Local ecological knowledge on the population dynamics of elephants (*Loxodonta africana*) in the Highlands of Northwest Namibia

Michael Wenborn

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OXFORD BROOKES UNIVERSITY

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Abstract

There is a small population of elephants (*Loxodonta africana*) in the mountainous, remote area of northwest Namibia that is locally referred to as the Northern Highlands. The objective of this Research Project was to build a knowledge base on the population, behaviour and movements of elephants in the Northern Highlands. Before this PhD Research Project there had been no research or publications specifically on the elephants in the Northern Highlands. This Research Project was planned to align with the objectives of Namibia's National Elephant Conservation and Management Plan, which includes a priority for research on elephants in northwest Namibia so that protection measures can be planned. Given that counting and monitoring elephant populations and behaviour in such a mountainous and rocky landscape is particularly challenging, the Research Project was largely based on collating the local ecological knowledge of the community game guards. These game guards have been employed and trained under community conservancy programmes that started to be set up in the 1990s. The research method involved detailed semi-structured interviews with 34 game guards and, importantly, much time spent in the field to verify the findings, including identifying evidence of elephant movements in the study area. Based on details of groups of elephants known by the game guards, and taking into account double counting, it is estimated that there are between 78 and 212 elephants in the Northern Highlands (best estimate 128 elephants). The population has been increasing in the last 10-20 years with elephants now spending much of the year in the Highlands area, whereas they previously tended to visit only in the rainy season. It is concluded from this research that the challenges with damage at water points are starting to be addressed by investment programmes of the Government of Namibia to upgrade water points. This includes installation of solar power, protection walls and concrete holding dams so that water is more permanently available for people and elephants. There are still many water points that need such investment. The research has identified hotspots of human-elephant conflict at which upgrades to water points could be prioritised. The number of vegetable gardens has increased in the Northern Highlands since 2019 and a new concern of the communities is elephant damage at vegetable gardens. The research has also concluded that elephants prefer the tree species associated with the higher rocky slopes such as the African star chestnut (*Sterculia africana*) and *Commiphora* species. These species are likely to be a major factor in elephant movements from Etosha National Park into the Northern Highlands. The research also identified specific routes that the elephants are taking within the Highlands and potential areas in which they tend not to move. However, further research is needed on elephant movements, for example through GPS collaring. The Research Project has provided a robust baseline for conservation measures for the elephants and mitigation measures to address human-elephant conflict. Several areas of future research are identified in this thesis. Given the considerable knowledge of game guards, confirmed during this study, it is recommended that the role of game guards should be enhanced in future research and in future activities to protect the elephants of the Northern Highlands.

Acknowledgements

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Most of all, I would like to thank the community game guards in the Northern Highlands. They have so much enthusiasm and willingness to protect wildlife and help communities, despite the constraints to their role. They were always fully supportive of this Research Project and they were thoroughly enjoyable to work with.



Mr Rotho Huwe, game guard for more than 30 years in Orupupa Conservancy, who passed away in December 2022, but I will always remember his enthusiasm, knowledge and kindness.

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Abbreviations

CBD	Convention on Biological Diversity
CBNRM	Community-based natural resource management
CITES	Convention on International Trade in Endangered Species
EHRA	Elephant Human Relations Aid
GPS	Global Positioning System
GRN	Government of the Republic of Namibia
IRDNC	Integrated Rural Development and Nature Conservation
IUCN	International Union for Conservation of Nature
KRCCA	Kunene Regional Community Conservancy Association
MEFT	Ministry of Environment, Forestry and Tourism
MET	Ministry of Environment and Tourism
NACSO	Namibia Association of CBNRM Organisations
NBRI	Namibia Botanical Research Institute
NCRST	National Commission of Research, Science and Technology
NGO	Non-Government Organisation
NSA	Namibia Statistics Agency
NUST	Namibia University of Science and Technology
RSA	Republic of South Africa
SANBI	South African National Biodiversity Institute
SDG	Sustainable Development Goals
TOSCO	Tourism Supporting Conservation Trust
WWF	World Wide Fund for Nature

Chapter 1 – Introduction and context

This chapter includes initial context on conservation of African savanna elephants (*Loxodonta africana*), concepts on the use of local ecological knowledge in conservation, and the location of the study area of Northern Highlands. It includes an overview of the elephant population and ranges in Namibia, background on the fragile landscape and risks from climate events in northwest Namibia, on the local people and their challenges in the study area, and on the current programmes for community-based conservation. These points on context provide the foundation for the overall Research Project Objectives, which are provided at the end of Chapter 1.

1.1 Conservation status and threats to the African savanna elephant

The decline in the total population of African savanna elephant (*Loxodonta africana*) has been widely reported, due to poaching and loss of habitat in particular (Chase *et al.*, 2016; CITES, 2016). The most recent assessment for the IUCN Red List of Threatened Species concluded that the African savanna elephant is Endangered (Gobush *et al.*, 2021). The uplist in classification from Vulnerable (Blanc, 2008) to Endangered was based on an estimated 30% reduction in total population of African savanna elephants and African forest elephants (*Loxodonta cyclotis*) since 2006, to about 415,000 elephants in 2016 (Chase *et al.*, 2016). The reduction in population of African savanna elephants has been widely reported to be mainly because of poaching and loss of habitat (Thouless *et al.*, 2016; Gobush *et al.*, 2021).

The IUCN African Elephant Status Report identifies addressing human-elephant conflict as of critical conservation importance (Thouless *et al*., 2016). The IUCN Red List assessment also identifies one of the threats to the species as the increase in human-elephant conflict (Gobush *et al.*, 2021). Human-elephant conflict can result in damage to water points and reduction in water availability, impacts on livelihoods (e.g. crop farming), damage to other infrastructure, and risks to the safety of people and elephants. There has been much research across range countries of the African savanna elephant on the factors influencing human-elephant conflict, the potential impacts to livelihoods, and on potential solutions (e.g. Kioko *et al*., 2008; Hoare, 2012; King *et al.*, 2013; Ndlovu *et al.*, 2016; Drake *et al.*, 2021). There have been several publications over many years on mitigation measures, including guidance handbooks (e.g. IUCN, 2001; World Bank, 2020; Save the Elephants, 2022). The IUCN Human-Wildlife Conflict and Coexistence Specialist Group notes there are particular challenges in addressing human-wildlife conflict because the underlying cultural, political and economic aspects that shape these conflicts are often very complex and poorly understood (IUCN, 2020). Several studies have indicated that the trends in incidents of human-elephant conflict depend on unique local factors and the applicability of mitigation measures depends on practical aspects related to the local situation where the conflict is occurring (Hoare, 2012; Save the Elephants, 2022).

1.2 Use of local ecological knowledge in wildlife conservation

The collation of local ecological knowledge is increasing in use as a method for monitoring wildlife populations and habitats to inform research and conservation planning, with the local knowledge-holders including hunters, community members and wildlife rangers (Stern and Humphries, 2022). The use of local ecological knowledge includes specific studies as well as wider structured programmes (including citizen science), some of which take advantage of web-based technology on smart phones.

Benefits of the use of local ecological knowledge in wildlife and other research include collection of data in situations where other survey methods are challenging, often with relatively lower cost of data collection. Also, the local knowledge tends to have been built up over a long time period, and therefore historical memories and trends in data can be obtained (Hoole and Berkes, 2010; Mubalama and Banswe, 2023), for example from a study in Ehi-Rovipuka Conservancy in northwest Namibia (Hoole and Sullivan, 2024). Local factors affecting wildlife populations can be identified. However, there are several constraints to the collation of local ecological knowledge. Potential limitations include that it is difficult to assess the reliability of the data, the information might be relevant only to a small local area, and there can be communication challenges because of local cultural and language differences. In particular, there can be local biases influenced by local opinions and politics, and also challenges because local people might simply tend to tell researchers what they think the researchers want to hear. In practice, local ecological knowledge can be particularly valuable for wildlife research when it supplements other monitoring and surveying approaches. For example, Mubalama and Banswe (2023) compared elephant population estimates from dung counts in eastern DR Congo with information on elephants from local subsistence hunters.

The use of local ecological knowledge in research on wildlife populations in Africa is not a new concept. Shortridge (1934) collated records from early explorers and hunters in Namibia, including their discussions with local chiefs. More recent examples include collation of knowledge on elephant movements and human-elephant conflict in Botswana through interviews of local community experts (Buchholtz *et al*., 2020), and a study on the abundance of the African forest elephant (*Loxodonta cyclotis*) in Cameroon through interviews of community members (Brittain *et al*., 2020). Surveys have been used for collecting information from larger numbers of local people, for example related to the impacts of climate change on human-wildlife conflict in northwest Namibia (Carpenter, 2022), and related to local perceptions of trophy hunting on communal lands in Namibia (Angula *et al*., 2018). Other methods have included facilitating workshops with local stakeholders on human-wildlife conflict in Namibia (Luetkemeier *et al*., 2023), and interviewing wildlife rangers about the number of lions (*Panthera leo*) in northwest Uganda (Braczkowski, 2024). Local interviews can also be conducted to assess the local impacts of conservation strategies, such as interventions under the community-based natural resources management (CBNRM) programme and alternative livelihood strategies in Namibia (Sullivan, 1999; Hoole, 2010).

The methods, results and conclusions from the publications mentioned in the above paragraphs demonstrate the importance of the process to select the local people from

whom to obtain the knowledge, as well as attention to planning of the method in order to enhance the reliability of the information. Stern and Humphries (2022) assessed literature on various methods of use of local, expert and indigenous knowledge in wildlife research and their conclusions included the need for structured and standardised approaches. They noted that it is particularly important that the collated local ecological knowledge is verified through triangulation activities.

1.3 Elephant populations in Namibia

The IUCN compiles and manages the African Elephant Database, which includes information on estimated populations of African elephants in different ranges in different countries, mainly from surveys of elephants (IUCN, 2024a). It publishes the African Elephant Status Report, with the most recent report in 2016 (Thouless *et al.*, 2016) and the previous one in 2007 (Blanc *et al.*, 2007). The estimate of the elephant population in Namibia in the IUCN African Elephant Status Report was about 22,700 in 2016 (Thouless *et al.*, 2016), and this is still the estimate in the African Elephant Database as of 17 December 2024 (IUCN, 2024a). Over 80% of the population is located in the northeast of the country, in the Zambezi and Khaudum-Kavango wildlife complex (Figure 1.1). Other ranges in Namibia include a population in Etosha National Park and in the Kunene Region.

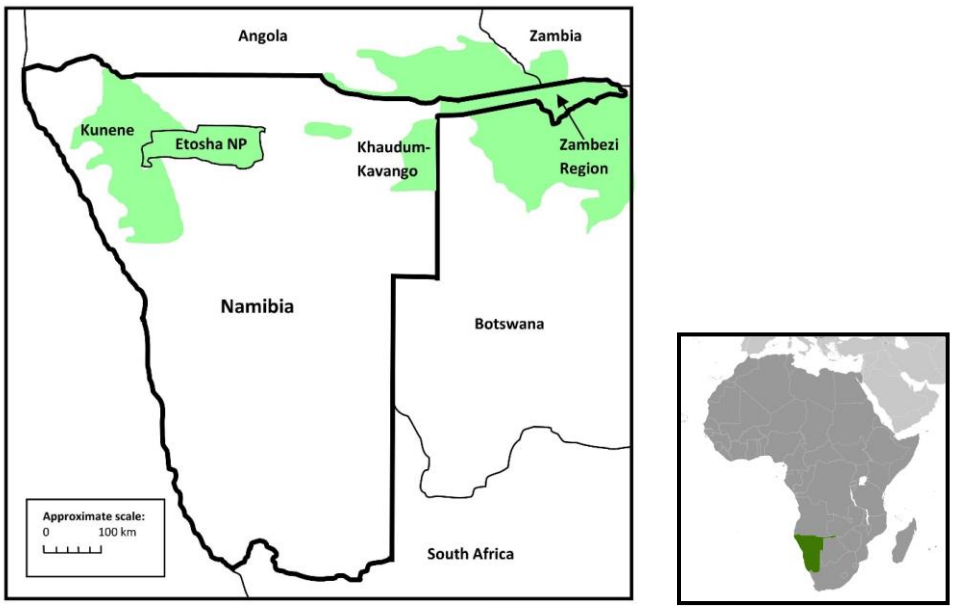


Figure 1.1 - Elephant Ranges in Namibia; the green areas indicating the approximate range, (adapted from the most recent African Elephant Status Report, Thouless *et al.*, 2016).

The population estimate for northwest Namibia (marked as “Kunene” in Figure 1.1) in the African Elephant Database was 314 elephants in 2016, which was about 1.5% of the total population of elephants in Namibia (IUCN, 2024a). The range area of elephants in northwest Namibia was estimated to at least 41,000 km^2 in 2016 but has been expanding (Thouless *et al*., 2016; MEFT, 2021). This range area of elephants in the northwest is shown in Figure 1.2 as the area inside the dashed line, outside Etosha National Park. The range area in the northwest includes the study area for this Research Project of the Northern Highlands, which is about 12,000 km^2 (Figure 1.2). The elephants in the northwest have a very low population density (i.e. about 314 elephants over an area of 41,000 km^2). As a comparison,

Etosha National Park covers an area of about 22,000 km^2, and had an estimated population of about 2,900 elephants in 2016 (Thouless *et al*., 2016).

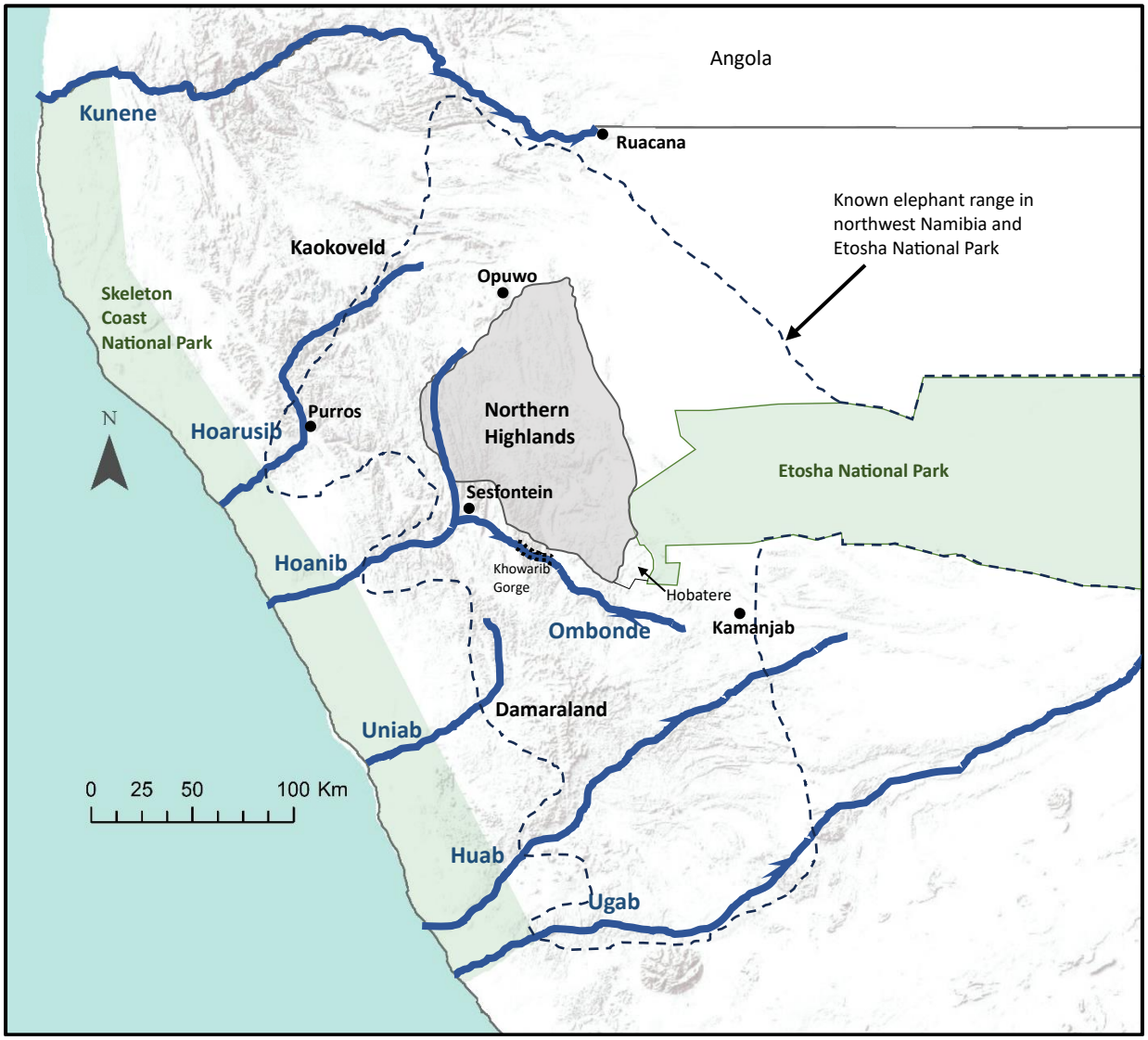


Figure 1.2 – Location of the Northern Highlands, national parks and main rivers in northwest Namibia. Each catchment has many tributary rivers, not shown in the map.

The Government of Namibia appropriately focuses its resources for monitoring elephants on northeast Namibia, ahead of northwest Namibia (Figure 1.1). The northeast has a much higher elephant population (Thouless *et al.*, 2016), and there is also a much higher human population in the Zambezi Region (Atlas of Namibia, 2022) and more incidents of human-elephant conflict (MEFT/NACSO, 2022; Meyer and Börner, 2022; Buchholtz *et al.*, 2023). Also, there are higher risks of poaching in the northeast because of the high density of elephants and because there are several close borders with other countries, which give poachers the potential to enter and leave Namibia within a few hours.

1.4 Northwest Namibia and the Northern Highlands

Northwest Namibia is a highly remote landscape with very low human population density. One of the commonly used names for the area was the Kaokoveld until Namibian independence in 1990, when it became part of the Kunene Region under the new regional institutional framework.

From its eastern border with Botswana, much of northern Namibia is flat landscape, of altitude over 1,000 m a.s.l., including the flat plains of Etosha National Park. To the west of Etosha National Park, is the Northern Highlands (Figure 1.2), a mountainous terrain with altitudes up to about 1,800 m a.s.l. Further to the west of the Northern Highlands, the landscape drops, with an escarpment down to the Skeleton Coast. The Northern Highlands area is described as semi-desert habitat, whereas the very dry landscape of the Skeleton Coast is desert (Atlas of Namibia, 2022). Examples of these varying landscapes are shown in Figure 1.3.

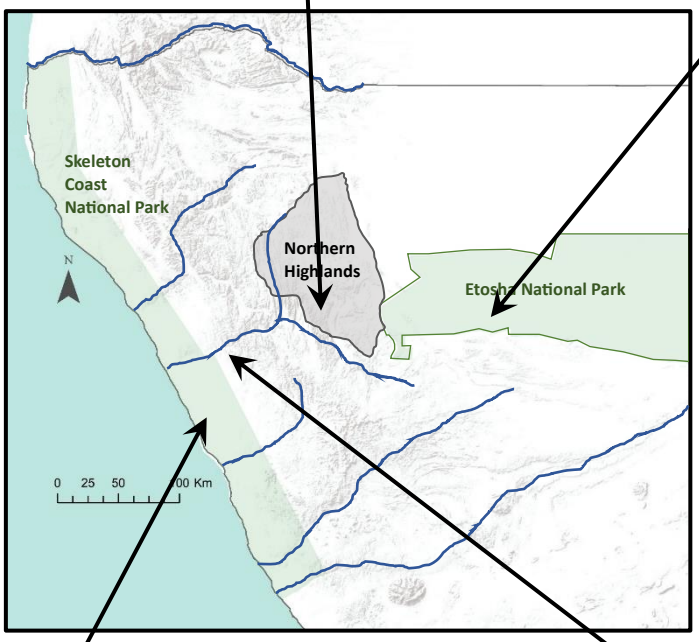
The local communities in the Northern Highlands carry out their day-to-day lives alongside a population of elephants, as in many countries in Africa. The African savanna elephant does occur in diverse habitats, but is usually associated with the flat plains of Africa (Skinner and Chimimba, 2005). However, elephants in the Northern Highlands walk up steep mountain slopes, a behaviour that might not be associated with such a large and heavy species (Wall *et al*., 2006). They regularly move down from the higher areas into the villages to drink at the community water points. Several studies have concluded that there are challenges with human-elephant conflict in northwest Namibia (Hunninck *et al*., 2017; Schnegg and Kiaka, 2018; MEFT, 2021; MEFT/NACSO, 2022; Wenborn *et al.,* 2022a), including studies that collated local knowledge on human-wildlife conflict (Hoole, 2008; Luetkemeier *et al.*, 2023). The National Elephant Conservation and Management Plan for Namibia includes the objective to reduce the incidents of human-elephant conflict in northwest Namibia (MEFT, 2021). It identifies that more research is needed on human-elephant conflict in northwest Namibia to inform mitigation strategies.



Steep, rocky slopes of mountains in the northern part of Omatendeka Conservancy in the **Northern Highlands**, 26 January 2023.

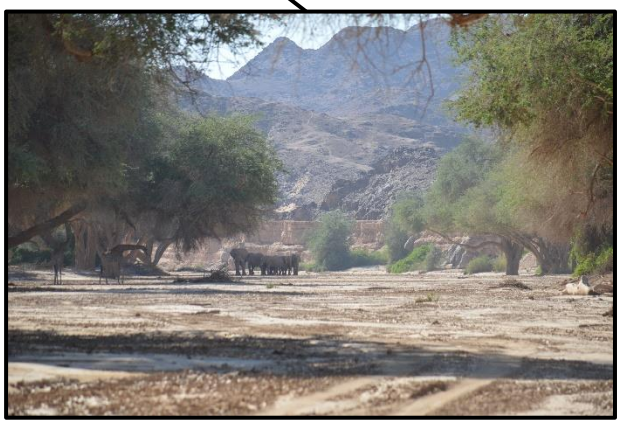


Elephants in the flat landscape of **Etosha National Park**, 26 December 2020.





Example landscape near the coast of **Skeleton Coast National Park**, 7 November 2012.



Desert-adapted elephants in the **lower Hoanib**, just outside Skeleton Coast National Park, 11 April 2021.

Figure 1.3 – Photographs of the changing landscapes from Etosha to the Skeleton Coast.

The Northern Highlands landscape includes rugged mountains and rolling hills (Figure 1.4), with many of the higher altitudes having steep and particularly rocky slopes (Figure 1.5). Some valleys are narrow and steeply cut, and some areas of larger valleys are wider and flatter (Figure 1.6). The flat area near Omuramba, in northern Omatendeka Conservancy, for example, has large areas of thick sand/silt. Natural springs across the Highlands are critical for the wildlife (Atlas of Namibia, 2022), (Figure 1.7).

There is a rich diversity of species of vegetation in the Northern Highlands. It is dominated in the valleys by mopane trees (*Colophospermum mopane*) (Inman *et al*., 2020a), (Figure 1.6). Many species of trees and shrubs in the Northern Highlands are associated with the mountain topography, such as the African star chestnut (*Sterculia africana*) and several species of *Commiphora* (Le Roux and Müller, 2018).



Figure 1.4 – Elephant in the rolling hills of Ozondundu Conservancy in the Northern Highlands, 25 January 2023.



Figure 1.5 – Steep, rocky slopes of mountains near Orupara, in the northern part of Omatendeka Conservancy in the Northern Highlands, 26 January 2023.



Figure 1.6 – Example of flat valley and steep valley slopes in northern Omatendeka Conservancy in the Northern Highlands, 9 February 2023. This is also an example of a valley dominated by mopane trees.



Figure 1.7 – Elephants at Okomutati spring, Ehi-Rovipuka Conservancy in the Northern Highlands, 20 January 2018.

Until the 1960s, large parts of the Kaokoveld in northwest Namibia remained unexplored by "western" travellers. In 1858, Charles Andersson, a Swedish explorer, led the first overland attempt to explore the Kaokoveld. The records indicate that, after travelling across the plains of Damaraland (Figure 1.2), the expedition moved north to enter an area of arid mountains that were so steep and rugged that they were prevented from moving further north (Owen-Smith, 1972). Those mountains are likely to have been the Northern Highlands.

1.5 Local people of the Northern Highlands

The Northern Highlands is a rural area with very low human population density (about one person/km^2). The estimated human population in the Northern Highlands is less than 10,000 (NACSO, 2024), mainly living in small villages (Figure 1.8). The largest town in northwest Namibia is Opuwo, just to the north of the Northern Highlands study area, and the growing town of Sesfontein is to the west of the study area (Figure 1.2).

The local people living in the Northern Highlands are mainly Herero community (Figure 1.9), with Himba community traditionally living north of the Highlands and Damara community to the south and west (Sullivan, Dieckmann, and Lendelvo, 2024). The main livelihood in the Northern Highlands is livestock farming (goats and cows), (Figures 1.10 and 1.11). The local people have a major reliance on the availability of water resources and vegetation for livestock (Bollig, 2020; Heydinger, 2021a). A network of boreholes has been developed for use as community water points near most villages (Figures 1.12 and 1.13), and livestock and elephants drink at the water points and springs. The Herero people that live in the Northern Highlands are semi-nomadic in that some migrate seasonally to cattle posts (Figure 1.14). There are a few cattle posts in the study area. Typically these cattle posts have a water resource, and have just a few houses for temporary living, and the livestock farmers move there after the rains to benefit from fresh grasses away from their village. According to local feedback, depending on the amount of rainfall in the rainy season, they might stay about three months at the cattle post. Some cattle posts over time have become small villages as households decide to stay all year if water is permanently available (e.g. the small village of Okarumbu in Ozondundu Conservancy used to be a cattle post). A few cattle posts have not continued because the water resource has dried (e.g. Okahororua in Orupupa Conservancy). The local people also grow maize and other vegetables at villages across the Northern Highlands, mainly on a small-scale (Figure 1.15).

Figure 1.16 is a map of the villages, cattle posts and roads in the six core community conservancies involved in my Research Project (I describe my method in Section 2 for selection of these six conservancies and include a map showing the location of these conservancies in the Northern Highlands).



Figure 1.8 – Example homestead on the edge of the village of Ondivet, Omatendeka Conservancy in the Northern Highlands, 9 February 2023.



Figure 1.9 – Traditional dress of Herero ladies at a community event, 3 February 2018. This has been the traditional dress since the early 1900s during the time Namibia was German South West Africa (up to 1915).



Figure 1.10 – Goats near Omunuandjai water point, Okangundumba Conservancy, 5 February 2023. There are many more goats than cows in northwest Namibia.



Figure 1.11 – Cows at Omunuandjai water point, Okangundumba Conservancy, 12 January 2021. Cows tend to be owned only by the richer members of the communities.



Figure 1.12 – Example of a community water point at Okatapati in Okangundumba Conservancy, 16 December 2022. The plastic tanks are for drinking water for people.



Figure 1.13 – Example of concrete holding dam at Okonjota, Ehi-Rovipuka Conservancy. These dams hold water intended for livestock, but often elephants drink from these dams. Photograph taken on 26 March 2021.



Figure 1.14 – Example of overgrazing around the Cattle Post at Omunuandjai water point, Okangundumba Conservancy. I did not observe grasses in this area after good rains. Photograph taken on 12 January 2021.



Figure 1.15 – Example of a vegetable garden at Okombako in Omatendeka Conservancy, 8 January 2023. This garden is watered from a nearby spring, but most vegetable gardens rely on rain water.

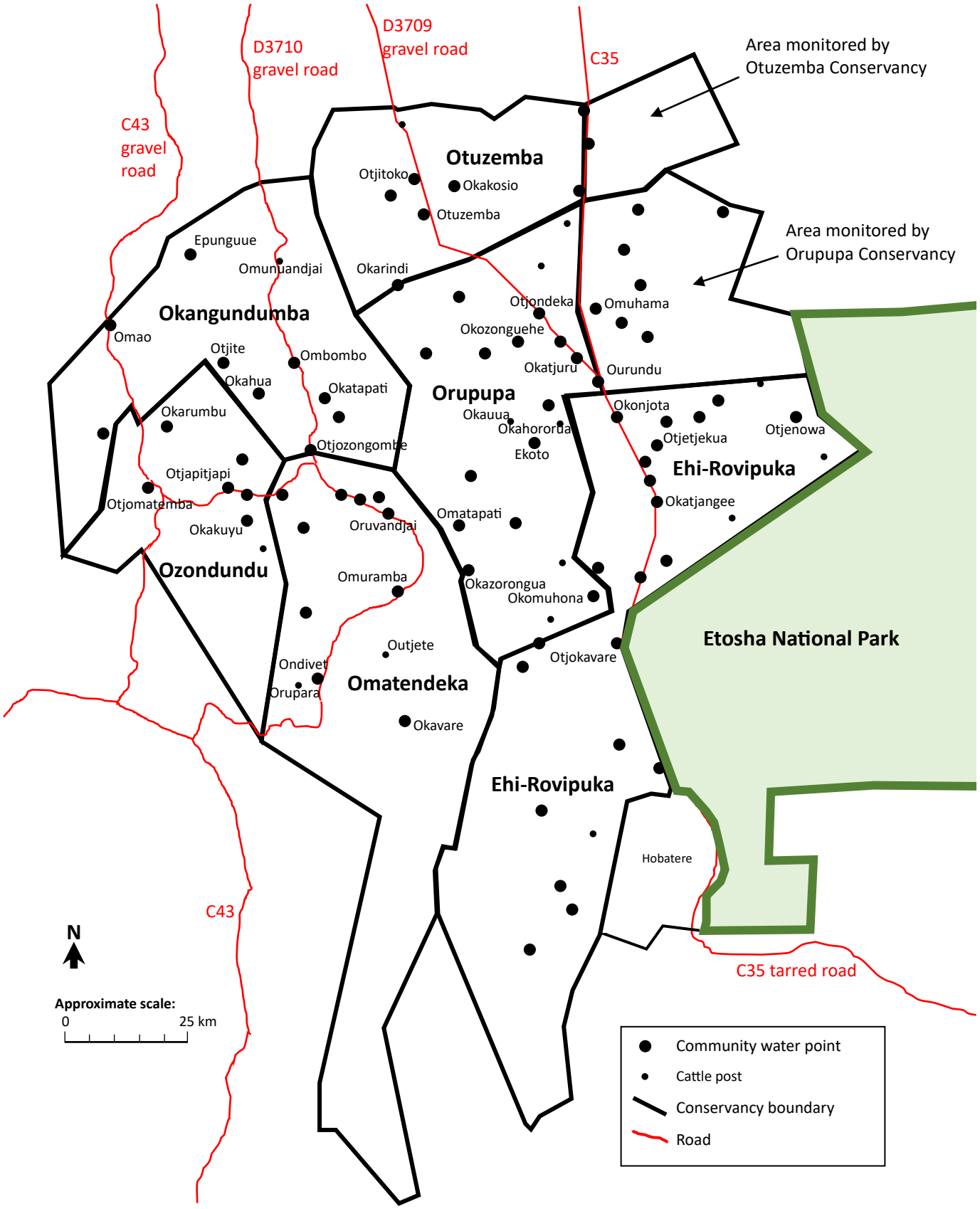


Figure 1.16 - Main villages in the six conservancies

The main C35 tarred road passes north-south alongside the eastern edge of the Highlands (Figure 1.17), for a while next to the western boundary of Etosha National Park (Figure 1.16), and there are a few gravel roads running north-south in the Highlands (Figure 1.18). The roads are mainly well-maintained by the Namibia Roads Authority, although the gravel roads can become damaged after heavy rains. There are several villages located near the main roads, for example villages near the C35 tar road and D3709 in Ehi-Rovipuka, Orupupa and Otuzemba Conservancies. The main villages in Okangundumba (Ombombo) and Omatendeka (Otjozongombe, Oruvandjei, Omuramba) are on the D3710 gravel road, but the villages away from the roads, such as Okahua and Epunguue in Okangundumba (Figure 1.16), tend to be smaller, and accessed on tracks. Some households have been moving to live nearer the main roads in the last 20-30 years, and some villages have therefore been growing, particularly near the tar road. For example, the village of Okonjota is on the tar road in Ehi-Rovipuka Conservancy, has a reliable water point, mobile phone network and primary school, and, according to the conservancy chairperson, its population has been increasing. There have been examples where whole villages have moved, for example the village of Orupara, near a spring in northern Omatendeka Conservancy, no longer exists because in the early 1990s a borehole was drilled at Ondivet, and the households moved about 5 km to live near that water point.



Figure 1.17 – C35 tarred road at Ourundu, Orupupa Conservancy, 9 September 2018.



Figure 1.18 – Example of a gravel road (D3710 near Omuramba, Omatendeka Conservancy), 8 March 2022.

Namibia is an advanced country relative to most countries in sub-Saharan Africa (UNDP, 2023), but the rural communities in the Northern Highlands are some of the poorest in Namibia (Atlas of Namibia, 2022). There is low formal employment in the Northern Highlands, with most jobs being in schools and health clinics. Although Etosha National Park is the most visited tourist attraction in the country (Namibia Tourism Board, 2023), there is minimal tourism in the Northern Highlands. About 39% of the population in the Kunene Region were classified as poor in 2011[1] (i.e. individuals living on less than US$1/day) (GRN, 2015a; Heydinger *et al.,* 2019). The drought in 2018-2019 (Sasscal, 2024) caused a high loss of livestock, which has added to the problems with poverty (Inman *et al.,* 2020b), as well as the loss of employment and/or income for some households in the Covid-19 pandemic (Lendelvo *et al*., 2020).

[1] More recent socio-economic data has not been formally published at Government level for northwest Namibia (a national census was carried out in November 2023, but the results were not yet available as of January 2024 (NSA, 2024)).

1.6 The climate of the Northern Highlands

The climate plays a particularly important role in the lives of the local communities of the Northern Highlands. Northwest Namibia is an extremely dry area, with daytime temperatures over 30°C for several months of the year (Atlas of Namibia, 2022; Sasscal, 2024). Rainfall in the Northern Highlands is typically 50 to 200 mm per year, with a lower average annual rainfall in the west of the area (NSA, 2013; Namibia Meteorological Service, 2023; Weather and Climate, 2024). The rainy season tends to be from January to April, with the main rains in March/April, but usually the rainfall is erratic and unpredictable. The ephemeral rivers tend only to flow for a few hours or days of the year (Figures 1.19, 1.20), but then might have standing water in places for several weeks. When it occurs, rainfall tends to be localised and can be extremely heavy, causing soil erosion problems, a situation made worse by the serious over-grazing in the area (Leggett *et al.,* 2003a; NACSO, 2017; Heydinger, 2021a), (an example is shown in Figure 1.14). In some years there is no rain in some areas. The potential risks of climate change in the future include more severe droughts, which would increase competition between humans and wildlife for natural resources in this fragile environment (Zeidler *et al.*, 2013) and therefore contribute to increased human-elephant conflict (Carpenter, 2022; Guarnieri *et al.*, 2024). It has been anticipated that climate change will play a major role in the future stability of this fragile ecosystem, with Southern Africa predicted to warm twice as fast as the global average (Turpie *et al.*, 2010; Niang *et al.*, 2014; WMO, 2021). These aspects have also been identified in the baseline study for the National Elephant Conservation and Management Plan (MEFT, 2021) as a risk to the elephant population in northwest Namibia.



Figure 1.19 – Typical dry river bed, Omuramba, Omatendeka Conservancy, 7 March 2022.

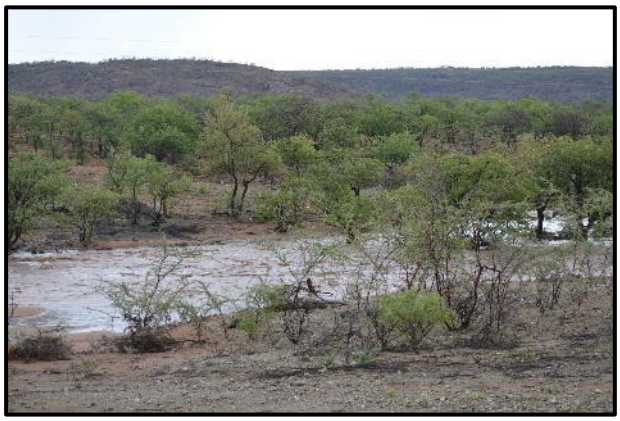


Figure 1.20 – After heavy rains, rivers might flow for a few hours or days, Otjokavare, Ehi-Rovipuka Conservancy, 25 February 2022.

1.7 Community-based wildlife conservation in northwest Namibia

The Ministry of Environment, Forestry and Tourism (MEFT) is responsible for the development and implementation of policy on wildlife conservation, including management of the Protected Areas in Namibia and enforcement of wildlife conservation laws in communal areas. A draft National Parks and Wildlife Management Bill is being developed by MEFT. This will replace the Nature Conservation Ordinance (No.4 of 1975) (RSA, 1975), and Nature Conservation Amendment Act (No.5 of 1996) (GRN, 1996). In practice, there are practical difficulties in the enforcement of laws on wildlife conservation in remote areas of northwest Namibia, including the Northern Highlands, particularly in terms of travel distances for enforcement officers. Community commitment to wildlife protection is therefore important. In the 1990s, the Government of Namibia adopted a national policy to implement a programme of community wildlife conservancies (MET, 1995). Conservancies now cover a large proportion of the communal land in the northwest (MEFT/NACSO, 2022), including most of the Northern Highlands. The conservancy programme has been supported by several wildlife NGOs (e.g. WWF, IRDNC, NACSO, EHRA[2]) and has resulted in improved awareness and higher commitment of local communities to wildlife protection in the northwest (Boudreaux and Nelson, 2011; Angula *et al.*, 2018; Jacobsohn, 2019; Störmer *et al*., 2019; Wenborn *et al*., 2022b). In particular, following many decades of poaching of elephants, the population in northwest Namibia has been increasing, and the conservancy programme has been a major factor (Owen-Smith, 2010; Craig *et al.*, 2021; MEFT, 2021; MEFT/NACSO, 2022). The set-up of the conservancy programme includes the employment of wildlife rangers, known in Namibia as community game guards, at each conservancy. In the Northern Highlands, some of the game guards have had over 20 years of experience in their roles.

The challenges described above with increased local poverty, lack of investment in tourism for several conservancies, and human-wildlife conflict, have the potential to erode the commitment of local people to wildlife conservation (Wenborn *et al.*, 2024). This is a risk to the success of the conservancy programme. It also raises the importance of the conservation of the elephant population and the need for research on elephants in the Northern Highlands to underpin the planning of the conservation actions.

The studies in 2006 and 2007 (Hoole and Berkes, 2010) on CBNRM and mapping of historical human movements focused on a case study in Ehi-Rovipuka Conservancy, which is alongside the western boundary of Etosha National Park and the northwestern part of the Conservancy includes Northern Highlands landscape. Those studies benefited from historical knowledge of village elders, whereas the experience of community game guards since the early 2000s now presents an opportunity to collate local knowledge for wildlife research.

[2] WWF World Wide Fund for Nature (Namibia)
IRDNC Integrated Rural Development and Nature Conservation
NACSO Namibian Association of CBNRM Support Organisations
EHRA Elephant-Human Relations Aid

1.8 The priority needs for research on the elephants in the Northern Highlands

The desert-adapted elephants to the west of the Northern Highlands have been extensively studied in the lower Hoanib (west of Sesfontein) and lower Hoarusib Rivers (Figure 1.2), (Viljoen, 1987; Viljoen, 1989a; Viljoen and Bothma, 1990; Leggett *et al.*, 2003b; Leggett *et al.*, 2011; Ramey *et al.*, 2013; Brown and Ramey, 2022). The desert-adapted elephants have also had much coverage in the media (e.g. BBC, 2008; Wildblood, 2012; BBC 2019; Sky Nature, 2020). The elephants in Etosha National Park have also been studied, as the Ministry of Environment, Forestry and Tourism (MEFT) operates research stations in the park. However, published information on the elephants in the Northern Highlands, which range in an area in between these two well-studied populations, was minimal before this Research Project.

A detailed understanding of the population and movement routes of the elephants, including the factors affecting their movements, is needed for planning the protection of this population as well as reducing human-elephant conflict. Examples of the benefits of research could include:

- Credible information on elephant movements would inform any planning, if applicable, of protection of migration corridors.
- Data on hotspots of human-elephant conflict (combined with information on elephant movements) would help to prioritise investment in mitigation measures to reduce potential damage, for example to focus investment on those community water points most visited by elephants.
- Knowledge on factors affecting elephant movements will help to plan community-based conservation measures, for example keeping livestock away from specific natural springs or specific areas of habitat that are regularly visited by elephants.
- Knowledge on trends in elephant behaviour could also help local people to change their day-to-day activities to be safer (for example staying away from water points at times when elephants tend to visit).
- Reliable data on the baseline population of elephants and trends in population are needed to assess the performance of different conservation measures.
- The results will also help to prioritise more detailed research, for example information from this Research Project on known elephant herds or individual males, and on trends in elephant movements, will help plan GPS collaring programmes.

1.9 Research Project objectives

The objectives of this Research Project are:

- **Knowledge base on elephants in the Northern Highlands**
  To produce reliable estimates of population; population dynamics; and migration patterns of Highland Elephants; including historical trends.

- **Factors impacting elephants in the Northern Highlands**
  To identify the priority factors impacting the population of Highland Elephants.

The core method for this Research Project involves use of local ecological knowledge from the community game guards (Chapter 2). The objectives are in alignment with the priorities in Namibia's National Elephant Conservation and Management Plan (MEFT, 2021). They are also consistent with Namibia's commitments related to the United Nations (UN) Sustainable Development Goals (e.g. protection of endangered species under SDG 15 Life on Land) (UN, 2024), and the UN Convention on Biological Diversity (CBD) (e.g. Target 4 to minimise human-wildlife conflict) (UNEP, 2022). More information on the elephants, if appropriately disseminated, will also provide benefits to community conservancies in terms of planning and promoting tourism opportunities, and creating alternative livelihoods in sectors outside livestock farming.

A small number of relevant studies were published, or reports made available by MEFT, on elephants in northwest Namibia before the start of my Research Project. However, these either covered elephants across all of northwest in general, or were specific to the desert-adapted elephants to the west of the Northern Highlands. I have identified no publications prior to my Research Project specifically on elephants in the Northern Highlands. In addition, before my Research Project, there was minimal published data or maps, and no central database in the relevant ministries, on the locations of water points in the Northern Highlands. During the initial discussions with national-level stakeholders in Namibia about the feasibility of a Research Project in the Northern Highlands, they emphasised the challenges of collecting data in such a remote area.

1.10 Thesis Structure

I carried out the self-funded Research Project on a part-time basis, under the supervision of the Faculty of Humanities and Social Sciences at Oxford Brookes University.

Chapter 2 provides details of my methodology.

Chapter 3 covers my estimation of the size of the population of elephants in the Northern Highlands.

Chapter 4 covers my analysis on human-elephant conflict in the Northern Highlands, including on lessons from mitigation measures.

Chapter 5 covers my research on the preferred vegetation of the elephants in the Highlands.

Chapter 6 covers my research on movements of elephants in the Northern Highlands, drawing on some of the results of earlier chapters, such as on hotspots of incidents of human-elephant conflict.

Chapter 7 is a synthesis that covers the community-based approach to wildlife conservation, and in particular the role of the game guards, who were my main counterparts for this Research Project in terms of their local ecological knowledge.

Chapter 8 provides my conclusions and recommendations.

In preparing some of the chapters, I had in mind that future readers are unlikely to read the whole thesis from start to finish. I therefore have structured the thesis to include some aspects related to the method, and relevant literature review, within some of the chapters. For example, I consider that there is much scope for further research on elephant movements in the study area, and a reader planning such research in future would mainly look at Chapter 6 for background reading. Therefore, Chapter 6 on elephant movements has some information on the method and background literature review, so that such a reader in future would easily gain the required information mainly from that chapter. The thesis does contain cross-references between chapters.

