structuring plant communities, other elephant impacts include trampling, path formation, zoochory and nutrient cycling (Landman *et al.* 2008).

Potential impacts on existing elephants

There are two female elephants currently in the GFRNR. They were part of a group of orphan calves that were introduced in the mid-1990s. They have never reproduced and appear to only utilise a small area in the northern portion of the reserve. The interaction between the existing and new elephants will be monitored by ECPTA staff. In addition to this, the ECPTA is supporting a research project (ECPTA reference RA 0293), led by Dr Marion Garai of the Elephant Reintegration Trust, to assess stress levels in the existing elephants before and after the reintroduction. The project will determine whether the introduction results in a difference in stress levels, measured through analysis of faecal glucocorticoid metabolites and behavioural parameters.

We anticipate that the introduction of new elephants may be beneficial to the welfare of the existing elephants, particularly if they manage to integrate with the new groups. This was the case in Madikwe in 1993 when the introduction of new family groups resulted in positive effects on the behaviour on elephants that were previously introduced as juveniles (Grobler 2008). The presence of additional elephant in the GFRNR may promote wider ranging by the existing elephant, and this may reduce the impact on the areas where elephant activity is currently concentrated.

Potential impacts:

We have identified the following potential impacts of the introduction on existing elephants:

- Integration of existing elephants with new elephant groups, resulting in enhanced welfare and home range expansion of existing elephants; and
- Conflict between existing elephants and new elephant.

Mitigation:

The following will be done to mitigate impacts of new elephants on the existing elephants:

- Research will be conducted on the behaviour and welfare parameters of the existing and new elephants, in order to understand the nature of the interactions;
- Interactions between existing and new elephant will be monitored; and
- Management responses will be developed if necessary.

Assessment:

With adequate monitoring and response, the consequences of conflict between the existing and new elephants is likely to be low. The probability of either positive or negative impacts occurring is difficult to estimate and is likely to be determined by the nature of the individual elephant. The existing elephants do not belong to a normal elephant social structure and the opportunity to establish this appears to outweigh the risks.

Impacts on habitat structure

In Albany Thicket, high elephant densities cause a reduction in plant biomass (Pentzhorn *et al*. 1974) and changes to habitat structure, increasing the proportion of path or open habitat (Kerley & Landman 2006; Landman 2012). This affects browse availability and may lead to changes in microclimate, with open habitats having more extreme air and soil temperature ranges. During dry times, elephants concentrate around surface water points, and this results in a gradient of intensifying impacts on vegetation (the piosphere effect). Piospheres display larger amounts of bare ground, soil compaction and erosion and decreases in the density of trees and palatable perennial herbs.

Potential impacts:

We have identified the following potential impacts of elephants on habitat structure:

- In thicket mosaics and savanna, grass cover and open habitat may increase at the expense of woody plant cover and closed habitat; and
- Solid thicket may become more open as paths are developed.

Mitigation:

The following will mitigate the impact of elephants on habitat structure:

- Elephants will be maintained at a low density through immunocontraception;
- Regular spacing of water points and year-round availability of water is anticipated to disperse elephant impacts across the reserve and reduce piosphere effects; and
- Changes to vegetation structure will be monitored and management responses will be developed should acceptability thresholds be crossed.

Assessment:

At low densities, it is anticipated that the impact of elephant on habitat structure will be acceptable. The solid, impenetrable vegetation that occurs in the absence of megaherbivores in some Albany thicket variants is not a natural state, but rather a consequence of megaherbivore release. Changes to vegetation structure might not be as apparent in GFRNR compared to other systems where megaherbivores have been absent, due to the high density of black rhino, which have already opened the vegetation.

Surface-water management has been suggested as a tool to manage elephant impacts because altering the distribution of water will change elephant ranging behaviour. However, due to the high density of water sources in the GFRNR, it is generally not feasible to manipulate elephant habitat use on the reserve by manipulating water sources. The almost uniform availability of water may serve to distribute impacts widely across the reserve and may reduce piosphere effects. However, this may also mean that there are few areas inaccessible to elephant (and thus few areas not experiencing elephant disturbance) due to water being a limiting factor. Nevertheless, the rugged topography of the reserve should still provide for refugia, where habitat structure will be unaffected by the introduction of elephant.

Impacts of elephant on plant species

Elephant are destructive in their foraging and can cause mortality in trees through felling, uprooting and bark removal (Kerley *et al.* 2008). Elephant will also selectively feed on preferred plant species (Parker & Bernard 2009). Due to their broad diet diversity, Kerley & Landman (2006) state that elephant influence the fate of more plant species in Eastern Cape thickets than any other mammalian herbivore. In enclosed systems, that do not allow for natural movements, selective feeding by elephants on preferred plant species can lead to changes in plant population structure and, in some cases, lead to local extinctions (Parker & Bernard 2009).