I have been fortunate to spend much time in Namibia since 2012, including a total of 10 months in the country during this Research Project, which started in September 2020. All the photographs that I have included in this thesis were taken by myself. I learned some of the key points in Chapter 1 on context from stakeholder consultation during my scoping activities for the Research Project. An important aspect is that I continued to learn about the study area throughout the field activities during the Project.

Chapter 2 – Project method

This Chapter presents the overall method for the Research Project. More details on specific methods for components of the Research Project are provided in the relevant chapters.

2.1 Background on method planning

I have managed several environmental projects in Namibia since 2012, including two in northwest Namibia linked to tourism planning, and I built up a network of relevant contacts. I carried out a short research project in 2018 in northwest Namibia, spending four weeks in the country, as part of the MSc in Conservation Ecology with Oxford Brookes University. The objective was to evaluate the conservancy model in northwest Namibia based on case studies of six conservancies, four of which are in the Northern Highlands. Through that project, I observed the dedication and knowledge of the community game guards, noting the challenges that they had in carrying out their roles, such as low pay and lack of equipment. Through these projects, including observations in the field and discussions with stakeholders, I also became aware of the lack of knowledge at national planning level on the elephants in the Northern Highlands. I noted the challenges that the elephants are bringing to the local communities, and that these problems were one of the risks to maintaining the commitment of local people to the conservancy programme. I recognised the need for more reliable information on the elephants and started to consider ideas for planning a research project.

Surveying elephant numbers and monitoring elephant movements and behaviour in northwest Namibia are difficult because of the low density of elephants and the large range covered by the species. In the Northern Highlands, the mountainous terrain and difficult access also constrain monitoring activities such as foot patrols and aerial surveys (Leggett, 2019; MEFT, 2021; Craig *et al.,* 2021).

The conservancies each typically employ five to ten community game guards, some of whom have had over 20 years of service in their roles. They are responsible for recording wildlife sightings and incidents of human-wildlife conflict in Event Books. Their role also includes raising awareness in communities on the benefits of conservation of habitats and wildlife, in line with the core objectives of the conservancy programme. The game guards have received training from Ministry of Environment, Forestry and Tourism (MEFT) and the main NGOs (NACSO/WWF/IRDNC) involved in community-based wildlife conservation in Namibia. They carry out several foot patrols each week, during which they usually do not see elephants, but they will often observe evidence of elephant movements and numbers, such as through footprints, dung and tree species that have been browsed by elephants. The game guards therefore have much useful local ecological knowledge on the elephants in the Northern Highlands, which could inform planning of conservation measures. However, until my Research Project, this knowledge was not being collated and used.

Buchholtz *et al*. (2020) carried out a study on local expert knowledge on elephants in Botswana. The study focused on the behaviour of elephants in terms of their landscape use (e.g. preferred habitats, preferred vegetation and preferred landscape). The method

involved simple interviews that included ranking activities (for example scoring from one to five where one would indicate the local opinion that elephants are never found in a specific habitat and five for elephants are always found around the habitat). The study did not focus on estimating the populations of elephants or local identification of herds. The study included comparison of results from surveys with results on elephant movements from GPS collaring. The conclusions were positive on the use of local expert knowledge to understand patterns of landscape use. There had been similar positive conclusions from research on pooling local knowledge and opinions in Cameroon on populations of 33 wildlife species, including elephants, and comparison with field surveys on the ground (Van der Hoeven *et al.*, 2004).

I had considered consultation methods using focused group discussions with communities, surveys of a large sample size of individual community members, and interviews with conservancy management and/or village elders. However, it was clear that the most applicable core focus of my method to achieve the objectives of building a knowledge base on the population and movements of elephants in the Northern Highlands should be to collate the local ecological knowledge of the community game guards through semi-structured interviews on an individual basis.

The Event Books have been a tool for consistent monitoring and reporting by game guards, and in most conservancies in northwest Namibia there are records going back over 10 years. The Event Book system was set up by the MEFT with the support of Namibian wildlife NGOs, and the training of game guards includes recording methods in Event Books. It is evident from discussions with the game guards that the training and support from MEFT and the NGOs involved in the community-based wildlife conservation have resulted in strong commitment to the monitoring system by the conservancies and their game guards, as had been the intention at an early stage in the monitoring system (Stuart-Hill *et al.*, 2005). MEFT and the NGOs do analyse the data in Event Books, but only to a high-level (NACSO, 2023a).

The Research Project started in September 2020. I planned three phases to the Research Project, which are illustrated in Figure 2.1 and described in the sub-sections below:

- Phase 1 - Project scoping and planning
- Phase 2 - Core data collection
- Phase 3 - Analysis and reporting

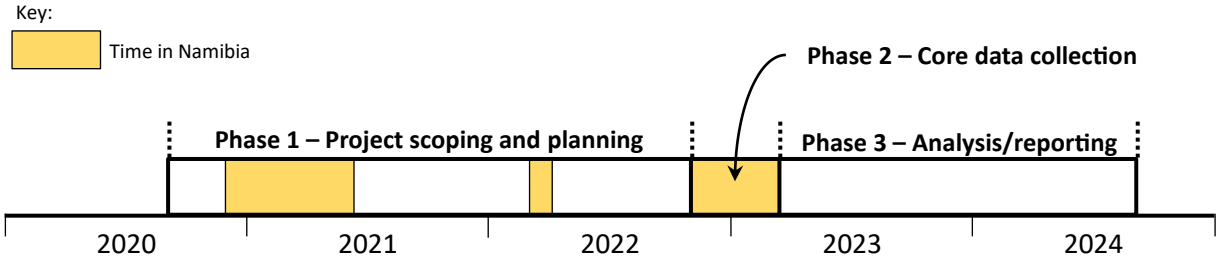


Figure 2.1 – Research Project timeline

2.2 Phase 1 - Project scoping and planning

Project scoping and planning involved initial consultation with stakeholders; identification of existing publications, reports and other sources of data; desk-based review; and scoping visits to the study area.

2.2.1 Desk-based consultation and review

One of my first steps was to carry out stakeholder analysis, which was updated during the Research Project. Box 2.1 provides a summary of stakeholders. This analysis was important so that I could prioritise consultation and keep stakeholder groups informed about the Research Project.

Box 2.1 – Priority stakeholders

Community conservancies:
- Conservancy chairpersons
- Conservancy management teams
- Community game guards (including field officers, which are the head game guards)

Traditional Authorities
- Chiefs and elders

Other relevant local stakeholders
- Ministry of Environment, Forestry and Tourism (MEFT)
- Ministry of Agriculture, Water and Land Reform
- Directorate of Survey and Mapping
- Namibia University of Science and Technology (NUST)
- Local offices of MEFT in Opuwo and Outjo.
- Wildlife NGOs (e.g. WWF, IRDNC, NACSO, EHRA[3])
- *Kunene* Regional Community *Conservancy Association*
- Namibian wildlife and elephant specialists

The available maps at the Directorate of Survey and Mapping in Windhoek cover a large area with scale 1:250,000, produced in the early 2000s, or more detailed 1:50,000 maps, produced in the early 1980s. IRDNC, an NGO that focuses on supporting the community conservancies, has developed detailed maps of the conservancies, showing the conservancy boundaries and main villages. I also found Google Earth very useful for planning and analysis, particularly because I took GPS co-ordinates throughout the fieldwork.

Some of my early stakeholder consultation for the Research Project was carried out online, for example with MEFT, Namibian NGOs and Namibian wildlife specialists. There was strong support from MEFT for the Research Project and the discussions helped me to align my method with the priorities in Namibia's National Elephant Conservation and Management

[3] WWF World Wide Fund for Nature
IRDNC Integrated Rural Development and Nature Conservation
NACSO Namibian Association of CBNRM Support Organisations
EHRA Elephant-Human Relations Aid

Plan (MEFT, 2021). MEFT provided unpublished reports, such as from aerial surveys of wildlife in northwest Namibia. At this stage I identified that there was a lack of centralised information on locations of community water points in the Northern Highlands, which I considered important as water availability was likely to be one of most important factors affecting movement of elephants (Birkett *et al*., 2012; Purdon *et al*., 2018; Tsalyuk *et al*., 2019). A desk-based investigation to collate records of information on locations and dates of boreholes drilled (and which are operational) would be a major undertaking (Bollig, 2020).

In parallel, I carried out a detailed desk-based search and assessment of publications on relevant topics including:

- History of northwest Namibia, in particular historical aspects of wildlife conservation and protected areas;
- Elephant populations in northwest Namibia;
- Elephant movements;
- Elephant behaviour;
- Community-based wildlife conservation in Namibia;
- Human-elephant conflict;
- Examples of use of local ecological knowledge in wildlife-based research;
- Research methods in social sciences.

My desk-based research on elephants covered a range of publications from a book published in 1934 with a compilation of the early records of explorers in northwest Namibia (Shortridge, 1934), through to several more recent publications on the desert-adapted elephants to the west of the Northern Highlands (e.g. Viljoen, 1987; Leggett *et al.*, 2003b; Brown and Ramey, 2022). In addition, two books provided accounts of the initiatives in northwest Namibia to develop community-based conservation since independence in 1990. They covered many aspects on the local culture, including local opinions on wildlife conservation, which were important learning for planning my research methods (Owen-Smith, 2010; Jacobsohn, 2019).

My desk-based review and initial consultation activities confirmed that there had been minimal publications specifically on the elephants in the Northern Highlands and therefore supported the need for my Research Project.

2.2.2 Scoping visit to Namibia

The start of my Research Project (September 2020) was during a time of travel restrictions because of the Covid-19 pandemic. The restrictions were lifted in November that year and I took the opportunity to visit Namibia to meet with key stakeholders and get to know the study area. This visit turned into extended scoping because travel restrictions were re-introduced and I was in Namibia for nearly six months (December 2020 to May 2021). This had the benefit that I was able to spend much more time in the Northern Highlands study area and learn about local factors to take into account during the planning of the method.

I spent over 15 days with different game guards, in effect equivalent to informal meetings. With each game guard I tended to drive with them to water points. The main intentions were to ask them various aspects about the elephant movements, but also to assess their

level of knowledge and experience, and to start to collect information on the water points (e.g. GPS co-ordinates, types of infrastructure (pumps, water tanks, etc.), state-of-repair). I set up these meetings / activities through first meeting the conservancy chairpersons to describe the Project and ask them about local priorities, to foster support for the Research Project and to obtain their agreement for me to meet their game guards. I consulted local stakeholders from 10 conservancies, all of which showed strong support for the Research Project.

There are 13 conservancies in the Northern Highlands, shown in Figure 2.2. In some cases only part of a conservancy is in the Northern Highlands. One important aspect of the initial consultations was that this helped me to identify the conservancies in the Northern Highlands that have higher elephant populations. It would not be possible in the time period of the PhD Research Project to carry out detailed research for all 13 conservancies covering nearly 12,000 km^2. I realised that I would have to focus on those conservancies with higher elephant populations. During consultation, it became clear that there were fewer elephants in the far western and northwestern parts of the Northern Highlands. I therefore selected six core conservancies for the Research Project: Ehi-Rovipuka, Orupupa, Otuzemba, Omatendeka, Ozondundu, Okangundumba (Figure 2.2), and two additional conservancies (Otjombande and Okongoro). The selection was based on local feedback from game guards, field observations, and also assessment of the high-level data from NACSO / IRDNC on total incidents of human-elephant conflict in each conservancy (NACSO, 2023a).

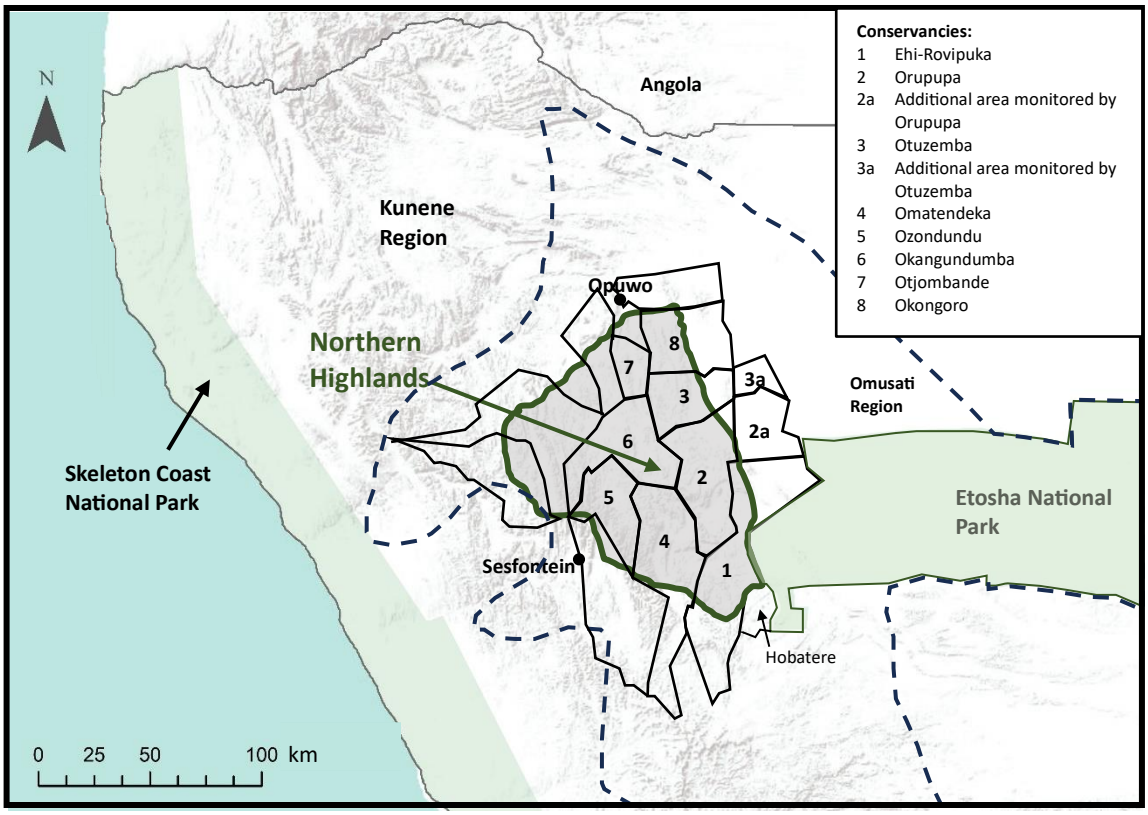


Figure 2.2 - Location of the Northern Highlands in northwest Namibia, including the area (inside the dashed line) that was the known elephant range in northwest Namibia and Etosha National Park in 2016 (according to the African Elephant Status Report, Thouless *et al*., 2016), and also showing the 13 community conservancies that cover the Northern Highlands and listing the eight conservancies in which game guards were consulted for the core data collection in this study.

I returned to Namibia for four weeks in February to March 2022 to update stakeholders, maintain working relationships, and obtain additional baseline information for the development of the method. In total, I spent 12 weeks in the study area during the scoping visits, meeting representatives of 10 conservancies, including 26 game guards (mostly on an individual basis) and 27 conservancy committee members (mostly in group meetings) in total. This included time with game guards for field walks and visits to water points. A list of my stakeholder meetings with counterparts in Namibia during the whole of my Research Project is included in Appendix A1.

During the main scoping visit (six months in Namibia), there were virtually no international tourists in the country. A few tourist facilities remained open for Namibian people, but were often empty. I managed to spend a total of eight nights on three separate occasions at tourist facilities who had experienced guides, and, with the benefit of being the only tourist, was able to spend many hours each day with just the guide, focusing on observing elephant behaviour and learning from the guide. This was outside my study area and included a game reserve next to Etosha National Park and a facility in the lower Hoanib, where the desert-adapted elephants can be observed (Figure 1.2). This situation, with minimal other tourists, facilitated my learning about elephant behaviour. Also, in Etosha National Park, for example, it is much easier to find elephants and observe behaviour than in the Northern Highlands, where the elephants stay much further away from people. I also spent a day with guides from EHRA in the Ugab river catchment (Figure 1.2), again learning from their experience on elephant behaviour and identifying distinguishing features of elephants.

The time in the study area also enabled me to identify local priorities and trends. For example, following the loss of livestock in the droughts of 2018-2019, more people were setting up vegetable gardens. This had increased the number of reported incidents involving elephants in vegetable gardens. I checked this feedback by copying the Event Book data for one conservancy (Orupupa Conservancy) and carrying out analysis of the reported incidents, which did show a step increase in incidents at vegetable gardens in 2020. A paper was subsequently published, based on that analysis (Wenborn *et al.*, 2022a). That initial Event Book analysis also demonstrated to me that more detailed analysis of the Event Book data would be an important component of my Research Project.

2.2.3 Development of the research method

Based on the information and ideas from the scoping visits and desk-based review, I planned the core method for the Research Project to include inter-related components with the following aims:

- Estimating the population of elephants in the Northern Highlands;
- Assessment of human-elephant conflict;
- Identification of vegetation browsing preferences of elephants in the Northern Highlands;
- Assessment of elephant movements;
- Review of community based conservation and the role of the game guards.

These components relate to Chapters 3 to 7 of this thesis. I planned topic areas for discussion with game guards, listed in Box 2.2. The topic areas cover the above components

as well as areas that provide more general background. The interview protocol, with the specific questions, is included in Appendix A2.

Box 2.2 – Topics for discussion with game guards as planned for the semi-structured interviews

1. Meeting details
2. Conservancy information
3. Background on the game guard
4. Environmental and social setting
5. Elephant range and movements (mapping exercise)
6. Elephant behaviour
7. Elephant population
8. Uncertainty in estimates of elephant population (explanation)
9. Elephant "groups" and individuals
10. Human-elephant conflict
11. Typical movements of elephants
12. Tree species preferred by elephants (tree selection exercise)
13. Historical changes
14. Benefits and problems
15. Other points

I have designed and carried out or managed community surveys over 30 years, but mostly not as academic research. My experience is in surveys as part of stakeholder consultation related to environmental and social projects, for example socio-economic surveys as part of Environmental and Social Impact Assessments. However, the time spent during the scoping phase of my Research Project with game guards was particularly important for designing a consultation approach that game guards would understand and would encourage game guards to be open and to provide reliable information. I also benefited from reading relevant sections of books on research methods in social sciences (e.g. Newing, 2011; Bernard, 2018).

The planning of a suitable approach to the consultation meetings with the individual game guards was just as important as the planning of the topic areas and questions. I noted during scoping that the game guards tend to be quite reserved, and I realised that it would be important to build a working relationship and make the consultation enjoyable for them. Based on the meetings during scoping, I considered that there was unlikely to be a problem of mistrust of my questions, but more that I would need to give time for game guards to understand the intentions of the research and rationale behind the questions. Most questions would need some explanation. I therefore planned semi-structured interviews, where there was plenty of time for me to ask additional follow-up questions (also noting that such an approach had been effectively used in previous surveys of communities in rural Namibia (e.g. Silva and Mosimane, 2012). I designed the interview protocol to be quite informal. I included a mix of methods during the interview, for example:

- Background questions at the start of the meeting on nearby villages, water points, springs, etc; all aspects on which the game guards were very likely to be confident in their knowledge. I considered that this would be a sensible start as I could then positively demonstrate to them early on in the interviews that their knowledge is very useful.

- I included a mix of open and closed questions throughout the interview protocol. For example, an open question on the opinion of game guards on the attitudes of local people to elephants (facilitating follow-up discussions); and a closed question asking game guards to list the Top 5 water points or springs in their opinion most visited in the conservancy by elephants (facilitating direct comparison of answers).
- A set of 10 statements on elephant trends and behaviour and asking game guards whether they strongly agreed, agreed, etc, with the statements on a Likert scale. I deliberately included one statement for which the situation is well-known and worded the question[4] to expect a negative answer (disagree or strongly disagree). I included this to make sure the game guards understood the method and did not simply agree with all statements.
- I asked the game guards to draw on a map of their conservancy the main areas where elephant herds or individual males are often seen and their opinion on the typical directions of movement of those elephants. Game guards are familiar with the maps of their conservancy.
- I also designed and printed a set of 20 A4 cards of common tree species in the Northern Highlands for the game guards to select the Top 5 species in their opinion most preferred by elephants and the Top 5 least preferred.
- I asked about aspects of their role and activities, including the main challenges in carrying out their role.

I was aware that the interviews would take time and my intention of this mix of methods was to break up the time and make it more engaging and enjoyable for the game guards (e.g. different types of questions, drawings on maps, selection of cards of tree species, etc). My adoption of this approach was mainly based on my conclusions from time with game guards in the field during scoping, but also some lessons from published papers on qualitative and quantitative approaches in northwest Namibia and elsewhere (e.g. Drury *et al.*, 2011; Angula *et al.*, 2018; Heydinger *et al.*, 2019; Buchholtz *et al*., 2020; Luetkemeier *et al.*, 2020; Luetkemeier *et al.*, 2023). In a paper on methods for interviews with local experts related to human-elephant conflict, Gross *et al.*, (2022) encourage the use of participatory mapping.

I have included more specific detail on the method for different components in the relevant chapters, for example detail on the method to select preferred tree species is included in Chapter 5. During the planning and implementation of the Research Project, I complied with the requirements of the Oxford Brookes University ethics approval process. I received ethics approval on 13 September 2022 (Appendix A3). I also ensured that the research was carried out within Namibian permit requirements (my most recent Research Permit from the National Commission of Research, Science and Technology (NCRST) is included in Appendix A4; I have renewed the Research Permit each year since the first approval in 2021).

[4] Game guards were asked whether they agree with the following statement using the Likert scale: "*In rainy season, elephants like to stay in sandy areas*." It is well-known that elephants stay away from these areas after rains because of risks of being stuck in the mud.

2.3 Phase 2 - Core data collection

I spent a total of 11 weeks in the study area during the time period of the semi-structured interviews (from the start of December 2022 to the end of February 2023). During that time, I carried out the individual interviews with 34 game guards in 8 conservancies: Ehi-Rovipuka (2 game guards), Orupupa (6), Otuzemba (6), Omatendeka (8), Ozondundu (6), Okangundumba (4), Otjombande (1) and Okongoro (1), (Figure 2.2). The game guards had between one and 30 years of experience, with an average of 10.3 years in their role.

The interviews with individual game guards typically took about four hours, but a few were up to six hours, for example when a translator was needed. They were mostly held sitting on chairs under a tree (Figures 2.3 and 2.4), or a few times in a conservancy office. The long time for each interview was planned and expected, but it was important in the structure to include breaks to the discussion, for example the exercise to draw elephant movements on the maps or to select the preferred tree species. During the interviews I made coffee for the game guards as well as a basic lunch. The standard of spoken English of many of the game guards is good (English is not the first language of most people in Namibia, but it is the most common language used). A translator joined for 20 of the 34 interviews, but for 10 of these the translator said very little and was just in attendance as back up in case clarification was needed by the game guard. A total of five translators were used, one for each conservancy except for Ehi-Rovipuka as this was not needed. During the interviews, I wrote detailed notes. I had decided not to record the interviews because this might constrain the discussions because I thought game guards would be less open, and recording was not compatible with the informal nature needed in the interviews. To show gratitude, I gave a small amount of money to the game guards and translators (equivalent to between £2.50 and £5.00 depending on the length of the interview and field activities). Their typical monthly salary is £50 to £75, so my contribution for a half day or one day of their time was proportionate. Those payments were not discussed with game guards until after the interviews.



Figure 2.3 – Game guard, discussing elephant groups and behaviour, Ombombo, Okangundumba Conservancy, 21 January 2023. (A translator was available, but not used for this meeting).



Figure 2.4 – Game guard, at the interview in Okazorongua, with translator, 9 January 2023.

My time in the study area also included 10 field walks for four to six hours in Omatendeka, Ozondundu, Orupupa and Ehi-Rovipuka conservancies to observe evidence of elephant movements in the mountains and valleys (Figures 2.5 and 2.6), including trees that had been

eaten by elephants. It also included many (about 60) short field walks (about one hour each), usually on my own, for informal observations, almost daily. Much time had also been spent with game guards, including field trips and walks, during my earlier scoping visits in 2021 and early 2022. These field walks with game guards were not their formal foot patrols as part of their role, because they usually follow set routes and cover many wildlife species, but extra activities specific to elephant movements and behaviour. Throughout this thesis I refer to these activities, which were a very important part of the research in terms of verifying on the ground some of the common points learned from interviews, as "field walks", so as not to confuse with the "foot patrols" that are formal roles of the game guards.



Figure 2.5 – Game guard, observing elephant dung, on a field walk near Ourundu in Orupupa Conservancy, 14 February 2023.



Figure 2.6 – Game guards, observing elephant foot prints, on patrol near Okazarongua, in Orupupa Conservancy, 24 January 2023.

During time spent with game guards in scoping and the core field work, I visited 107 locations of water sources, including 65 water points (five of which were hand pumps), 10 earth dams and 32 springs. I made observations (and took photographs) on the infrastructure, types of pump, state-of-repair and evidence of elephant presence and elephant damage. More details on these activities and relevant outputs are included in Chapter 4. During these site visits, on several occasions I had the benefit of informal discussion with one or more members of the community.

I continued informal discussions on various aspects relevant to the research with the game guards during the travel and visits to water points and springs, and during the field walks. There was an element that driving with game guards to water points and villages did help them to carry out their role (e.g. meeting with communities to raise awareness) and this also helped me to build good working relationships with the game guards.

Having recognised that much more analysis of data in Event Books would be important for the components on human-elephant conflict and on elephant movements, I copied the relevant pages in the Event Books for the six main conservancies[5] for the 10 years from 2012 to 2021. I used the camera on my smart phone to do this. I ensured that I had the permission of conservancy chairpersons to make the copies and, as a courtesy, also checked with IRDNC, WWF and NACSO, as they work with conservancies on Event Book training and high-level data analysis.

[5] Ehi-Rovipuka, Orupupa, Otuzemba, Omatendeka, Ozondundu, Okangundumba.

2.4 Phase 3 - Analysis and reporting

The questions for the semi-structured interviews (Appendix A2) included a mix of open and closed questions, as well as questions involving selection by game guards (e.g. selection of Top 5 tree species preferred by elephants, selection of Top 5 water points visited by elephants, selection on a Likert scale related to statements on elephant behaviour). The analysis was therefore carried out by inputting responses into Excel sheets and using descriptive analysis for the closed questions and selection questions, and a thematic analysis approach for the open questions. The thematic-type analysis facilitated identification of common points made by game guards. For example, for the open question (Appendix A2) on the main reasons for elephant movements in the local area, responses included common themes such as movement to find water, movement to find vegetation, movement to stay away from people, movement to find shade during the heat of the day, etc. Similarly, I used Excel for descriptive analysis of Event Book data. Some of the analysis was iterative, for example through testing the method to estimate the elephant population size using information on herds known by game guards (Chapter 3), and I include more details on the approach for the analysis as I present results in the relevant chapters. Throughout the chapters I also include many photographs to demonstrate where I checked and verified some of the results on the ground.

During the Research Project I was looking for opportunities to publish my findings, which had the advantage of raising the profile of the elephants and people in the Northern Highlands, as well as raising my own profile. I have established a pipeline of publications (Box 2.3), and provided MEFT with the opportunity to review and provide comments on the draft manuscripts. For example, an early publication to raise the profile was on the elephants in the Northern Highlands in Swara (Wenborn *et al.*, 2022c). The publications are included in Appendix E.

One common point mentioned by several conservancy chairpersons and by MEFT is that, although research is welcomed in Namibia, many researchers do not return to the area to present results. I therefore am planning to return to Namibia to present results to stakeholders later in 2024, (I had already presented initial results of Event Book analysis in meetings with Ehi-Rovipuka and Orupupa chairpersons and game guards in 2022, and have presented some of the main preliminary results in this thesis in online meetings with the Ministry of Environment, Forestry and Tourism (MEFT) and Namibian University of Science and Technology (NUST) in April 2024).

During this Research Project I wanted to go a step further than presenting the results in terms of more inclusion of local stakeholders. Therefore, where appropriate, I have invited relevant local persons that have been involved in the components of the research to be co-authors for publications, in particular the community game guards. For example, the game guards from Orupupa Conservancy were co-authors of the paper mentioned above on human-elephant conflict in that conservancy (Wenborn *et al.*, 2022a), (Figures 2.7 and 2.8). I consider this approach to be particularly important because it is the game guards who record the data on incidents involving elephants.



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Analysis of records from community game guards of human-elephant conflict in Orupupa Conservancy, northwest Namibia

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ABSTRACT
Competition between local people and elephants (*Loxodonta africana*) for water and vegetation is an increasing concern in many conservancies in northwest Namibia. Many livestock were lost during droughts in 2018-2019, and there are risks of more severe droughts in the future because of climate change. Little research has been published on elephants in the Northern Highlands, although the community game guards have been collecting data for many years in Event Books, as part of their role within conservancies. These include records of human-elephant conflict incidents. The objective of this study was to assess in detail the data on human-elephant conflict in Event Books for Orupupa Conservancy. In addition to analysis of Event Book data, consultations were carried out with community game guards in 2021 and 2022. Incidents involving elephants tend not to be frequent, but damage at water points can have a major impact on a local community because of the time taken and expenses of repairing the infrastructure. In 2019 and 2020 there was a changing dynamic in which some local communities set up vegetable gardens near water points or springs. The number of incidents of elephant damage at vegetable gardens greatly increased in 2020. Our study demonstrates that detailed analysis of Event Book data for additional conservancies would be useful. Combined with local ecological knowledge, the Event Book data can be used to inform the planning of local actions to reduce human-elephant conflict, including conservation of elephants and their habitats, in line with the actions in Namibia's National Elephant Conservation and Management Plan. The study also confirmed the substantial knowledge of community game guards and their important work in keeping records in Event Books. The expansion of their monitoring role to identify specific elephant herds would provide benefits in terms of improving knowledge on the elephant population and movements, and the potential for early warning between villages about the more problematic herds.

Figure 2.7 – Publication with game guards of Orupupa Conservancy as co-authors (Wenborn *et al.*, 2022a).

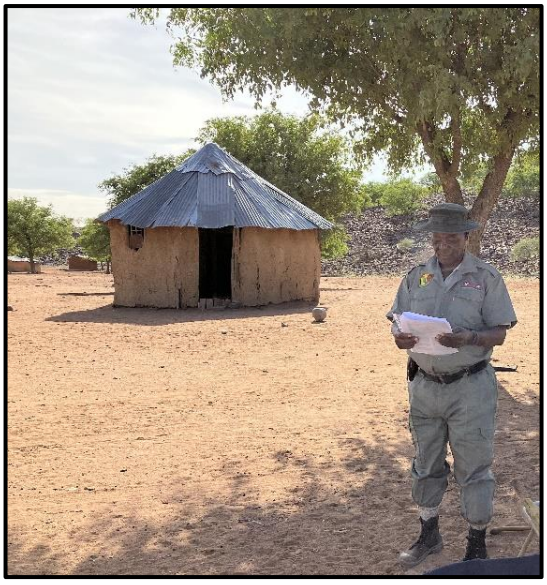


Figure 2.8 – Mr Joshua Hinu, community game guard for 13 years for Orupupa Conservancy. I presented him with a printed copy of the published paper (9 January 2023).

Box 2.3 – Pipeline of publications and manuscripts

Published (as of 20 December 2024)

1. Wenborn, M., Nijman, V., Kangombe, D., Zaako, R. K., Tjimuine, U., Kavita, A., Hinu, J., Huwe, R., Ngarukue, V. J., Kapringi, K. J. and Svensson, M. S. (2022a). 'Analysis of records from community game guards of human-elephant conflict in Orupupa Conservancy, northwest Namibia', *Namibian Journal of Environment*, 6(A), pp.92-100.
2. Wenborn, M., Svensson, M.S., Katupa, S., Collinson, R. and Nijman, V. (2022b). 'Lessons on the Community Conservancy Model for Wildlife Protection in Namibia', *The Journal of Environment and Development*, 31(4), pp.375–394.
3. Wenborn, M., Collinson, R., Nijman, V. and Svensson, M.S. (2022c). 'Highland Elephants keeping a low profile in Namibia', *Swara Magazine*, April-June, pp.48-51.
4. Wenborn, M., Collinson, R; Muzuma, S, Kangombe, D., Nijman, V. and Svensson, M. S. (2024). 'Communities and elephants in the northern highlands, Kunene Region, Namibia', in Sullivan, S., Dieckmann, U. and Lendelvo, S. (ed.) *Etosha Pan to the Skeleton Coast: Conservation Histories, Policies and Practices in North-west Namibia,* Chapter 11. Open Book Publishers.
5. Wenborn, M., Svensson, M.S. and Nijman, V. (2024). 'Estimating an elephant population size through local ecological knowledge', *Biology*, 13, 971.
6. Wenborn, M., Nijman, V., Parton, A., Svensson, M.S., Nashongo, A.N. and Hauptfleisch, M. (2025). 'Preferred vegetation of African savanna elephants in the semi-desert highlands of northwest Namibia', *Journal of Arid Environment*. Collaboration with Namibia University of Science and Technology.
7. Wenborn, M., Katjimbari, R., Tjiseua, J., Muheue, K., Tjimuine, U., Tjituhaa Muundjua, S., Nijman, V. and Svensson, M.S. (2025). 'Assessment of human-elephant conflict in the highlands of northwest Namibia', *Journal of Environment and Development*.

Accepted (to be published) (as of 18 January 2024)

8. Wenborn, M., Collinson, R., Penaani, Katjiku., Kozohura, D., Tjomazeva, R., Hinu, J., Kuvare, K., and Kangombe, I. 'Elephants in Namibia walking up mountains for breakfast', *African Wildlife and Environment*. [In press].

Chapter 3 – Estimation of the size of the elephant population in the Northern Highlands

This Chapter provides more detail on the method, and the results and conclusions for the component of the Research Project on estimating the population size of elephants in the Northern Highlands, based on local ecological knowledge.

3.1 Context

The African savanna elephant (*Loxodonta africana*) is now classified as Endangered in the IUCN Red List of Threatened Species (Gobush *et al.*, 2021). It is important to have a reliable estimate of the population of elephants in the Northern Highlands as a baseline for monitoring the performance of conservation measures, and to have a cost-effective method to monitor trends in population.

The elephants in the Kunene Region are estimated to be about 1.5% of the Namibian elephant population, spread over a very large area of at least 41,000 km^2, outside of Etosha National Park (Figure 1.1) (Thouless *et al.*, 2016). This area includes the Northern Highlands, which is about 12,000 km^2 (Figure 2.2). Reliable estimates of elephant numbers in the northwest are difficult to obtain because of the very low density of elephants and the large range covered by the species. In the Northern Highlands, the mountainous terrain and difficult access constrain monitoring activities such as foot patrols and aerial surveys (Leggett, 2019; MEFT, 2021; Craig *et al.,* 2021).

In the most recent IUCN African Elephant Status Report, the population estimate for northwest Namibia, including the Northern Highlands, was 314 elephants (Thouless *et al*., 2016). This estimate was based on the results of an aerial survey in 2011 of part of the northwest (MET, 2011), which concluded with a range of elephants with 95% confidence limit of 221 to 529. This is still the estimate in the African Elephant Database (IUCN, 2024a), but the estimates in this and other aerial surveys since the year 2000 have high uncertainty (MEFT, 2021). The estimate of 314 elephants for northwest Namibia compares to the estimated population in Etosha National Park of 2,911 elephants (Thouless *et al*., 2016). Some elephants in the Northern Highlands are moving in and out of Etosha National Park.

As mentioned, there was minimal monitoring and research on elephants in the Northern Highlands before my Research Project. The desert-adapted elephants in the west of the region (Figure 1.2) have been extensively studied in the lower Hoanib and Hoarusib River catchments, mainly through observations on the ground (Viljoen, 1987; Viljoen, 1989a; Viljoen and Bothma, 1990; Leggett *et al.*, 2003b; Leggett *et al.*, 2011). The latest population estimate is 28 elephants in total in the lower Hoanib and lower Hoarusib rivers, for which there was high confidence in the estimates (Brown and Ramey, 2022). These small populations are well-known in terms of identification and knowledge of individual groups and some individual elephants, with the researchers carrying out annual monitoring visits and having the benefit of vehicles and equipment (e.g. binoculars, cameras) (Ramey *et al.*, 2013; Brown and Ramey, 2022).

The desert-adapted elephants have been proven to be the same species (Ishida *et al.,* 2016; Leggett, 2019) as the African savanna elephant, but they are unique in terms of their adaptation for living in the desert. The elephants in the Northern Highlands are, however, also quite a unique population in terms of living in mountainous terrain. A more detailed understanding of the elephant population and movement in the Northern Highlands is essential as the basis for planning the protection of this unique population and reducing human-elephant conflict. The National Elephant Conservation and Management Plan for Namibia (MEFT 2021) identifies that more research is needed to obtain more reliable estimates of the number of elephants in northwest Namibia.

Elephants in the Northern Highlands tend to visit the water points and vegetable gardens near villages at night. The local people keep their distance from elephants and the game guards do not have binoculars or spotlights. During the day, there is much space in the remote landscape for the elephants to spend time away from people (Figure 3.1). Game guards therefore do not often see elephants, but part of their role is to meet regularly with community members, often hearing descriptions of elephant herds. During my consultation with game guards in the scoping visits, I concluded at that time that most game guards had knowledge of two to three herds of elephants, plus some individual males, based on their own observations. I confirmed during the scoping activities the potential to try to develop a reliable estimate of the elephant population in the Northern Highlands through collating information on the groups known by game guards.



Figure 3.1 – Elephant near Epako, Orupupa Conservancy. The photograph illustrates the difficulty in finding (and counting) such a low density of elephants in the landscape of the Northern Highlands, 25 March 2021. After about 30 minutes of observation from a distance, the game guard and myself concluded that there were three elephants in this group, but we were not totally certain because the vegetation size does easily hide the elephants.

3.2 Research objectives on the elephant population

The basis for this component of the research on the elephant population was to collate the local ecological knowledge of the game guards on known groups of elephants in order to develop an estimate of the population. Available information from records on historical elephant populations also provides potential insight into the factors currently affecting the population and movements. The objectives of this component of my research were to:

- Carry out a detailed literature review on previous research and surveys on elephant populations and trends in northwest Namibia.
- Apply and test a structured method to interview game guards about known groups of elephants in the Northern Highlands.
- Combine the results from the literature review and consultation with game guards on known groups to propose an estimate of the elephant population in the Northern Highlands.

3.3 Method

During the scoping consultations with game guards, I confirmed that my method could not involve simply asking the game guards of their estimation of the number of elephants in their conservancy. I noticed that some game guards had a tendency to potentially over-exaggerate the number of elephants. The method would be much more reliable if I asked about knowledge on individual groups of elephants as a basis for building an overall estimate of the population.

Therefore I planned the most detailed component of the interviews with the game guards to include semi-structured discussion on known groups of elephants (game guards tend to refer to herds of elephants as “groups”). In particular, I asked game guards about their perception of the number of elephants in a known group and any distinguishing features in the group (for example broken tusks, torn ears, etc, of the matriarch or another specific elephant in the group). Other questions on each group included the estimated time spent by the group in the conservancy per year, and the number of years that the game guard had been aware of the specific group. I also asked the game guards to assign their rating of uncertainty for their estimate of the number of elephants in each known group (Box 3.1).

The aim of the discussions with game guards on their known groups was to enable me to test this method and estimate the number of groups and the approximate size of each group. The key aspect was to take into account double counting, because several game guards would know the same group. The intention was that I use this approach to develop an estimate of the elephant population in the Northern Highlands.

Before I planned the consultation, I carried out a desk-based assessment of existing grey and peer-reviewed information on the historical and current population and movements of elephants in northwest Namibia, particularly the Northern Highlands. This included available results of previous aerial surveys, provided by the Ministry of Environment, Forestry and

Tourism (MEFT). Such an assessment provides context on the potential factors that could be affecting elephant populations. Section 3.4 provides the results from the literature review.

It was my extensive search and review of publications for which the method includes the use of local ecological knowledge on elephant populations in Africa that demonstrated that my objective using local knowledge on known groups was important to test the method, as well as obtaining an estimate. For example, one of the relevant studies on local knowledge of elephant populations focused mainly on elephant movements, habitat use and human-elephant conflict in Botswana, rather than estimating population size (Buchholtz *et al*., 2020; Buchholtz *et al*., 2023). One study in Cameroon did use local knowledge to estimate population, but did not go into any detail on known groups. It asked local people the number of elephants in a specific area, and guided the questions by first asking if there were more or less than a certain number, and then changing that number down or up and continuing the approach to questioning to obtain an estimate (Van der Hoeven *et al.*, 2004). Brittain *et al*., (2020) carried out a more detailed study on local knowledge on elephant abundance in forest areas of eastern Cameroon, using open and closed questions in informal interviews, but again not focusing on known groups. In some areas of northwest Namibia, the wildlife NGOs organise annual full moon counts (NACSO, 2023b), but these do not directly focus on identification of groups, but instead a total count (these activities are described further in 3.4.2).

The steps developed and tested for the analysis of the results from the interviews on known groups are described in Section 3.5. As well as consultation with community game guards, I organised meetings with MEFT, wildlife NGOs (e.g. WWF, IRDNC, NACSO, EHRA[6]) and several independent wildlife specialists to discuss elephant populations and movements in the northwest, and to obtain other sources of data.

My time in the study area on field walks with game guards and visiting water points, and driving with game guards in my vehicle, provided additional information through more informal discussions and field observations.

As mentioned in Section 2, I was also fortunate to spend several days observing elephants with trained guides, outside the study area, to learn elephant behaviour and identify examples of distinguishing features. This included time with guides with the NGO, EHRA (EHRA Elephant-Human Relations Aid), which works in the Ugab River catchment, south of the Northern Highlands (Figure 1.2), and has been developing a method for identifying individual elephants through distinguishing features (EHRA, 2020). This NGO has therefore started an approach to use the known group method, although focusing on a much smaller elephant population than in the Northern Highlands.

[6] WWF World Wide Fund for nature
IRDNC Integrated Rural Development and Nature Conservation
NACSO Namibian Association of CBNRM Support Organisations
EHRA Elephant-Human Relations Aid

Box 3.1 – Taking account of the uncertainty in estimates of number of elephants in a group

Many of the times that game guards are close to elephants are at night at village water points, and it is difficult to count the elephants (game guards do not have spotlights, and need to keep a distance for safety reasons). In addition, the number of elephants in a group varies, as adult male elephants tend to spend some time with a herd and some time away. Game guards know more about some herds than other herds, some through their own observations and some from feedback about the herds from community members. Therefore, I asked the game guards to assign an uncertainty rating to each estimate of number of elephants in a group. The uncertainty ratings used were:

A Estimate based on many sightings and observations by yourself, verified with much feedback from other game guards and local people, with high confidence.
B Estimate based on some sightings and observations by yourself, verified with much feedback from other game guards, and with some confirmation by local people, with good confidence.
C Estimate based on some sightings and observations by yourself, some feedback from game guards and local people, with medium confidence.
D Estimate based on a few sightings and observations by yourself, some feedback from local people, with low confidence.
E Estimate based on only feedback from local people, no sightings and observations by yourself or other game guards, minimal confidence.

During the interviews, I made a relative assessment of the experience and knowledge of the individual game guards, and my confidence in their answers. During the time spent discussing each known group, I assessed my confidence in the number of elephants stated by the game guards for each known group, and I assigned a similar category (A to E). Each known group therefore was assigned two ratings of uncertainty; one by the relevant game guard and one by myself. This was useful as a starting point for the analysis.

3.4 Literature review on elephant populations and trends in northwest Namibia

This section describes my key findings from a literature review of the available publications and reports on elephant populations and trends in northwest Namibia. Throughout this and subsequent chapters, I provide descriptions and photographs from my field observations. The field activities were very important to cross-check my findings from interviews with game guards and from literature review. For example, on one field walk in the study area I noted rock art of an elephant (Figure 3.2). The age of the rock art is unknown, but it indicates that elephants are likely to have been present in the area for a long time.



Figure 3.2 – Rock art of an elephant near Epako, Orupupa Conservancy, 6 March 2021.

It was the extensive ground surveys by Phillip Viljoen of the University of Pretoria in the late 1970s and 1980s that raised the profile of the elephants in the Kaokoveld, particularly the desert-adapted elephants, to the west of the Northern Highlands. Garth Owen-Smith, who pioneered the community wildlife conservancy programme in Namibia, also kept extensive records on wildlife in northwest Namibia from the 1960s. In the 2000s Keith Leggett, of the University of New South Wales, published several papers on his research on the population dynamics of the desert-adapted elephants. MEFT has carried out a few aerial monitoring surveys of elephants and other wildlife in northwest Namibia, but the large area and challenging topography make it difficult to carry out comprehensive surveys. I describe these monitoring and research activities in the next subsections, 3.4.1 and 3.4.2.

3.4.1 History of elephants in northwest Namibia

Until the 1960s, there had been minimal exploration of the Kaokoveld by "western" travellers. Most information before the 1980s on elephants in the Kaokoveld was recorded in travel journals and hunting reports. These records often included elephant sightings, but there were also records of elephant dung, which indicated that the elephants covered a large range in the 1800s from the Kunene River, on the northern border with Angola, down to the Ugab River (Figure 1.2), over 200 km south of the Northern Highlands (Viljoen, 1987). Commercial elephant hunting for ivory started in Namibia in the mid-1800s (Bollig and Olwage, 2016). Before German South West Africa was formed in 1884, the Dorsland Trekkers were exploring parts of northern Namibia and Angola from the 1870s. These were Boer families travelling from South Africa to seek better living conditions and political independence. Some Dorsland Trekkers travelled in the Kunene Region and provided the first

accounts of elephant populations in that area. These early accounts indicated that there might have been about 3,000 elephants in the Kaokoveld area at that time (Viljoen, 1987). However, hunting in the late 1800s, particularly by the Dorsland Trekkers themselves, greatly reduced the number of elephants. It was estimated that the elephant population in the northwest had declined by up to 80% by the 1910s (Bollig and Olwage, 2016; MEFT, 2021). The current area of Etosha National Park has had protected status since 1958, but the area was more accessible than the Kaokoveld before that and it is thought that poaching resulted in no elephants being in that area for about 70 years until the 1950s (Lindeque and Lindeque, 1991; MEFT 2021).

Travel in northwest Namibia was extremely challenging in the 1800s and the first half of the 1900s (Marsh, 2014), and early estimations of elephant numbers must have a very high uncertainty. In 1934, Guy Shortridge published a book containing a detailed summary of records on mammals in South West Africa and recognised that local community knowledge would be important to understanding the elephant populations. He estimated that elephant numbers had stabilised or recovered to about 600 to 1,000 elephants in the Kaokoveld by the 1930s. The basis for this estimate included consultation with local chiefs (Shortridge, 1934). Although the South African administration from 1915 controlled hunting by local people, for several decades hunting continued to be carried out by privileged white officials and their guests (Owen-Smith, 2010; Bollig and Olwage, 2016).

It is clear from the different reports that wildlife numbers have widely fluctuated since records began in the Kunene Region. Droughts would have had impacts, for example there were severe droughts in the late 1950s and early 1960s. Also, the policy of the South African administration in the 1950s and 1960s shifted to facilitating the intensification of livestock farming (Heydinger, 2021b). At that time the elimination of game (including elephants) in the northwest was encouraged as they were considered to be a liability to local farmers (Berry, 1997). Based on his extensive travels over several years in the late 1960s and early 1970s working as an Agricultural Officer in the Kaokoveld, the late Garth Owen-Smith noted that elephants were present throughout the Kaokoveld except near the Skeleton Coast (Owen-Smith, 1972; Owen-Smith, 2010). He had estimated an elephant population in the early 1970s of 700 to 800 in the Kaokoveld and he sketched a map of estimated elephant distribution (Figure 3.3). The left hand map is Owen-Smith's original map, published by Viljoen (1987) and the right hand map is the same with the area of the Northern Highlands included. The un-shaded area in the map by Garth Owen-Smith is almost exactly the same area as the more mountainous part of the Northern Highlands study area. This indicates that either it was considered that there were no elephants in the mountains of the Northern Highlands in 1970 or, more likely, the area had not been surveyed, or indeed travelled much, at that time. My consultations with colleagues of Garth Owen-Smith do indicate that he did not travel much in the Northern Highlands until after the 1970s, and this is implied in his subsequent records (Owen-Smith, 2010). Therefore the map in Figure 3.3 reflects a gap in knowledge on the elephants in the Northern Highlands at that time.

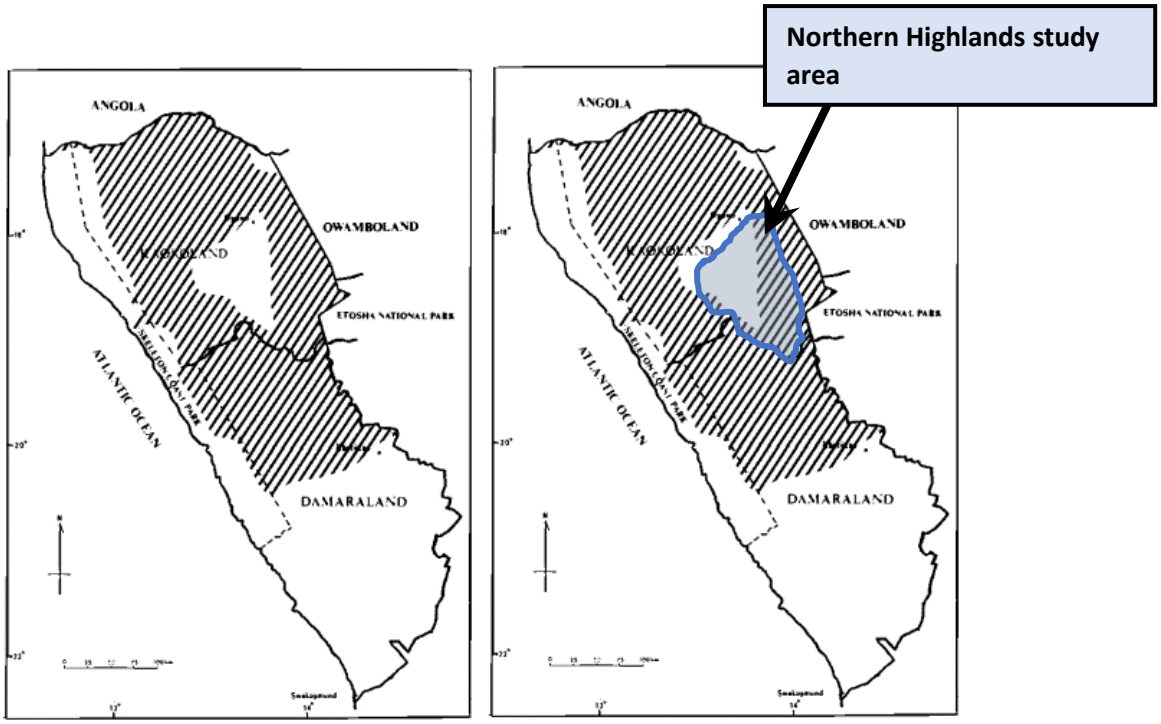


Figure 3.3 – Estimated distribution of elephants in the Kaokoveld in 1970, drawn by Garth Owen-Smith based on many years of travel in the area (Viljoen, 1987). The blue overlaid shape on the right hand map shows the Northern Highlands study area, on the same base map.

The policies of the Government of South Africa on the protected status of areas of northwest Namibia changed from 1958 to 1970 (Figure 3.4). By 1970, large areas of the Kaokoveld that had a form of protected status had been de-proclaimed and the protected areas had been reduced to the current boundary of Etosha National Park, although it should be noted that local people lived in the game reserve outside of the current Etosha boundary, so that area did not have the same level of protection as a National Park (Berry, 1997; Botha 2000; Heydinger, 2021b; Dieckmann, Sullivan and Lendelvo, 2024). The situation on the ground in northwest Namibia in the 1970s and 1980s in terms of community livelihoods (e.g. access to grazing areas) and wildlife conservation was complicated, being influenced by several policy and local factors, as well as climatic factors. Historical accounts have been documented in a comprehensive recently published book (Sullivan, Dieckmann, and Lendelvo, 2024). In practice, the enforcement of wildlife protection had been not been comprehensive in the large areas that had protected status before 1970, but the de-proclamation might have contributed to a reduction in migration of wildlife along the west-flowing river valleys, which no longer crossed protected areas. It was thought that at that time the number of elephants migrating west out of Etosha started to decrease (Schoeman, 2010). The South African Administration approved the set up of a large trophy hunting concession (15,000 km^2) in the late 1970s in between the Hoanib and Ugab rivers (Figure 1.2), to the southwest of the Northern Highlands (Sullivan, 2024). From the mid-1970s the growing black market for ivory, plus the conflict in southern Angola and northern Namibia, had led to increased poaching (Schnegg and Kiaka, 2018). The local administration handed out 2,000-3,000 rifles (mostly unregistered) to local residents in the Kaokoveld to protect themselves during the conflict (Bollig and Olwage, 2016). This would have contributed to the increase in poaching.

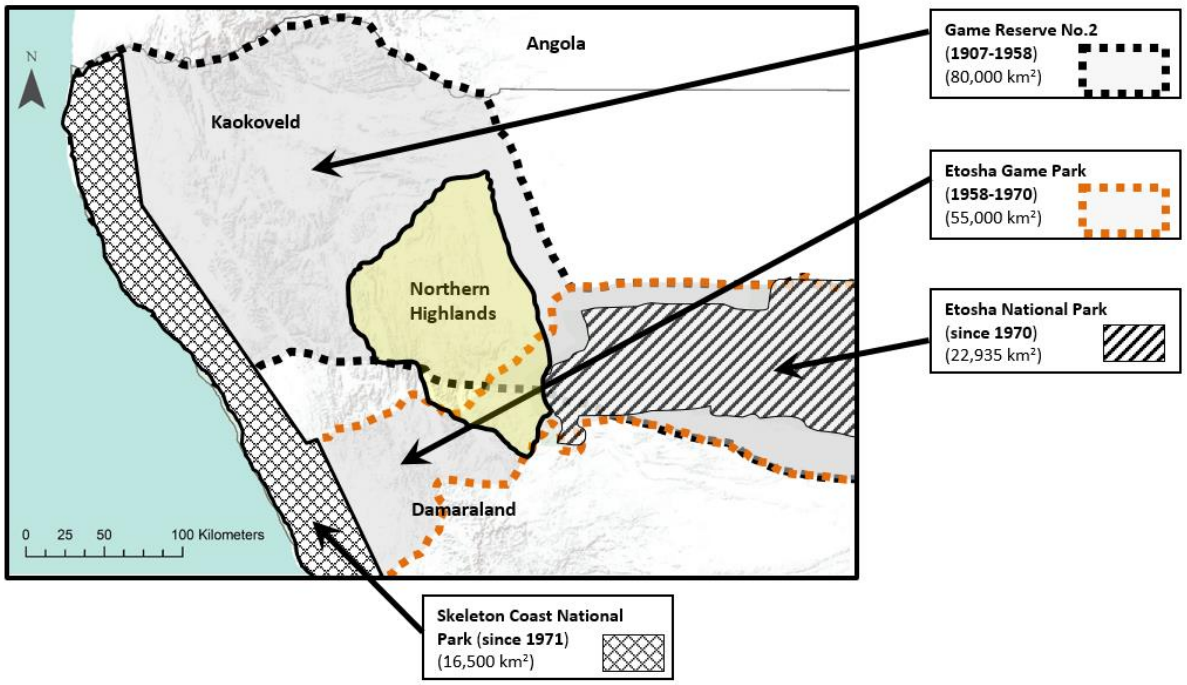


Figure 3.4 - Historical boundaries of protected areas in northwest Namibia

Several more drought years also had an impact. The severe drought of 1980-1981, with up to 95% loss of cattle, also increased motivation for poaching, and feedback from local people is that they did kill elephants, as well as for example oryx (*Oryx gazella*), springbok (*Antidorcas marsupialis*) and kudu (*Tragelaphus strepsiceros*), for bushmeat.

The most comprehensive published survey work on elephants in the Kaokoveld in the 1970s and 1980s was by Phillip Viljoen. Based mainly on his own ground survey work, he estimated that there were 500 elephants in the Kaokoveld in the mid-1970s. He then carried out detailed ground surveys between 1980 and 1983. He recorded 357 elephants in that time, and 123 carcasses, of which over 100 had been shot, which demonstrates the lack of control of poaching at that time (Viljoen, 1987) and potentially a lack of control of trophy hunting. Viljoen continued his extensive studies on the desert-adapted elephants, and concluded that there were 70 elephants in the western areas of the Kaokoveld in the early 1980s (Viljoen, 1989a). These areas were mainly the lower Hoanib and lower Hoarusib rivers, west and northwest of Sesfontein, outside of the Northern Highlands (Figure 1.2).

There were seven aerial surveys in the 1980s, with concluding estimations of populations in the northwest of about 100 to 250 elephants, but the survey areas and methods were often inconsistent or unclear (MEFT, 2021). By the mid-1980s, the wildlife in the Kaokoveld had been greatly depleted, particularly because of the severe droughts (Owen-Smith, 2010). Bollig and Olwage (2016) concluded that only about 200 elephants remained in the area by the early 1980s. Loutit and Douglas-Hamilton (1992) estimated 366 elephants from an aerial survey in 1992.

Keith Leggett has published a number of studies since 2003, mainly on the population dynamics of the elephants in the Hoanib River catchment. He concluded from his studies, and also based on surveys by the Government of Namibia, that the elephant population in northwest Namibia had recovered from the estimate of 357 in the early 1980s to about 760 in the early 2000s (Leggett *et al.,* 2003b). The community conservancy programme, and in particular its core focus on helping local communities to gain from the value of wildlife, would have had a role in the increase in wildlife populations in the region (Jacobsohn, 2019; MEFT/NACSO, 2022; Störmer *et al.,* 2019).

3.4.2 Current estimates of population of elephants in the Kunene Region

In many situations, aerial surveys would be the most applicable method for estimating the population of large animals present over a large area (Caughley, 1977). Aerial surveys of elephants for a large area tend to cover a sample area and involve scaling up of the number of elephants observed to estimate the total for the range area. It is important for the proportion of the total range area that is surveyed (the survey intensity) to be high enough to have confidence in the results. The mountainous terrain of the Northern Highlands means that aerial surveys are difficult (Thouless *et al*., 2016; MEFT, 2021), in particular for those survey methods that require an aircraft to fly at consistent height above ground level. Helicopters are often better for mountainous terrain than fixed-wing aircraft (Craig, 2012). Appendix B1 provides more detail from my review early in this Research Project of potential methods to estimate elephant populations.

The particular challenge of aerial surveys over the large range area in northwest Namibia is the low density of elephants, especially at the edge of range. It is difficult to estimate the range area, and difficult to scale up sample counts with confidence. Observations of a large herd can skew the results of an estimated population when there is low survey intensity. The range area in northwest Namibia is considered to be at least 41,000 km^2, and has been expanding in recent years (Skinner and Chimimba, 2005; Thouless *et al*., 2016; MEFT, 2021). The Northern Highlands is about 12,000 km^2 and makes up a part of the total range of elephants in the northwest (Figure 1.2).

The IUCN African Elephant Status Reports (Blanc *et al.*, 2007; Thouless *et al*., 2016) involve analysis and comparison of several surveys. An appendix to Namibia's National Elephant Conservation and Management Plan (MEFT, 2021) also includes a detailed assessment of the surveys carried out in northwest Namibia. These reports on the surveys vary in terminology for the area of the elephant population, most either referring to the area as the "Kunene Region" or as "northwest Namibia". The scaled up estimates from the various surveys effectively represent the estimated population for the total range of elephants in northwest Namibia (outside of Etosha National Park).

According to the African Elephant Database (IUCN, 2024a), northwest Namibia accounts for an estimated 1.5% of the total elephant population in Namibia. The costs and practicalities of aerial surveys mean that resources have to be focused on the largest populations in a country (Chase and Landen, 2019). It is understandable that the Government of Namibia has prioritised its resources for monitoring of elephants in other areas where larger elephant populations are found. The elephant density in northwest Namibia is much lower that other

core areas of elephant range in Namibia (Thouless *et al*., 2016), and therefore significant resources would be needed to monitor properly such a large area and obtain accurate population data through aerial surveys. A large survey effort, involving many hours of survey flying, would be needed to provide a reliable count. The mountainous terrain also constrains other monitoring activities such as foot patrols and counts from vehicles.

There have been four systematic aerial surveys of elephants in northwest Namibia since the year 2000 (Blanc *et al.,* 2002; MET, 2005, 2011; Craig and Gibson, 2016). These surveys each cover parts of northwest Namibia. The survey reports for 2005, 2011 and 2016 were provided by the Ministry of Environment, Forestry and Tourism (MEFT). The reports on the surveys include calculations that scale up the sample counts during the surveys to provide estimates of total elephant population in the northwest. There are significant uncertainties associated with the estimates derived from all the surveys and the results cannot be compared with confidence (Craig *et al.,* 2021; MEFT, 2021). Only the most recent survey in 2016 included the whole of the Northern Highlands. The different areas of the three most recent surveys in 2005, 2011 and 2016 are provided below in Figures 3.5 to 3.7 respectively, also showing the area of the Northern Highlands added to the maps. A summary of each survey is included in Table 3.1.

The implication from the four surveys is that the elephant population in northwest Namibia is within the range of 169 to 1,173 (Craig and Gibson, 2016; Craig *et al*., 2021; MEFT, 2021). The estimate in 2016 is from a more comprehensive survey and covers a large area that includes the commercial farms southwest of Etosha. The estimates from the 2016 survey are reported to be in the range 416 to 3,015 elephants, with a 95% confidence limit. The report of the 2016 survey does recommend that, when planning elephant management, a precautionary approach would assume an estimate of 416 for northwest Namibia, again demonstrating the high uncertainty in the estimates (Craig and Gibson, 2016). The results of the 2011 survey (estimated 314 elephants in the Northwest, range 221-529 at 95% confidence limit (MET, 2011)) were used as the basis for the estimate in the most recent IUCN Status Report (Thouless *et al.,* 2016) and are still the figures in the IUCN African Elephant Database (IUCN, 2024a) as of 20 June 2024. These estimates are for the whole of northwest Namibia, whereas the Northern Highlands population is a proportion of the total northwest population.

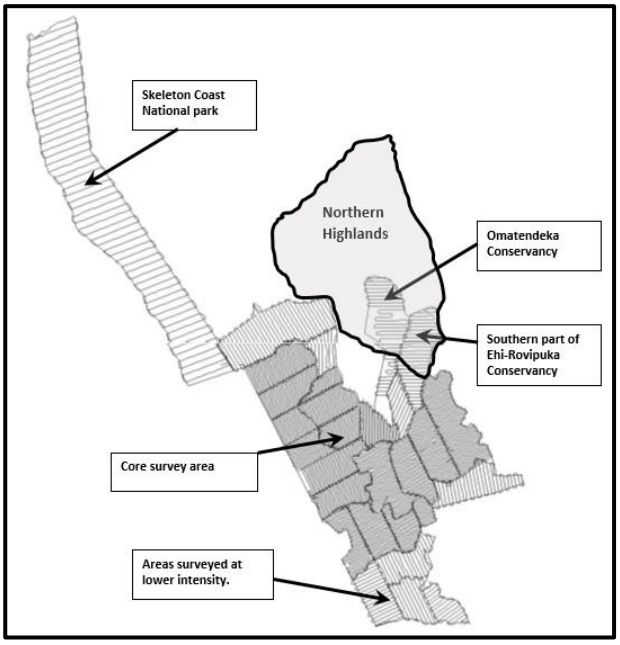


Figure 3.5 – Area of aerial survey in 2005 (adapted from MET, 2005).

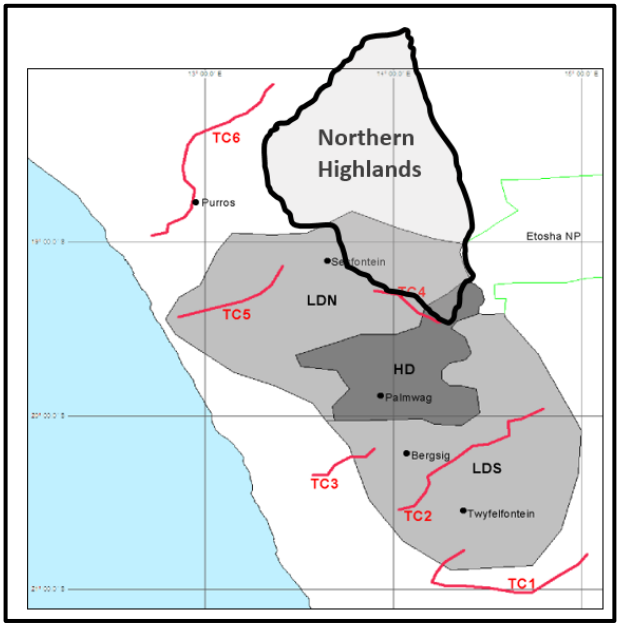


Figure 3.6 – Area of aerial survey in 2011 (adapted from MET, 2011). (TC = total count, LDN = low density north, LDS = low density south, HD = high density).

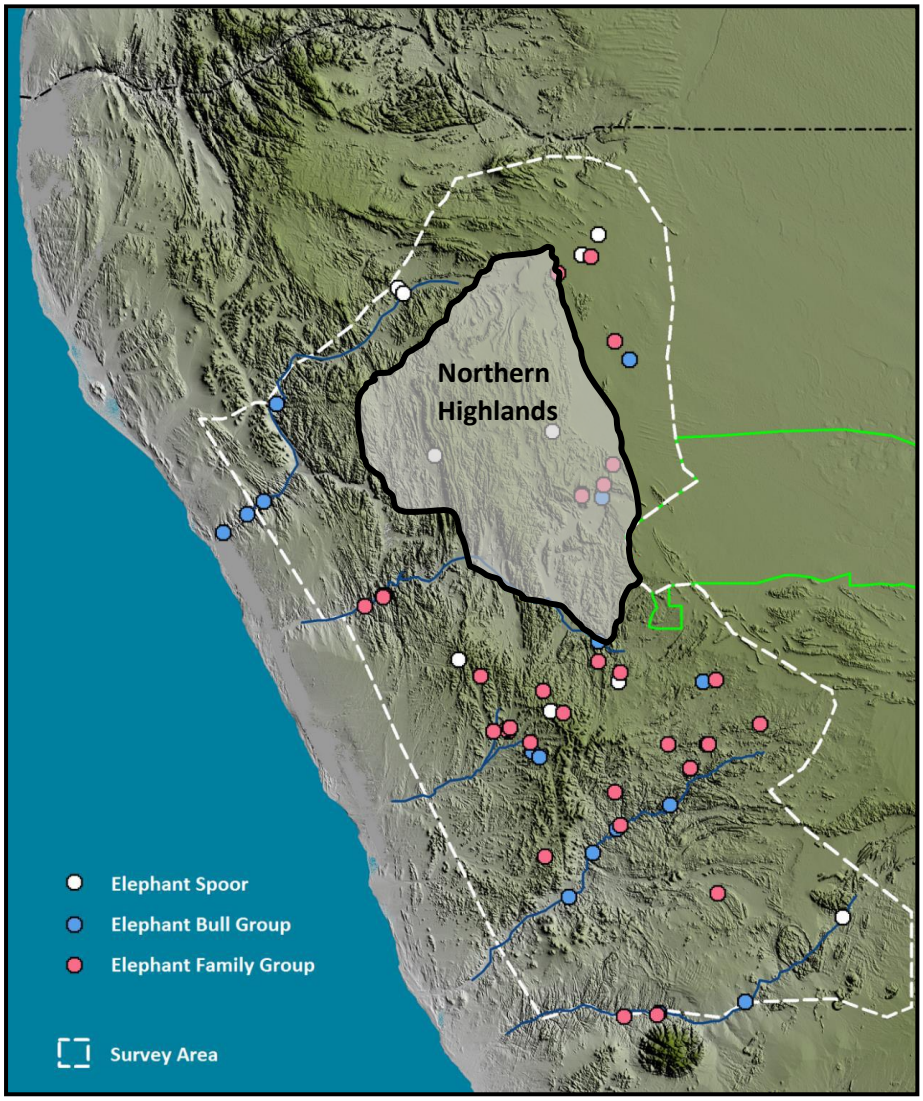


Figure 3.7 – Area of aerial survey in 2016 (adapted from Craig and Gibson, 2016), showing four female-led groups observed in the Northern Highlands area.

The reports on the results of the 2005 and 2016 surveys provide an average population density of elephants in the areas surveyed in different parts of northwest Namibia of 0.7 to 2.71 elephants per 100 km^2. From this I calculated an estimated population in the Northern Highlands (about 12,000 km^2) of 84 to 325 elephants. The recommended estimate for management plans of 416 elephants in the northwest from the most recent survey (Craig and Gibson, 2016) would give a density of 0.96 elephants per 100 km^2 in the northwest and from this I calculated a best estimate of 115 elephants in the Northern Highlands from the aerial surveys. In practice, the number of elephants in the Northern Highlands varies at different times of year because of their movements, particularly during the rainy season (Leggett, 2009a; MEFT, 2021).

The main NGOs involved in community-based wildlife conservation in northwest Namibia have carried out a full moon waterhole count of elephants and other wildlife over 3-4 nights in September, each year since 2018. The count is carried out by the game guards. The NGOs estimate an approximate population of elephants based on the results of the count, taking into account an assumed drinking frequency of 1.8 days. The estimated total population for five of the six conservancies in this Research Project has been about 100 to 200 elephants since 2018 (counts were carried out in Orupupa, Otuzemba, Okangundumba, Ozondundu and Omatendeka). There are several sources of uncertainty, including the potential for double counting, and the notes in the published results sheets state that the estimates are approximate and should be used only as a guide to relative abundance over time (NACSO, 2023b). However, the estimates from the full moon counts are within the order of the estimate based on elephant density from aerial surveys. The number of elephants counted has increased each year since 2019.

Table 3.1 - Summary of the four main aerial surveys of elephants in northwest Namibia since the year 2000

Study	Population estimate	Notes
MET survey in 2000	663	• Used as the basis for the estimate of 663 elephants in the 2002 IUCN Status Report (Blanc *et al*., 2002) for the Kunene Region. The IUCN report emphasises the uncertainty in the estimate. • The survey results are unpublished and have not been available for review in this Research Project. IUCN received the data as a personal communication, and indicated the survey is based on sample aerial counts (blocks and transects according to MEFT (2021)).
Northwest aerial survey, MET (2005).	210 (range 169 to 374, 95% confidence limit)	• Used as the basis for the estimate in the 2007 IUCN Status Report (Blanc *et al*., 2007) for the Kunene Region. • Estimates based on an aerial sample survey of total counts along transects, carried out for part of the northwest (Figure 3.5). • Covered conservancies to the south of the Northern Highlands and also included the lower Hoanib river valley in Sesfontein, and Skeleton Coast National Park. • The survey only covered Omatendeka and southern Ehi-Rovipuka in the Northern Highlands study area. • The survey intensity was low in many areas. • The report gives an elephant density of 0.7 elephants per 100 km^2 in the northwest.
Countrywide survey of elephants in Namibia, (MET, 2011).	314 (range 221 to 529, 95% confidence limit)	• The survey method involved a block count in what was considered as a core area and a total count along selected river valleys (Figure 3.6). • The actual survey only included a small part of the Northern Highlands (the southern part of Ehi-Rovipuka, northern part of Omatendeka and small parts of Ozondundu and Orupupa conservancies). • The results were used as the basis for the estimate in the most recent IUCN Status Report (Thouless *et al*., 2016).
Aerial survey of elephants and other animals in northwest Namibia, (Craig and Gibson, 2016)	1173 (range 416-3015, 95% confidence limit)	• This was the only survey in the last 20 years to cover all of the Northern Highlands (Figure 3.7). • Estimated elephant population of 1,173 in the northwest. The wide range in 95% confidence interval of 416-3,015 demonstrates the high uncertainty in the estimate. • The reported results are broken down into estimates of individual strata covered by the survey, and part of five strata cover the Northern Highlands. • This estimate of 1,173 is for elephants in northwest Namibia, including elephants on commercial farms around Kamanjab. The estimate covers 63,000 km^2, an area much larger than the Northern Highlands and larger than the range for northwest Namibia in the IUCN Status Report (Thouless *et al*., 2016). • The report of the 2016 survey does recommend that, when planning elephant management, a precautionary approach would assume an estimate of 416. • The report gives an elephant density of 2.71 elephants per 100 km^2 in the northwest, based on the survey results.

3.5 Collating knowledge of game guards on the elephant population in the Northern Highlands

This section covers my analysis of the data and information on the elephant population that I collected from 34 game guards in semi-structured interviews during the Research Project. As noted in Section 3.3, an important objective of this research component was to test a method of data collection and analysis using local ecological knowledge on known groups of elephants. Therefore, the rationale for the steps in testing the method for the analysis is described in this section.

3.5.1 Trends in elephant population

As context for my analysis of the current population of elephants, it is important to take into account the trends in population size. The perception of most of the game guards that I interviewed was that the number of elephants has increased in the Northern Highlands since 2012. 32 of the 34 game guards interviewed (95%) either agreed or strongly agreed with the statement: "*the number of elephants in the conservancy has increased in the last 10 years*." 25 of 34 (74%) game guards strongly agreed with that statement.

I also included an open question in the interviews on the trend in size of elephant population over the previous 10 years (i.e. 2002-2012). In 2012, 17 of the 34 interviewees were working as a game guard, but several others had a different role in the wildlife conservancy or an interest in conservation, which then helped them to get the job as a game guard. Three interviewees were not able to comment on this question because of their lack of experience and knowledge at that time. 16 of 31 game guards (52%) perceived that the elephant numbers were increasing in the Northern Highlands over that time period (2002-2012) and three game guards (10%) consider that the elephant population was decreasing. Further discussions indicated a common opinion that the rate of increase in elephant population has stepped up since 2012. This is also backed up through the consultations, when 27 of 34 game guards (79%) agreed or strongly agreed with statement "*Elephants used to move into the area from Etosha and go back, but now spend most of the time in the Highlands*." My interpretation of these results and the related discussions during the interviews is that there is a common perception among the game guards that elephants moved into the area from Etosha but stayed only for the rainy season, for example in the 2000s, but since around 2012 more elephants are spending more of the year in the Highlands. This is likely to be partly because of the programme to upgrade water points, funded by the Government of Namibia and development NGOs, which has increased the availability of water for people and elephants. It is also partly because there is less poaching and more community commitment to protect the elephants (as discussed in Section 1.5 and in more detail in Chapter 7). Game guards from Okangundumba, Ozondundu and Omatendeka Conservancies in particular stated that elephants moved back to Etosha in the 2000s because of poaching, only visiting the area around the rainy season. One experienced game guard (over 12 years in service), based at Okavare in Omatendeka Conservancy (Figure 1.16), stated that elephants can sense when another elephant has been shot and killed in the area because of poaching or trophy hunting, and even now this will result in groups

moving away from such areas and perhaps back to Etosha National Park. Two game guards from Orupupa Conservancy provided similar accounts.

3.5.2 Analysis of data collected from game guards on known groups

One of the main components that I planned for the semi-structured interviews was on the details of elephant groups known by each individual game guard. The aim was that this would enable me to develop an estimate of the elephant population in the Northern Highlands. I define a "known group" for this analysis as a group of elephants that is known by an individual game guard. This means that there would likely be much double counting where several of the 34 game guards interviewed would each know the same group.

The interviews each took between four and six hours. About half that time was spent discussing known groups. In particular, at each interview we discussed the number of elephants and distinguishing features of individual elephants in each known group. These aspects were going to be important for me to identify cases where several game guards know the same group (i.e. double counting). To facilitate the analysis, I also asked game guards to assign a rating of uncertainty for their estimate of the number of elephants in each group (Box 3.1), and I also assigned my own uncertainty rating based on my confidence in the knowledge of the game guard on a known group.

Appendix B2 provides the full table of results for all the known groups of elephants. The total number of known groups identified by the 34 game guards was 158. This total included 45 groups that were identified by game guards to be male individuals or groups of males. This large total number of known groups made me realise that: (i) there would have been much double counting where several game guards know the same group, and (ii) a useful first step would be to make an informed judgement on the total number of groups likely to be in the Northern Highlands.

My approach for the analysis of known groups was to develop an estimate of the elephant population by identifying the likely number of elephant groups that are more permanently in the Northern Highlands and the likely size of each group. I did this by dividing the total set of known groups into subsets of similar group size, and analysing each subset. The interviews were carried out from the start of December 2022 to the end of February 2023, and therefore the estimates developed in this Chapter can be assumed to represent the elephant population in 2022. The steps in my analysis to estimate the elephant population in the Northern Highlands were:

- Step 1 - Estimating the minimum and maximum **number of female-led groups** of elephants that are more permanently in the Northern Highlands.
- Step 2 – Identifying and assessing **sources of uncertainty** in estimates by game guards of the number of elephants in each group and in the distinguishing features identified.
- Step 3 – **Reviewing at a high-level the complete set of known groups** to plan the more detailed analysis.
- Step 4 – **More detailed assessment of results**, starting with the group that is best known by individual game guards based on distinguishing features identified.
- Step 5 – Collating the results of the more detailed assessment of known groups to **develop an estimate for the elephant population** in the Northern Highlands.

Figure 3.8 provides a more detailed summary of the process to estimate the elephant population from the set of known groups within the above steps.

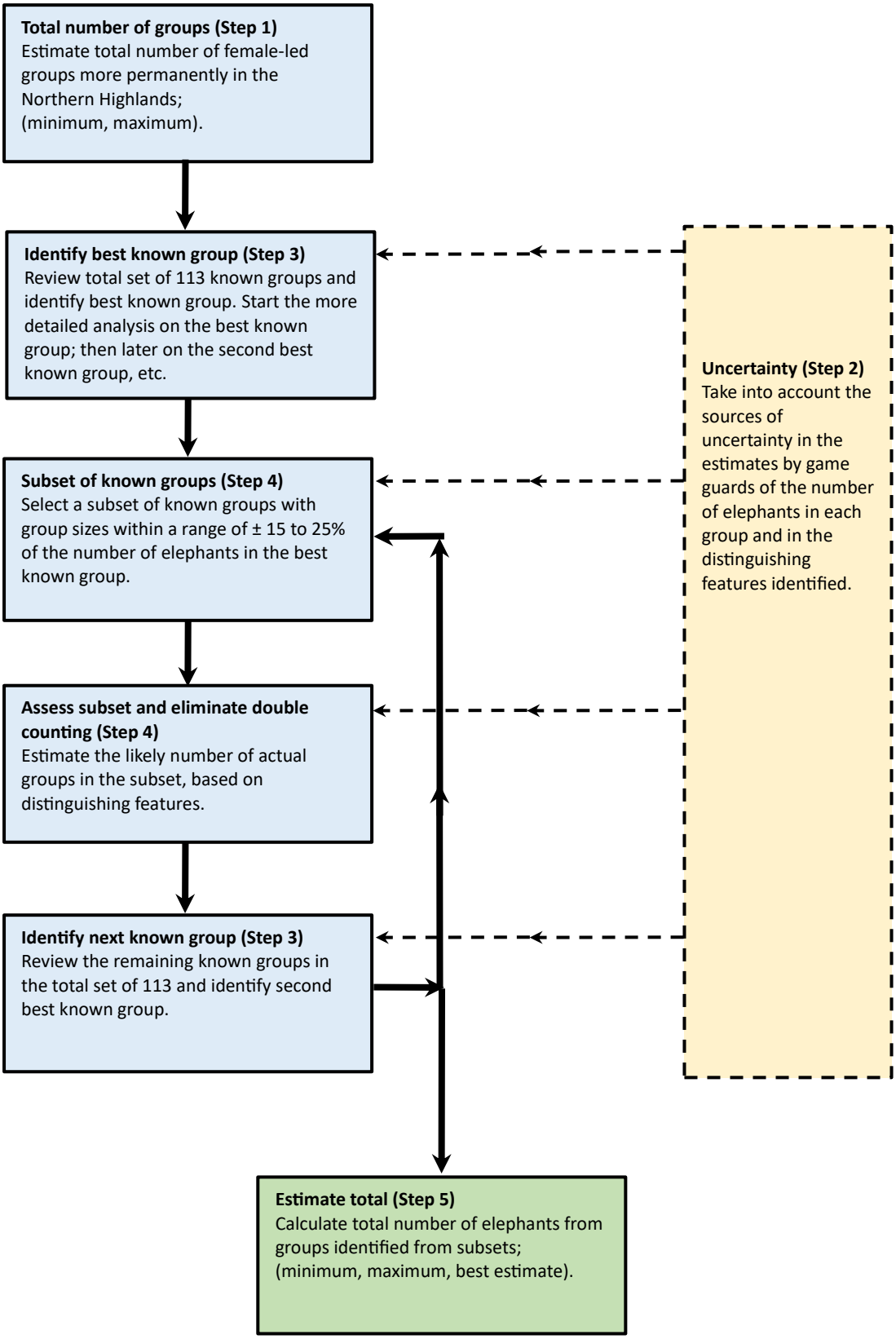


Figure 3.8 - Overview of iterative process to estimate elephant population from the set of known groups

Step 1 - Estimating the minimum and maximum number of female-led groups of elephants that are more permanently in the Northern Highlands

I prepared Table 3.2 and Figure 3.9 to provide a summary on the number of female-led groups known by individual game guards. The game guards identified a total of 113 known female-led groups, and individual game guards know 3.3 female-led groups on average. Game guards from Orupupa know the most groups (almost five female-led known groups per game guard on average). Out of the 34 game guards, 16 said that they know four or more female-led groups (Figure 3.9), but no game guard has knowledge of more than six female-led groups. My judgement based on interviews with the 34 game guards and on all the time that I spent in the field is that the number of large groups (e.g. of 10 or more elephants) is likely to be between three and ten. The fact that game guards identified 99 known groups of ten or more elephants is another indication of the amount of double counting. My assumption that there are three to ten larger groups is supported by the results of the only aerial survey in the last 20 years to cover all of the Northern Highlands, which observed four female-led herds of elephants in the Northern Highlands (Craig and Gibson, 2016) (Figure 3.7).

Table 3.2 - Summary of number of female-led groups known by game guards in each conservancy

	No. game guards interviewed	Total No. groups named by game guards interviewed in each conservancy	Average No. groups known per game guard in each conservancy
Ehi-Rovipuka	2	8	3.0
Okangundumba	4	16	4.0
Okongoro	1	1	1.0
Omatendeka	8	17	2.1
Orupupa	6	27	4.8
Otjombande	1	4	4.0
Otuzemba	6	21	3.5
Ozondundu	6	19	3.2
	34	113	3.3

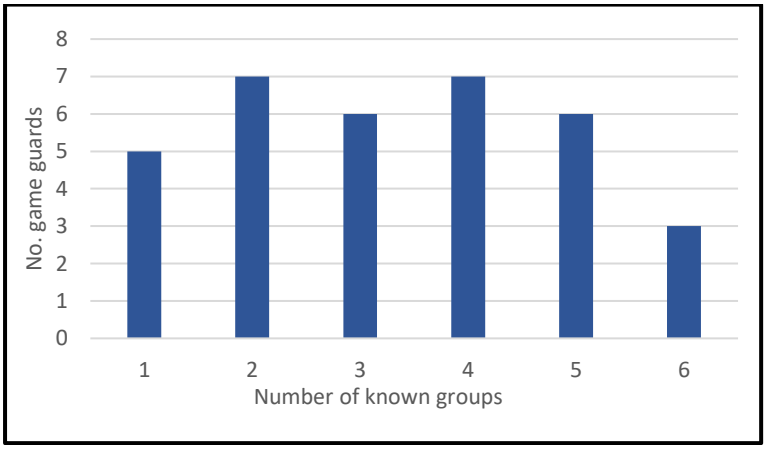


Figure 3.9 - Number of groups known by individual game guards

Step 2 – Identifying and assessing the sources of uncertainty in the estimates by game guards of the number of elephants in each group and in the distinguishing features identified

Before describing my analysis of known groups, it is important to summarise the main uncertainties and their implications for the analysis. There are several sources of uncertainty in the number of elephants estimated by game guards in their known groups, even for those that were assigned category A by game guards (the system for categorisation related to uncertainty is explained in Box 3.1). Example sources of uncertainty include:

- Game guards mainly see the groups at night, when it is difficult to count them accurately. Elephants tend to spend daytime away from the villages. Even early records of explorers state that "*it is remarkable how seldom, unless tracked up, elephant are come upon by day, and also how shadowy and inconspicuous they are at most times*" (Shortridge, 1934, p.363).
- The game guards do sometimes see elephants during the day, but the game guards prefer to keep a distance (Figure 3.10), because of safety concerns, and it is difficult to count groups from a distance. I observed this behaviour of the game guards during all four of my field walks when elephants were seen (once in Ozondundu, once in Orupupa and twice in Omatendeka Conservancies).
- Many areas of the Northern Highlands do have much tree cover, with mopane (*Colophospermum mopane*) being the dominant species (Inman *et al*., 2020a), as observed in the valleys and therefore near many villages. Mature mopane trees tend to be 4-6m tall (or taller along the riverines) and hold their leaves for much of the year, meaning that, during some daytime observations, some elephants in a group are likely to be hidden when observed in the valleys (Figure 3.11). Even on the mountain slopes, where the vegetation is usually less dense, elephants can sometimes be difficult to observe and count (Figure 3.12).
- Game guards do not have binoculars or spotlights, which would help them to count elephants in a group.
- Game guards will often check elephant footprints in the morning after a night time visit to the water point (Figure 3.13), but it is difficult to count a large group size from many footprints.
- Adult male elephants tend to move in and out of groups, as mentioned by many game guards, so group size tends to change.
- According to a few game guards, larger groups of elephants might sometimes split up, in particular when visiting a water point (effectively sub-groups might take turns to visit a water point).
- Sometimes two groups are seen together at water points, and game guards have observed this (one game guard indicated that the noises made from the elephants are different when two groups are at a water point).
- Many game guards pointed out that groups have several babies, and this can make counting difficult because adult elephants tend to shield babies (Garstang, 2015) (Figure 3.14).



Figure 3.10 – Game guards in Ozondundu Conservancy were reluctant to move any closer to the elephant in the photograph, demonstrating the concern over safety and also the difficulty in counting elephants from such a distance (25 January 2023).



Figure 3.11 – Elephant in shade of mopane trees in the afternoon in a valley near Okambonde, Omatendeka Conservancy. The photograph shows the challenges in finding elephants. Taken 20 January 2023.



Figure 3.12 – Even when elephants are on the slopes in the Northern Highlands, they can be difficult to see. This photograph of an elephant up a slope in Ozondundu Conservancy, taken 25 January 2023, also demonstrates the difficulty with counting the number of elephants.



Figure 3.13 – Checking footprints near water points in the morning is one method used to count herd size, Ondivet, Omatendeka Conservancy, 7 January 2023.



Figure 3.14 – This photograph, taken at Etosha Heights on 16 February 2023, demonstrates how smaller elephants tend to be hidden/protected by larger elephants and could easily be missed out when counting group size.