Lombard *et al.* (2001) found that species richness in Spekboomveld declined exponentially with length of exposure to elephant browsing, halving approximately every seven years. Kerley & Landman (2006) noted that some plants that were previously thought to disappear due to elephant herbivory are not eaten by elephants and suggested that alternative mechanisms are responsible for this. Moolman & Cowling (cited in Kerley & Landman 2006) found that species richness, density and cover were lower in elephant browsed sites in Addo.

Although further research is required to improve the understanding of the vulnerability of plant taxa to elephant impacts, some knowledge exists on taxa that should be monitored:

- Midgley & Joubert (cited in Kerley & Landman 2006) found that mistletoes (*Viscum spp*.) were nearly locally extinct within the elephant enclosure at Addo Elephant National Park. *Moquinella rubra, Viscum rotundifolium* and *V. crassulae* are good indicator species of elephant browse intensity (Kerley & Landman 2006; Cowling & Kerley 2002);
- Aloes are highly preferred by elephant. They either break off the crown (a type of damage exclusively caused by elephants) or push the entire plant over to access the succulent meristem (Parker & Bernard 2009). There has been a near disappearance of aloes (*Aloe africana*) in the elephant enclosure at Addo Elephant National Park (Barratt & Hall-Martin, cited in Kerley & Landman 2006). Parker & Bernard (2009) found a higher incidence of aloe mortality in sites that had elephants for more than four years compared to sites where elephant had only recently been introduced (<2 years; Parker & Bernard 2009). It is not clear if the loss of aloes is a cause for concern. Parker & Bernard (2009) suggest that the vegetation might be returning to a more natural state after a long period of mega-herbivore release. The large stands of aloes currently found in the Eastern Cape are derived from a cohort of seedlings that became established about a century ago, during a window of opportunity that arose from low elephant densities due to hunting. Parker & Bernard (2009) state that is not clear to what impact this process will have on the long-term conservation of aloes and associated biodiversity. Interestingly, Parker (2017) found that elephant may facilitate *A. africana*. Aloe species that are impacted include *Aloe ferox* and *A. striata* (Cowling & Kerley 2002);
- In areas newly opened to elephant, *Portulacaria afra* experiences more elephant-induced damage than trees and shrubs such as *Schotia afra, Euclea undulata, Azima tetracantha* and *Capparis sepiaria* (Barratt & Hall-Martin, cited in Kerley & Landman 2006; Parker 2017)*;*
- However, woody shrubs are still vulnerable to elephant browsing, including *Rhigozum obovatum* (Stuart-Hill 1992), *Lycium oxycarpum* (Cowling & Kerley 2002), *Grewia robusta* (Cowling & Kerley 2002; Parker 2017), *Azima tetracantha* (Parker 2017), *Gymnosporia polycantha* (Parker 2017) and *Schotia afra* (Parker 2017);
- Succulents, which are disproportionately represented among the rare and endemic component of the thickets in the region, are especially vulnerable to elephant impacts (Cowling & Kerley 2002; Johnson 1998). Moolman & Cowling (cited in Kerley & Landman 2006) found that fewer endemic succulents occurred in elephant browsed sites than in control sites. They also found that species richness, density and cover were lower in these sites. Among the possible exceptions to this are some members of the Crassulaceae Family, which are capable of vegetative reproduction and probably more resilient to elephant impacts (Cowling & Phillipson 1999). *Crassula ovata* however has shown substantial decreases in response to elephant browsing in the study of Stuart-Hill (1992). Members of the Euphorbiaceae Family that are vulnerable to elephant impacts including: *Euphorbia mauritanica*, *E. tetragona*, *E. curvirama*, *E. grandidens, E. tetragona*

(Cowling & Kerley 2002; Johnson 1998; Parker 2017; Cowling *et al.* 2009). Succulent members of the Liliaceae Family are also thought to be vulnerable (Johnson 1998);

- Members of the Apocynaceae Family are thought to be vulnerable (Johnson 1998); and
- Moolman & Cowling (1994) found that lower-stratum geophytes are vulnerable to local extinction from elephant impact.

Potential impact:

The following impacts on plant species could occur after introduction of elephant:

- In areas heavily utilised by elephant, there may be declines and possible extirpation of plant taxa vulnerable to elephant browsing; and
- Some plant taxa may benefit from elephant presence, and their relative density may increase.

Mitigation:

The impact of elephant of plant species within the GFRNR will be mitigated by:

- Maintaining a low density of elephant through immunocontraception;
- The presence of topographical refugia for vulnerable plant species; and
- Monitoring of vulnerable species and developing management responses to prevent extirpation (if required).

Assessment:

Since elephant historically occurred in the region, the presence of species vulnerable to elephant impacts is likely a result of expansion of their ranges through megaherbivore release. Given the topographical complexity of the reserve, there are likely to be sites that are inaccessible to elephant that can serve as refugia to elephant impacts. In special cases, local populations of threatened or endemic plants may need protection through elephant exclosures.