In the interviews I asked game guards to describe any distinguishing features of the groups they know. My analysis could then focus on trying to identify similar sized groups for which different game guards noted similar distinguishing features. Some game guards had not identified any features, apart from the number of elephants. Distinguishing features described by game guards for some groups included:

- Groups including an elephant with a broken tusk or tusks (Figures 3.15, 3.16).
- Groups including an elephant with a torn ear or ears (Figures 3.16, 3.17).
- Groups where footprints show that an elephant has a distinguishing hole or bad toe in a foot or several feet (Figure 3.18).
- Four game guards know a group because of a characteristic rumble sound often given by one of the adults at night when they visit the community water point.



Figure 3.15 – Example of an elephant with a broken or worn tusk, Etosha Heights, 26 December 2020.



Figure 3.16 – Example of an elephant with a broken or missing tusk and a tear in its ear. Distinguishing features such as broken tusk or torn ear tend to be more easily noted on the larger elephants in the group by the game guards; Lower Hoanib, 11 April 2021.



Figure 3.17 – Example of an elephant with a regular set of tusks, but with a tear in its ear, Lower Hoanib, 11 April 2021.



Figure 3.18 – Some elephants tend to have cracked feet, especially those spending time in sandy areas (this photo was taken in the lower Hoanib desert areas, west of the Northern Highlands, 12 April 2021). Game guards can sometimes recognise an elephant or known group has visited by known footprints seen in the morning (particularly evidence of a bad toe or hole in foot observed in a footprint).

A high proportion of known groups were observed by game guards as having several babies, so this could not be used as a feature to distinguish between groups as the number of babies was not known or was too uncertain.

Game guards do not have binoculars or spotlights, as mentioned, and they could therefore easily make an error in identifying distinguishing features of an individual in a group, especially considering the game guard would be observing the group from a distance and often at night.

The points above demonstrate that there are several uncertainties in terms of estimates by game guards of the number of elephants in a group and identification of distinguishing features. Also, there was some uncertainty in the interview method, and during the field work I identified lessons for improving the method. In particular, there was uncertainty when game guards said that a “left” or “right” tusk was broken or “left” or “right” ear was torn. My questioning was not specific on whether it was the elephant’s left or right side, or the left or right side when looking at the elephant. Therefore in my analysis below of known groups, the left/right aspect was not taken into account, whereas this aspect would have enhanced the analysis if there had been more certainty in the answer.

According to game guards, elephants in the Northern Highlands that walk on the rocky slopes tend to have smoother feet, whereas those spending most of their time in the sandy areas, such as in Etosha or the desert areas in the lower Hoanib, have more cracks in their feet (Figure 3.18). Again, it would have been better if I had included more detailed follow-up in the interview method when game guards mentioned distinguishing features related to feet, such as “bad toe”, “hole in foot” or “large crack in foot”. However, I have assumed that, when a game guard identifies these points, they are distinguishing features that can be taken into account in the analysis as they are features more noteworthy than the normal

cracks in feet from elephants from sandy areas. Likewise, the mention of “hole in ear” or “torn ear” was assumed to be a similar feature, but the method could be enhanced in future by finding out more precise detail on the type of damage to an ear.

Given the sources of uncertainty described above, my assumption is that the stated size of a known group by a game guard, for groups assigned Category A (in terms of confidence in group size), can only be accurate to ± 15 to 25%.

Step 3 – Reviewing at a high-level the complete set of known groups to plan the more detailed analysis

My approach was to carry out high-level assessment through visual inspection of the data set (Appendix B2) to try to identify and confirm groups that are potentially known by several game guards. With so many known groups identified by the game guards, and with uncertainties for all known groups, it was important to define an appropriate starting point for the analysis. Using the plot of known groups in Figure 3.19, I identified subsets of the known female-led groups with the intention of assessing the known groups in each subset to identify where different game guards know the same groups, using my notes on the distinguishing features described by game guards. My starting point was to identify the group that is best known by individual game guards and select a subset of known groups with sizes around the size of the best known group.

Out of the 113 known groups that were female-led, 61 were given category A by the game guards in terms of their confidence in their knowledge about the number in the group. These 61 groups are plotted in Figure 3.19. Category A means the estimated number of elephants is based on many observations by the game guards (Box 3.1). During the interviews, I also assigned a category for each known group (also A to E), of my confidence in the estimate based on my assessment of the game guard knowledge of the known group. I assigned Category A to 20 of the 61 known groups for which game guards had assigned Category A. For the selection of subsets of known groups, I focused initially on these 20 known groups on which I had most confidence in the information.

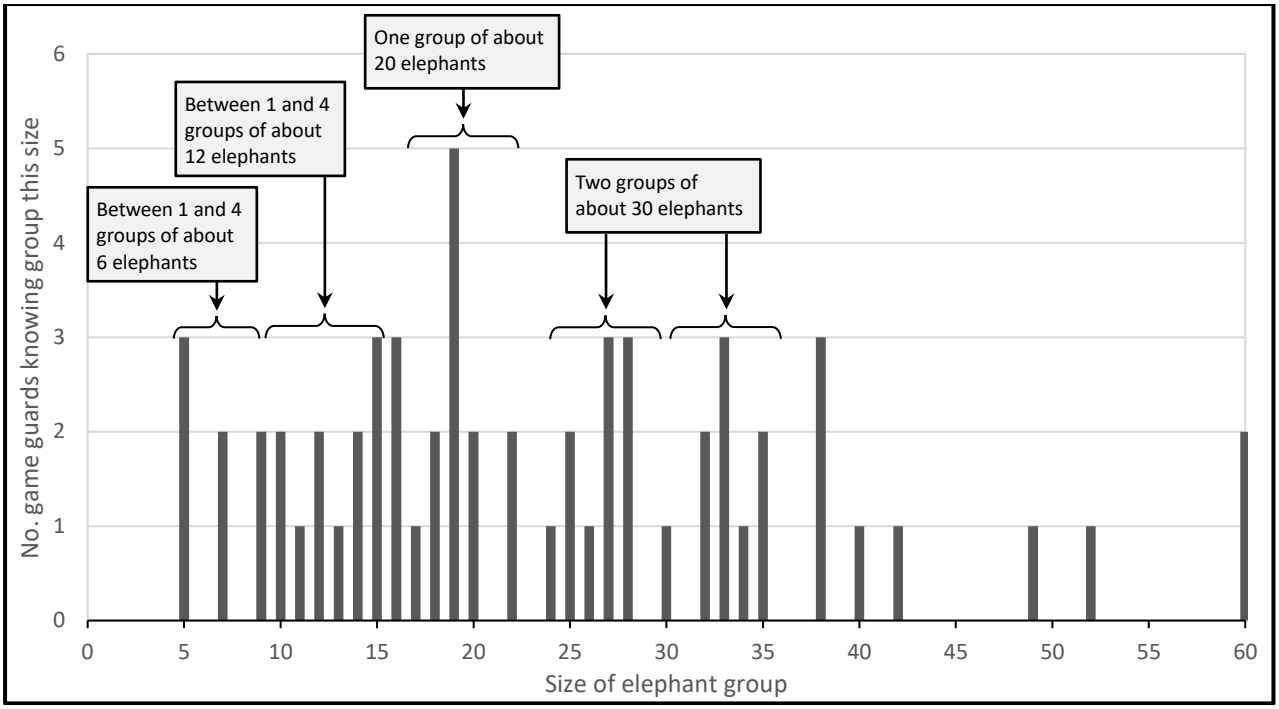


Figure 3.19 - Number of game guards knowing groups of a specific size for the 61 known groups with Category A level of certainty.

Out of the 20 known groups for which both the game guard and myself assigned Category A, the three most experienced game guards from Otuzemba Conservancy (average years of service 9.7 years), including the head game guard, each identified a known group of 19 elephants that they have named "Topoti". These game guards were based in Otjitoko, Otuzemba and Okarindi villages (Figure 1.16). Given that there is some common knowledge on the Topoti group, and it was the only female-led group that had been given a name by any of the 34 game guards, it was appropriate for my analysis to use this group as a starting point. A group of this size (19 elephants) also shows a peak in the chart in Figure 3.19. The uncertainties described above under Step 2 mean the number of elephants estimated by a game guard in a group can only be assumed to be accurate to about ± 15% at best. Therefore I selected the first subset of known groups within an estimated size of **16 to 22 elephants**, on the assumption that other game guards might also have been observing the Topoti group of about 19 elephants. I could then carry out a more detailed assessment of this first subset, which I describe under Step 4 below.

For selection of the second subset of known groups, I had noted during the interviews that there were several game guards with knowledge of a group or groups of about 30 elephants. This was the group size for which the data collected provided me with the second highest level of confidence. I used the information from two game guards with particular experience and detailed knowledge as a starting point for the analysis of the information on known groups around that size:

- The Head Game Guard for Okangundumba Conservancy with over 10 years of experience, who I noted during the interviews as being particularly dedicated to the leadership role. He lives in in Okahua (Figure 1.16), a small village regularly visited by elephants. He identified a known group of 35 elephants, describing their movements and some distinguishing features with confidence.

- A game guard with over 13 years of experience, living at Otjozongombe in Omatendeka Conservancy (Figure 1.16), a larger village on a road junction, at which information on elephant movements is likely to be more often communicated between local people. He identified one group of 33 and one of 28 elephants.

From an initial assessment of the table of known groups (Appendix B2), I identified similar features for several of the known groups with the number of elephants around 28 to 35. I therefore selected a second subset for more detailed analysis (described in Step 4 below) with a range of **25 to 40 elephants** in a known group, taking into account the perceived uncertainty of at least ±20% for larger sized groups.

Other subsets that I identified in the full data set in Appendix B2 include 13 known groups of between **nine and 15 elephants** (with Category A rating of uncertainty), and nine known groups of between **four and eight elephants**. These subsets are also discussed further in the analysis under Step 4 below.

Step 4 – More detailed assessment of results, starting with the group that is best known by individual game guards based on distinguishing features identified

This more detailed assessment describes the comparison of distinguishing features and assumptions on the subsets selected under Step 3 of female-led known groups of elephants. At the end of the assessment of each subset of known groups, I have included text boxes to provide summaries of my best estimate of the size of a group or groups of elephants. I have then added these, under Step 5, to give the total estimate for the number of elephants in known groups more permanently in the Northern Highlands in 2022.

For three of the subsets, I extracted Tables 3.3, 3.4 and 3.5 from Appendix B2. In these tables, my assessment of known groups and distinguishing features was helped by my colour coding of relevant items identified in those tables (Box 3.2).

Box 3.2 – Legend for Tables 3.3, 3.4 and 3.5

tusk broken	Highlights broken tusk or tusks
big tusks	Highlights unusually long tusks
bad toe	Highlands a problem with a foot or feet
ear torn	Highlights a torn ear or hole in ear
distinct noise	Highlights a group that makes a distinct noise
Topoti	Highlights a named group
Nelson (Otjozongombe)	Shows a game guard who has identified more than one known group in a subset.

The common point from the three game guards in Otuzemba Conservancy who have named the Topoti group is their opinion that there are 19 elephants. One of the three game guards

listed no other distinguishing features to the group, but the others noted that one elephant has unusually longer tusks and longer tail, and one elephant has a torn ear.

Table 3.3 lists the first subset of 15 known groups identified by game guards between the size of **16 to 22 elephants**. The key points from my analysis of the subset are:

- The subset includes the three known groups named as Topoti.
- Out of the 12 known groups not named as Topoti, the game guards identified distinguishing features for seven.
- One known group of 19 elephants had been identified by the game guard based at Okarumbu in Ozondundu Conservancy (Figure 1.16) with the same distinguishing feature of an elephant with big tusks.
- A known group of 16 was identified by the game guard from Okakuyu in Ozondundu with an elephant with longer than normal tusks.
- Potentially, a group of 16 identified at Otjozongombe, on the boundary of Okangundumba and Omatendeka Conservancies, could be the same group as one elephant also was identified with a torn ear.

I have some confidence that the known groups noted in the points above identified by the game guards at Okarumbu and Okakuyu is the same as the Topoti group. This demonstrates that the elephant groups are moving around the Northern Highlands (Otjitoko in Otuzemba Conservancy to Okakuyu in Ozondundu Conservancy is over 80 km on a direct route). Also, given that the game guard at Okakuyu identified that one elephant in the group has a large crack in its foot, and two other game guards noted a group around this size also with an elephant with a distinguishing feature in its foot, there is potential for more of these game guards to be noting the same group (i.e. the group named Topoti by the Otuzemba game guards).

In summary, the interviews and assessment of results on known groups indicate that there is a group of about 19 elephants, with several babies and sometimes male elephants moving in and out of the group, with a large female that has unusually long tusks, one elephant has a torn ear, and the footprints of one elephant might show a problem (e.g. large hole/crack) in its foot. This approach has uncertainties, but does demonstrate the viability of the method if there was a more structured approach over time and the game guards were to have equipment (e.g. binoculars, spotlights).

Based on my assessment, there are likely to be between one and three groups of this size (about 20 elephants). The subset for this range size of 16 to 22 elephants involved identification of 15 known groups from 14 game guards (i.e. only one game guard considers that there is more than one group in this size range). My assumption is that it is more likely that there is only one group of this size in the Northern Highlands.

Summary of above analysis:

I assume there is likely to be one group of about **20 elephants** (Topoti group) in the Northern Highlands.

Table 3.3 – Subset of 15 known groups (Category A) in range of 16 to 22 elephants noted by game guards

Conservancy	Game guard (village)	Estimated number in group	Main place observed	Confidence of GG	Confidence interviewer	No. years observed	Distinguishing features	Movements described by game guard	Estimate of time per year in the conservancy
Orupupa	Abia (Ekoto)	22	Ekoto, Okauua, Okongutirwa, Epako, Okomutati	A	A	2-5 years	Sometimes 3 males split from group (sometimes 19 in group). Big male has left tusk broken. Group has 3-4 babies.	To Ehi-Rovipuka, plus Okarindi and into Otuzemba.	9 months
Orupupa	Tjuimene (Okozonguehe)	20-25	Ekoto-Okauua	A	C	<2 years	Lots of young ones.	Also moves to Okanandjira, Otjozongombe, Okazorongua, Okonjota, Otjokavare.	>6 months
Orupupa	John (Omuhama)	20±	Omuhama-Ozongundu	A	C	<2 years	One big female has half broken left tusk; one young male has footprint with hole.	Go away for 1-2 weeks but no more, perhaps moving to Ehi-Rovipuka.	>6months
Otjombande	Zavarura (Okavare)	20	Okavare and the southern/western area of Otjombande conservancy	A	B	>5 years	Only 4-5 adults, but many teenagers and babies.	Moves less into neighbouring conservancies.	6-7 months
Ozondundu	Kaperue (Okarumbu)	19	Okarumbu, Otjomatemba, Okomuhana	A	A	2-5 years	Big matriarch with big tusks. One elephant has distinct scream. Perhaps 4-6 babies.	Sometimes Otjaptijapti, Otjomaoru. Possibly to Okangundumba (Okahua, Okatapati). Not often on road to Otjozongombe. Possibly Anabeb (Otjondunda).	3-6 months
Otuzemba	Oscar (Otuzemba)	19	Otuzemba-Otjitoko-west of conservancy	A	A	2-5 years	None observed. Topoti group, named by Otuzemba GGs.	GG thinks this group stays in Otuzemba Conservancy.	>6 months
Otuzemba	Sam (Otjitoko)	19	Otuzemba-Okarindi	A	A	>5 years	One old female left ear torn. Topoti group, named by Otuzemba GGs.	In dry season move out, probably Okangundumba.	6 months ±
Ozondundu	Samani (Otjomatemba)	19	Otjomatemba-Okarumbu	A	A	2-5 years	No. babies has increased. In 2019 group size was 14-15. One young male with broken right tusk. Small female with two short tusks. 3-4 babies.	All over Ozondundu including Omao and Otjize, plus Otjondunda in Anabeb, but GG thinks not Omatendeka much. Also does go to Okahua in Okangundumba.	5 months ±

Conservancy	Game guard (village)	Estimated number in group	Main place observed	Confidence of GG	Confidence interviewer	No. years observed	Distinguishing features	Movements described by game guard	Estimate of time per year in the conservancy
Otuzemba	Uakongo (Okarindi)	19	Okarindi-Otuzemba	A	A	<2 years	One elephant has longer tusks and longer tail. Know the footrprints of larger elephants. Topoti group, named by Otuzemba GGs.	Tends to be one week at Okarindi, one week Otuzemba, one week Okangundumba (Omunuandjai).	6 months ±
Ozondundu	Appy (Otjomaoru)	18	From Omatendeka or Okangundumba	A	D	<2 years	None observed.	Only seen twice.	<3 months
Omatendeka	Nelson (Otjozongombe)	18	Okomupia, Okomuhana, Okapanda, Omuramba, Otjozongombe	A	B	>5 years	None observed. Several babies (could be 8-9 young ones). Births each year.	Especially goes into Ozondundu, but also Okangundumba. Goes all around Omatendeka including Okavare.	7 months ±
Ozondundu	Rakatota (Otjaptijapi)	17	Otjomatemba-Otjapitjapi	A	B	> 5 years	One male has short left tusk, lots of babies in group, one with bad right toe.	All over Ozondundu, sometimes Anabeb, but Okangundumba a lot in dry season.	5-6 months
Ozondundu	Don (Okakuyu)	16	Okarumbu-Otjomatemba	A	B	2-5 years	One female has longer than normal tusks; one has large cracks in one foot.	Move to Okahua in Okangundumba.	6 months ±
Okangundumba	Khuse (Okahua)	16	Okahua-Otjite-Ombombo-Otjozongombe	A	A	>5 years	None observed.	Moves all around, including Otjozongombe in Omatendeka and Okarumbu in Ozondundu, plus Okatumba in Ombujokanguindi. Moves away in rains, plus Orupupa and Otuzemba.	6 months ±
Omatendeka	Nelson (Otjozongombe)	16	Okambonde, Okomupia, Ondivet, Okavare, Otjozongombe, Omuramba	A	B	>5 years	One big female has torn right ear. Several babies in group.	Group moves a lot.	5 months ±

Out of the 61 known groups assigned Category A by game guards (in terms of their confidence in the number of elephants according to game guards), 22 groups were within the range of **25 and 40 elephants**.

Table 3.4 lists the second subset of 22 known groups in this range that have been noted as having some similar distinguishing features. However, this table demonstrates the difficulty in the analysis of known groups:

- For 8 of the 22 groups, no distinguishing features had been observed.
- For 12 of the 14 groups with distinguishing features noted, game guards had observed a large elephant has a broken tusk or tusks, but there was a variation in the details described, with both tusks being broken or short in five cases, one tusk being broken on a male elephant in four cases, and one tusk being broken on a female elephant in three cases.
- In addition, four game guards stated that a group with around this number of elephants includes an elephant with a torn ear (three indicated that this is a male elephant).
- Two game guards noted that an elephant in the group has particularly cracked feet.
- Two game guards pointed out that one elephant in the group is heard by villagers making a distinctive noise when drinking at water points at night.

A total of 15 game guards identified the 22 known groups within the range of 25 to 40 elephants. Three game guards have each identified two different known groups and two game guards each identified three known groups within this range. As several game guards identified more than one known group within this range, I have assumed there is more likely to be two groups around this size in the Northern Highlands. Based on the descriptions from game guards, it is likely that both groups have several baby elephants. My assumption that there are two groups of about this size (30 elephants) is supported by the point that 10 game guards have seen 45 or more elephants at the same time at a water point, and six of these had noted around 60 elephants at a water point. I have also been shown a short video (in 2022), by a representative of the Namibian NGO IRDNC, of about 60 elephants at Omunuandjai cattle post in Okangundumba Conservancy. From my discussion with game guards, I concluded that these cases are likely to be two groups of about 30 elephants occasionally coming together at water points (and the game guards agreed with this suggestion). Based on the data set shown in Figure 3.19, it is likely that one of these two groups has less than 30 elephants (e.g. about 27 elephants) and one has more than 30 elephants (e.g. about 33 elephants).

One important point that can be concluded with confidence, about the group or groups of around 30 elephants in size, is that the groups are moving long distances across the areas of the Northern Highlands. This is because this subset of known groups is from game guards based across different parts of all six main conservancies.

Summary of above analysis:

From the analysis described above, I assume there are likely to be two groups of about **30 elephants** in the Northern Highlands.

Table 3.4 – Subset of 22 known groups (Category A) in range of 25 to 40 elephants noted by game guards

Conservancy	Game guard (village)	Estimated number in group	Main place observed	Confidence of GG	Confidence interviewer	No. years observed	Distinguishing features	Movements described by game guard	Estimate of time per year in the conservancy
Okangundumba	Werner (Otjipoko)	40	Ombombo-Okahua-Okatapati	A	B	>5 years	One female with half left tusk. One bull has big crack in foot. One younger male has hole in ear.	Sometimes to Omunuandjai. Also moves out of conservancy for 2-3 months.	9 months ±
Ozondundu	Appy (Otjomaoru)	38	Okomuhana-Otjomatemba-Okarumbu	A	C	2-5 years	Group has grown rapidly in recent years. Might have been just 18 elephants a few years ago when first seen. 8 babies, one adult with cracks in 2 feet, one big elephant with no tusks, one bigger male.	Also Otjaptitjapi, Otjomaoru also. Sometimes to Anabeb and Okangundumba.	>8 months
Omatendeka	Jacob (Ondivet)	38	Otjozongombe, Okapanda, Okakuyu, Omuramba	A	B	2-5 years	One male has short tusk, group has lots of babies (estimated 3-4).	Sometimes Okavare, perhaps to Ozondundu, Okangundumba and Orupupa.	3 months ±
Orupupa	Joshua (Okazorongua)	38	Ekoto, Okomutati, Okonjota, Ourundu, Okongutirwa, Okauua	A	B	2-5 years	One male has half broken right tusk. That male comes in and out of 38. Another male has torn ear.	Moves to Ehi-Rovipuka, not to Omatendeka.	9 months ±
Okangundumba	Khuse (Okahua)	35	Okahua-Otjite-Ombombo-Otjozongombe	A	A	>5years	3 young babies. Big female with broken tusk died in 2021. Used to be 33, now 35.	Moves all around, including Otjozongombe in Omatendeka and Okarumbu in Ozondundu. Moves away in rains, but sometimes stays at Omarindi as there is a natural pond. Moves to Orupupa, Otuzemba. Once went to Purros.	9 months ±
Otuzemba	Sam (Otjitoko)	30-40	Otuzemba-Okarindi	A	C	>5 years	None observed.	Similar to Topoti 19, but more movement in west / northwest of conservancy; but might move less out of conservancy than Topoti.	>6 months
Okangundumba	Werner (Otjipoko)	34	Otjozongombe-Okahua	A	B	>5 years	Female with broken tusk, male with torn ear.	Moves to Omatendeka and in rains to Ozondundu.	6 months ±

Conservancy	Game guard (village)	Estimated number in group	Main place observed	Confidence of GG	Confidence interviewer	No. years observed	Distinguishing features	Movements described by game guard	Estimate of time per year in the conservancy
Okangundumba	Aqua (Ombombo)	33	Otjite, Okahua, Epungwee, Omao, Otjize, Ombombo, Omunuandjai	A	B	2-5 years	None observed except 7 babies in group.	Move to Ozondundu and perhaps to other conservancies.	9 months ±
Omatendeka	Nelson (Otjozongombe)	33	Omuramba, Outjete, Okavare, Ondiwet	A	A	>5 years	Includes 3 males that move in and out of group. One of 3 males has broken right tusk. Many babies in group.	Sometimes to Otjozongombe, Okapanda, Okomupia. To Orupupa, Okangundumba, Ozondundu. Move a lot in vegetable season.	6 months ±
Orupupa	Richard (Otjondeka)	33	Otjondeka-Orundu-Ozongundu	A	B	<2 years	One old male in group (not breeding) has two short tusks (one very short).	Also to Otuzemba (Ondereko). Possibly to Omize, Okauua.	6 months ±
Okangundumba	Fanny (Epunguue)	32	Epunguue, Omao, Omunuandjai, Ombombo, Otjozongombe, Okahua	A	B	2 years	Female with both tusks broken. One male broken left tusk. One male makes distinct noise at water. Lots of babies.	Sometimes Okatumba and Otjahorowara in Ombujokanguindi conservancy. Move further in rains, possibly to Otuzemba.	8-9 months
Ehi-Rovipuka	Thom (Okomutati)	32	Ekoto, Okauua, Okomutati, Okanandjira, Okongutirwa, Okazorongua	A	B	<2 years	Lots of babies.	Uncertain about movement to other conservancies.	Unknown
Otjombande	Zavarura (Okavare)	30	Okavare and the southern area of Otjombande conservancy	A	B	>5 years	Big female has 2 long tusks and small ears. Group has several small males. Sometimes a bull will join. Most of group has short tusks.	Sometimes to Omitumbirua and into Okatjandja Kozomenje Conservancy but only in vegetable season. Also to Otuzemba and Okangundumba.	>6 months
Ozondundu	Appy (Otjomaoru)	28	From Okangundumba (Okahua)	A	C	2-5 years	None observed.	Occasional visitors, perhaps go to Anabeb and Omatendeka also. In Ozondundu get to Okarumbu and Otjomatemba.	<6 months
Omatendeka	Nelson (Otjozongombe)	28	Otjozongombe, Okapanda, Okomupia, Omuramba, Outjete, Okavare.	A	A	>5 years	One big elephant has torn right ear (not the matriarch). One has broken left tusk. Several babies in group.	Moves into Okangundumba, perhaps Orupupa, not so much into Ozondundu.	6 months ±

Conservancy	Game guard (village)	Estimated number in group	Main place observed	Confidence of GG	Confidence interviewer	No. years observed	Distinguishing features	Movements described by game guard	Estimate of time per year in the conservancy
Ozondundu	Samani (Otjomatemba)	28	From Okahua area of Okangundumba	A	C	<2 years	One male has more curved tusks.	Mainly in Okangundumba.	1 month
Otuzemba	Sam (Otjitoko)	25-30	Ondereko	A	C	2-5 years	None observed.	Moves into Orupupa but probably spends more time in Otuzemba.	6 months ±
Omatendeka	Tjipeta (Otjihorongo)	27	Otjozongombe, Okapanda, Okukuyu	A	B	<2 years	None observed.	Uncertain about movement to other conservancies.	Unknown
Okangundumba	Werner (Otjipoko)	27	Otjipoko-Oketoveni	A	B	2-5 years	One male has two v short tusks; one female no hair on tail; one elephant makes very characteristic groan / rumble at water.	Sometimes to Otjozongombe, into Orupupa (Okozonguehe) (GG has discussed with Orupupa Tjuimene), sometimes Okahua.	6 months ±
Orupupa	Joshua (Okazorongua)	26	Okauua, Okozonguehe, Ekoto	A	B	2-5 years	Counted in FMC and patrols. No distinguishing features observed.	Mainly stay in Orupupa.	12 months
Orupupa	Joshua (Okazorongua)	25	Epako, Okazorongua, Omuramba, Okauua, Ekoto, Omatapati	A	C	>5 years	Group sometimes splits up, sometimes 10-20 elephants seen. Only identify from footprints.	Sometimes to Omatendeka (Omuramba) but mostly in Orupupa.	>11 months
Ozondundu	Kaperue (Okarumbu)	25	Otjize, Okarumbu, Omao, Okahua	A	B	2-5 years	Big female has no tusks. 4 babies in group.	Mostly in Ozondundu after rainy season for vegetables.	2 months ±

Out of the 61 known groups identified by game guards with Category A rating of uncertainty, 13 were groups of between nine and 15 elephants. Table 3.5 contains this third subset of known groups. However, the distinguishing features noted were not sufficient to make an informed conclusion about the number of groups of this size in the Northern Highlands. Based on the discussions with game guards over the time period in the field, I have assumed that there are between one and four groups of this size (around 12 elephants), with the most likely number of groups being two. There are high uncertainties in this assumption. Figure 3.19 for example indicates that there might be one group of about 12 elephants and one group of about 15 elephants, but this is inconclusive.

Summary of above analysis:

I assume there is likely to be two groups of about **12 elephants** in the Northern Highlands.

Game guards identified seven female-led known groups (in the whole data set) of between four and nine elephants (of Category A), but with little observations of distinguishing features. I assume that there are between one and four groups of this size (around six elephants), with the most likely number of groups of this size being two. Again, there are high uncertainties with this assumption.

Summary:

I assume there is likely to be two groups of about **six elephants** in the Northern Highlands.

Adult male elephants often associate in groups. According to game guards, up to four individual male elephants have been observed in a group in the Highlands. The male elephants tend to keep more distance between them than female-led groups (Skinner and Chimimba, 2005; Allen *et al*., 2020). The males are often observed by game guards when they come together at water points. On several occasions in 2022 and 2023 near Okomutati in Ehi-Rovipuka Conservancy I observed three male elephants visiting the spring, generally about 15 to 30 minutes apart.

During the interviews, game guards told me about several individual male elephants and informal known groups of male elephants. From the information provided by game guards on known groups (Appendix B2), I estimate that there is a total of between 10 to 20 adult male elephants moving as individuals or groups in the Northern Highlands. There are uncertainties, including because adult males have been observed by game guards to join the female-led groups at times.

Summary:

I assume there is likely to be **10-20 adult male elephants** in the Northern Highlands.

Table 3.5 – Subset of 13 known groups (Category A) in range of 9 to 15 elephants noted by game guards

Conservancy	Game guard (village)	Estimated number in group	Main place observed	Confidence of GG	Confidence interviewer	No. years observed	Distinguishing features	Movements described by game guard	Estimate of time per year in the conservancy
Otuzemba	Inembo (Ondereko)	15	Otjipoko-Okahodu-Otuzemba-Ondereko	A	B	<2 years	Includes one short round female (not the matriarch).	Move also to Orupupa and Okangundumba.	<6 months
Otuzemba	Oscar (Otuzemba)	15	Okahodu-Otuzemba	A	C	2-5 years	One female with shorter tusk.	Uncertain about movement to other conservancies.	Unknown
Otuzemba	Rutjani (Otuzemba)	15	**Otuzemba**. West of conservancy, Okarindi, Otuzemba, Otjitoko	A	A	2-5 years	Big female matriarch. Group size increasing 5 babies in group.	Also to Ondereko; plus Orupupa and Okangundumba.	5 months ±
Okangundumba	Khuse (Okahua)	14	Okahua-Otjite-Ombombo-Otjozongombe	A	A	>5 years	6 female, 4 male, 4 babies. No other features observed.	Moves all around, including Otjozongombe in Omatendeka and Okarumbu in Ozondundu, plus Okatumba in Ombujokanguindi. Moves away in rains, plus Orupupa and Otuzemba.	6 months ±
Okangundumba	Fanny (Epunguue)	14	Epunguue, Omunuandjai, Ombombo, Okatapati, Okahua	A	B	5 years	One large elephant. Four babies.	Sometimes to Omatendeka, Ozondundu, Otuzemba and Otjahorowara water point in Ombujokanguindi conservancy.	8-9 months
Ozondundu	Samani (Otjomatemba)	13	Okomuhana-Otjomatemba	A	B	> 5 years	No. babies has increased. One male with half right tusk and no left tusk goes in and out of group. Rest of group has short tusks.	Mainly from Omatendeka (Okapanda and Otjozongombe).	7 months ±
Orupupa	Abia (Ekoto)	12	Omatapati, Okanandjira, Okambaronga, Okazorongua	A	B	<2 years	1-2 babies. No other features observed.	Probably to Omuramba in Omatendeka, not sure about Otjozongombe; group doesn't visit Ekoto much and tends to stay in west area of Orupupa.	Unknown

Conservancy	Game guard (village)	Estimated number in group	Main place observed	Confidence of GG	Confidence interviewer	No. years observed	Distinguishing features	Movements described by game guard	Estimate of time per year in the conservancy
Orupupa	Joshua (Okazorongua)	12	Okanandjira, Okauua, Okozonguehe, Ekoto	A	A	>5 years	Seen many times on patrols. One male has very short tusks. That male is often a distance from the group. There are babies in the group.	Moves to Omatendeka (Otjozongombe).	7 months ±
Ozondundu	Rakatota (Otjaptijapi)	11	Okarumbu-Okomuhana-Otjomatemba-Otjapitjapi	A	A	> 5 years	One male with broken right tusk, one male makes groaning noise at water.	Sometimes to Okangundumba (Otjize), Omatendeka (Otjozongombe), Anabeb (Otjondunda).	6 months ±
Ozondundu	Appy (Otjomaoru)	10	From Omatendeka or Okangundumba	A	D	<2 years	None observed.	Only seen once.	<3 months
Ehi-Rovipuka	Saki (Okatjangee)	10	Okonjota-Orundu	A	C	<2 years	Perhaps includes 2 babies.	Moves into Orupupa-Okatjovosandu. Okomutati also.	Unknown
Ozondundu	Don (Okakuyu)	9	Okomuhana-Otjomatemba-Okarumbu	A	A	2-5 years	2 babies in the last 2-3 years; two main females but one is particularly large; single male often joins (he has broken left tusk).	Otjaptitjapi, Okakuyu, Otjomaoru also. Sometimes to Anabeb (Otjondunda, Okanandjoze, Ongongo), sometimes Omatendeka (Otjozongombe, Okapanda).	4-6 months
Okangundumba	Khuse (Okahua)	9	Okahua-Otjite-Ombombo-Otjozongombe	A	A	>5 years	None observed.	Moves across conservancy and out in rainy season for up to 6 months to Omatendeka, Orupupa and perhaps Otuzemba.	>6 months

Step 5 – Collating the results of the more detailed assessment of known groups to develop an estimate for the elephant population in the Northern Highlands

Based on this above analysis of known groups, summarised in Table 3.6, my estimate is that there are between 78 and 212 elephants in the Northern Highlands (as of 2022), with a best estimate of 128 elephants.

In addition, there are some groups and individuals leaving Etosha National Park for short time periods but spending most of their time in the Park, as described by game guards from Ehi-Rovipuka and Orupupa, the conservancies on the eastern side of the Highlands, nearest to the Park (Figure 1.16).

Table 3.6 – Summary of analysis for estimated number of elephants in the Northern Highlands, based on known groups identified by game guards

Group type	Group size	Range in number of groups	Range in total number of elephants	Best estimate of number of groups	Best estimate of number of elephants
Female-led	30	1-2	30-60	2	60
Female-led	20	1-3	20-60	1	20
Female-led	12	1-4	12-48	2	24
Female-led	6	1-4	6-24	2	12
Individual or groups of males			10-20		12
Estimated total number of elephants			**78-212**		**128**

The estimated population of elephants in the Northern Highlands from known groups of between 78 and 212 elephants would only provide an "*informed guess*", a term used for the second most uncertain type of estimate in the IUCN African Elephant Status Report (Appendix B1) (Thouless *et al*., 2016). Although the uncertainties at present in this method are high for the known groups in the Northern Highlands, it is considered that the method could be applied with confidence if the game guards were implementing a structured approach over time, using binoculars and spotlights so that they could more easily identify distinguishing features.

I derived the above estimate from local knowledge at six of the 13 conservancies in the Northern Highlands (Figure 3.20). Therefore, it is important to consider whether the estimate represents the total for the Northern Highlands or just part of the Northern Highlands (the six conservancies covered by my interviews). I did have meetings with representatives of four of the other six conservancies and learned about the relative number of elephants likely to be in those areas. As discussed in Chapter 2 (Method), the basis for my selection of the six conservancies covered in this Research Project, in the south and east of

the Highlands was the feedback during scoping that there are much fewer elephants in the other six conservancies in the north and west (Figure 3.20). The summary in Box 3.3 for the six conservancies demonstrates that most elephant groups that are seen in those conservancies in the north and west are coming from the Highlands area and are likely to already be included in the estimates above. Therefore, given that my estimate has some uncertainty and a wide range in minimum/maximum to reflect this, I conclude that my estimate of between 78 and 212 elephants (best estimate 128) does represent the whole of the Northern Highlands.

Box 3.3 – Summary of local feedback on elephants in the other seven conservancies in the Northern Highlands that were not included in detail in this Research Project

- **Otjombande** - I carried out one of the 34 interviews with the head game guard, who knows one group of about 20 elephants (which could be the Topoti group named by Otuzemba game guards) and one group of about 30 elephants, which visits from Okangundumba and Otuzemba. My analysis is that these are likely to be groups already identified in my estimate of total population above, although this is not certain.
- **Okongoro** – I carried out one of the 34 interviews with the head game guard, who knows just one female-led group (of about 30 elephants), which tends to visit the conservancy from the south, from Otuzemba Conservancy in the Highlands. The implication was that the group probably spends more time in the conservancies to the south than in Okongoro. Again, my analysis is that this group of 30 is likely to be one of the groups already identified in my estimate of total population above.
- **Otjindjerese** – Most of this Conservancy is outside the Highlands and it contains the town of Opuwo and surrounding villages, and has a relatively high human population. I did meet the head game guard during scoping, who told me that elephants often move into the Conservancy from the flat plains areas to the east (from Omusati Region), but not often from the Highlands area to the south.
- **Otjikondovirongo** – I met with the Chairperson of Otjikondovirongo Conservancy during scoping, and the feedback was that there are few elephants in the conservancy. They visit in some years and only after good rains, and usually only one female-led group visits.
- **Ombujokanguindi** – I did not have meetings with this conservancy. The game guards who I met at the neighbouring Okangundumba Conservancy indicated that elephants sometimes move from their conservancy a short distance into Ombujokanguindi Conservancy, but that at most times of the year there would be few elephants in Ombujokanguindi Conservancy.
- **Okatjandja Kozomenje** - I did not have meetings with this conservancy but the head game guard at Otjombande Conservancy told me that elephants do sometimes move into Okatjandja Kozomenje Conservancy from Otjombande in the vegetable growing season.
- **Anabeb** – game guards in Ozondundu Conservancy indicate that elephants sometimes move into Anabeb to the springs near Otjondunda village on the C43 road, but that the elephants return from there after a few days.

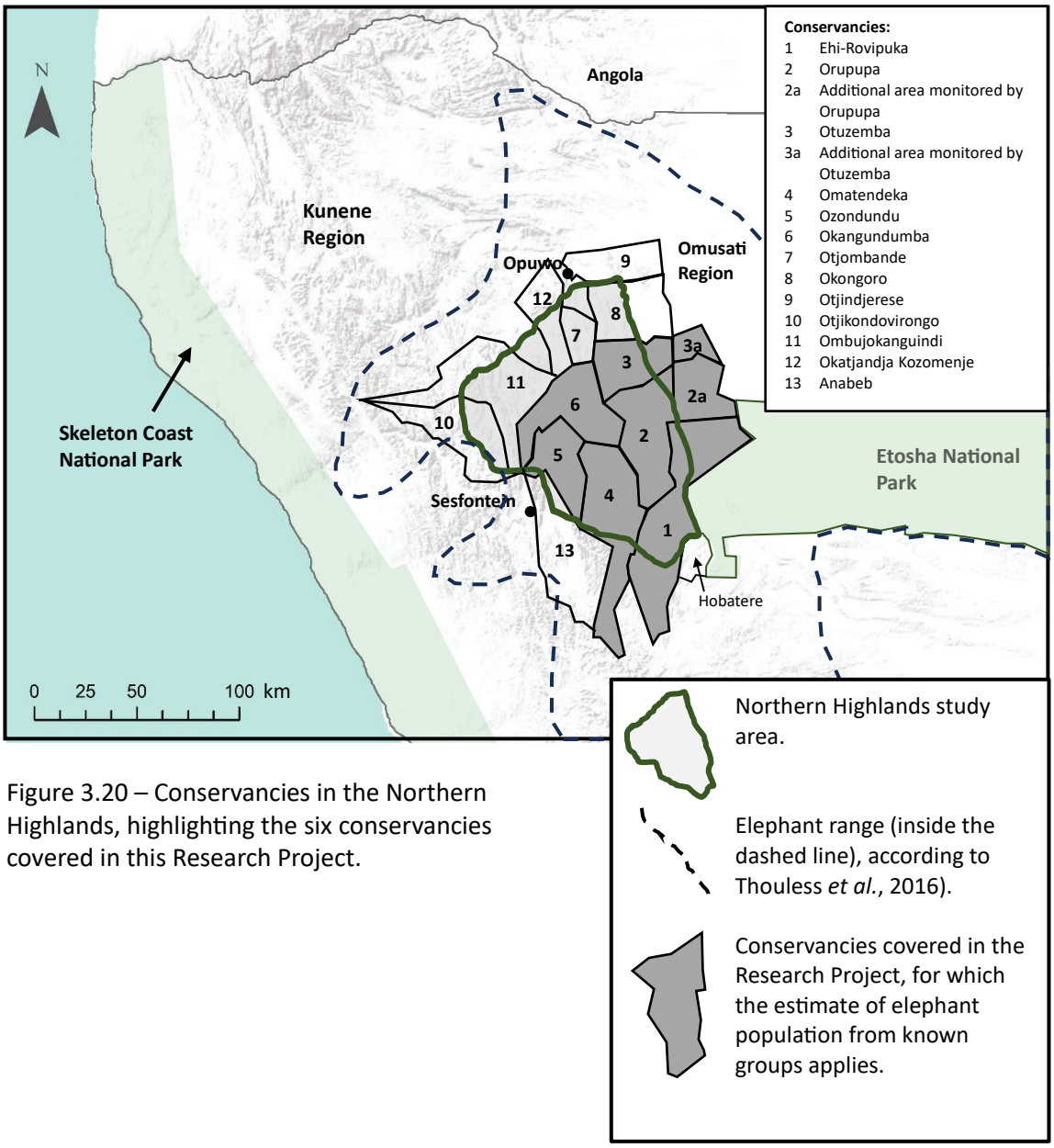


Figure 3.20 – Conservancies in the Northern Highlands, highlighting the six conservancies covered in this Research Project.

3.6 Conclusions

A reliable estimate of the current number of elephants in the Northern Highlands, and knowledge of the trends in population, is important as the baseline for planning measures to protect the elephants and to reduce human-elephant conflict. Knowledge to be able to identify individual herds (groups) of elephants, and individual males, would also be useful because common feedback from game guards is that only a proportion of groups and individual males cause problems with human-elephant conflict (Chapter 4). For example, the game guards in Otuzemba, Omatendeka and Ozondundu Conservancies have given names to individual problem male elephants. Information on specific herds and individual males would also be useful to help plan GPS collaring programmes, which is part of the action plan for the northwest in the Government of Namibia's National Elephant Conservation and Management Plan.

The research on available information on historical trends in elephant populations in northwest Namibia provides useful insight into the factors currently affecting the population and movements. The detailed literature review and stakeholder consultation have confirmed that, prior to this Research Project, there was minimal published research on the elephant population in the Northern Highlands. Monitoring and research since the 1980s on the small, high-profile populations of desert-adapted elephants outside the Northern Highlands, have been carried out to such a detail so that the groups and most individuals are known, and some individual elephants assigned names, for the populations in the Ugab and lower Hoanib river catchments (Brown and Ramey, 2022; EHRA, 2024).

It is difficult to obtain reliable estimates of the elephant population from aerial or ground surveys over such a large and mountainous area. The large area (12,000 km^2 for the Northern Highlands) and low density of elephants mean that scaling up observations from sample counts gives results with high uncertainty. In addition, elephants are likely to be moving in and out of the area, particularly during rains, so the population is changing.

Even at a very early stage in the times of travel by "western" explorers in northwest Namibia, the value of local knowledge was recognised and records of elephant populations included information from consultation with local people. For example, a local chief in the 1920s had told an explorer when asked about elephants that "*several individuals are recognisable by such peculiarities as broken or malformed tusks might occasionally be seen within short intervals in widely distant areas*" (Shortridge, 1934, p.358).

Community conservancies now cover the majority of the Northern Highlands area. The conservancies employ game guards, and this presents an opportunity to collate local ecological knowledge on the elephant population. This is based on their observations and build-up of knowledge over many years in their role, compared to sightings in an aerial survey at one point in time. My interviews with 34 game guards and time spent on patrols with game guards demonstrated their experience and knowledge. Seventeen of the game guards interviewed had over 10 years of experience, seven of which had over 20 years in their role. Given the difficulties in getting a reliable estimate of the elephant population in the Northern Highlands from aerial surveys, my aim was to try to estimate the elephant population based on the knowledge of the game guards.

The method involved much time during each interview discussing with individual game guards their "known groups" of elephants, and developing a total estimate based on the number of elephants in known groups. I define a "known group" as a group of elephants that is known by an individual game guard. The game guards identified 158 known groups in total, which included 113 female-led groups and 45 informal male groups or individuals. It was clear from the interviews and from the time spent in the field that there is a lot of double counting, where several of the 34 game guards interviewed would each know the same groups. Based on earlier meetings with 26 game guards during scoping activities, I had made the initial conclusion that each game guard knows two or three female-led herds of elephants. The most recent aerial survey in 2016 observed four female-led herds of elephants in the Northern Highlands (Craig and Gibson, 2016). From the more detailed interviews in the core research, I calculated that on average each game guard knows 3.3 female-led groups and no game guard knows more than six groups. Based on my extensive travel across the study area, my judgement was that there are between three and ten larger groups of elephants (e.g. more than ten elephants in a group) in the Northern Highlands, and I have high confidence in this range. My method then involved comparing information described by game guards on similar sized groups in relation to distinguishing features, such as broken tusks, torn ears, evidence of a bad foot, etc.

Based on the analysis of information collected, I have estimated the population in the Northern Highlands in 2022 to be between 78 and 212 elephants in known groups, with a best estimate of 128 elephants. This represents an estimate of the number of elephants more permanently in the Northern Highlands in 2022. In addition, there are some groups and individuals leaving Etosha National Park for short time periods but spending most of their time in the park. This estimated range would only provide an "informed guess", a term used for the second most uncertain type of estimate in the IUCN African Elephant Status Report (Appendix B1) (Thouless *et al*., 2016; IUCN, 2024b). My estimate of 78 and 212 elephants (best estimate 128 elephants) from the assessment of known groups compares to my estimate of 84 to 325 elephants (best estimate 115 elephants) in the Northern Highlands based on elephant density calculated from aerial surveys of northwest Namibia.

One of the key points identified from my analysis of the data collected on known groups is the confirmation with a high level of confidence that known groups are moving all around the Northern Highlands. This is because the known groups of about 20 and 30 elephants have been identified by game guards based in different locations across several conservancies. The common opinion of game guards is that groups of elephants often stay around the area of their village and water point for up to two weeks (typically spending the daytime some distance from the human population and visiting water points at night). The groups then tend to more away for weeks or months. At this point, when the elephants have moved out of the area of the village of the game guard and out of the conservancy, most game guards are uncertain about the distance and direction moved. Chapter 6 of this thesis covers more detail on elephant movements.

The uncertainties at present in this method are high. I have confidence that there are between three and ten large groups of elephants in the Northern Highlands, but less confidence in the estimated number of elephants in a group, for example because game

guards mainly observe elephants at night when it is difficult to count them (they do not have binoculars or spotlights). However, an important conclusion from this component of this Research Project is that the method could be applied with confidence if the game guards were implementing a structured approach over time, using binoculars and spotlights so that they could more easily identify distinguishing features. This would be a cost-effective approach of estimating and tracking the population of elephants over time, compared to aerial surveys. Having tested the method, I have identified several points related to improving the interview questions (Box 3.4).

Box 3.4 – Assessment of the interview method on known groups

- The categorisation of uncertainty for each group (A, B, C, D, E) is a useful indicator, and the game guards understood this approach after my explanation. Their understanding is demonstrated by the fact that 27 groups were listed in categories D or E, of which only 5 groups (19%) had distinguishing features mentioned by game guards, compared to 54% of category A groups. Categories D and E represent groups where the game guards had heard more from the community about the group than they had actually seen themselves.
- More direct questions are needed when game guards note that a “left” or “right” tusk is broken or “left” or “right” ear is torn, in terms of clarity on whether it is the elephant’s left or right side, or the left or right side when looking at the elephant.
- The information on typical movements of each known group will be useful when game guards have equipment and know the groups better.
- The information on number of years that the game guards has known the group is useful, for assessing confidence and comparison between game guards.
- The judgement of game guards on the time that elephants spend in their conservancy is particularly uncertain.
- An additional question on when (month and year) the game guards last definitely observed the group would have added useful information for the analysis.

At present in the Northern Highlands the game guards are not proactively looking for distinguishing features of groups of elephants. They have not been instructed or trained to do this. However, an established NGO, Elephant-Human Relations Aid (EHRA), carries out elephant tracking for the small population of desert-adapted elephants in the Ugab River catchment, over 200 km to the south of the Highlands (Figure 1.2). EHRA supports communities in that area with projects to protect water infrastructure from elephants, community awareness programmes, etc. It has developed an elephant identification protocol (EHRA, 2020), which includes a more structured approach to identify groups and individual elephants. EHRA trains community game guards in the Ugab area, including in elephant identification methods (EHRA, 2024). Although there are more elephants and more game guards over a much larger area in the Northern Highlands than the Ugab catchment, there is an opportunity for the EHRA training programme to be rolled out in the Northern Highlands, subject to funding, to set up a more structured approach over time, implemented by the community game guards using the EHRA protocol. EHRA works closely with the Ministry of Environment, Forestry and Tourism (MEFT) and has the support of MEFT for its

activities. In order to properly implement a structured approach over time, the game guards would need binoculars and spotlights so that they could more easily identify distinguishing features. Ideally, they would also have cameras with zoom lenses, to take photographs of groups and distinguishing features of specific elephants in the groups. However, cameras are currently less practical because game guards do not have the equipment to download photographs onto computers or other devices, and there is a lack of electricity in many villages.

One of the objectives of this research component was to test the method based on local knowledge of elephant groups. The research has demonstrated that the method to estimate the elephant population using local knowledge on known groups needs to be sharpened and improved. However, it will then provide useful and reliable results on elephant populations and movements in the Northern Highlands, a large area with low elephant density, when a structured approach is set up. This would include training and provision of equipment to game guards. The results of such monitoring activities would then provide estimated populations on which there would be higher confidence. This approach would be more applicable in the Northern Highlands than aerial surveys, is likely to provide more reliable and useful results, and would definitely be much cheaper than aerial surveys.

Chapter 4 - Assessment of trends in human-elephant conflict in the Northern Highlands

This Chapter covers an assessment of Event Book data and local ecological knowledge on human-elephant conflict in the Northern Highlands. Some of the results, such as maps of hotspots of reported incidents of human-elephant conflict, provide input into Chapter 6 on elephant movements. This Chapter also covers lessons learned in mitigating human-elephant conflict in the Northern Highlands.

4.1 Context

There has been an increase in the number of elephants in the Northern Highlands in the last 10-20 years, as discussed in Chapter 3. Based on consultation with local people, with local NGOs, and other studies (Heydinger, 2021a), there has been a rapid increase in livestock in the Kunene Region over the last 10-20 years, including goats and cows, although the numbers do vary over time. Drought years, for example since 2013, can greatly affect the number of livestock, and have resulted in increasing local pressures in terms of competition for local resources between wildlife, including elephants, and people. Human-elephant conflict at community water points in northwest Namibia is a particular problem that is adding to challenges for the local communities (Hunninck *et al*. 2017; MEFT/NACSO 2022; MEFT 2021).

In the Northern Highlands, natural springs provide a lifeline for a diversity of wildlife (Figure 4.1). Community water points (boreholes) across the area, near villages and cattle posts, provide the water supply for people (Figures 4.2, 4.3) and, along with rain water in earth dams (Figure 4.4), facilitate the farming of livestock. Elephants and other mammal species tend to migrate in the rainy season to search for fresh vegetation, and livestock farmers also move with the seasons, depending on rainfall. The rainy season in the Northern Highlands is usually from January to April, with the main rains often in March/April. There is sometimes rain in November / December.



Figure 4.1 – Hartmann's mountain zebra (*Equus zebra hartmannae*) at Okomutati spring (a permanent spring), Ehi-Rovipuka Conservancy, 14 February 2023.



Figure 4.2 –Water point at the cattle post at Okauua, Orupupa Conservancy, 28 February 2022.



Figure 4.3 – Hand pump at Okakuyu, Ozondundu Conservancy, 18 December 2022.



Figure 4.4 – The study area includes some earth dams, which can hold water for several months after a good rainy season, and reduce the need to pump water for livestock at water points. Earth dams also provide water for wildlife. This example is at Omuramba, Omatendeka Conservancy, 5 January 2023.

My scoping activities in 2021 and 2022 for this Research Project included meetings with 26 community game guards and several senior community members (e.g. conservancy chairpersons) in 10 conservancies across the Northern Highlands. One of my main initial findings at that stage was that there were high levels of concern in local communities about safety and damage from incidents of human-elephant conflict. There were particular concerns about incidents at water points and vegetable gardens (Wenborn *et al.*, 2022a). This presents a risk to the commitment of communities in the Northern Highlands to the conservation of elephants and other wildlife under the conservancy programme (Wenborn *et al.* 2022b).

Incidents involving elephants in the northwest of Namibia can result in damage to pipes and tanks at community water points, vegetables being eaten and/or damaged at community vegetable gardens, damage to structures (such as kraal fences), death or injury to livestock (for example through interactions with elephants at water points), occasional death or injury to people, and occasional death or injury to elephants (MEFT, 2021). Elephants have been observed to prefer cleaner drinking water (Ramey *et al.*, 2013) and damage at water points, for example to water pipes or the plastic storage tanks for drinking water, can have a major impact on a local community because of the time taken and expenses in repairing the infrastructure (Schnegg and Kiaka, 2018). My consultation during scoping identified that this can leave communities without nearby access to water for several weeks. Most community water points tend to be about 10 km apart.

The game guards informed me that these problems can lead to actions by communities to try to frighten elephants away, such as making loud noises, throwing stones, etc. In a study on elephant stress levels, Hunnick *et al.*, (2017) found higher stress levels in elephants in the community areas of Kunene Region than in Etosha National Park, based on analysis of dung samples for indicator chemicals of physiological stress. That study concluded that the reason for the higher stress levels was the higher number of interactions between elephants and people in the community areas.

As mentioned in Chapter 2, my discussions during scoping meetings and site visits with game guards confirmed that the widespread loss of livestock in the northwest during the droughts of 2018 and 2019 has led to more people starting community vegetable gardens in the area (Figure 4.5). Maize is one of the main crops, with a range of different vegetables also grown, generally all at small-scale. Some were set up for growing vegetables only in the rainy season (Figure 4.6), and some were set up near water points or springs for growing vegetables over a longer time period (Figure 4.7, 4.8). This changing dynamic has been to provide sources of food for households, much needed because of the loss of livelihoods and income due to the reduction in livestock. During my scoping activities for this Research Project, game guards indicated their perception that this increase in vegetable gardens has resulted in an increase in incidents with elephants near to villages (Wenborn *et al.*, 2022a).

There have been many studies and projects elsewhere in Africa related to human-elephant conflict at vegetable gardens (e.g. Hoare, 2012; King *et al.*, 2013; Ndlovu *et al.*, 2016). A study in northeast Namibia found that the loss of vegetables from elephant damage can have high costs to individual households (Drake *et al.*, 2021). However, the growing of vegetables in the wetter northeast is a more common livelihood than in the northwest, because in the northwest the arid environment means that it tends to be a small-scale additional practice that supplements livelihoods for a few households (Silva and Mosimane, 2012). The increase in gardens in 2019 in northwest Namibia is an example of the changing situation on the ground that affects human-elephant conflict.

Although there has been minimal published research on the elephants in the Northern Highlands, including a lack of study on trends in human-elephant conflict, there is much knowledge in the local communities. In particular, over many years in their roles, the community game guards have built up knowledge on the elephants and their movements. Their responsibilities include visiting villages for investigation of incidents of human-wildlife conflict (Figures 4.9, 4.10). The game guards maintain records in Event Books of incidents of damage caused by elephants (Figure 4.11, 4.12). The records include date and location of an incident, type of damage and complainant, and the number of elephants if known. The Event Books have provided a tool for consistent monitoring, and in most conservancies in northwest Namibia there are records going back over 10 years. The Event Book system was set up by the Ministry of Environment, Forestry and Tourism (MEFT) with the support of Namibian wildlife NGOs, and extensive training has been provided to game guards.



Figure 4.5 – Preparation of vegetable gardens early in the rainy season at Otjapijapi village, Ozondundu Conservancy, 17 January 2023.



Figure 4.6 – Relatively large vegetable garden at Ovinbanduangoma in southern Orupupa. This is an example of a garden that would depend on rain water, 24 January 2023.



Figure 4.7 – The vegetable garden at Ombombo in Okangundumba Conservancy is located next to the spring near the village, and is an example where vegetables can be grown over a longer time period because of the availability of water, 12 January 2021.



Figure 4.8 – Channels or pipes are used at several villages near springs to transfer water towards vegetable gardens, Okakuyu village, Ozondundu Conservancy, 18 December 2022.



Figure 4.9 – Game guard investigating damage by elephants at water point at Okatutu in Ehi-Rovipuka Conservancy, near to Etosha National Park; photograph taken 26 March 2021. The elephants had pulled out the pipe from the plastic water tank, used to store drinking water. The hole in the nearest water tank shows where the missing pipe used to be connected.



Figure 4.10 – Game guards with conservancy committee member assessing damage at water point near Ekoto, in Orupupa Conservancy, 28 February 2022.

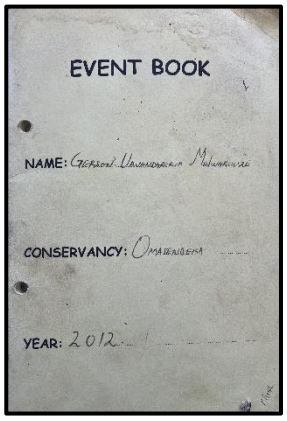


Figure 4.11 – Example Event Book cover page, Omatendeka Conservancy.

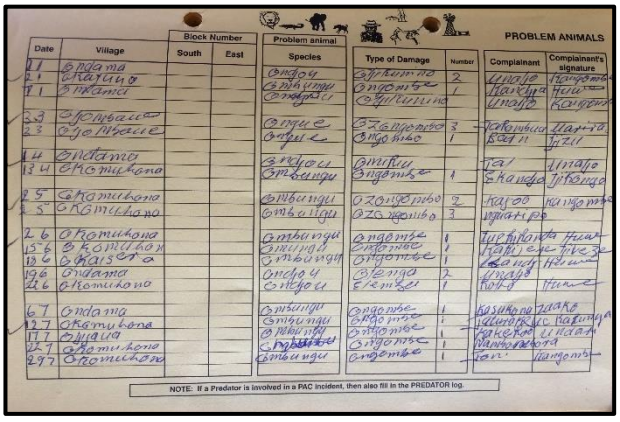


Figure 4.12 – Example completed page of Event Book for Orupupa Conservancy, in local Otjiherero language.

MEFT and the NGOs involved in the community-based wildlife monitoring through Event Books (NACSO/WWF/IRDNC[7]) do analyse the data, but only at a high-level of total number and types of incidents per conservancy (NACSO, 2023a). Detailed analysis to identify the main villages where incidents with elephants occur, or the months of the year when they most occur, has not been reported for northwest Namibia from the Event Book programme. Such analysis would be useful to identify trends in human-elephant conflict and hotspots where most incidents occur. Tavolaro *et al.*, (2022) did review patterns of human-wildlife conflict, covering all incidents (i.e. including predator species) across selected conservancies in different areas across Namibia and concluded that more detailed analysis is needed to identify hotspots and temporal patterns.

My visits with game guards during scoping to some community water points showed that some mitigation measures have been carried out, and an assessment of lessons from these measures would be beneficial for MEFT and community conservancies. I noted from the time in the study area during scoping visits that there have been minimal mitigation measures tested at vegetable gardens in the Northern Highlands.

The uplisting in 2021 in Red List status for the African savanna elephant to Endangered reflects the increasingly serious risk to the population of the species (Blanc, 2008; Gobush *et al.*, 2021). The IUCN African Elephant Status Report identifies addressing human-elephant conflict as of critical conservation importance (Thouless *et al*., 2016), and the IUCN Red List assessment identifies the increase in human-elephant conflict as one of the threats to the species (Gobush *et al.*, 2021).

The 2030 Targets of the Kunming-Montreal Global Biodiversity Framework (2022) under the UN Convention on Biological Diversity include requirements for actions to manage human-wildlife interactions and minimise human-wildlife conflict (Target 4), (UNEP, 2022). The IUCN Human-Wildlife Conflict and Coexistence Specialist Group notes there are particular challenges in addressing human-wildlife conflict because the underlying cultural, political and economic aspects that shape these conflicts are often very complex and poorly understood (IUCN, 2020). It would be important for my Research Project to identify and prioritise the local factors that are most relevant to addressing human-elephant conflict in the Northern Highlands.

The National Elephant Conservation and Management Plan for Namibia includes the strategic objectives to plan local interventions to protect the elephants and their habitats in northwest Namibia, and in particular to reduce the incidents of human-elephant conflict (MEFT 2021). It identifies that more research is needed on human-elephant conflict in northwest Namibia to inform mitigation strategies. This Research Project is also in alignment with Namibia's Policy on Human-Wildlife Conflict Management (MET, 2018).

[7] NACSO Namibian Association of CBNRM Support Organisations
WWF World Wide Fund for nature
IRDNC Integrated Rural Development and Nature Conservation

4.2 Research objectives on human-elephant conflict

The objectives of this component of the research were to:

- Assess the trends in human-elephant conflict in the Northern Highlands and identify local factors and priorities.
- Identify lessons from existing mitigation measures in the Northern Highlands and elsewhere if applicable.
- Provide conclusions to inform the planning of future human-elephant conflict mitigation measures, for example on types of measures and the main locations where measures are a priority in the Northern Highlands.

4.3 Method

One of the topics that I included in the semi-structured interviews with 34 game guards (December 2022 to February 2023) covered several questions on their experience, opinion and knowledge on trends in human-elephant conflict in the Northern Highlands. I also spent much time with game guards visiting water points, springs, and vegetable gardens, to assess the situation on the ground related to potential human-elephant conflict. These site visits were during the time in the field for scoping activities and for the core interviews / data collection. At the community water points, I took many photographs, recorded GPS coordinates and wrote notes on the situation related to whether the pump was diesel or solar-powered, existing mitigation infrastructure, the state-of-repair of the water point, etc. It was apparent that the water points had been drilled and some upgraded under different funding programmes over many years, some by the Ministry of Environment, Forestry and Tourism, some by the Ministry of Agriculture, Water and Land Reform, and some by non-government organisations (NGOs). However, there was no central database of information on water points in the ministries. Therefore, I developed a spreadsheet on the water points during the visits (Figure 4.13), and I have provided this to the two relevant ministries and to relevant Namibian NGOs.

Name of water point	Type of water point	Other description	Conservancy	Village (if applicable)	GPS	Year drilled (according to game guards)	Solar, diesel or wind	Date solar installed	Protection wall	Date protection installed	Elephants visit?	Included in full moon count	dam that elephants can drink from	Date of installation of holding dam	Most recent visit by MW
Okamungundi Dam	Dam (old borrow pit)	Rain water dam	Okangundumba / Otjo	N/A	18°28'67"S 13°54'25"E	N/A	N/A	N/A	N/A	N/A	Yes	No	N/A	N/A	12 January 2021
Omunuandjai Cattle Post	Borehole	Cattle post, two concrete dams (one short, one old tall (not used)) and tank. Diesel pump before 2020, when s	Okangundumba	N/A	18°33'35"S 13°56'6"E	>30 years ago	Solar	2020	Yes	2020	Yes	Yes	Short concrete dam	>30 years ago	12 January 2021
Otjitjra	Natural pond	East of Omunuandjai, a natural pond in rainy season.	Okangundumba	N/A	?	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A	N/A	Not visited
Ombombo spring	Natural spring	Pipe to tall concrete dam. Too tall for most elephants.	Okangundumba	Ombombo	18°40'13"S 13°56'19"E	N/A	N/A	N/A	N/A	N/A	Yes	No	Tall concrete dam	?	12 January 2021
Ombombo borehole	Borehole	Borehole to east of Ombombo village, no longer used because people use spring rather than pay for diesel.	Okangundumba	Ombombo	?	>10 years ago	Diesel	N/A	?	?	?	No	?	?	Not visited
Earth dam south of Ombom	Earth dam (borrow p	On D3710 south of Ombombo, borrow pit does fill with rain water.	Okangundumba	N/A	18°42'36"S 13°57'5"E	N/A	N/A	N/A	N/A	N/A	Yes	No	N/A	N/A	29 January 2021
Okahua Borehole	Borehole	Main water point for community and livestock, tank with protection.	Okangundumba	Okahua	18°44'1"S 13°53'4"E	>10 years ago	Solar	2020	Yes	2020	Yes	?	Tall metal dam	?	12 January 2021
Okahua Elephant Dam	Dam for elephants	2km from borehole, under repair as of Jan 2021, water pumped up from Okahua borehole.	Okangundumba	Okahua	18°44'39"S 13°53'42"E	See above	N/A	N/A	N/A	N/A	Yes	?	Short concrete dam	2002	12 January 2021
Otjite Cattle Post	Borehole	Cattle post, one short concrete dam, tank with protection. Solar is being planned.	Okangundumba	Otjite	18°41'19"S 13°51'29"E	>10 years ago	Diesel	N/A	Yes	?	Yes	Yes	Short concrete dam	>20 years ago	12 January 2021
Epungwe 1	Borehole	Diesel pump and two concrete dams, one short, one tall.	Okangundumba	Epungwee	18°34'45"S 13°48'59"E	>30 years ago	Diesel	N/A	No	N/A	Yes	No	Concrete	>20 years ago	10 February 2023
Epungwe 2	Borehole	Diesel pump and concrete dam. Used for domestic animals only, not human consumption (water apparently h	Okangundumba	Epungwee	18°34'9"S 13°49'56"E	2001	Diesel	No	N/A	Yes	No	No	Concrete	2001	10 February 2023
Otuhanangombe	Natural pond	North of Epungwee, a natural pond in rainy season	Okangundumba	Epungwee	?	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A	N/A	Not visited
Otohongo Cattle Post	Borehole	Near Epungwee. Water point sometimes used. Diesel. Plastic tank. No concrete dam. Possibleplan to install co	Okangundumba	Epungwee	?	>10 years ago	Diesel	N/A	?	?	?	No	No dam	N/A	Not visited
Omao	Borehole	Water point with diesel, short concrete dam.	Okangundumba	Omao	?	>20 years ago	Diesel	N/A	?	?	Yes	?	Short concrete dam	>20 years ago	Not visited
Okaeruu	Handpump	Handpump (there are plans for a proper water point). West of C43.	Okangundumba	Okaeruu	?	>10 years ago	N/A	N/A	No	N/A	No	No	N/A	N/A	Not visited
Omaserelunda	Borehole	Cattle post near Okaeruu C43, concrete dam with short wall (constructed 10-15 years ago), protection wall, die	Okangundumba	N/A	?	>10 years ago	Diesel	N/A	Yes	?	?	No	Short concrete dam	>10 years ago	Not visited
Otjikukutu	Spring	Village near Spring	Okangundumba	Otjikukutu	?	N/A	N/A	N/A	N/A	N/A	No	No	N/A	N/A	Not visited
Okambombombonga	Borehole	Cattle post that is now rarely used as it is now in a core wildlife zone, except by people in Ombanti village, wh	Okangundumba	N/A	?	>10 years ago	Solar	>5years ago	?	?	Yes	No	N/A	?	Not visited
Onkawe	Spring	Used to be a cattle post, but now not used as in a core wildlife area. Elephants not somuch in this area.	Okangundumba	N/A	?	N/A	N/A	N/A	N/A	N/A	No	No	N/A	N/A	Not visited
Hewero Tented Camp	Springs in river	Permanent water in Skeim River at old site of Hewero Tented Camp (no longer operational)	Okangundumba	N/A	18°46'48"S 13°42'27"E		N/A	N/A	N/A	N/A	?	No	N/A		April 2019
Okatapati Water Point	Borehole	Village near D3710. Solar pump but no concrete dam, just plastic tanks, a tap and a trough. Used to be a har	Okangundumba	Okatapati	18°43'50"S 13°67'41"E	About 2018	Solar	About 2018	Yes	About 2018	No	No	No	N/A	16 December 2022
Otjipoko water point	Borehole	Village 3 km east of D3710. Diesel pump. Two concrete tanks, both short. Plastic tank in protection wall.	Okangundumba	Otjipoko	18°44'31"S 13°59'24"E	>20 years	Diesel	N/A	Yes	?	Yes	No	Short concrete dam	>20 years	16 December 2022
Oketovemi	Borehole	Private borehole, east of Otjipoko near Ovujuua border.	Okangundumba	N/A	?	>10 years ago	?	?	?	?	?	No	?	?	Not visited
Ondundazongonoa spring	Spring	Spring to the southwest of Oketovemi village, east of Otjipoko. Some people / livestock use this spring.	Okangundumba	N/A	?	N/A	N/A	N/A	N/A	N/A	?	No	N/A	N/A	Not visited
Okomuvore (Okahodhu) Cat	Borehole	Cattle post, borehole next to D3709, one concrete dam.	Otuzemba	N/A	18°25'0"S 14°4'41"E	">50 years ago"	Diesel	N/A	N/A	N/A	Yes, not often	No	Tall metal dam	?	13 January 2021
Okahama private borehole	Borehole	Near D3709. South of Okahodhu.	Otuzemba	N/A	?	"About 2012"	?	?	?	?	?	No	?	?	Not visited
Okahama spring	Spring	Near D3709. Not enough water for elephants. Near private borehole. South of Okahodhu.	Otuzemba	N/A	?	N/A	N/A	N/A	N/A	N/A	No	No	N/A	N/A	Not visited
Otjitoko Water Point	Borehole	Diesel pump and short concrete dam. Uncertain if Otjitoko is in the full moon count.	Otuzemba	Otjitoko	18°28'47"S 14°6'7"E	About 40 years ago	Diesel	N/A	No	N/A	Yes	No	Short concrete dam	About 40 years ago	04 January 2023
Otjitoko Spring	Natural spring	Uncertain if Otjitoko is in the full moon count.	Otuzemba	Otjitoko	18°30'12"S 14°5'22"E	N/A	N/A	N/A	N/A	N/A	Yes	?	N/A	N/A	13 January 2021
Okakoiki Cattle Post	Borehole	Diesel pump until 2021 when solar installed. Short concrete dam.	Otuzemba	Otjitoko	18°28'52"S 14°9'44"E	?	Solar	2021	Yes	?	Yes	?	Short concrete dam	10-20 years ago	13 January 2021
Otuzemba Spring	Natural spring	Site includes a concrete tank (covered) for storing water for vegetable gardens. Might be in the full moon cou	Otuzemba	Otuzemba	18°33'4"S 14°6'48"E	N/A	N/A	N/A	N/A	N/A	Yes	?	N/A	N/A	13 January 2021
Oruee water point	Borehole	Borehole, diesel pump, plastic tank, no concrete dam.	Otuzemba	Oruue	?	?	Diesel	N/A	?	?	?	?	No dam	N/A	Not visited
Otjihangkua (Otuzemba) de	Holds water from the	Gravity flow of water through channels to large pond near village.	Otuzemba	Otuzemba	18°32'15"S 14°7'0"E	N/A	N/A	N/A	N/A	N/A	Yes	No	N/A	N/A	13 January 2021
Okatuzembowa springs	Natural spring	Two springs, 1-2km from Otuzemba springs, on track to Okarindi.	Otuzemba	Otuzemba	18°33'30"S 14°6'21"E	N/A	N/A	N/A	N/A	N/A	Yes	Yes	N/A	N/A	13 January 2021
Okahua spring	Natural spring	East of Okarindi.	Otuzemba	N/A	?	N/A	N/A	N/A	N/A	N/A	Yes	No	N/A	N/A	Not visited
Okarindi Komutati Cattle Po	Borehole	Cattle post with solar pump, concrete dam. Damaged plastic water tank not in use.	Otuzemba	Okarindi	18°37'13"S 14°3'48"E	?	Solar	2021	Yes	?	Yes	Yes	Short concrete dam	?	13 February 2023
Otjitire, Otjikojo and Otjimi	Ponds in rainy seaso	Old cattle posts with natural ponds, boreholes were drilled but groundwater not sufficient to have water point	Otuzemba	N/A	?	N/A	N/A	N/A	N/A	N/A	?	No	N/A	N/A	Not visited
Ondereko hand pump	Borehole	Damaged by elephants in about July 2022, not working at present	Otuzemba	Ondereko	18°29'37"S 14°18'21"E	"Many years ago"	Hand	N/A	No	N/A	Yes	No	N/A	N/A	07 December 2022
Ondereko water point	Borehole	Diesel pump and tall concrete dam.	Otuzemba	Ondereko	18°28'54"S 14°18'27"E	"Many years ago"	Diesel	N/A	No	N/A	Yes	No	Tall concrete dam	?	07 December 2022
Ondjombo Ya Makongo wat	Borehole	Solar pump, plastic tanks, trough, all protected, no place for elephants to drink.	Otuzemba	Ondjombo	18°28'38"S 14°18'28"E	?	Solar	2018	Yes	2018	?	No	No dam	N/A	07 December 2022
Okangima water point	Borehole	Diesel pump uncovered, tall concrete dam.	Okangundumba	Okangima	18°25'15"S 14°18'27"E	"Many years ago"	Diesel	N/A	No	N/A	Yes	No	Tall concrete dam	?	07 December 2022

Figure 4.13 – Screenshot of part of the spreadsheet with information collected during the Research Project on water points in the Northern Highlands. The database has been provided to the Ministry of Environment, Forestry and Tourism, and the Ministry of Agriculture, Water and Land Reform.

During the time that I spent with different game guards, we visited 107 locations of water sources, including 65 water points (five of which were hand pumps), 10 earth dams and 32

springs. As well as taking notes on the infrastructure, types of pump, etc., I made observations on evidence of elephant presence and elephant damage. I prepared photographs and notes on the water points, including maps using GPS readings, as a presentation of water points for each Conservancy, and these will be provided to Conservancy Chairpersons and have been provided to the two relevant ministries (and NGOs) for their records (Figure 4.14, 4.15). In addition, I visited vegetable gardens at 18 villages during the study.

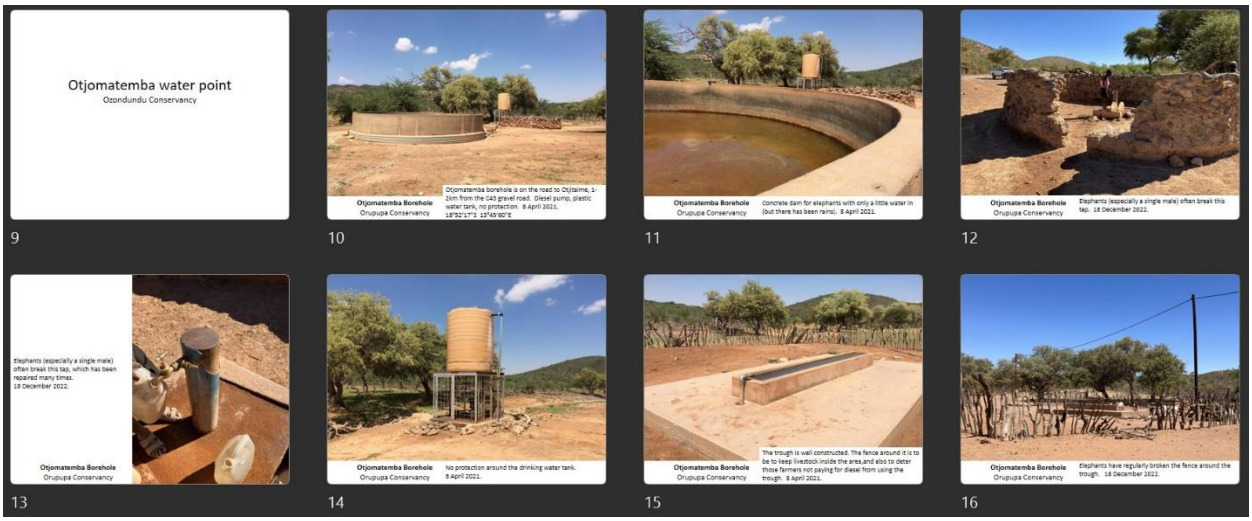


Figure 4.14 – Example page of presentation for conservancies with information on water points, springs, etc. Six presentations were prepared as notes/records and will be provided to the conservancy chairpersons. This example is for one water point in Ozondundu Conservancy.

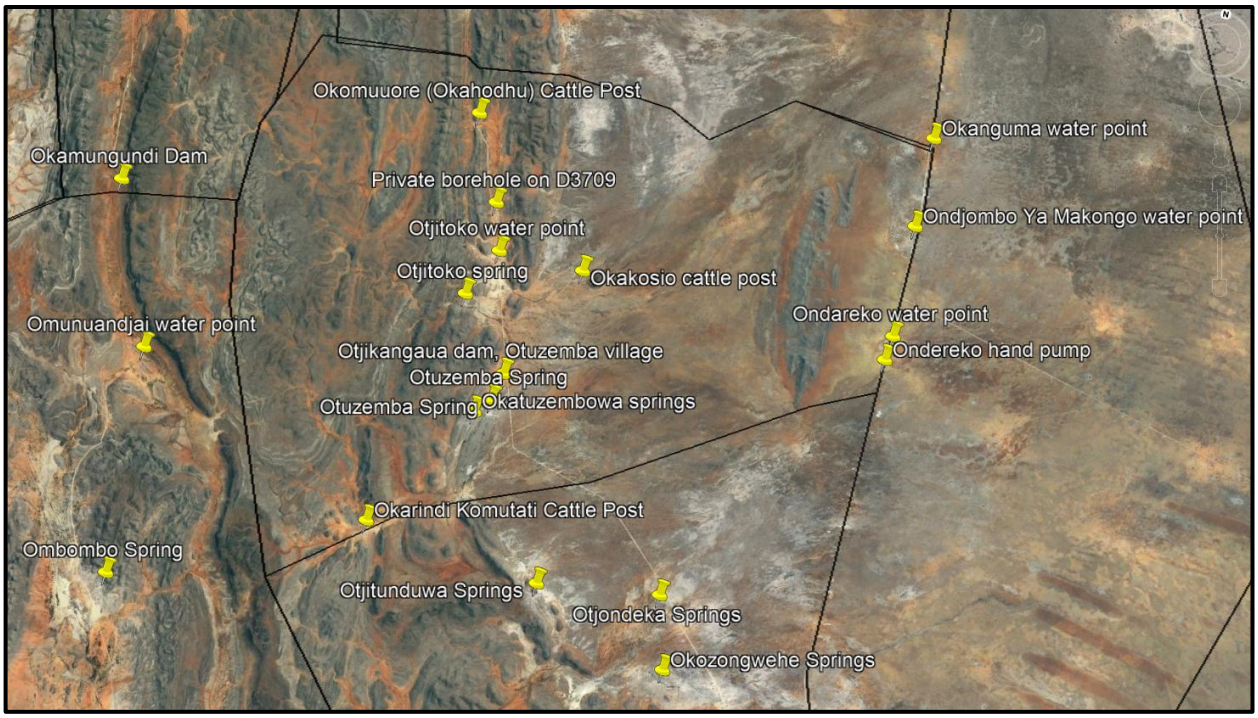


Figure 4.15 – GPS coordinates were taken for all water points and springs visited, and maps included in the presentations for conservancies. This example is Otuzemba Conservancy.

I carried out detailed descriptive analysis of the data recorded in Event Books using Excel spreadsheets. My analysis drilled down to village level, identifying villages with the most incidents, and calculating the trends in different types of incidents in different years and different months of the year. Such detailed analysis provides information to support prioritisation and planning of mitigation measures at water points and vegetable gardens in the villages. I copied relevant pages in the Event Books for the six main conservancies with the help of the game guards and the permission of the conservancy chairpersons for Ehi-Rovipuka, Orupupa, Otuzemba, Omatendeka, Ozondundu and Okangundumba. My research for this chapter therefore combined information obtained from site visits, collation of knowledge from game guards, and analysis of Event Book data on recorded incidents of human-elephant conflict.

I also carried out consultation meetings with senior stakeholders to discuss the research, as well as policy aspects including the compensation system for damage from human-elephant conflict. This included national and regional representatives from the Ministry of Environment, Forestry and Tourism (MEFT), two Traditional Authorities (local Chiefs) in the study area and conservancy chairpersons. The common feedback was that research is welcomed, but there was disappointment that researchers in the past tended not to return to present results. Therefore, an important part of this research will be for me to return to Namibia in late 2024 to present the charts and maps in this chapter in particular, and also other results from other chapters. I have organised the charts and maps in Appendix C1 in a structure as they will be presented to individual conservancies and other stakeholders. MEFT and the conservancies will also be provided with the maps and charts that cover all six conservancies (from this and other chapters). In addition, Appendix C2 includes the spreadsheet that I developed on water points in the Northern Highlands, and Appendix C3 is the presentations on water points for each conservancy, which will also be provided to relevant conservancies and other stakeholders. I will present and explain the details in the stakeholder meetings, including question and answer sessions.

4.4 Results and analysis

This section presents the results from my analysis of trends in total human-elephant conflict incidents across the six conservancies (Section 4.4.1), and comparison of total incidents over 10 years in individual conservancies (Section 4.4.2). The section also covers the identification of hotspots in human-elephant conflict (Section 4.4.3) and trends for specific conservancies (4.4.4), and identification of the main months in which incidents tend to occur (Section 4.4.5). I include discussion on my confidence in the data in Section 4.4.6 and describe and assess mitigation measures in Section 4.4.7.

4.4.1 Total incidents of human-elephant conflict across six conservancies in the Northern Highlands

Figure 4.16 presents the results from my analysis of the total reported incidents involving elephants over 10 years (2012-2021), recorded in Event Books for the six main conservancies in this Research Project (Ehi-Rovipuka, Orupupa, Otuzemba, Omatendeka, Ozondundu, Okangundumba). The totals for different types of incident are shown, including at water

points, vegetable gardens and other incidents (which tend to be damage to kraals and other structures, or injury or killing of livestock by elephants at water points). It is important to interpret and present the results from Event Books in the most useful way to help the planning of mitigation measures at hotspots (Box 4.1).

Box 4.1 – Approach to interpretation of Event Book data

The detailed study of data in Event Books revealed that there are a few cases when many events at vegetable gardens are recorded for the same village in one night, despite my observations that there are rarely more than five vegetable gardens in a village. For example, nine incidents at vegetable gardens were recorded in the Event Book at Otjitoko in Otuzemba Conservancy on 7 March 2021. In practice, vegetable gardens are sometimes jointly managed, or different people attend to separate plot areas within one fenced garden. When there are several incidents reported in one night, all the people with a stake in the garden might be reporting separate incidents to the game guard. I consider it to be more useful practice in the analysis to interpret these as one incident in a village on one date. The results presented in the charts and maps therefore, in effect, represent the number of days in which at least one incident by elephants in a village is recorded in Event Books. This is important to identify the priority hotspots. For the analysis, when a water point and at least one vegetable garden were damaged in one night at the same village, I considered this as two incidents at that village. This is because information on the types of incident is needed for planning mitigation measures at hotspots.

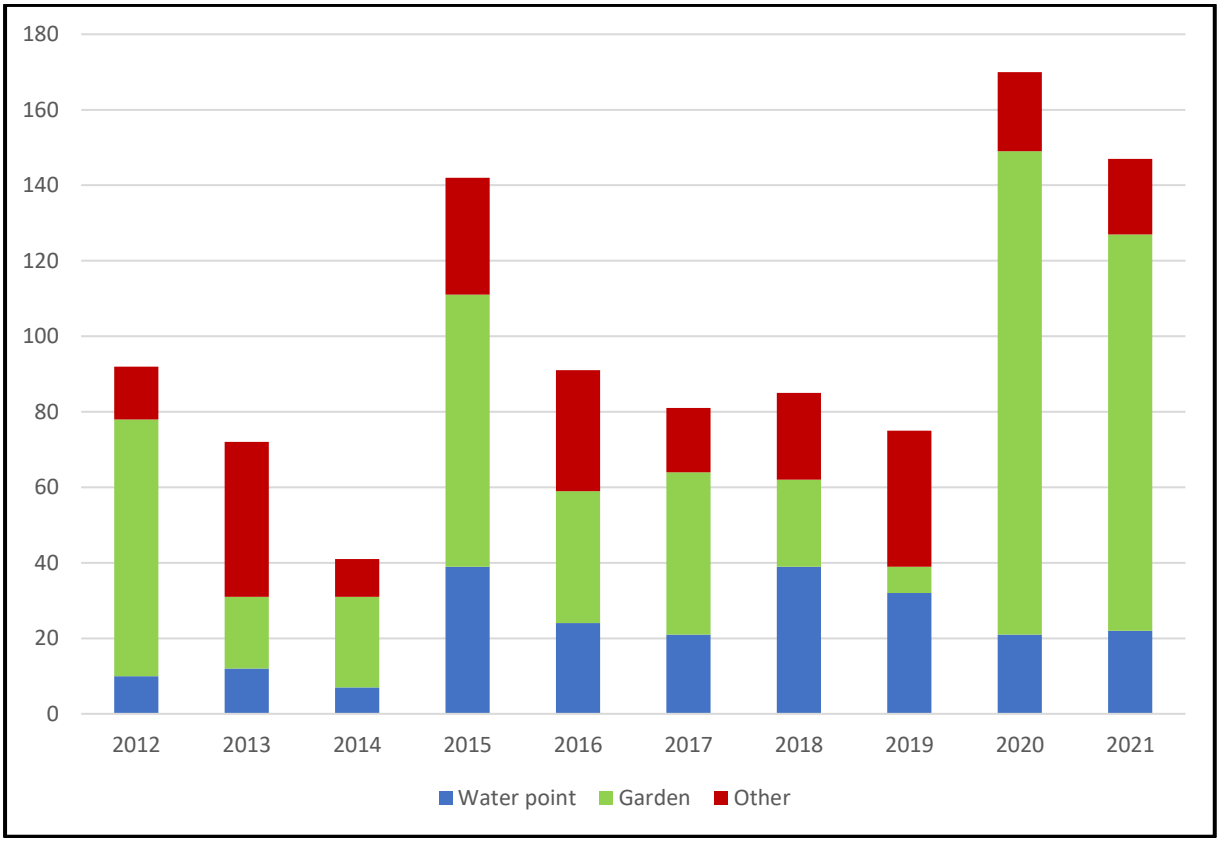


Figure 4.16 – Total incidents involving elephants recorded in Event Books in six conservancies (2012-2021) (Ehi-Rovipuka, Orupupa, Otuzemba, Omatendeka, Ozondundu, Okangundumba).

During the consultation interviews, I asked the 34 game guards about the type of incidents involving elephants that concern people in the community at present. The results indicate the communities are currently more concerned about incidents at vegetable gardens (Table 4.1). 13 of the 24 game guards (38%) specifically said that problems at vegetable gardens were the main concern, whereas four game guards (12%) said that the community is most concerned specifically about problems at water points. 14 game guards (41%) said that the community is equally concerned about all types of incidents, and mentioned vegetable gardens, water points, damage to kraals, family safety and potential livestock kills by elephants at water points.

Table 4.1 – Responses from game guards (n=34) to questions on human-elephant conflict.