Impacts on fauna

High elephant densities can impact on the richness and abundance of a range of animal species, mostly through changes in habitat structure (Maciejewski & Kerley 2014). As is the case for plants, the understanding of elephant impacts on animals across the range of taxa is not yet fully understood. The understanding is complicated by the fact that elephants can have cascading effects on ecosystems.

Invertebrates

We are not currently aware of any threatened invertebrates on the GFRNR. However, invertebrates are understudied, in general and on the reserve, and species inventories for the reserve are far from complete. It is likely that species of special concern will emerge with further study, and especially that locally endemic species occur on the reserve.

There are few published papers on the impacts of elephant on invertebrates (Feleha 2018). In their review of elephant impacts, Guldemond *et al.* (2017) found that elephants had neutral impacts on invertebrate abundance and diversity and on ecological processes associated with invertebrates. It appears, however, that some phytophagous insect species may benefit from elephant presence through an increase in the quality of browsed plants due to a decline in secondary chemical compounds. This may be offset thought by a decline in overall plant biomass in the presence of elephants, but this requires further study (Kerley & Landman 2006). Bonnington (2010) found that elephant activity increased butterfly diversity in miombo habitats in Tanzania, probably due to the increased proportion of gaps in the vegetation canopy and increased habitat heterogeneity. Haddad *et al.* 2009 found that elephant feeding in sand forest increased species richness of spiders, probably through the creation of new microhabitats. Feleha (2018) reports lower ant species richness and the absence of cicadas in elephant impacted woodlands, while mantid communities appeared to be unchanged. Botes *et al.* noted changes to dung beetle assemblages in KwaZulu-Natal in elephant-impacted sites.

Herpetofauna

There are no threatened amphibians known to occur on the GFRNR and the only threatened reptile known to occur in the reserve is the Albany sandveld lizard *Nucras taeniolata*. This species is listed as Near Threatened. African python *Python natalensis* was reintroduced to the reserve, but the introduction appears to have been unsuccessful.

Nasseri *et al.* 2010 found that damage caused by elephants to *Vachellia* trees resulted in significantly higher herpetofaunal species richness compared to control sites without elephants. Refuge availability is a primary driver of habitat selection by herpetofaunal species. Elephant foraging resulted in increased habitat complexity and increased the amount of coarse woody debris, which is used by herpetofauna for refuges, hunting areas and breeding grounds. Kerley *et al.* (cited in Kerley & Landman 2006) suggested that elephants may facilitate high tortoise densities due increasing open habitat patches and paths. The decline in geophytes and small succulent shrubs commonly attributed to elephants may in fact be due to increased tortoise browsing.

Birds

There are four endangered bird species (black harrier, martial eagle, grey crowned crane and southern ground hornbill) and eight vulnerable (Verreaux's eagle, crowned eagle, secretary bird, lanner falcon, African finfoot, southern black korhaan, Dehman's bustard and black stork) confirmed to occur on the GFRNR.

Cummings *et al.* (1997) found changes to bird communities and a reduction in species richness in elephant-impacted miombo woodlands. In contrast, Herremans (1995) found that dramatic woodland degradation by elephants did not result in a reduction in bird diversity in riverine forest and Mopane woodlands. Chabie (cited in Kerley & Landman 2006) reported a shift away from frugivorous birds towards insectivores and granivores in thicket that had been opened (as would occur with high densities of elephants). Motsumi (2002) found that gallinaceous birds were more abundant in elephant impact areas in the Chobe River region of Botswana. Morrison & Kemp (2005) state that elephants can have both beneficial and detrimental impacts on nesting and foraging sites for southern ground hornbills. While elephants can reduce nesting opportunities, they can increase foraging opportunities for this species. Monadjem & Garcelon (2005) suggest that elephants may reduce nesting opportunities for raptors and vultures through their impacts on trees.

Mammals

There are no threatened small mammal species known to occur on the GFRNR. Of the large mammalian herbivores occurring on the GFRNR, black rhino and mountain reedbuck are listed as threatened (Child *et al.* 2016). Leopard occurs on the reserve and is classified as vulnerable.

There are few studies of the impacts of elephants on small mammals. In East African savannas, elephant presence has been correlated with an increase in species richness of small mammals, likely due to habitat alteration (Keesing 2000). Elephant-induced reduction in woodland canopy cover could be expected to result in reduced roosting sites for bats, but Fenton *et al.* (1998) did not detect a decrease in insectivorous bat species richness or a loss in specialists with a reduction in woodland canopy cover.