What are the main current concerns of the community in terms of types of human-elephant conflict incidents (e.g. water points, vegetable gardens, other damage)?		*What is your perception of the trends in human-elephant conflict incidents over the last 10 years / since 2012 / since before the drought years?*	
Incidents at water points	4 (12%)	Conflict is increasing	16 (47%)
Incidents at vegetable gardens	13 (38%)	Conflict is decreasing	4 (12%)
All types of incidents	14 (41%)	Conflict trend is up and down but overall about the same	10 (29%)
No answer / don't know	3 (9%)	No answer / don't know	4 (12%)

The type of local concern perceived by game guards does vary between conservancies. The communities in Orupupa and Omatendeka are more concerned about vegetable gardens (eight of 13 game guards (68%) interviewed from these two conservancies answered that their local communities are mainly concerned about incidents at vegetable gardens), rather than about water points and other types of incidents. In Ozondundu and Okangundumba, only 2 of 10 game guards interviewed (20%) said that conflict at vegetable gardens was the main concern of the community. Appendix C1 includes summaries of responses to these questions for each of the six conservancies.

Game guards were also asked about the trends in human-elephant conflict, and whether incidents had been increasing or decreasing since 2012. Generally game guards have good memory of years, potentially because of their role in recording in Event Books each year, but, to make the question easier to understand, it was phrased with the additional explanation: "*since before the main years of droughts*", which started around 2013. More game guards perceive that incidents have been increasing (Table 4.1). 16 game guards (47%) said there had been an increase, with four (12%) saying decrease and 10 game guards (29%) saying there had been no overall change (with several making the point that the number of incidents varies from year to year). 13 of the 16 game guards who consider that human-elephant conflict has been increasing are based in Otuzemba, Orupupa and Omatendeka conservancies.

The results from Event Books in Figure 4.16 for the six conservancies are in alignment with the feedback from game guards that the number of incidents at vegetable gardens has

increased since the drought of 2019. This potentially demonstrates why the communities currently tend to be more concerned with incidents at vegetable gardens. Although the total number of incidents has increased in 2020 and 2021 the overall trend from 2012 to 2019 (Figure 4.16) does not confirm the increase in total incidents over the last 10 years perceived by a higher proportion of game guards (Table 4.1). A Spearman's correlation analysis on the trend in incidents in Figure 4.16 from 2012 to 2019 indicates no statistically significant increasing or decreasing trend in incidents. This applies to the total incidents (rho = 0.442, n = 10, p = 0.200) and to incidents at water points (rho = 0.482, n = 10, p = 0.159) and at vegetable gardens (rho = 0.273, n = 10, p = 0.446).

Several of the game guards who said that there has not been an overall decrease or increase in the trend, did explain their perception that the number of incidents at vegetable gardens has been going up, but incidents at water point going down because of the installation of protection infrastructure. The average total is 99.6 incidents reported per year across the six conservancies. The totals in 2020 and 2021 were 170 and 147. Indications from game guards are that some people have stopped growing vegetables in 2022 and 2023 because of the problems with elephants, for example at Okakosio in Otuzemba Conservancy. Over the 10 years, the average number of incidents at vegetable gardens is 52.4 per year, with 128 in 2020 and 105 in 2021. The average annual incidents at water points is 22.7 over the 10 years, and the overall results from the Event Books are not consistent with the perception of game guards that the incidents at water points are decreasing, although it should be noted that the protection measures have not been installed at all water points.

Even though the frequency of reported incidents is low in most villages, and there are more incidents at vegetable gardens than water points, it is the damage of an incident by elephants at a water point can have the most substantial impact on the local community. Water points typically include a diesel or solar pump, raised plastic tanks for drinking water, taps to fill containers with drinking water, pipes to a nearby trough for livestock drinking, and often a concrete or metal dam for holding water for livestock (Figures 4.17 to 4.20). It is from these dams that elephants often drink.

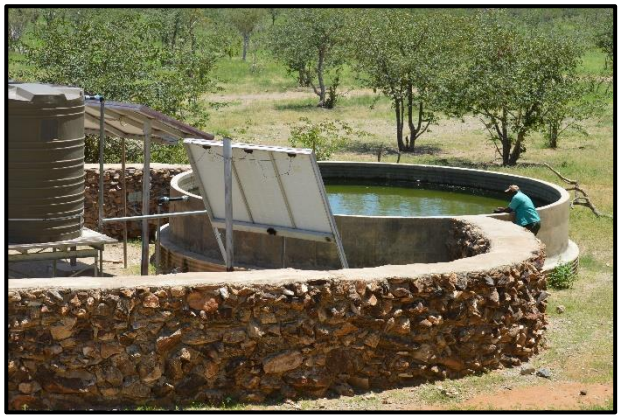


Figure 4.17 – Water point near Enduu, southern Ehi-Rovipuka Conservancy, with solar pump and showing concrete dam for holding drinking water for livestock. Elephants drink from these concrete dams; 5 March 2022.



Figure 4.18 – Water point at Okonjota, Ehi-Rovipuka Conservancy, showing raised plastic tanks for drinking water for people, with protection wall that aims to keep elephants away from the tanks, 26 March 2021.



Figure 4.19 – Diesel pump with security cage at Otjitoko water point, Otuzemba Conservancy, 13 January 2021. The plastic water tank and pipes do not have the wall for protection from elephants.



Figure 4.20 – Water points have nearby troughs for livestock drinking; this example at Ondjombo Ya Makongo water point, in the flatter landscape of the eastern part of Otuzemba Conservancy, 7 December 2022.

When water point infrastructure is damaged, in practice it often takes much time to repair, partly because of the large distances to travel to suppliers to buy parts and equipment. This can leave communities without nearby access to water for several weeks. For example, the infrastructure at the water point at the cattle post at Otjamusirika in northern Orupupa was damaged by elephants in 2020 (Figure 4.21), and could not be immediately repaired, so for one month people were having to walk 5km back to Otjondeka to obtain water. Other examples of damage are shown and described in Figures 4.22 to 4.24. Further discussion with game guards indicated their perception that the number of incidents at water points that resulted in serious damage by elephants has been decreasing.



Figure 4.21 – Damage by elephant at Otjamusirika, Orupupa Conservancy. The plastic water tank had been pushed off the raised platform above the pump protection cage and pushed about 100m away. Photograph taken 24 March 2021.



Figure 4.22 – Water point at Okarindi, Otuzemba Conservancy. The plastic tank for storage of drinking water can no longer be used because of damage by elephants, including piercing a hole in the tank by a tusk, and the pipe pulled out. Photograph taken 13 January 2021.



Figure 4.23 – Protection wall broken by elephants at Okazorongua in Orupupa Conservancy, 24 January 2023.



Figure 4.24 – Pipes from the holding tank to the troughs are regularly pulled up by elephants, and large stones sometimes used to try to protect the pipes. This example is at Ombombo in Okangundumba Conservancy, 12 January 2021.

A study in 2017 using community surveys across four conservancies in northwest Namibia (including Omatendeka in the Northern Highlands) identified that local people perceive that human-wildlife conflict increases during drought years, although that survey did not distinguish between incidents involving elephants and those involving predators (Carpenter, 2022). Given that 2018 and 2019 were serious drought years in northwest Namibia (Sasscal, 2024), the results in Figure 4.16 are not consistent with the finding of that study. This does potentially support the point that trends in incidents of human-elephant conflict depend on unique local factors (Hoare, 2012; Save the Elephants, 2022).

4.4.2 Total incidents of human-elephant conflict in different conservancies

Table 4.2 and Figure 4.25 provide a comparison of the total number of incidents and average incidents per unit area across the conservancies over the 10 years (2012-2021). Okangundumba and Orupupa have recorded the most incidents, with Ehi-Rovipuka the least incidents. A study in Tanzania concluded that crop damage by elephants was higher for farms located near protected areas, although other factors, such as type of crop, also affected the area of crop damage (Eustace *et al.*, 2022). It is interesting that Ehi-Rovipuka is closest to Etosha National Park and has the least incidents (Figure 4.25), despite northern Ehi-Rovipuka having many villages (Figure 1.16). Therefore the results in the Northern Highlands do not align with the results of the study in Tanzania.

Okangundumba and Orupupa have had the most incidents per unit area over the ten years, at 2.4 and 2.1 incidents per year reported per 100 km^2 respectively. The incidents are higher per unit area in parts of the conservancies that have more human population, as would be expected because there are more water points, more vegetable gardens and more people to report the incidents. For example, the area of southern Ehi-Rovipuka to the south of Otjokavare averaged 0.2 incidents per year reported per 100 km^2, whereas the area to the north of Otjokavare (Figure 4.25), which has more villages and higher human population, averaged about 1.0 incidents per year reported per 100 km^2. Southern Omatendeka, an area of about 620 km^2 south of Okavare (Figure 4.25), had zero incidents reported from 2012 to 2021, mainly because there are very few human settlements. Therefore all the incidents in Omatendeka were in the north, over an area of about 1,000 km^2, and in this area the

average number of incidents per 100 km^2 was about 1.5 per year, above the average of 1.3 incidents per 100 km^2 for the whole area of the six conservancies.

Table 4.2 – Comparison of incidents involving elephants reported in Event Books per unit area in the six conservancies

	Approx. human population (NACSO, 2024)	**Area** (km^2) (NACSO, 2024)	**Total incidents** (2012-2021)	**Average number of incidents per 100 km^2 per year**
Ehi-Rovipuka	1,346	1,980	103	0.5
Orupupa	1,387	1,234	258	2.1
Otuzemba	449	742	117	1.6
Omatendeka	2,939	1,619	148	0.9
Ozondundu	390	745	103	1.4
Okangundumba	2,331	1,131	267	2.4
Total		7,451	996	1.3

Figure 4.26 presents the results for individual conservancies. It illustrates that there are more incidents at vegetable gardens in all conservancies than at water points or other types of incidents, except in Ozondundu Conservancy, which has fewer vegetable gardens according to game guards. No clear patterns on water points can be identified from this high-level presentation of results in Figure 4.26. Otuzemba has had fewer incidents at water points, which might be expected because the Conservancy has many springs (Figure 4.27). Omatendeka also has several springs in some parts of the conservancy and reports few incidents at water points. However, Orupupa has many springs (Figure 4.28) but still reports a higher number of incidents at water points, and Ehi-Rovipuka has few springs and reports few incidents at water points. Okarumbu water point in Ozondundu Conservancy has skewed the results because there have been 54 incidents reported at that water point over the 10 years. My more detailed assessment to identify hotspots at villages is covered in Section 4.4.3 below.

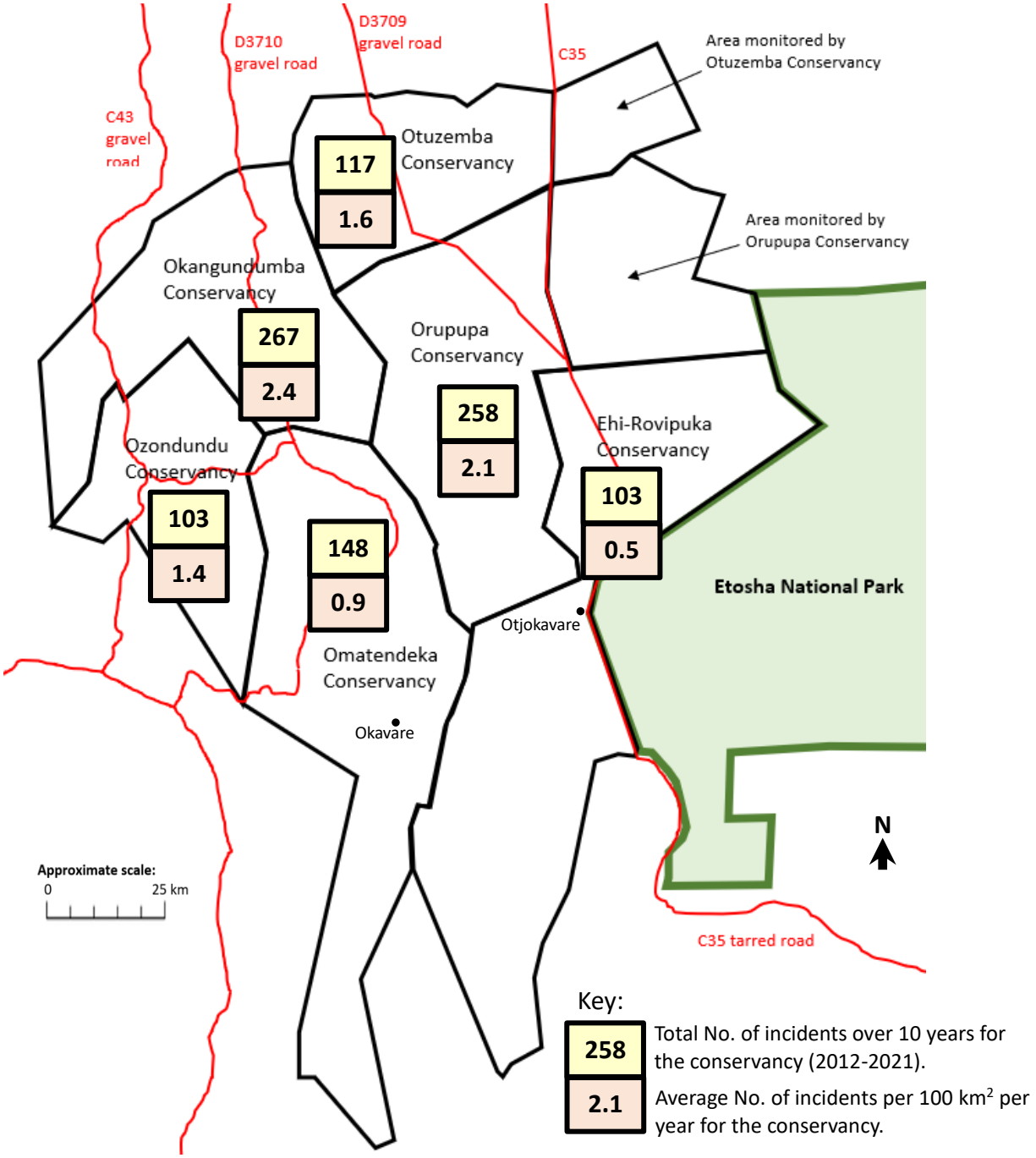


Figure 4.25 - Comparison of incidents per unit area across the six main conservancies (Ehi-Rovipuka, Orupupa, Otuzemba, Omatendeka, Ozondundu, Okangundumba)

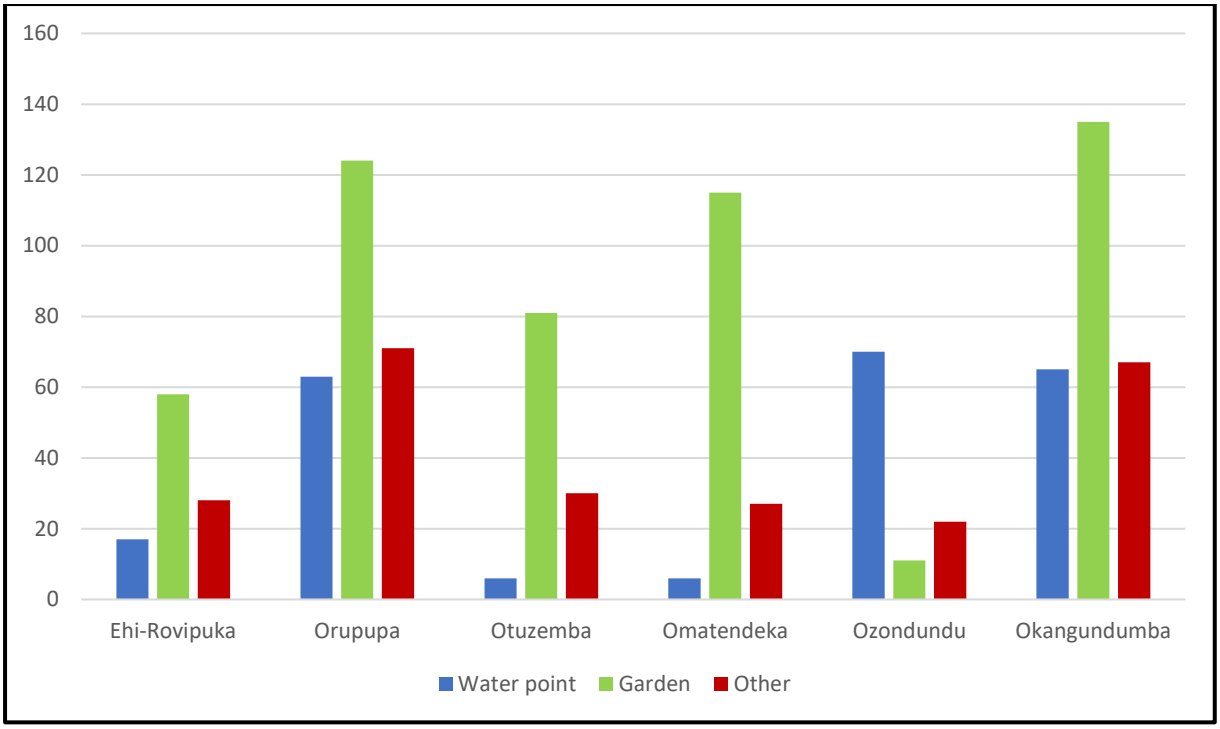


Figure 4.26 - Comparison across six conservancies of total incidents involving elephants reported in Event Books (2012-2021)



Figure 4.27 – Otuzemba Springs, Otuzemba Conservancy. The Conservancy has many springs and there are relatively few reported incidents involving elephants at the community water points. Photograph taken 13 January 2021.



Figure 4.28 – Ombingugohenda Spring above Ekoto, in Orupupa Conservancy, 28 February 2022. Orupupa has many springs but still a relatively high number of incidents are reported at community water points.

4.4.3 Identification of hotspots of human-elephant conflict in conservancies

The Event Book data include location of incidents in terms of nearest village or cattle post, which enables analysis of hotspots of human-elephant conflict. The map of the six conservancies in Figure 4.29 shows the total number of incidents at different locations over the 10 years of 2012 to 2021. These include incidents at water points, vegetable gardens and other types.

The main hotspots for incidents appear to be in the western part of the six conservancies, including Epunguee (Okangundumba), Okarumbu (Ozondundu), Otjozongombe (on the boundary between Okangundumba and Omatendeka), Omuramba (Omatendeka) and Okarindi (on the boundary between Otuzemba and Orupupa). It might be expected that more incidents are reported in villages with more people, also because there are likely to be more vegetable gardens. However, the results show that this is not necessarily the case because the human populations of Omuramba and Otjozongombe villages are relatively high but the populations in the other hotspots of Epunguue, Okarumbu and Okarindi are low. Figure 4.29 does show several hotspots near the roads. Much of the population in the Northern Highlands lives in villages near the main roads, and therefore a high proportion of water points and vegetable gardens are nearer the roads, and higher reported incidents near roads would be expected.

Figures 4.30 and 4.31 are maps for which I disaggregated the Event Book data to illustrate hotspots specific to incidents at water points and vegetable gardens. These show that the main hotspots with repeated incidents at water points are in Okangundumba and Ozondundu Conservancies (Figure 4.30), but also reported incidents at water points are quite scattered, with many water points having up to five incidents over 10 years. The main incidents at vegetable gardens are across five of the six conservancies (Figure 4.31), with Ozondundu Conservancy being the exception. These results add another component in terms of identification of priorities for mitigation measures and knowledge of elephant movements. Maps of hotspots for individual conservancies are included in Appendix C1.

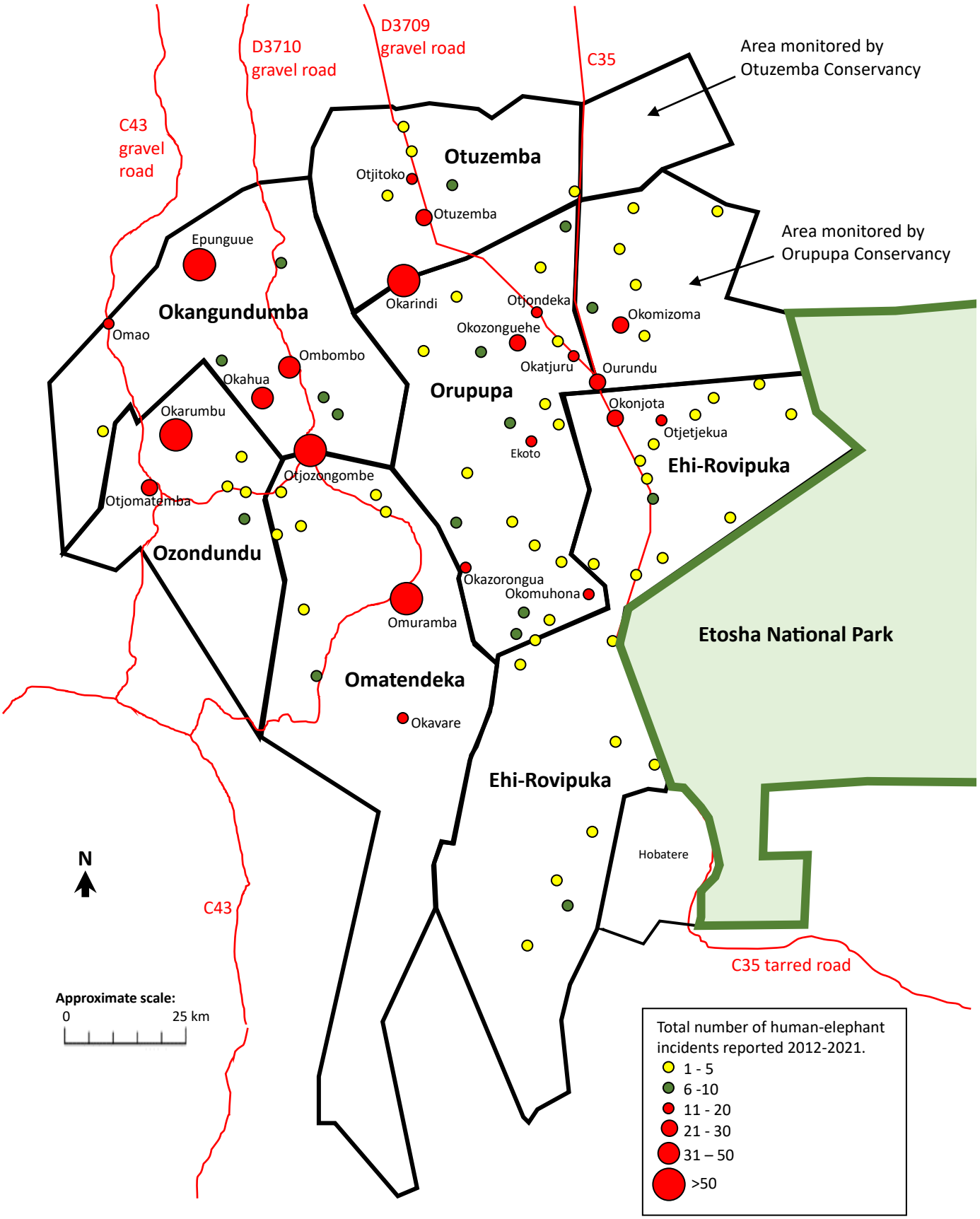


Figure 4.29 – Location of human-elephant conflict incidents recorded by game guards in six conservancies between 2012 and 2021

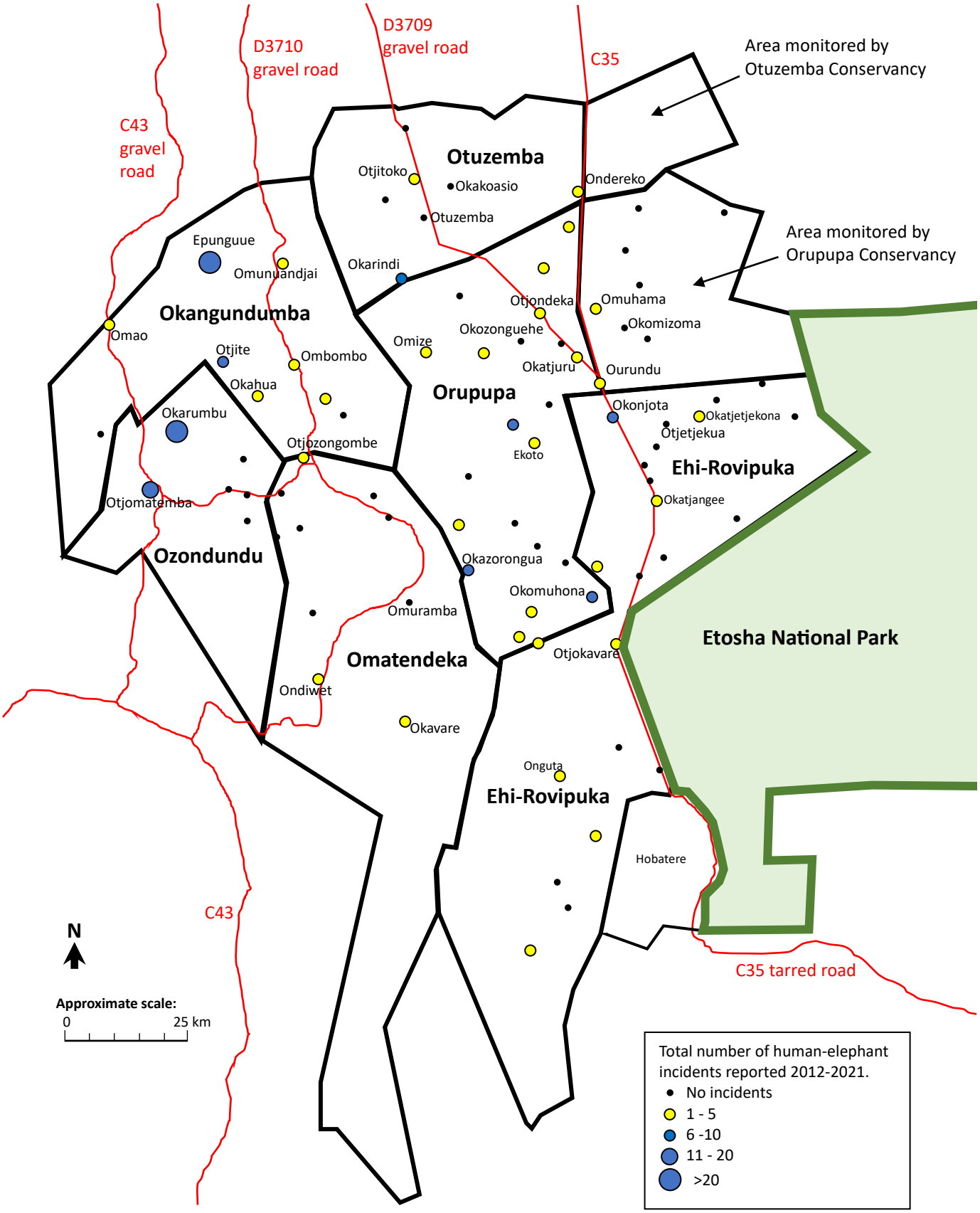


Figure 4.30 - Incidents involving elephants at **water points**, reported in Event Books in different villages across the six conservancies (2012-2021)

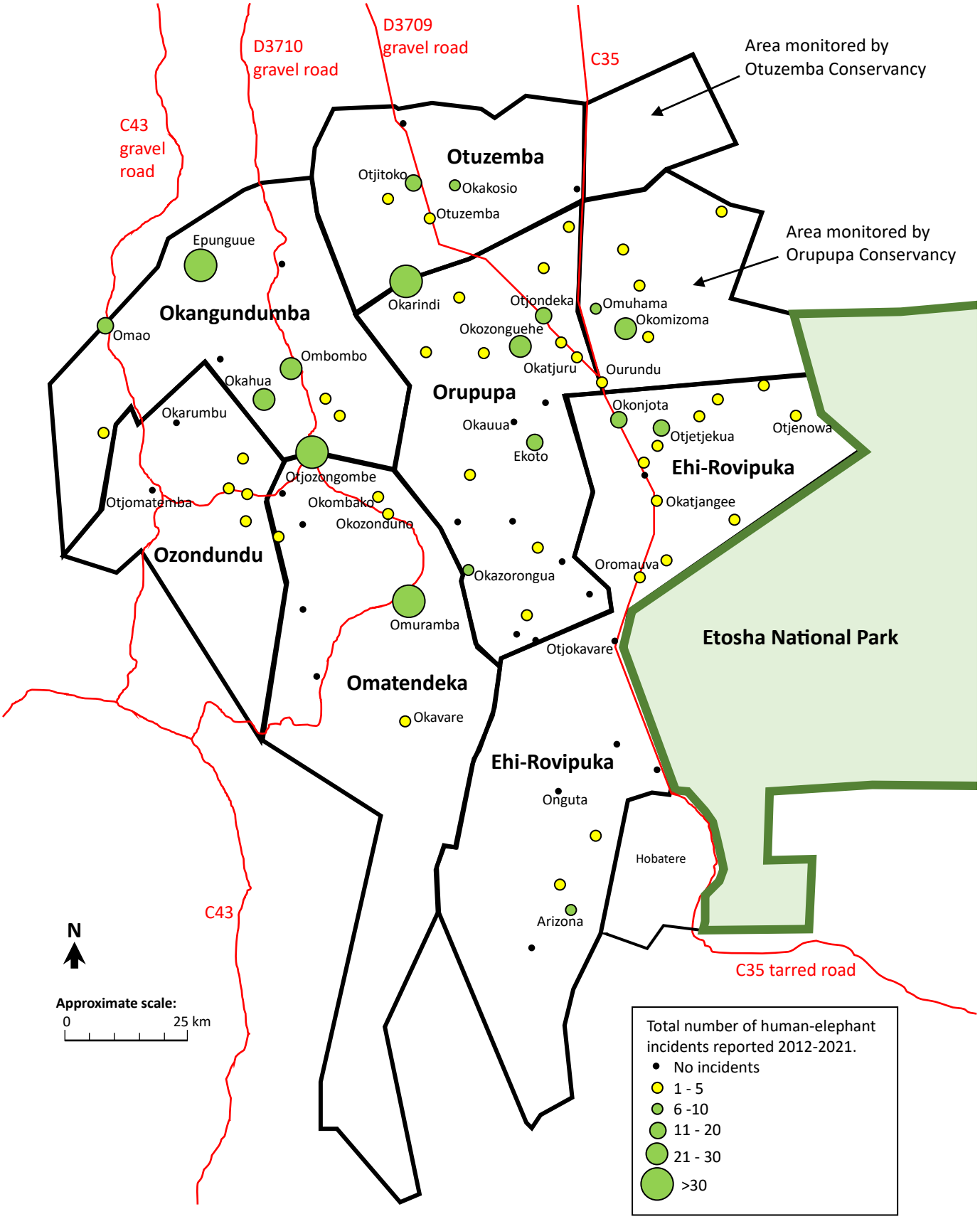


Figure 4.31 - Incidents involving elephants at **vegetable gardens**, reported in Event Books in different villages across the six conservancies (2012-2021)

Even at village level, the trends cannot always be explained. For example, incidents in Ozondundu Conservancy are dominated by incidents at the water point in Okarumbu (Figures 4.32 and 4.33), for which had 46 incidents involving elephants were recorded in Event Books in 2015, 2016 and 2018 (out of 103 total incidents over 10 years for the whole Conservancy). There were no incidents at the water point reported at Okarumbu in 2019, 2020 and 2021. It would be expected that extra protection might have been installed in 2018 and this might explain the results, but this was not the case. According to the game guards, the water point has had a protection wall for over 20 years, and a solar pump since 2005 (upgraded to a pump with higher power in 2021).



Figure 4.32 – Okarumbu water point, Ozondundu Conservancy. According to the Event Books, the water point has had the highest number of incidents compared to other water points in the six conservancies. Photograph taken 18 January 2023.



Figure 4.33 – At Okarumbu, there is a separate concrete dam about 2km from the borehole. The intention was for this dam to have water for elephants and this would keep them away from the water point near the village. It was constructed in 2005 but the solar pump at the borehole was not strong enough to pump water to the separate dam for elephants. A new pump was installed in 2021 but the separate dam has not yet been connected.

4.4.4 Trends in incidents of human-elephant conflict in conservancies

The number of incidents of human-elephant conflict varies each year. Figure 4.16 and the associated correlation analysis indicate no clear increase or decrease in total incidents for all the six conservancies over the last 10 years, except an increase at vegetable gardens in 2020 and 2021. Figure 4.34 presents the disaggregation of the data in Figure 4.16 to show the trends in incidents for the six individual conservancies. Figure 4.34 also shows increases in incidents at vegetable gardens in 2020 and 2021 in Otuzemba, Orupupa and Omatendeka Conservancies in particular, because of the increase in number of households setting up gardens after the drought of 2018-2019. In Okangundumba Conservancy, which has had the most incidents over the 10 years, the number of incidents per year has been showing an increasing trend for incidents at water points (Spearman's correlation rho = 0.716, n = 10, p = 0.02) and other incidents (rho = 0.805, n = 10, p = 0.05), but Okangundumba has fewer vegetable gardens and there has not been a significant trend in incidents at vegetable gardens (rho = -0.134, n = 10, p = 0.712). At the other conservancies, incidents per year are shown to be up and down over time and there is no clear trend of increase or decrease over the 10 years, as confirmed by Spearman's correlation analysis on the trends in total incidents and trends in different types of incidents at the other five conservancies (only the incidents at water points in Orupupa Conservancy show a statistically significant increasing trend over the 10 years, rho = 0.648, n=10, p = 0.043).

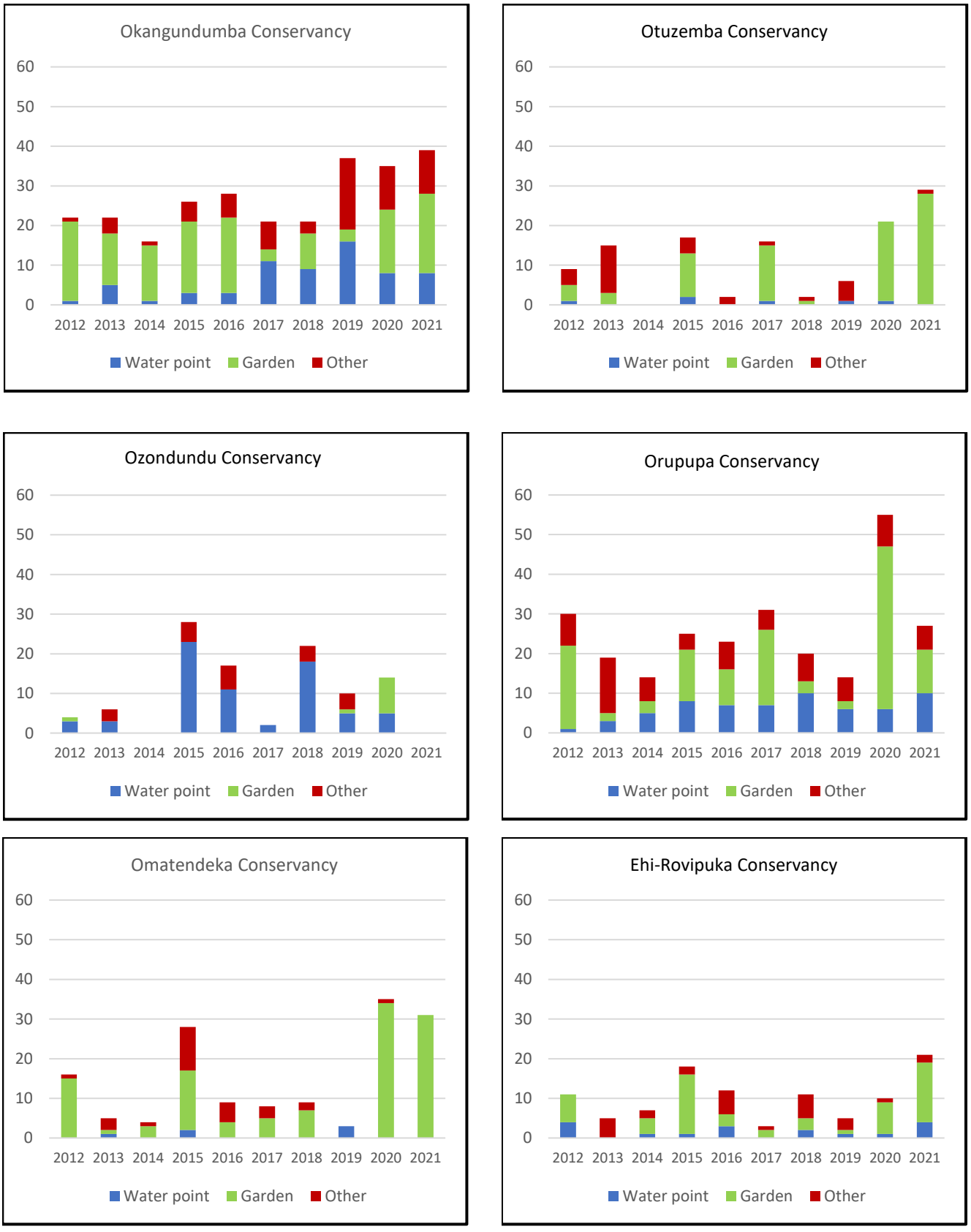


Figure 4.34 – Total incidents recorded in Event Books in the six core conservancies (2012-2021)

4.4.5 Trends in incidents involving elephants by month

The information on incidents recorded by game guards in Event Books includes the date of the incident, and this provides useful information for my analysis of elephant incidents and movements at different times of year. There are several potential factors influencing elephant movements in the Northern Highlands, including timing of the rains, availability of water points, vegetation, etc. The rains tend to fall at some stage in the months of January to April. Vegetables tend to be planted after the first rains and ripen around April to May. Figure 4.35 presents all incidents recorded in the six conservancies over the 10 years from 2012 to 2021 and shows the total incidents recorded each month. The highest number of incidents are occurring in April and May because these are the main months for growing vegetables in gardens. There has been a large variation in the number of incidents in vegetable gardens in the rainy season (Figure 4.35). The maximum was 47 incidents across the six conservancies in May 2021, but in May of 2019, a year with a serious drought, there were no incidents at vegetable gardens because the community were growing less vegetables and many elephants are likely to have moved out of the area to find vegetation and water. During these incidents, elephants cause damage to the fences, as well as taking vegetables (Figure 4.36, 4.37).

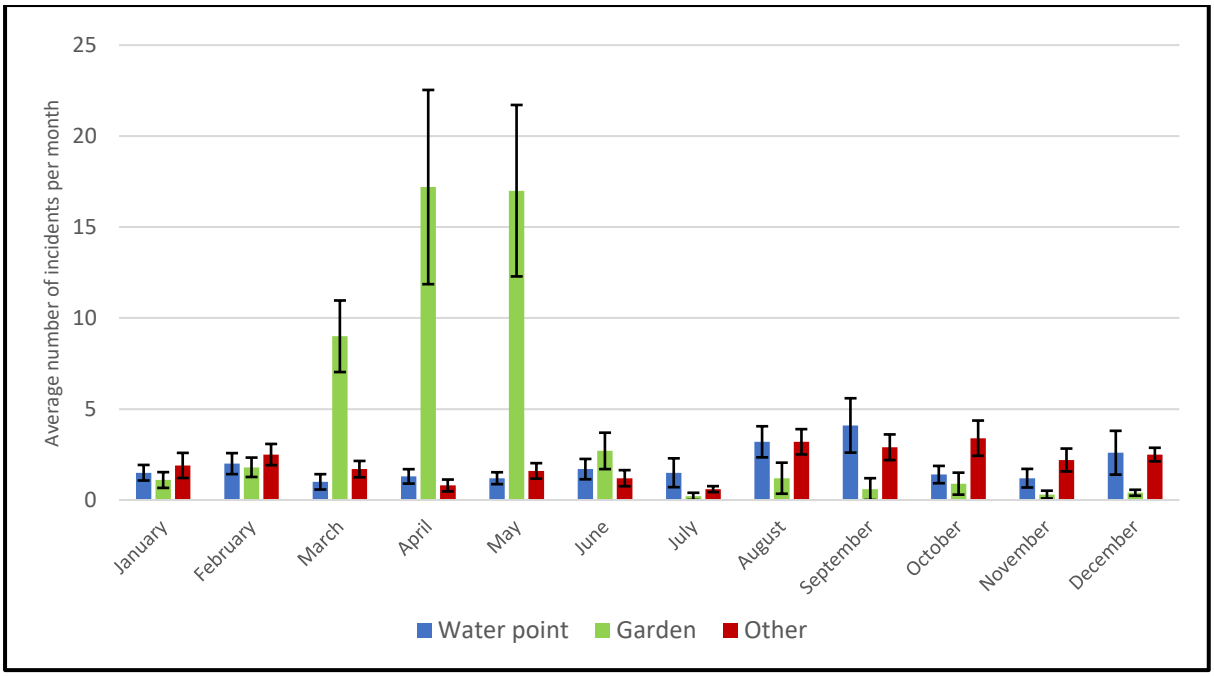


Figure 4.35 - Mean number of recorded incidents involving elephants per month over 10 years (2012-2021), showing standard error bars, in six conservancies (Ehi-Rovipuka, Orupupa, Otuzemba, Omatendeka, Ozondundu, Okangundumba).

I also asked game guards whether they agreed or disagreed with the statement: "*Elephants wait until vegetables are ripe before taking them from vegetable gardens.*" 25 game guards (74%) strongly agreed and six agreed (18%), (Figure 4.38). There is a common opinion with the game guards that elephants had been spending time away from villages in the mountains in the rainy season, where their preferred vegetation has fresh leaves. They are now also coming down more often to the valleys towards the end of the rainy season to take ripe vegetables from villages.

Figure 4.35 shows a small but noticeable increase in incidents at water points in the dry season from May to December. This is more evident when analysed at a conservancy level for Okangundumba and Ozondundu conservancies (Figure 4.39). Equivalent charts for other conservancies are included in Appendix C1.



Figure 4.36 – Vegetable gardens at Okakuyu in Ozondundu Conservancy are fed by spring water, so the growing season is longer. However, at Okakuyu there have been relatively fewer incidents with elephants than at some other villages. There was one incident recorded in 2019 and four in 2020, but none in other years between 2012 and 2021. The local people sometimes use branches of thorn bushes to try to protect the gardens. Photograph taken 18 December 2022.



Figure 4.37 – Elephants damage fences at vegetable gardens and kraals, Otjitoko, Otuzemba Conservancy, 13 January 2021.

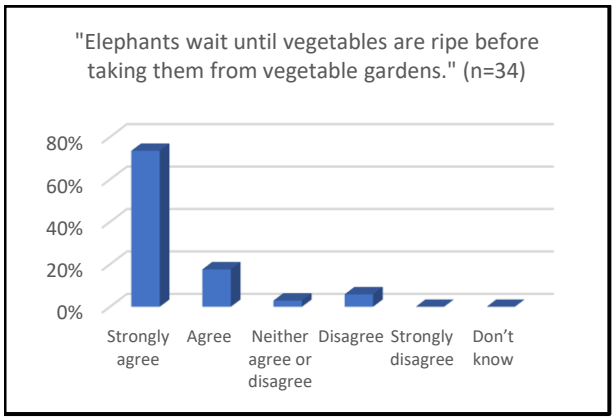


Figure 4.38 – Opinion of game guards on timing of elephant visits to vegetable gardens.