In terms of large mammals, there is the potential for competition between elephant and species with overlapping diets. However, Sigwela (1999) found that elephants had no effect on kudu diet in areas with elephant, even though kudu and elephant diet overlap substantially. Kerley & Landman (2006) consequently suggest that dietary items are not limiting to either species at the sites studied in the Addo Elephant National Park. Kerley & Landman (2006) note that Cape grysbok, bushbuck and bushpig numbers have declined in the Addo Elephant Park but could not state conclusively that this was due to elephant impact.

Valeix *et. al.* (2005) found partial evidence for their hypotheses that an increase in elephant numbers i) should be correlated to a decrease in mesobrowsers and mesomixed-feeders, ii) should not affect mesograzers, and iii) should not affect other megaherbivores. Besides direct competition for foraging resources, they suggest that a diversity of mechanisms could be responsible for changes to large ungulate communities in the presence of elephant, including competition for water and indirect effects of habitat on predation rates.

Elephants have been recorded killing black rhino, and this has occurred in the nearby Addo Elephant National Park, but this has been attributed to aberrant behaviour brought about through abnormal population structures (Kerley & Landman 2006). The causes and significance of this need to be further examined. Initially after elephant introduction, the increases in path and open areas may facilitate access to browse by black rhino. However, as elephant paths increase, vegetation cover and density decreases browse availability to black rhino and may result in a loss of forage opportunities (Kerley & Landman 2006).

Potential impacts

The following impacts to fauna could occur with the introduction of elephants:

- Declines in populations of certain taxa through competition with elephants, loss of habitat or through disturbance caused by elephants;
- Increases in populations of certain taxa through facilitation by elephant, including the creation of foraging opportunities and new habitats
- Some of threatened bird species (martial eagle, secretary bird, crowned eagle) recorded in the GFRNR are tree nesters and could potentially be impacted by elephant through the loss of potential nest sites.

Mitigation

The following will be done to mitigate the impact of elephant on fauna:

- Biodiversity inventories will be conducted on the GFRNR to understand the occurrence of species of special concern that could be affected by elephant;
- Research will be promoted to further our understanding the nature of elephant impacts on fauna; and
- Monitoring of species (particularly of black rhino through a dedicated monitoring program and large mammals in general through aerial game census) to detect changes to abundance and distribution.

Assessment

The presence of megaherbivores (rhino, in particular) in GFRNR has already resulted in the opening of thicket habitat in the reserve and shifts in foraging guilds (for example, in birds) after the introduction of elephant may not be as apparent as elsewhere. Due to the presence of elephant refugia and the low density of elephant, it is unlikely that nesting opportunities for tree nesting birds will become limiting.

The threatened large mammal species occurring in the GFRNR are not likely to be significantly impacted by the introduction of additional elephant. Elephant have been known to occasionally kill black rhinoceros, but they typically co-occur in many areas without conflict. It must however be acknowledged that one of the principal objectives of the GFRNR is the conservation of its rhino population and the presence of elephant cannot be allowed to compromise this. There are no game or other mammal species that are endemic to the reserve or to the Albany Thicket Biome that would be at risk from the reintroduction of elephant.

Impacts of elephant on people

Safety and security

The reserve is certified as being adequately enclosed for elephant and, besides for ECPTA staff, there are no communities living within the reserve. A breakout plan has been produced in the event of elephant escaping from the reserve. The presence of dangerous game on the reserve (including rhino and buffalo) has already placed restrictions on the movement of tourists through the reserve (for example, tourists are not allowed to walk freely in the reserve). In addition, tourists will be advised of the presence of elephant in the reserve and the necessary precautions that they should take.

Considering the above, we do not anticipate that the introduction will result in any risk to the safety and security of people in and around the reserve.

Tourism

Elephants are a significant attraction to people wishing to visit nature reserves and wildlife parks. Kerley *et al.* (2003) found that most tourists visiting Addo Elephant National Park primarily did so to view elephants. The GFRNR is underdeveloped in terms of realising its tourism potential. The presence of this large, charismatic species will support efforts to develop tourism, which in turn will lead to additional resources for the management of the reserve.

Job creation

The ECPTA will seek to utilise the presence of elephant on the GFRNR to develop opportunities for adjacent communities. One such opportunity will be the training of community guides who can take tourists to view elephant, while also educating them on elephant ecology and behaviour.

Educational opportunities

The presence of additional elephant on the GFRNR will provide opportunities to further understand the role of elephants in Albany Thicket ecosystems. The ECPTA has established relationships with Nelson Mandela University, Fort Hare University and Rhodes University, and will actively promote research on elephant impacts.

CONCLUSION

Elephant are a natural component of Albany Thicket ecosystems. As such, the ECPTA does not expect significant negative impacts to arise through the introduction, provided that the long-term objective of maintaining relatively low elephant density is achieved. The presence of elephant at low densities is expected to result in benefits to people and is seen as a way of restoring some of the ecological processes that shaped the habitat of the reserve and its plant and animal communities.

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