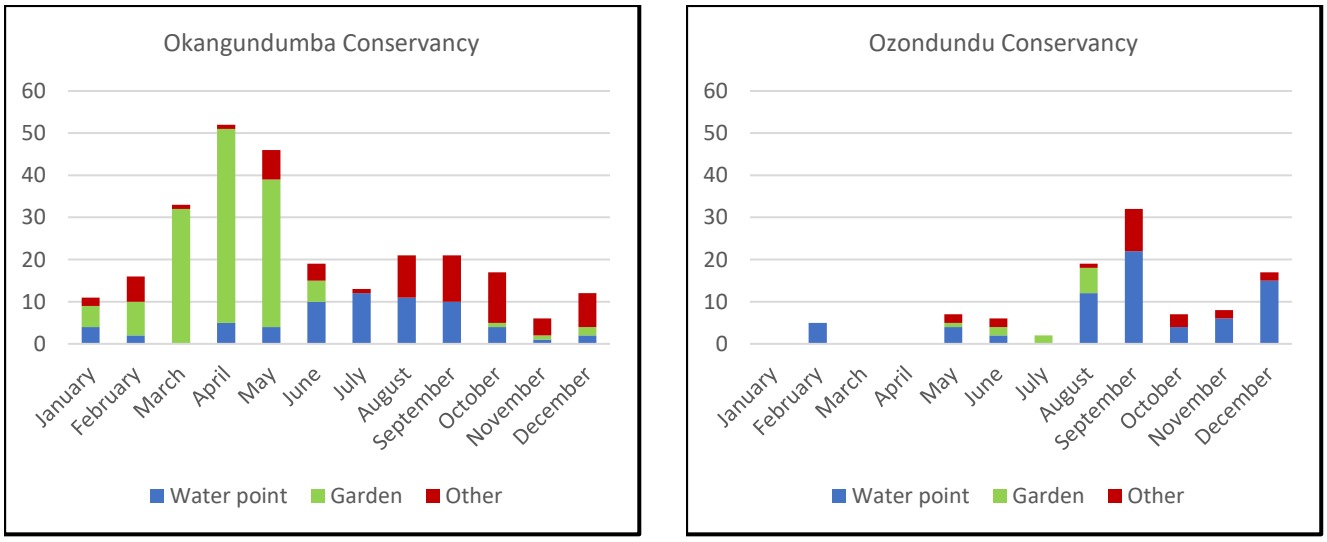


Figure 4.39 - Total incidents involving elephants recorded in Event Books in Okangundumba and Ozondundu conservancies by month (2012-2021)

4.4.6 Data quality

The data quality in Event Books should be assessed with consideration of the context of the challenges for the game guards. They receive low salaries, many lack proper walking boots and none of the 34 game guards that I interviewed had binoculars. Although I observed much enthusiasm and commitment from most game guards to their role, in reality, on some days, they might have a lack of motivation for keeping proper records in the Event Books. There is therefore some uncertainty in the data in Event Books in terms of whether it provides a comprehensive record of the total number of incidents. It is likely that some incidents go unreported, particularly in those villages located long distances from the villages in which the game guards live. The game guards usually do not have access to a vehicle and have to walk between villages. For example there was damage from elephants at Otjamusirika cattle post in Orupupa Conservancy in 2020, discussed during a site visit in March 2021 (Figure 4.21), but later I noted from Conservancy Event Books that it was not recorded.

However, the game guards have received training and they carry out several foot patrols each week, during which time they make many observations that enhance their local ecological knowledge. As well as discussing incidents with communities when reporting them in Event Books, game guards are responsible for raising awareness in communities on the benefits of conservation of habitats and wildlife. Therefore they have much interaction with the local communities and have a good understanding of local perceptions on wildlife, including elephants. Although there is some uncertainty in the Event Book data, there is confidence in the local ecological knowledge of the game guards. The game guards consulted had between one and 30 years of experience in their role and the average experience of the game guards was 10.3 years. The combination during this research of collating local knowledge, analysing Event Book data, and field observations in the study area, provides confidence in the results and conclusions of this research. More assessment on the knowledge of game guards is covered in Chapter 7.

4.4.7 Measures to reduce human-elephant conflict

Elephant damage at vegetable gardens not only involves elephants eating the vegetables but also damage to fences (Figure 4.37), and often the crushing of other vegetables that are not eaten, especially if a herd of elephants enters a garden. There have been more incidents reported at vegetable gardens (53% of the total 996 incidents over 10 years in the six conservancies) than at water points (23%), and the annual incidents at vegetable gardens have increased in 2020 and 2021 (Figures 4.16).

(a) Measures to reduce conflict at water points

As mentioned, incidents at community water points are not frequent, but can have high impact. Damage can be to pipes, taps, plastic water tanks that hold drinking water for people, protection walls, metal holding dams, and sometimes to the pumping equipment. At the water points, although they tend to visit at night, elephants sometimes come close to people and their livestock during the day, and this can result in actions from stressed elephants that could cause damage. Elephants drink 150 litres/day on average (Skinner and

Chimimba, 2005; Schnegg and Kiaka, 2018; IEF, 2023). Even when elephants have not damaged any infrastructure, but have drunk the water that had been pumped into a holding dam for livestock, this often results in a cost for the village in terms of the diesel fuel needed to pump the extra groundwater. Although such incidents are not recorded in Event Books, they do affect community attitudes towards elephant conservation. Villages then tend not to leave dams full, to avoid losing the costs of diesel, and this can then lead to damage to pipes by elephants when they find empty dams (Figures 4.40 to 4.43).



Figure 4.40 – Elephants regularly revisit community water points to drink. If they do not find water where they previously have drunk, then they sometimes pull up pipes and cause other damage when they can smell water. I noted this example of evidence of elephants looking for water at Ombaiki water point, Anabeb Conservancy, 28 January 2021.



Figure 4.41 – Elephants returned to this water point, 2km from Ekoto in Orupupa Conservancy, to find no water in the concrete holding dam. They caused damage by pulling out the pipes. Photograph taken 28 February 2022.



Figure 4.42 – Elephants became frustrated when finding the holding dam had no water in Okazorongua in Orupupa Conservancy, and broke the pipework (Figure 4.43). Photograph taken 1 April 2021.



Figure 4.43 – Elephants broke the pipework to the trough at Okazorongua in Orupupa Conservancy, because they found no water in the concrete dam (Figure 4.42). Photograph taken 1 April 2021.

The upgrades to water points over the last 20 years, funded by the Namibian Government and some by NGOs, have been particularly important. According to the game guards, measures such as changing metal holding dams to concrete dams have helped reduce damage (Figures 4.44 and 4.45), as well as building protection walls around the pumping equipment and plastic tanks (Figures 4.17, 4.18), building pipes into the ground and fixed in concrete at troughs (Figures 4.46), and using rocks on the ground around infrastructure as a deterrent (Figures 4.47). In particular, upgrading from diesel to solar pumps has been important (Figure 4.45). This helps to ensure that water is more permanently available in the holding dams, and, although there is a capital cost for the infrastructure, operational costs are minimal compared to diesel pumps. Investment in converting water infrastructure to include solar pumps and adding walls to protect water points from elephant damage is the main intervention included in the National Elephant Conservation and Management Plan for reduction of human-elephant conflict at water points in the northwest (MEFT 2021).



Figure 4.44 – An elephant damaged this metal holding tank by leaning on top to drink water, Ekango, Orupupa Conservancy; photograph taken 12 December 2022.



Figure 4.45 – Example of upgraded water point. Concrete holding dams are good practice, at a height so that smaller elephants can drink the water. In this case the solar pump keeps the dam full; Okarumbu, Ozondundu Conservancy, 18 January 2023.



Figure 4.46 – Pipe to the trough is installed underground and built into the concrete next to the trough, which is good practice to mitigate damage by elephants; Orumatupa 26 March 2021.



Figure 4.47 – Rocks on the ground around water points and other infrastructure represent good practice at reducing damage by elephants. Ondjombo Ya Makongo, Otuzemba Conservancy 7 December 2022.

During time spent with game guards in the research, I visited 107 water sources, including 65 water points (five of which were hand pumps), 10 earth dams and 32 springs. Out of the 60 water points (excluding hand pumps), 47 (78%) had protection walls around the core infrastructure (e.g. around the pumps, plastic tanks for drinking water and usually a tap for filling containers). 33 of the 60 (55%) had a concrete holding dam (several of the others had a corrugated metal holding dam, which can be damaged by elephants). 24 water points (40%) had been converted to solar. These observations show that, although the common feedback from community game guards is that there has been good progress in addressing human-elephant conflict at water points in the Northern Highlands, there is still much more investment needed to upgrade additional water points with protection measures and conversion to solar pumps.

In theory, the Event Book data should facilitate comparison of frequency of incidents at water points for those with diesel and those with solar. However, although I did a comparative analysis the results were inconclusive because there are few water points for which the year of installation of the solar pumps is known.

The water supply at Okatjuru in Orupupa Conservancy is an example of the previously difficult situation for communities in terms of operating costs. Several years ago the community decided to close the groundwater borehole because of the costs of diesel fuel for pumping (Figure 4.48), and instead they use a hand pump for supply. In 2022 the water point was upgraded to solar (Figure 4.49), through funding from the Government of Namibia.



Figure 4.48 –The water point at Okatjuru had not been used for many years, Orupupa Conservancy. Photograph taken 24 March 2021.



Figure 4.49 – The water point at Okatjuru was reconstructed in November 2022 with a solar pump, which minimises operational costs for the community and keeps water in the concrete dam. Photograph taken 12 December 2022.

As mentioned, additional good practice to improve safety and reduce conflict is to build separate holding dams for elephants at least 1 km from the water point (Shiweda *et al.*, 2023). The solar pumps need to have sufficient power to pump the water to the separate dams, and the pipes must be buried underground. The separate dam encourages elephants to stay away from the community water points. This has helped at Okaaua in Orupupa Conservancy (Figure 4.50) and Okonjota in Ehi-Rovipuka (Figure 4.51), but at Okarumbu in Ozondundu Conservancy (Figure 4.33) and Okazorongua in Orupupa Conservancy, separate dams have been constructed 1.5 to 2 km from the water points, but dams are not connected to the boreholes.



Figure 4.50 – Separate water dam for elephants at Okauua in Orupupa Conservancy, about 0.5 km from the borehole. This has been successful in keeping elephants away from the community water point. Photograph taken 24 March 2021.



Figure 4.51 – Separate water dam for elephants at Okonjota in Ehi-Rovipuka Conservancy, 1 km from the main borehole at the village, 26 March 2021.

(b) Measures to reduce conflict at vegetable gardens

One of my questions to the 34 game guards was for their opinion on the top three problems caused by elephants. According to game guards, at present the problems at vegetable gardens are the main concern with elephants. 25 game guards (74%) included problems at vegetable gardens in their top three problems, with 13 game guards (38%) saying vegetable gardens is the No.1 problem, eight (24%) saying safety of people is the No.1 problem and five (15%) saying damage to water points. This aligns with the results from my more general question on community concerns that I asked earlier in the interviews (Table 4.1).

Elsewhere in Africa, there have been much research and many projects on human-elephant conflict at crops areas and vegetable gardens (e.g. Kioko *et al.*, 2008; Hoare, 2012; King *et al.*, 2013; Ndlovu *et al.*, 2016). There have been several publications over many years on mitigation measures, including guidance handbooks (IUCN, 2001; World Bank, 2020; Save the Elephants, 2022). In practice, the applicability of mitigation measures depends on practical factors related to the local situation where the conflict is occurring.

There have been minimal mitigation measures tested at vegetable gardens in the Northern Highlands (Figures 4.52, 4.53), perhaps in part because incidents involving elephants at vegetable gardens had a relatively small impact before 2019 compared to other types of

human-wildlife conflict. Several game guards, particularly in Orupupa and Okangundumba conservancies, said that the increase in damage at vegetable gardens and loss of crops since 2020 is reducing the progress of the conservancy model in that local people are becoming negative about elephants and less motivated to their conservation. Some compensation for damage to large vegetable gardens is provided by the Government of Namibia, but in practice compensation systems in remote areas are difficult to manage properly and most gardens in the Northern Highlands are smaller than the criteria for compensation.



Figure 4.52 – Vegetable garden at Ekoto, Orupupa Conservancy. Minimal mitigation methods have been tested at gardens in the Highlands. At some, plastic bottles were tied to the fence as local people think that this might make elephants nervous to enter. Photograph taken 28 February 2022.



Figure 5.53 – Vegetable garden at Okozonguehe, Orupupa Conservancy. Fences are often constructed of branches from thorn bushes, with the aim of keeping away other herbivores as well as elephants, although in practice elephants can easily get through these fences. Photograph taken 5 March 2021.

There are a number of potential methods to try to keep elephants away from vegetable gardens. I describe these in Table 4.3 and provide a brief assessment on applicability to the Northern Highlands. During the consultation with game guards, we also discussed the main applicable methods to prevent elephants entering vegetable gardens. 28 of 34 game guards (82%) suggested electric fences, 19 said burning chillies (56%) and 18 also said chasing elephants by making noise and using spotlights (53%).

At present, no deterrent methods at vegetable gardens are working properly in the Northern Highlands. Electric fences have the most potential (Box 4.2), but there are high costs at the start to purchase equipment. A project with an electric fence was set up in Otuzemba, but the vegetable plot is very large and the feedback was that the project has not been successful, potentially because there were not enough solar panels and/or battery storage. An electric fence project at a smaller garden in Ekoto, Orupupa Conservancy, was being planned in late 2023. One point about deterrent projects is that they only need to be applied for a few months of the year at most gardens, because of the short growing season.

Table 4.3 - Assessment of applicability of mitigation measures to the Northern Highlands of northwest Namibia

Measure	Description	Applicability to the Northern Highlands
Noise	Use of noise (e.g banging metal pots) by local people to try to keep elephants away from villages and gardens.	This is the main current method used in the Northern Highlands, but it has safety risks for the people.
Burning chillies	Burning chillies mixed with cow dung can keep elephants away because of the smell. Must be burned upwind.	This is currently used in some areas of the Highlands. Chillies can easily be grown locally and dried for future use.
Burn plastics or tyres	Burning plastics or tyres might keep elephants away because of the smell. Must be burned upwind.	This is currently used in some areas of the Highlands. Some negative risks to local air quality.
Protection wall or stones on the ground	Construction of protection walls or large sharp stones on the ground around a crop area or garden.	Labour intensive and a lot of stones required, which are locally available over the Highlands but vehicles needed for collection. Currently used successfully at several water points (Figure 4.47).
Trench around garden	Dig a deep, wide trench around the crop area or garden.	Not observed in the Highlands during the Research Project. Labour needed to dig the trench and low confidence that it would be successful because of the known agility of elephants.
Electric fence	Proven technique with some success in keeping elephants away.	Abundant solar energy in the Northern Highlands but battery storage might be needed as elephants tend to visit at night. Expensive procurement and installation costs.
Beehive fence	Beehives attached to a tight raised wire around the garden. Bees potentially attack elephants when disturbed. Proven to have some success in Kenya. One benefit is the honey for local people.	Unlikely to be applicable in the Northern Highlands because of the lack of flowers to provide for the bees for much of the year.
Communication between villages	Advanced warning system using phones or other communication so problem elephants can be moved away before they reach the village (e.g. by noise, spotlights, burning chillies).	Currently many areas of the Northern Highlands have no or poor mobile phone network. The safety risks would remain for people trying to move elephants away.

Box 4.2 – Example of performance of electric fence

There has been some monitoring of elephant movements using GPS collars at private farms about 150 km southwest of the Northern Highlands. The Hirabis farm provides a useful case study (Figure 4.54) because a simple electric fence (Figure 4.55) has been shown to deter elephants. In the map of movements of three collared elephants in Figure 4.54, they clearly are shown to move around the Hirabis farm. It is uncertain in a scenario where neighbouring farms had an electric fence whether the elephants would go through or round the fences, and there is an argument that electric fences and other deterrents simply move elephants on to the next farm or vegetable plot, which might be owned or managed by a poorer person without the funding available for an electric fence. However, the results are a clear indication of the potential deterrent by electric fences.

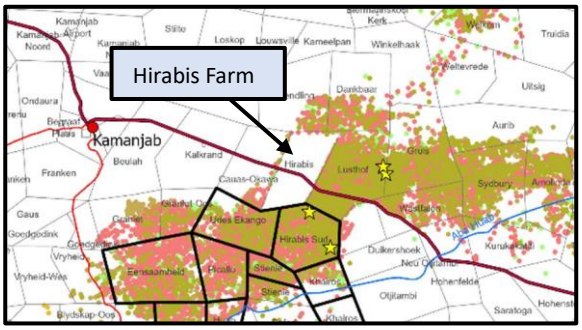


Figure 4.54 – Map showing movements of three collared elephants around Hirabis farm (MEFT, 2021).



Figure 4.55 – Electric fence at Hirabis private farm.

I asked game guards whether there were specific problem elephants that cause more damage, and whether overall it is the individual males or female herds that cause the most damage at gardens. There was common feedback from game guards that there are specific problem elephants that are individual males. In Omatendeka and Ozondundu in particular, the game guards are familiar with two individual males, which they have named. In terms of problems at vegetable gardens, 17 game guards (50%) said that the individual males cause most of the damage. 10 game guards (29%) said the female herds cause the most damage, partly because when they enter a vegetable garden, the high number of elephants means that many vegetables are taken or trampled. Three game guards (9%) said that individual males and female herds cause the same amount of damage, and four game guards did not know. The opinion of one head game guard is that larger herds tend to have more leadership and discipline, and cause fewer problems.

One practical measure, which is informally used in some areas of the Northern Highlands, is communicating the movements of elephants by mobile phone, so that villagers know when elephants are moving in their direction. This is particularly applicable for known problem elephants. In practice, all this means is that the elephants can be chased away before they reach the village and gardens, through noise, etc. 23 of 34 game guards (68%) do try to communicate elephant movements, but many areas of the Northern Highlands are without phone network and some game guards have to walk up the mountains into network coverage to communicate elephant movements. The network coverage has been improving in this rural area, and therefore a more formal communication system might be more applicable in future.

4.5 Conclusions

The National Elephant Conservation and Management Plan for Namibia includes the strategic objectives to plan local interventions to protect the elephants in northwest Namibia, and in particular to reduce the incidents of human-elephant conflict (MEFT 2021). It includes the requirement for more research on human-elephant conflict to inform mitigation strategies.

There has been a gap in research on human-elephant conflict in northwest Namibia, including the Northern Highlands. Before my Research Project, Event Book data had not been analysed in detail in terms of types of incidents involving elephants, hotspots in the Northern Highlands and trends over years and months of the year. The experience of game guards means that they are familiar with their conservancy and particularly their local area. Their knowledge, combined with the Event Book records and site visits, were useful for me to identify the trends, hotspots and concerns related to human-elephant conflict in the conservancies.

The language used by specialists in wildlife conservation tends to vary between “human-wildlife conflict” and “human-wildlife coexistence” (Hill, 2021). In northwest Namibia, the consultation with community game guards has shown that the situation is closer to conflict, in terms of damage by elephants and livestock kills by predators. The communities are concerned about safety risks and damage caused by elephants. The term ‘human-elephant conflict’ has therefore been used in this Research Project.

The perception of game guards is that human-elephant conflict has increased over the 10 years from 2012 to 2021 in the six conservancies studied in the Northern Highlands. The Event Book data indicates that the annual number of incidents recorded is up and down over time, but there is no clear increase except in 2020 and 2021 when local people set up more vegetable gardens following loss of livestock in the 2018-2019 drought. The larger number of gardens has resulted in more incidents involving elephants at vegetable gardens. According to game guards, most people in the local communities have now become more concerned about damage at vegetable gardens by elephants than damage at water points. The only conservancy out of the six studied that has had a clear increase since 2012 in total annual incidents recorded in Event Books is Okangundumba.

The community conservancy model, which has been implemented across northwest Namibia, including the Northern Highlands, since the 1990s, has had some success in terms of fostering the commitment of local people to participate in wildlife conservation. The feedback from game guards is that the increase in damage at vegetable gardens and loss of crops since 2020 is eroding the commitment of some local people to protection of elephants and contributing to the risks to the sustainability of the conservancy model. The identification of hotspots is important so that mitigation measures, such as electric fences, can be planned at priority locations.

Although there are more incidents at vegetable gardens than water points, in practice the incidents at water points can have more impact on the communities. This is because if pipes or tanks are damaged, it can take several weeks to repair the damage, partly because of the

costs and partly because of the practicalities of bringing in spare parts to these remote villages. One of the main actions funded by the Namibian Government (and some NGOs) has been to convert diesel pumps at water points to solar pumps. This helps to ensure the holding dams are kept full of water, which is important because, according to game guards, there have been many cases of elephants damaging water points when they find the holding dams to be empty. At villages with diesel pumps at the water points, there is a reluctance to spend money on the fuel to pump water for livestock when that water in the holding dam might be taken by a herd of elephants.

The perception of game guards is also that serious incidents at water points have been decreasing as a result of upgrades at several water points to include protection walls, concrete dams (rather than corrugated metal), and solar pumps. Although the Event Book data does not show a decrease in incidents at water points for the six conservancies from 2012 to 2021, the local feedback and site visits to water points do give confidence that serious damage at water points is less frequent. These protection measures are needed as soon as possible at other water points that have not yet been upgraded. This is particularly important considering the likely increase in competition for water resources between humans and elephants because of future climate change events (Zeidler *et al.*, 2013; Schnegg and Kiaka, 2018).

The successful upgrades to water points have provided support to the poor communities in the Northern Highlands by maintaining the availability of water supply in many villages. At several water points, a beneficial next step would be to install separate dams for elephants, further away from villages, so that there is less risk of interactions between humans and elephants at the main community water points. Such interventions require a strong enough solar pump to ensure there is always water available for elephants at the separate dam (e.g. preferably at least 1km from the water point) and connecting pipes must be installed underground.

Orupupa and Okangundumba conservancies have had the most incidents reported over the 10 years. The results partly show that incidents are higher in areas with higher human population, such as Omuramba village in Omatenedeka and Otjozongombe village on the boundary of Omatendeka and Okangundumba. The results also show that there are several hotspots in the villages near to the main roads. However, there are also hotspots at some of the smaller villages, such as Okarumbu in Ozondundu, Epunguue in Okangundumba, and Okarindi on the boundary of Orupupa and Otuzemba (Figure 4.29). The results on hotspots of incidents involving elephants are also relevant to the assessment of movements of elephants in the Northern Highlands (Chapter 6).

The records in Event Books include dates of the incidents and show that the highest number of incidents per month are in April and May at the end of the rainy season when the vegetables in gardens are growing. Some management measures, such as the use of electric fences, could focus mainly on implementation in these months.

Further research is more important related to mitigation measures at vegetable gardens than at water points. At the water points investment is needed to roll out proven solutions, but at the vegetable gardens pilot projects are needed to test different measures under

controlled and monitored circumstances. Such measures should include the higher cost solution of electric fences and a lower-cost option of burning chillies, potentially combining with organised communication systems between villages. It is important that the planning of mitigation measures in a particular village takes into account the specific local situation on the ground.

The game guards each cover an area of their conservancy and regularly interact with the local communities in that area. They have a good understanding of local perceptions on wildlife, including elephants. Although there is some uncertainty in the Event Book data, I have confidence in the local ecological knowledge of the game guards. The combination during this research of collating local knowledge, analysing Event Book data, and field observations in the study area, provides confidence in the results and conclusions.

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Chapter 5 - Preferred vegetation of elephants in the Northern Highlands

This Chapter covers the component of the Research Project on the preferred vegetation of elephants in the Northern Highlands. The vegetation potentially influences the movements of elephants and therefore the results and conclusions in this Chapter feed into Chapter 6 on movements.

5.1 Context

Elephants are herbivores that browse on trees and graze on grasses. The feeding habits of African savanna elephants have been widely studied. They require large quantities of vegetation, with adult elephants typically eating about 130-150 kg/day (NAG, 1997; BBC, 2008; Haynes, 2012; Elephants for Africa, 2016; National Geographic, 2023). In processing this substantial quantity of biomass, they are able to tolerate lower plant nutrient levels than most smaller herbivores (Marston *et al*., 2020). The diets of elephants vary on a seasonal basis, as they seek moisture and nutrients from the tissues in the vegetation (Haynes, 2012; Henley, 2019). In the rainy season, they graze more on fresh grasses and browse fresh leaves. They eat woody vegetation (twigs, branches and bark) in the dry season when the grasses have dried out, and they also eat fruits, pods and roots (Owen-Smith and Chafota, 2012; Roever *et al.*, 2012; Tsalyuk *et al*., 2019; Leggett, 2019; Thompson, 2019; Marston *et al*., 2020). There are sugars under the bark in the phloem layer and moisture in the xylem layer (Trees for Life, 2023). Elephants often strip bark from branches for the sugars and moisture (Haynes, 2012; Wildblood, 2012). In a detailed study on selective feeding of elephants in Botswana, Owen-Smith and Chafota (2012) concluded that in the dry season elephants consume a wide variety of species, whereas in the rainy season, when food availability is relatively high, they are selective in terms of the vegetation species that they prefer.

The distribution of tree and shrub species in Namibia is quite well documented. The projects associated with the Namibia Botanical Research Institute (NBRI) have published the most information on tree species in Namibia, in particular through the Tree Atlas Project. Under that project, information on tree species and distribution was collected over six years until the end of 2003. The database is published, including species distribution maps to a level of detail of 27.5km squares (NBRI, 2005a). Over time, this work was developed further into a detailed tree identification book: *Trees and Shrubs of Namibia*, (Le Roux and Müller, 2018). Some of the species of trees and shrubs in the Northern Highlands are associated with the mountain topography and tend to be less abundant in Etosha National Park. For example, the African star chestnut (*Sterculia africana*) and several species of *Commiphora* are associated with mountain landscape of the northwest, and absent from much of Etosha National Park (NBRI, 2005b, 2005c, 2005d, 2005e; Le Roux and Müller, 2018).

There have been a few other specific studies on abundance of vegetation species in northwest Namibia. These identify that mopane (*Colophospermum mopane*) dominates several areas of northwest Namibia (Inman *et al*., 2020a), including the Northern Highlands (Figure 5.1). Studies also identify that purple-pod terminalia (*Terminalia prunioides*) is

abundant across the whole area, and the kudu bush (*Combretum apiculatum*) abundant in eastern areas of the Northern Highlands (Leggett *et al.*, 2003c; Leggett, 2006a). Becker and Jürgens (2000) carried out a detailed study of vegetation along climate gradients in 1997-1998, but the transects were outside the Northern Highlands study area. That study confirmed the dependence of vegetation on the rainfall gradient, with lower species richness in the west.

There have been minimal published studies on the preferred vegetation of elephants in the Northern Highlands. The research on the desert-adapted elephants, to the west of the Highlands, has included some aspects of vegetation preferences. In the late 1980s, Viljoen studied many aspects of the desert-adapted elephants, including field observations of utilised tree species, and concluded that the most important woody food plants for elephants are *Colophospermum mopane* and *Combretum imberbe* (Viljoen, 1989b). However, it should be noted that the area of that study, west of Sesfontein (Figures 1.2), is drier than the Northern Highlands and has much lower coverage of tree and shrub species (Figures 5.1 to 5.4).



Figure 5.1 – Typical valley landscape in the eastern area of the Northern Highlands (in Ehi-Rovipuka Conservancy), 22 January 2018, showing higher vegetation coverage than in the areas of the desert-adapted elephants, west of Sesfontein (Figure 5.4). The photograph also shows an example of a valley dominated by *Colophospermum mopane*.



Figure 5.2 – Typical vegetation coverage in areas of rolling hills in the central area of the Northern Highlands, 12 January 2021 (near Ombombo in Okangundumba Conservancy), showing higher vegetation coverage than in the areas of the desert-adapted elephants in Figure 5.4.



Figure 5.3 – Typical landscape and vegetation coverage in the steeper western areas of the Northern Highlands, 16 April 2019 (at Otjitaime, near Otjomatemba, in Ozondundu Conservancy), showing higher vegetation coverage than in the areas of the desert-adapted elephants (Figure 5.4), but sparser coverage than in the east of the Northern Highlands (Figure 5.1).

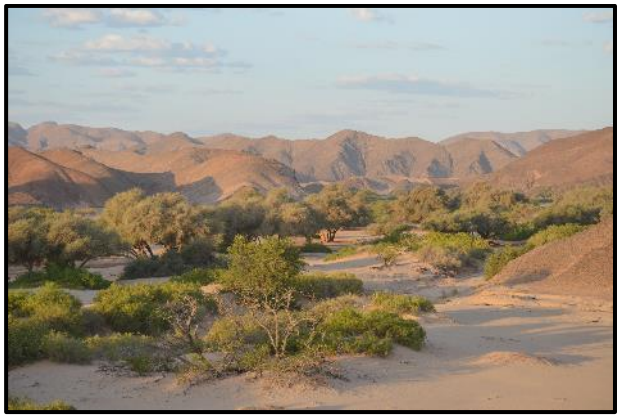


Figure 5.4 – Typical landscape and vegetation coverage in the main range areas of the desert-adapted elephants, in the lower Hoanib, west of Sesfontein (outside of the Northern Highlands). Photograph taken 10 April 2021, showing lower vegetation coverage than in the Northern Highlands (Figures 5.1 to 5.3).

In the 2000s Keith Leggett, of the University of New South Wales, published several papers on his research on the population dynamics of the desert-adapted elephants, in the desert area around the lower Hoanib catchment, west of the Northern Highlands (Figure 5.4). He also managed a study on vegetation in northwest Namibia and concluded that several species that sprout leaves just before and after the first rains of the wet season are browsed by wildlife and domestic livestock, in particular trees such as *Colophospermum mopane*, *Terminalia prunioides*, *Combretum apiculatum* and *Grewia* spp., (Leggett *et al*., 2003c; Leggett, 2006a; Leggett 2009a). The baseline study for the National Elephant Conservation and Management Plan (MEFT, 2021) notes that *Colophospermum mopane* is a nutritious food source for elephants but is loaded with secondary metabolites (tannins, phenols) as a defence against browsing, and that important food for elephants in Etosha National Park and northwest Namibia are the taller *Acacia* species and the *Commiphora* species.

In Chapter 3, my findings included that local feedback from game guards indicated that elephant numbers have been increasing in the Northern Highlands and that some elephants have moved back into the Highlands from Etosha National Park. In the times of conflict and droughts in the 1970s and 1980s in the northwest, it was considered that elephants tended to stay in Etosha National Park because of the better enforcement of wildlife protection and the better water availability in the Park (Owen-Smith, 2010; Schnegg and Kiaka, 2018; MEFT, 2021). Since 1990, there has been an increase in protection status for most of the area of the Northern Highlands through the set up of community wildlife conservancies. This community-based approach has been shifting the attitudes of local people to commit to wildlife protection (Owen-Smith, 2010; Jacobsohn, 2019; Störmer *et al.*, 2019; MEFT/NACSO, 2022; Wenborn *et al*., 2022b). During the scoping consultations, the game guards stated that the reduction in poaching was a factor in elephants moving back to the area. The availability of water resources is also an important factor influencing the return of elephants to the Northern Highlands. In Chapter 4, my findings include that the number of community water points has increased since the 1990s, and the government and development NGOs have stepped up programmes over the last decade to upgrade some community water points (MEFT, 2021). This involves installation of solar pumps to replace diesel pumps at boreholes, and construction of concrete holding dams, resulting in water being more permanently available to communities and also to elephants at many water points.

Improved wildlife protection and water availability are therefore now common both to Etosha National Park and the Northern Highlands. The reason for the ongoing increase in elephant population in the Northern Highlands could potentially be the different vegetation available in the Highlands compared to Etosha, and in particular the tree species associated with the mountain slopes. One important aspect is to identify whether there are specific tree species that might be a factor influencing the movement of elephants from Etosha to the Highlands and also their movement up the mountains.

5.2 Research objectives on vegetation preferences

The objectives of this component of the research were to:

- Investigate the preferred vegetation of elephants in the Northern Highlands.
- Assess the influence of vegetation type on elephant movements in the Northern Highlands.

5.3 Method

During the scoping phase, I spent longer than originally planned in Namibia due to Covid-19 travel restrictions, but this gave me the opportunity to identify and learn about tree species in the Northern Highlands. During that time, I identified the potentially significant influence of vegetation type on elephant movements, from discussions with game guards and also from field observations of tree species partly eaten by elephants and evidence of elephant movements. I therefore included elephant vegetation preferences as one of the topics in the semi-structured interviews with 34 game guards.

As a basis for the research in this component, it has been very important for me to learn the identification of the more common tree species in the Northern Highlands. I spent much time during scoping identifying and learning tree species in the field through observations and taking photographs of identification features such as leaf structure, bark, thorns, etc, and use of the detailed tree identification book: *Trees and Shrubs of Namibia*, (Le Roux and Müller, 2018). During field walks in the study area, I took photos of different features of trees and recorded voice messages to note the descriptions. Later, I prepared notes and photographs on 75 tree and shrub species that I identified in northwest Namibia (Figure 5.5 provides one example).

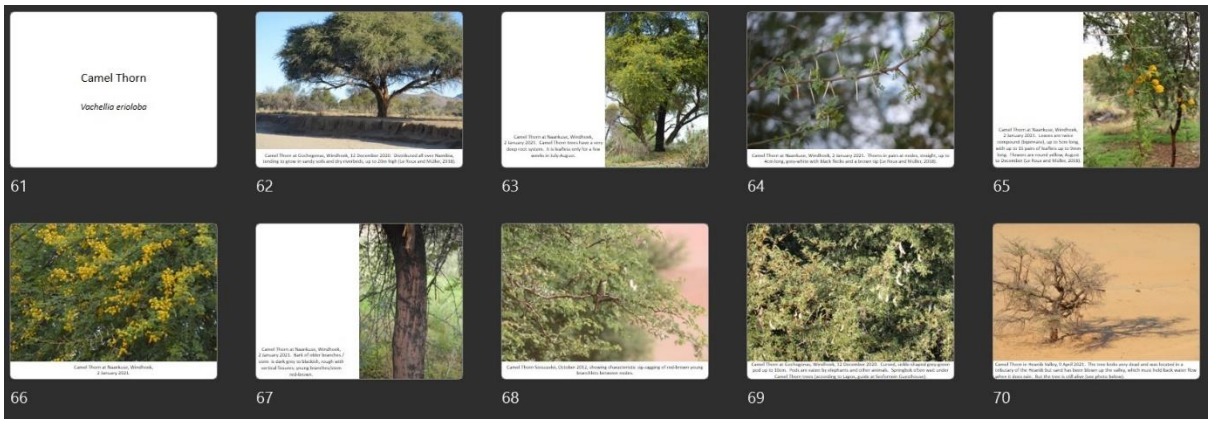


Figure 5.5 - Example of notes and photos on tree species developed when identifying and learning tree species in northwest Namibia during the study (*Vachellia erioloba*). I find that Powerpoint presentations are a useful way to record notes in combination with photographs.

Based on the initial discussions with game guards, and observations in the field, I selected a short-list of 20 tree species. These 20 species, listed in Box 5.1, are common in the Northern Highlands (as I identified during field visits in scoping). I prepared and printed A4 cards for each tree species, showing the names of the tree (including in the local Otjiherero language) and with photos of a tree, the bark, and leaves. Appendix D1 provides the tree cards used during the discussion with game guards, for the 20 species. Examples are shown in Figures 5.6 (*Terminalia prunioides*) and 5.7 (*Dichrostachys cinerea*). Appendix D2 provides my presentation-based notes and photographs on my identification of 75 tree species in northwest Namibia.

Box 5.1 - Short-list of 20 tree species for questions to game guards on elephant preferences (includes common name, scientific name and name in local Otjiherero language).

1. Leadwood (*Combretum imberbe*) - Omumborombonga
2. African star chestnut (*Sterculia africana*) - Omuhako
3. Camel thorn (*Vachellia erioloba*) - Omumbonde
4. Mopane (*Colophospermum mopane*) - Omutati
5. Purple-pod terminalia (*Terminalia prunioides*) - Omuhama
6. Sicklebush (*Dichrostachys cinerea*) - Omutjete
7. Sycamore fig (*Ficus sycomorus*) - Omukuyu
8. Blue-leaved corkwood (*Commiphora glaucescens*) - Omutungi
9. Tall common corkwood (*Commiphora glandulosa*) - Omukange
10. Velvet corkwood (*Commiphora mollis*) - Omurenda
11. Purple-stemmed corkwood (*Commiphora multijuga*) - Omuzumba
12. Large sour plum (*Ximenia caffra*) - Omumbeke
13. Herero sesame bush (*Sesamothamnus guerichii*) - Ongumbati
14. Shepherd's tree (*Boscia albitrunca*) - Omutendereti
15. Smelly shepherd's bush (*Boscia foetida*) - Otjinautoni
16. Trumpet thorn (*Catophractes alexandri*) - Omukaravize
17. Kudu bush (*Combretum apiculatum*) - Omumbuti
18. Buffalo thorn (*Ziziphus mucronata*) - Omukaru
19. Kaoko ceraria (*Ceraria longipedunculata*) - Omumbondororwa
20. Velvet raisin bush *(Grewia flava*) – Omuvapu

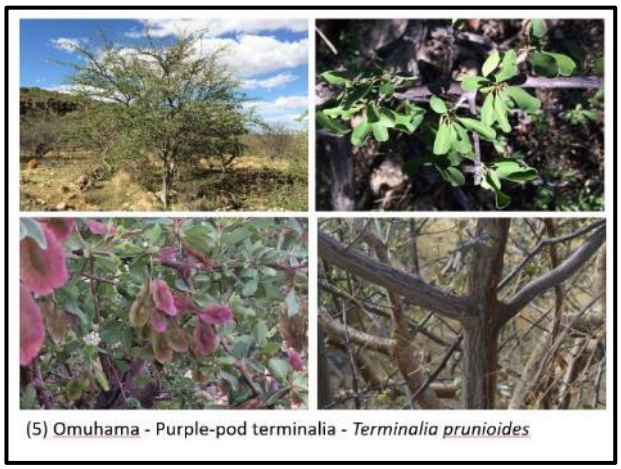


Figure 5.6 – Example of one of 20 cards (A4) of common tree species (*Terminalia prunioides*), from which game guards identified the Top 5 most and least preferred by elephants.



Figure 5.7 – Example of one of 20 cards (A4) of common tree species (*Dichrostachys cinerea*), from which game guards identified the Top 5 most and least preferred by elephants.

One of the topics in my consultation with the game guards was on their opinion and knowledge on the vegetation preferences of elephants in the Northern Highlands. The main part of this component of the consultation was to ask the game guards to review the 20 species and select the Top 5 species (in order) that in their opinion elephants most prefer, and the Top 5 species (in order) that elephants least prefer (Figures 5.8 and 5.9). I then asked the game guards whether the tree species that they selected are observed to be mainly in the mountains or valleys or both. The consultation also included specific discussion on the mopane tree species (*Colophospermum mopane*), which is abundant in the area.



Figure 5.8 – Field Officer (head game guard) identifying trees most and least preferred by elephants in Otjapitjapi, Ozondundu Conservancy (at the conservancy office), 21 December 2022.



Figure 5.9 – Game guard identifying trees most and least preferred by elephants in Okozonduno, Omatendeka Conservancy, 20 January 2023.

For this component of the Research Project, I combined the knowledge of game guards with my own observations on the ground. During my time in the field, as well as the interviews with 34 game guards, I also carried out 10 field walks for four to six hours with game guards to observe tree species and evidence of elephant movements in the mountains and valleys, including trees that had been eaten by elephants. I also carried out about 60 walks (about 1 hour each) for informal observations, almost daily. In discussion with game guards during field walks, it became easy to learn to identify trees that had been partially eaten by elephants. Generally, such trees tended to have stems larger than the size of tree or size of crown would imply, indicating that branches had been removed at one time (Figures 5.10 and 5.11). Sometimes the shape of the tree was unusual, with visible broken branches or implying branches had been removed in the past (Figure 5.12). In some cases branches had been removed and stripped of bark, with the remains left on the ground (Figure 5.13). In cases where damage was more recent, often I observed elephant dung and/or elephant footprints in the area. The main aspect to identify, where a tree appeared to have been damaged by elephants, was whether humans might have cut the tree at some stage, for example for firewood or to clear a vehicle track.

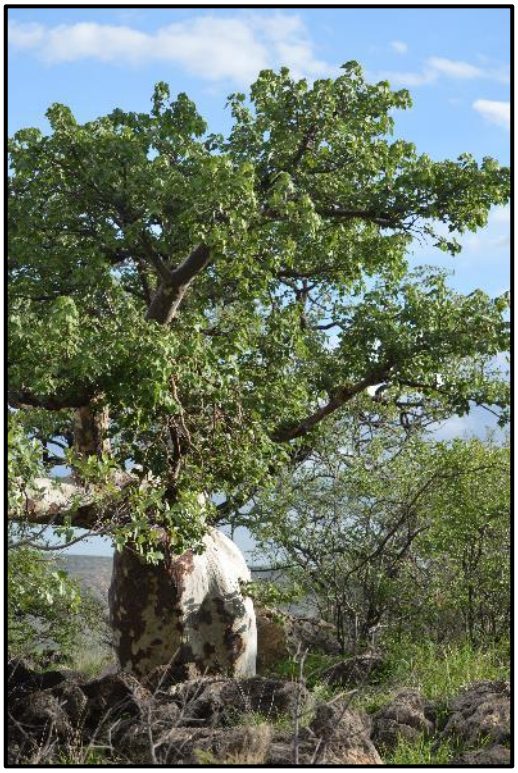


Figure 5.10 – This tree is likely to have been partially eaten by elephants several years ago because the trunk is much wider than expected for the size of the tree (African star chestnut (*Sterculia africana*), Okomutati, Ehi-Rovipuka Conservancy). Photograph taken 26 March 2021.



Figure 5.11 – The game guard indicates that some branches have been eaten by elephants and the tree would be expected to have a larger crown given the thickness of the stems (purple-stemmed corkwood (*Commiphora multijuga*), Orupupa Conservancy), 24 January 2023.

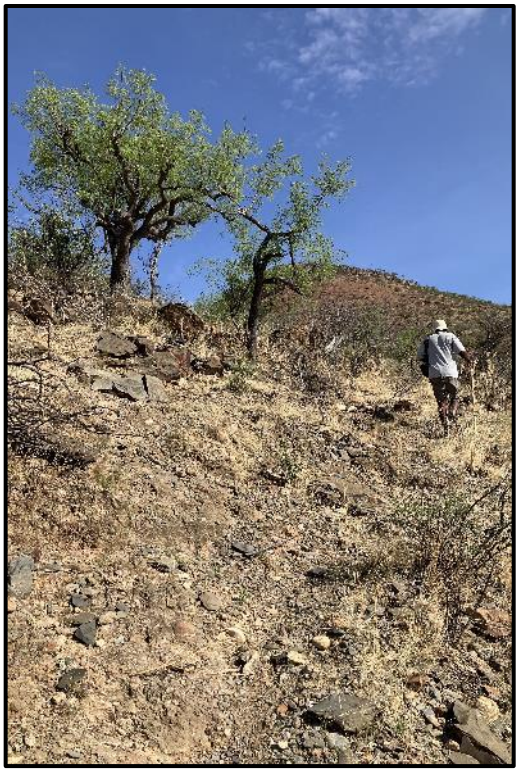


Figure 5.12 – Two purple-stemmed corkwood trees (*Commiphora multijuga*) on steep slopes had been partly eaten by elephants, as indicated by the broken branches (Omatendeka Conservancy), 26 January 2023.



Figure 5.13 – Example of mopane tree (*Colophospermum mopane*), often observed to be partly eaten by elephants, with indications of broken branches and stripped bark (Ehi-Rovipuka Conservancy), 14 December 2022.

The conservation laws in Namibia provide for individual species to be assigned protected status. Several of the species discussed in this study are protected (Box 5.2). For some of the tree species, their protected status is unexpected because of their abundance (based on my field observations). For example, *Colophospermum mopane* is highly abundant across much of northwest Namibia but included in the list of protected species because of the extent of use (GRN, 2015b). In practice, enforcement of protection of trees is very difficult in such a remote landscape.

Box 5.2 - Protected trees in northwest Namibia

Several tree species in Namibia have been assigned protected status in the Forest Regulations (No.170 of 2015) adopted under the Forest Act (No.12 of 2001), and some species are protected under the Nature Conservation Ordinance (No.4 of 1975), (RSA, 1975; GRN, 2001; GRN 2015b). The selection of species for protection is based on various factors, including endemism, restricted range, ecosystem services, economic value, extent of use, regeneration rate and population size (GRN, 2015b). In addition, all trees and shrubs are protected if within 100m of a watercourse (GRN, 2001). The species that have protected status in northwest Namibia and are discussed in this study are:

- Leadwood (*Combretum imberbe*)
- African star chestnut (*Sterculia africana*)
- Camel thorn (*Vachellia erioloba*)
- Mopane (*Colophospermum mopane*)
- Herero sesame bush (*Sesamothamnus guerichii*)
- Shepherd's tree (*Boscia albitrunca*)
- Buffalo thorn (*Ziziphus mucronata*)
- Ana tree (*Faidherbia albida*)

(GRN, 2001; GRN 2015b; Namibia Biodiversity Database, 2023)

Seven of the 20 trees included in the survey of game guards for this study have protected status in Namibia. 18 of the 20 trees included in the survey have been assessed under the IUCN Red List of Protected Species. All were assessed as Least Concern (IUCN, 2023). The two that have not been assessed are the Herero sesame bush (*Sesamothamnus guerichii*) and Kaoko ceraria (*Ceraria longipedunculata*).

5.4 Results and analysis

5.4.1 Local ecological knowledge on the influence of vegetation on elephant movements in the Northern Highlands

During the semi-structured interviews, I asked game guards an open question on the reasons for movements of elephants in the Northern Highlands. 16 of 34 game guards (47%) said the main reason for their movements was to find food, and 13 game guards (38%) answered that the reasons were both food and water. Additional reasons mentioned in discussion included movement to stay away from people, to go to vegetable gardens and to find sources of salt.

Studies have shown that elephants move after rains to find greener vegetation (Viljoen, 1989a; Leggett, 2006a; Harris *et al.*, 2008; Loarie *et al*., 2009a; Young *et al*., 2009; Garstang *et al.*, 2014; Purdon *et al*., 2018; Tsalyuk *et al*., 2019; Birkett *et al*., 2012). When I asked about movements at different times of the year, 31 of the 34 game guards (91%) said that one of the main reasons for the movement of elephants was to areas that have had rain and therefore have fresh vegetation. Game guards indicated that elephants had in the past been moving from Etosha to the Northern Highlands in the rainy season only, and now many elephants are more permanently in the Northern Highlands. Chapter 6 includes analysis and discussion on elephant movements in the Northern Highlands.

The common feedback from game guards was that elephants eat most types of vegetation when food sources are scarce (e.g. in the dry season or during drought years), as has been concluded from studies on elephant feeding activities (Owen-Smith and Chafota, 2012; Leggett, 2019). The game guards stated that, in the rainy season when much fresh vegetation is available, elephants much prefer some species of tree to others.

During the field work, I observed that the main locations of tree species depend on different factors, such as the landscape type, and locations of rivers and springs. For example, I observed mopane trees (*Colophospermum mopane*) to be dominant in the valleys and lower slopes, and particularly on the flat plains (Figures 5.14, 5.15), leadwood (*Combretum imberbe*) (Figure 5.16) and camel thorn (*Vachellia erioloba*) to be less abundant than some species and tend to be growing near the main river beds. The sycamore fig (*Ficus sycomorus*) also grows to a very large tree, and I observed it mostly only near springs (Figures 5.17). I observed the *Commiphora* species and the African star chestnut (*Sterculia africana*) only on the steep, rocky slopes (Figures 5.18, 5.19, 5.20), except for the tall common corkwood (*Commiphora glandulosa*), which also grows in the valleys (Figure 5.21). The Herero sesame bush (*Sesamothamnus guerichii*) is quite a distinct species that tends to grow in the more rolling hill landscapes, and sometimes in the flat valleys (Figure 5.22). The purple-pod terminalia (*Terminalia prunioides*) and sicklebush (*Dichrostachys cinerea*) are abundant in the area and I observed them to grow in the valleys and hills (Figure 5.23, 5.24). I observed the trumpet thorn (*Catophractes alexandri*) mainly in the valleys and not the hills (Figure 5.25). 31 of 34 game guards (91%) answered yes to the question: "*do elephants move to find specific tree species that they prefer?*" Also, 29 game guards (85%) said that elephants tend to spend more time in the mountains in the rainy season.



Figure 5.14 – Mopane trees (*Colophospermum mopane*) are dominant in the flat valleys in the Northern Highlands. The majority of trees in this valley, near Okavare, Omatendeka Conservancy, are mopane. Photograph taken 9 February 2023.



Figure 5.15 – Mopane trees (*Colophospermum mopane*) in the same valley as Figure 5.28. Mopane is also abundant in some areas of Etosha National Park. Photograph taken on 9 February 2023.



Figure 5.16 – Leadwood (*Combretum imberbe*) tends to grow on areas where the groundwater level is high (e.g. river beds). Communities use leadwood as an indicator for construction of a well, such as for these two leadwoods at Okomutati (note the hand pump), Ehi-Rovipuka Conservancy. Photograph taken 3 January 2023.

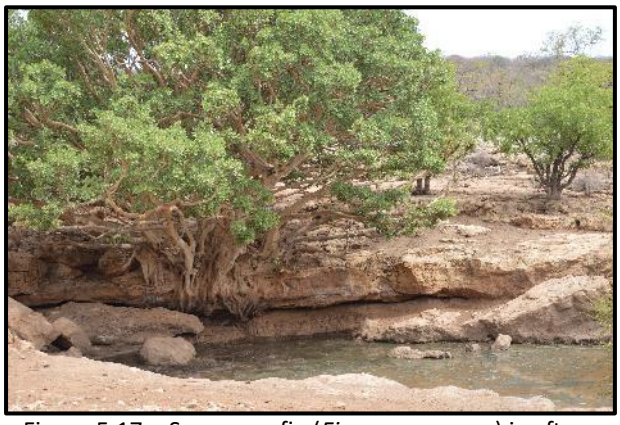


Figure 5.17 – Sycamore fig (*Ficus sycomorus*) is often observed near springs in the Northern Highlands; here at Otjitoko Spring, Otuzemba Conservancy. Photograph taken 13 January 2021.



Figure 5.18 – African star chestnut (*Sterculia africana*) tree up a steep slope above the valley above Okomutati, Ehi-Rovipuka Conservancy. Photograph taken 5 April 2021.



Figure 5.19 – Blue-leaved corkwood (*Commiphora glaucescens*) at top of steep slope, near the tree in Figure 5.18 near Okomutati, Ehi-Rovipuka Conservancy. Photograph taken 21 January 2023.



Figure 5.20 – Blue-leaved corkwood (*Commiphora glaucescens*) on rocky slopes, Ehi-Rovipuka Conservancy, Photograph taken 16 January 2021.



Figure 5.21 – Tall common corkwood (*Commiphora glandulosa*) grows on slopes and in flat valleys, unlike other *Commiphora* species in the Highlands, which only grow higher up mountains. This tree is in Orupupa Conservancy, near Okozongwehe. Photograph taken 13 February 2023.



Figure 5.22 – Herero sesame bush (*Sesamothamnus guerichii*) tends to grow on shallow slopes and rolling hills, as well as flat plains. This large individual is at Okomutati, Ehi-Rovipuka Conservancy. Photograph taken 16 January 2021.



Figure 5.23 – Purple-pod terminalia (*Terminalia prunioides*) in flower at Okomutati, Ehi-Rovipuka Conservancy. This species is abundant in parts of the Highlands and grows in valleys and mountains. Photograph taken 16 April 2019.



Figure 5.24 – Sicklebush (*Dichrostachys cinerea*), at Okomutati, Ehi-Rovipuka Conservancy, is considered an invasive species in Namibia (Le Roux and Müller, 2018). It is known also as the Kalahari Christmas tree, because the flowers are often out in December, and resemble lanterns. Photograph taken 13 January 2023.



Figure 5.25 – The common name of Trumpet thorn (*Catophractes alexandri*) is based on the shape of the flower. It is abundant in the valleys and plains in the Highlands, and in Etosha National Park. Photograph taken 20 March 2021.

One topic of discussion during the interviews was on elephant movements to mountains and specifically on the proportion of time spent in mountains and valleys. All 34 game guards said that elephants spend time in the mountains in the Northern Highlands. All game guards agreed or strongly agreed with statement: "*the main reason that elephants walk up steep slopes is to find their preferred vegetation*," with 21 game guards replying "strongly agree" (62%) and 13 replying "agree" (38%), (Figure 5.26). There are several potential factors influencing the movement of elephants up mountains in the Northern Highlands, discussed further in Chapter 6.

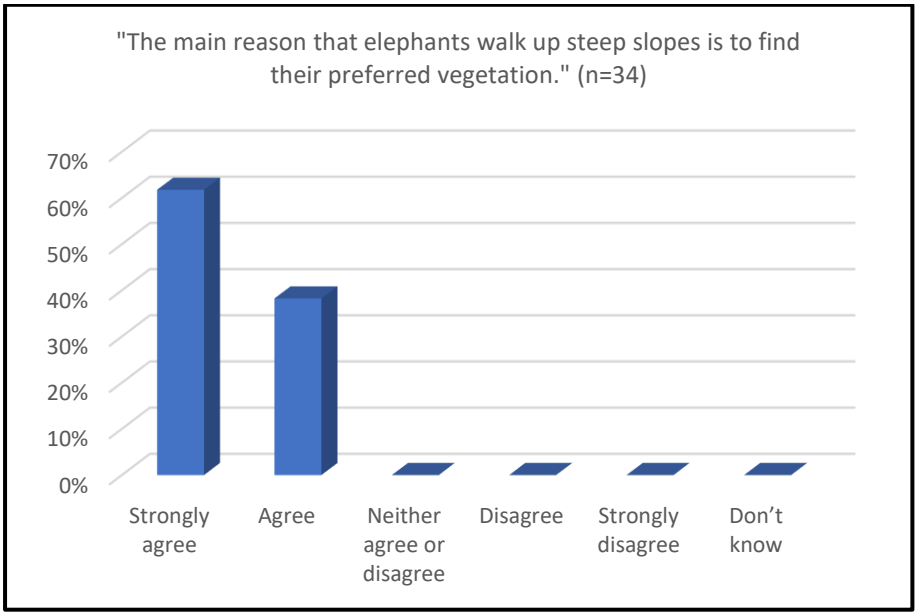


Figure 5.26 – Results from question to game guards on elephant movements to find vegetation in the mountains.

5.4.2 Local ecological knowledge on the preferred vegetation species of elephants in the Northern Highlands

(a) Elephant preferences for trees or grasses

Grasses have a short growing season in the Northern Highlands, depending on the rains. For some years there are minimal or no rains and therefore minimal fresh grass. When rainfall occurs, it is often very localised. Grasses grow quickly after several days of rains, but dry out fairly quickly after the rainy season (Figures 5.27 to 5.30). There are particular problems with over-grazing in the Northern Highlands, evident in areas that do not grow grasses even at times of good rain, particularly near the water points (Figure 5.30).



Figure 5.27 – Photograph taken on 29 January 2021, before the start of rains, next to D3710 road south of Omuramba, Omatendeka Conservancy.



Figure 5.28 – Photograph taken on 7 March 2022 in a location very close to the photograph in Figure 5.27, a couple of weeks after sustained rains. This was in a different year to Figure 5.27, but shows the contrast after rains in some areas.



Figure 5.29 – Photograph taken on 5 January 2023, near the location in Figures 5.27 and 5.28, showing the dry grasses from the previous growing season in 2022.



Figure 5.30 – Example of overgrazing at Omunuandjai water point, Okangundumba Conservancy. I drove past this water point many times, and stopped to make observations, but never observed grasses in this area near the water point after good rains. Photograph taken on 12 January 2021.

I questioned the game guards on their opinion on whether elephants prefer to eat trees or grasses, 33 of 34 game guards consulted in the Northern Highlands said elephants prefer trees. The other game guard said they eat both, and five game guards commented that elephants eat grasses after rains when the grass is green. Studies on feeding habits of African savanna elephants do conclude that they like to eat fresh grasses and leaves after rains (Haynes, 2012; Owen-Smith and Chafota, 2012; Henley, 2019; Tsalyuk *et al*., 2019; Marston *et al*., 2020). The reaction of many of the game guards in terms of their perception that elephants tend not to eat grasses demonstrates the need to consider the local factors and context behind the responses to questions. For the game guards, tree damage by elephants is very visible compared to evidence of consumption of grasses by elephants (grasses are also eaten by wildlife and livestock), and elephants would be eating grasses during the rainy season when they tend to spend more time away from the villages, so this behaviour is less likely to be observed.

(b) Approaches to present results on preferred trees

I asked the game guards to select their Top 5 trees species (in order) that are most preferred by elephants, and their Top 5 trees species (in order) that are least preferred by elephants. They did this from a set of A4 printed cards of 20 tree species abundant in the Northern Highlands area (Section 5.3). There are several ways to present the results for most preferred and least preferred:

- The number of times included in the Top 5 (Figures 5.31 and 5.32).
- The sum of the weighted scores for the Top 5 trees (No.1 = 5 points, No.2 = 4 points, etc) (Figures 5.33 and 5.34).
- The individual species that was named No.1 (Figure 5.35).

The results in the charts when weighted (Figures 5.33, 5.34) are similar to the results when the Top 5 are not weighted (Figure 5.31, 5.32). The weighted score provides a more comprehensive indication of local knowledge. I concluded that the clearest presentation of results is to combine the most preferred and least preferred on the same chart and present the results as the mean score given by game guards (Figure 5.36).

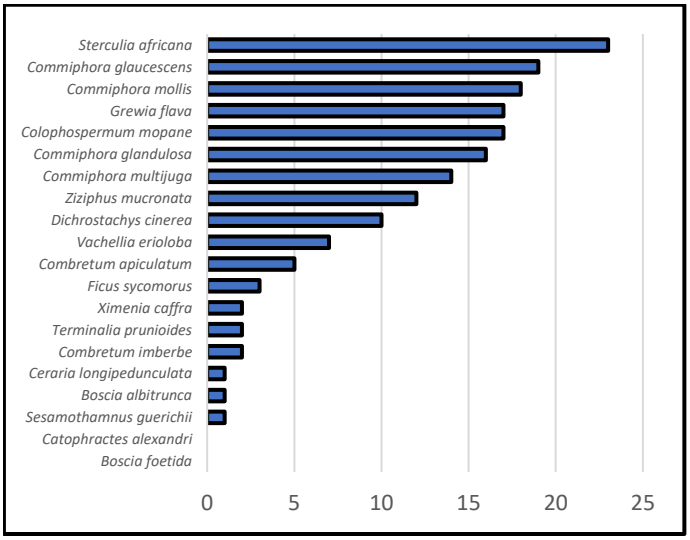


Figure 5.31 – Number of times species were included in Top 5 trees most preferred by elephants, as perceived by game guards (n=34), (unweighted)

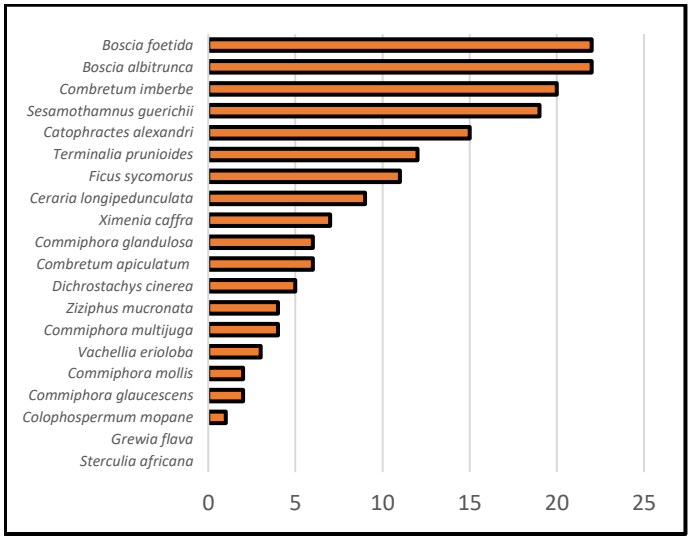


Figure 5.32 – Number of times species were included in Top 5 trees least preferred by elephants, as perceived by game guards (n=34), (unweighted).

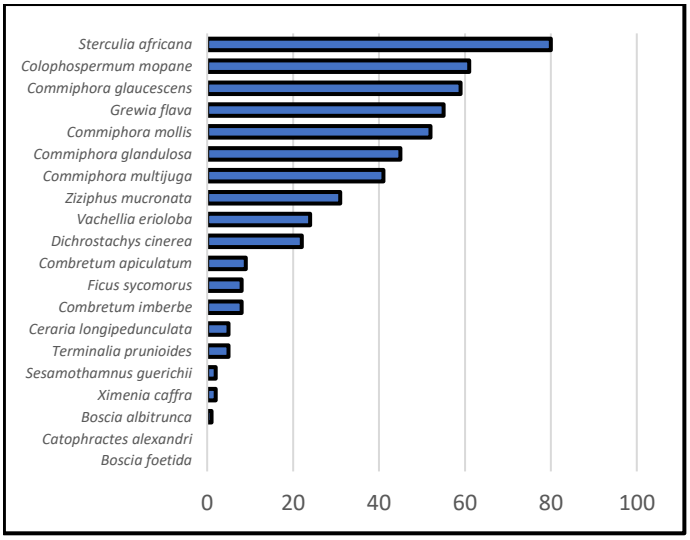


Figure 5.33 – Number of times species were included in Top 5 trees most preferred by elephants, as perceived by game guards (n=34), (sum of the weighted scores).

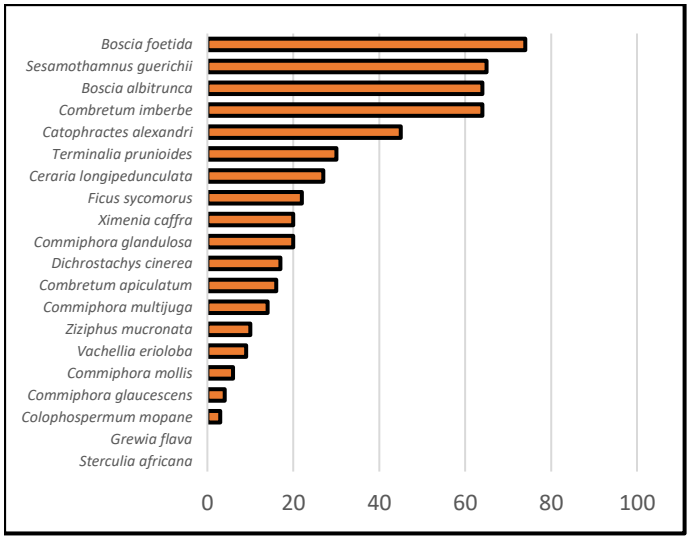


Figure 5.34 – Number of times species were included in Top 5 trees least preferred by elephants, as perceived by game guards (n=34), (sum of the weighted scores).

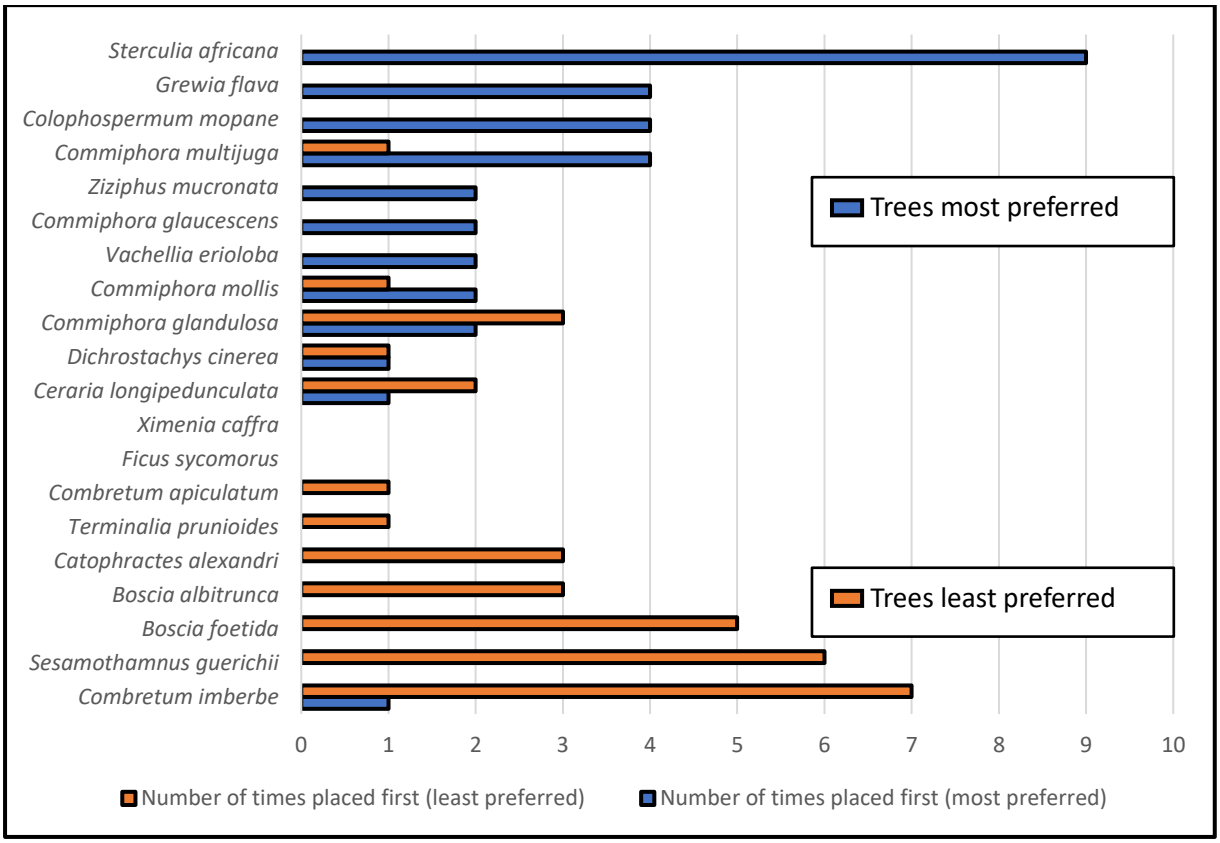


Figure 5.35 – Number of times tree species was named as No.1 most preferred and least preferred by elephants, as perceived by game guards (n=34).

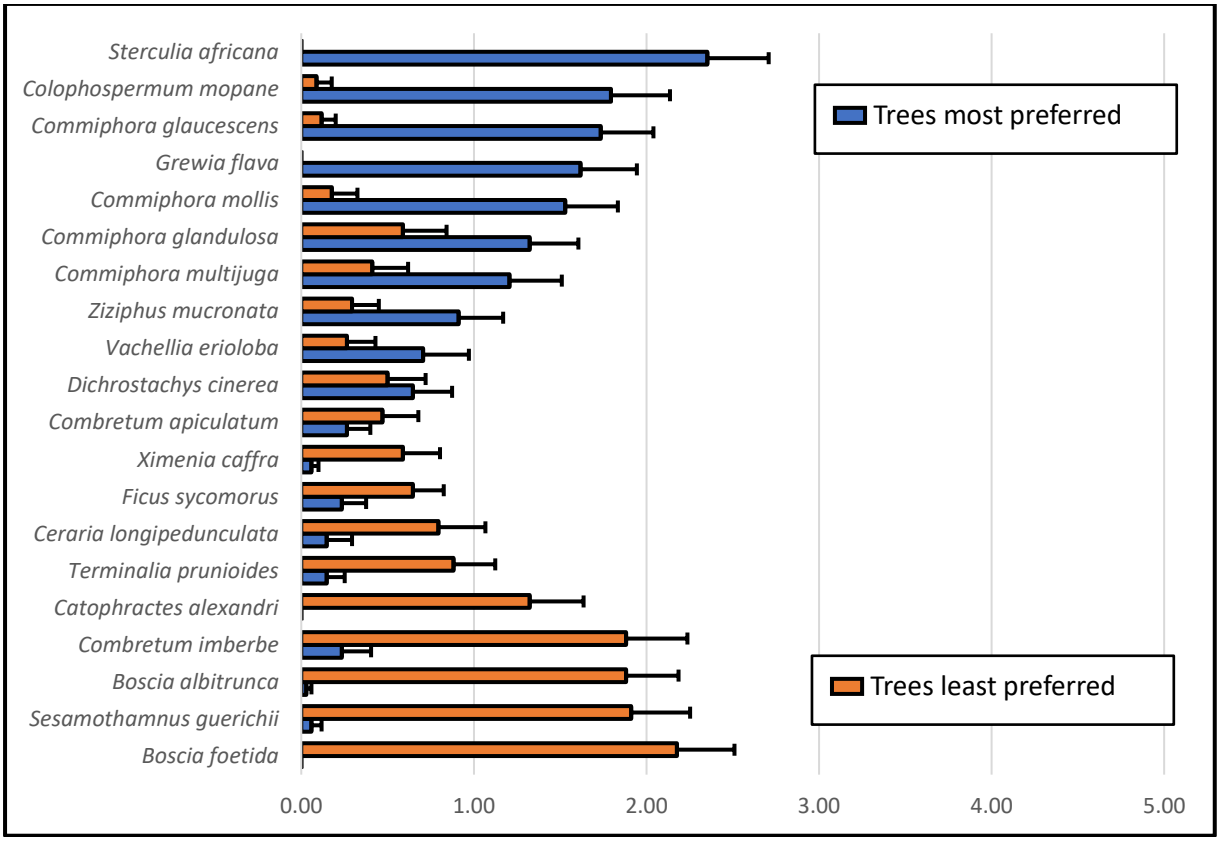


Figure 5.36 – Mean score (+1 Standard Error bars) for top 5 most preferred and top 5 least preferred trees, as identified by game guards (n=34); (most preferred=5 points, second most preferred 4 points, etc).

(c) Perception of game guards on the most preferred and least preferred trees species by elephants

The results in Figure 5.36, and the other charts above, indicate clear selection by game guards in terms of their perception of tree species most and least preferred by elephants. The results indicate that there are some species much more preferred by elephants (e.g. African star chestnut (*Sterculia africana*), *Commiphora* species, mopane (*Colophospermum mopane*) and velvet raisin bush (*Grewia flava*)). The results also indicate that some species are much less preferred (e.g. smelly shepherd's bush (*Boscia foetida*), shepherd's tree (*Boscia albitrunca*), Herero sesame bush (*Sesamothamnus guerichii*) and leadwood (*Combretum imberbe*)). The standard error bars show consistent variation in opinion of game guards on elephant browsing preferences.

It is useful to compare these core results on opinions from game guards with my observations on the ground. In many cases, I observed *Sterculia africana*, *Commiphora glaucescens, Commiphora multijuga and Colophospermum mopane* to have been partly browsed by elephants (Figures 5.37, 5.38 and 5.39). I found it more difficult to identify whether *Grewia flava* (and the several other *Grewia* species in the area) had been eaten by elephants or other wildlife /livestock, or cut and used by humans (Figure 5.40). The *Grewia* species tend to be shrubs or smaller trees, whereas *Sterculia africana* and *Commiphora* species tend to grow to larger trees. A partly eaten *Grewia* species is not necessarily because of elephants. I observed no cases where *Boscia foetida*, *Boscia albitrunca, Sesamothamnus guerichii* or leadwood *Combretum imberbe* had been eaten by elephants. My findings from field observations verify the results of local ecological knowledge on tree species most and least preferred by elephants. More discussion on elephant preferences for individual tree species is provided in Section 5.4.4.



Figure 5.37 – Blue-leaved corkwood (*Commiphora glaucescens*), eaten by elephants, in the mountains above Okomutati, Ehi-Rovipuka Conservancy, 15 January 2021. This was one of the few cases where I observed most of a *Commiphora* tree to have been eaten/broken. In most other cases, a smaller part of the tree had been eaten.



Figure 5.38 – Purple-stemmed corkwood (*Commiphora multijuga*), partly eaten by elephants, on a steep slope above Orupara Spring, Omatendeka Conservancy, 26 January 2023.



Figure 5.39 – Mopane (*Colophospermum mopane*), broken by elephants, in the valley near, Okatjovazandu, Ehi-Rovipuka Conservancy. Photograph taken 7 April 2021.



Figure 5.40 – Velvet raisin bush *(Grewia flava*) and other *Grewia* species are eaten by elephants, and also used by local people (e.g. to make traditional walking sticks), Okomutati, Ehi-Rovipuka Conservancy, 24 March 2021.

There were two other species, not included in the 20 short-list for the method, that were noted by game guards when I asked them about other species that elephants prefer. One is the blackthorn (*Acacia mellifera* (subsp. *detinens*)), a species that is abundant across much of Namibia, particularly the highlands of central Namibia (Figure 5.41), but less so in the Northern Highlands, and is browsed by wildlife including elephants (NBRI, 2005f). In addition, a few game guards mentioned the elephant preferences for ana trees (*Faidherbia albida*), although these large trees are mainly growing in the large rivers just to the south and west of the Highlands (the Ombonde River and Hoanib River (Figure 5.42)). The desert-adapted elephants are known to prefer this species and migrate long distances for the seed pods of the ana trees (Viljoen and Bothma, 1990; BBC, 2008; Leggett, 2006a; MEFT, 2021; Desert Elephant Conservation, 2023), and I observed them eating the pods in April 2021 (Figures 5.43 and 5.44).



Figure 5.41 – Blackthorn (*Acacia mellifera* (subsp. *detinens*) is considered a preferred species of elephants but is less common in the Highlands than elsewhere in Namibia (this photograph was taken outside Windhoek, in central Namibia, 1 January 2021).



Figure 5.42 – Ana trees (*Faidherbia albida*) in the lower Hoanib, west of the Northern Highlands, providing shade for the desert-adapted elephants. Photograph taken 11 April 2021.



Figure 5.43 – Pod of ana tree (*Faidherbia albida*), lower Hoanib, 12 April 2021.



Figure 5.44 – It has been concluded from studies that elephants will walk long distances to find the pods of ana trees at certain times of the year (*Faidherbia albida*), observed in the lower Hoanib, 12 April 2021.

5.4.3 Local ecological knowledge on location in mountains or valleys of tree species most preferred and least preferred by elephants

After the selection by game guards of the Top 5 tree species that they perceived that elephants most prefer and the Top 5 that elephants least prefer, I asked the game guards whether the tree species that they selected are observed to be mainly up the mountains or in the valleys or both. Tables 5.1 and 5.2 provide the list of the ten trees that were included the most times in the Top 5 most and least preferred respectively, for example the African star chestnut (*Sterculia africana*) was named in the Top 5 most preferred by elephants by 23 of 34 game guards. The tables also show the perceptions of game guards in terms of whether those trees are located in the mountains, valleys or both mountains and valleys. For example, all 23 game guards that included *Sterculia africana* in the Top 5 most preferred stated that these trees are located only in the mountains. These results on trees located in mountains are illustrated in Figures 5.45 and 5.46. These figures are presented as percentage of game guards who listed the trees in their Top 5 most preferred and least preferred, respectively, and who said the trees are in the mountains.

Figure 5.45 shows that several tree species perceived by game guards as the most preferred by elephants are located at higher elevations in the mountains (e.g. African star chestnut (*Sterculia africana*), blue-leaved corkwood (*Commiphora glaucescens*), purple-stemmed corkwood (*Commiphora multijuga*), and velvet corkwood (*Commiphora mollis*). The mopane trees (*Colophospermum mopane*) are very abundant in the valleys, and are often eaten by elephants, again according to game guards. These perceptions were confirmed by observations during surveys on foot during this Research Project.

Figure 5.46 shows that many of the trees least preferred by elephants, according to game guards, are not located up the mountains. These were observed mainly in the valleys or on the more shallow slopes on the lower sides of the valleys. These include the leadwood (*Combretum imberbe*), which was observed almost always only on the edge of the main river lines, trumpet thorn (*Catophractes alexandri*), smelly shepherd's bush (*Boscia foetida*), shepherd's tree (*Boscia albitrunca*) and the Herero sesame bush (*Sesamothamnus guerichii*).

Figure 5.47 provides a typical example of the variation in vegetation of the Northern Highlands landscape, in line with the results in Figures 5.45 and 5.46, in which the trumpet thorn (*Catophractes alexandri*) is abundant in the valleys, and mopane trees (*Colophospermum mopane*) are abundant in the valleys and lower slopes, and the species associated with steeper slopes are on the top part of the hill and the rocky outcrops (e.g. African star chestnut (*Sterculia africana*), blue-leaved corkwood (*Commiphora glaucescens*), purple-stemmed corkwood (*Commiphora multijuga*)).

The findings from my observations on the ground during field walks again verify the results of local ecological knowledge on typical locations of the tree species most and least preferred by elephants. In particular, I observed the African star chestnut (*Sterculia africana*) and *Commiphora* species most often to be partly eaten by elephants and located on mountain slopes (Figures 5.48 and 5.49). One of my overall conclusions from the consultations and field observations is the confidence in the local ecological knowledge.

Table 5.1 – Perception of game guards (n=34) of location in mountains or valleys of the ten trees that were listed in the Top 5 for the most preferred

	No. times species named No.1 **most preferred**	No. times species named in top 5 **most preferred**	% of game guards who listed the species in top 5 **most preferred** who said the tree is present in: mountains only/valleys only/both mountains and valleys
African Star Chestnut (*Sterculia africana*)	9	23	100 / 0 / 0
Blue-leaved Corkwood (*Commiphora glaucescens*)	2	19	100 / 0 / 0
Velvet Corkwood (*Commiphora mollis*)	2	18	83 / 6 / 11
Velvet Raisin Bush (*Grewia flava*)	4	17	6 / 41 / 53
Mopane (*Colophospermum mopane*)	4	17	0 / 12 / 88
Tall Common Corkwood (*Commiphora glandulosa*)	2	16	38 / 12 / 50
Purple-stemmed corkwood (*Commiphora multijuga*)	4	14	100 / 0 / 0
Buffalo Thorn (*Ziziphus mucronata*)	2	12	0 / 75 / 25
Sicklebush (*Dichrostachys cinerea*)	1	10	0 / 40 / 60
Camel thorn (*Vachellia erioloba*)	2	7	0 / 71 / 29

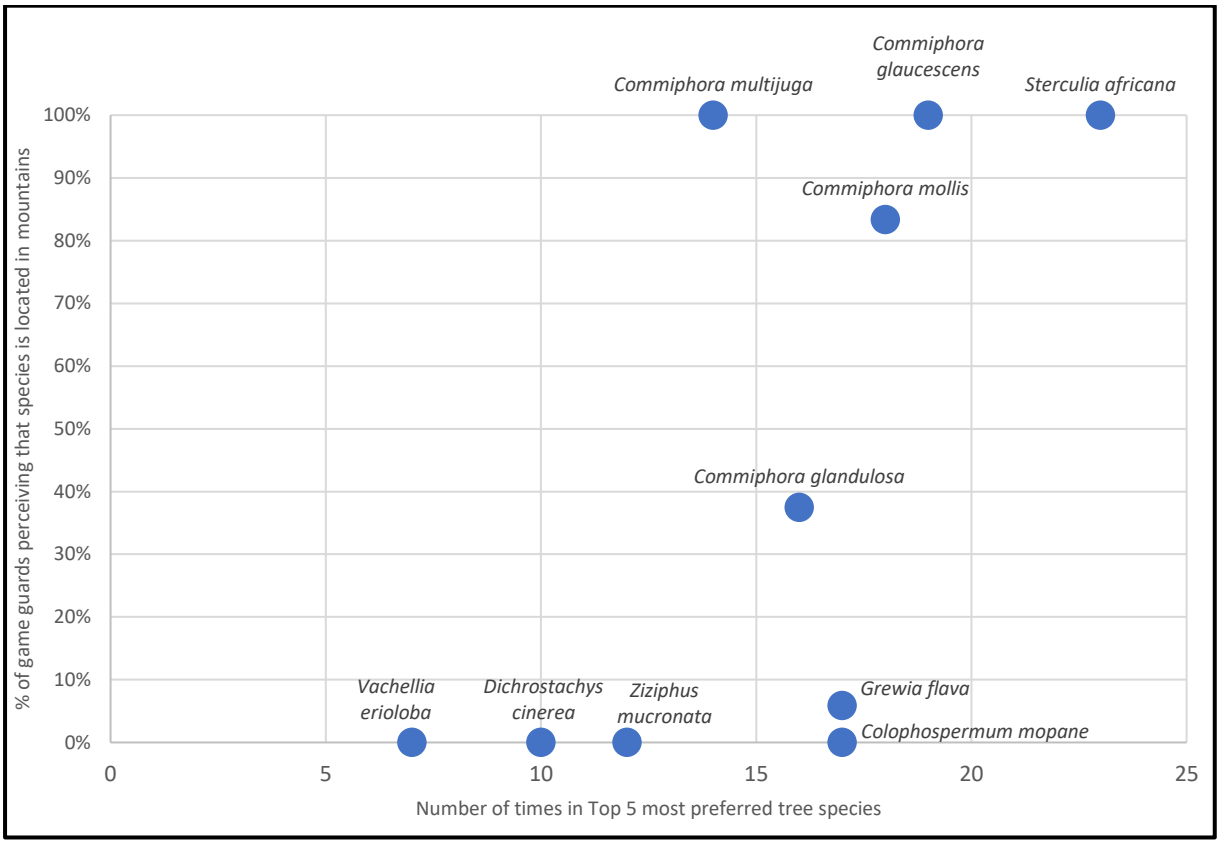


Figure 5.45 - Perception of game guards (n=34) on whether tree species most preferred by elephants are located in mountains

Table 5.2 – Perception of game guards (n=34) of location in mountains or valleys of the ten trees that were listed in the Top 5 for the least preferred

	No. times species named No.1 **least preferred**	No. times species named in top 5 **least preferred**	% of game guards who listed the species in top 5 **least preferred** who said the tree is present in: mountains only/valleys only/both mountains and valleys
Smelly Shepherd's Bush (*Boscia foetida*)	5	22	14 / 32 / 54
Shepherd's Tree (*Boscia albitrunca*)	3	22	9 / 23 / 68
Leadwood (*Combretum imberbe*)	7	20	0 / 80 / 20
Herero Sesame Bush (*Sesamothamnus guerichii*)	6	19	15 / 5 / 79
Trumpet Thorn (*Catophractes alexandri*)	3	15	0 / 40 / 60
Purple-pod Terminalia (*Terminalia prunioides*)	1	12	25 / 8 / 67
Sycamore Fig (*Ficus sycomorus*)	0	11	36 / 45 / 18
Kaoko Ceraria (*Ceraria longipedunculata*)	2	9	100 / 0 / 0
Large sour plum (*Ximenia caffra*)	0	7	29 / 43 / 29
Tall Common Corkwood (*Commiphora glandulosa*)	3	6	50 / 0 / 50

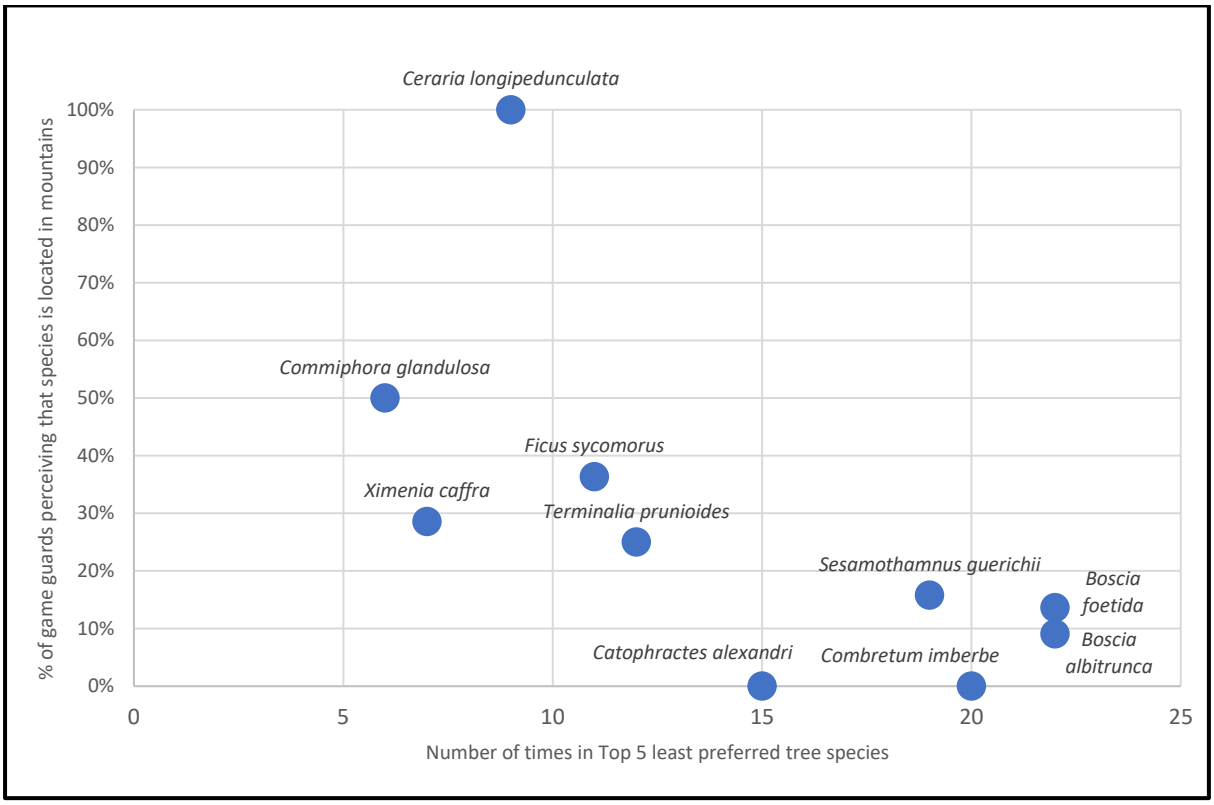


Figure 5.46 - Perception of game guards (n=34) on whether tree species least preferred by elephants are located in mountains



Figure 5.47 – Example of the changes in landscape and vegetation, Okomuhana, Ozondundu Conservancy, 8 February 2023. In the foreground are thick areas of Trumpet thorn (*Catophractes alexandri*), which is not preferred by elephants, according to game guards. On the lower slopes in this example, the vegetation is dominated by Mopane (*Colophospermum mopane*), which is sometimes eaten by elephants (e.g. early in the leaf season, or the bark in the dry season). On the steep slopes at the top of the hill and across the rocky outcrop are the species most preferred by elephants, according to game guards, such as African star chestnut (*Sterculia africana*) and the *Commiphora* species.



Figure 5.48 – African star chestnut (*Sterculia africana*), eaten by elephants, in the mountains above Omutirapo, Omatendeka Conservancy. Photograph taken 26 January 2023.



Figure 5.49 – Elephant eating African star chestnut (*Sterculia africana*), southeast of Otjomatemba, Ozondundu Conservancy. Photograph taken 25 January 2023.

5.4.4 Analysis of results on elephant preferences and behaviour for specific tree species

The common findings discussed in Sections 5.4.2 and 5.4.3 above provide confidence that elephants in the Northern Highlands prefer specific tree species that are associated with mountain slopes, such as *Sterculia africana* and several *Commiphora* species. This section provides more detailed analysis and discussion for specific species of tree, including points on the ability of game guards to identify tree species.

(a) African star chestnut (*Sterculia africana*)

Given the feedback that elephants have a preference for the African star chestnut tree (*Sterculia africana*), and my many observations in the field of these trees having been partially eaten by elephants, this species features in much of the analysis in this chapter. It is therefore important to note the distinguishing features of this species, which is easy to identify. My observations from the field included that it tends to be growing in single trees, rather than clusters, it is thick-stemmed and often prominent on the mountain slopes, being taller than most trees on the slopes (Figure 5.50). It often has purple/brown bark (Figure 5.51), but not always as some were noted with much paler bark. It has heart-shaped leaves (up to 10cm long) and star-shaped fruit (Figures 5.52 and 5.53). According to the information from the Tree Atlas Project (NBRI, 2005b; Le Roux and Müller, 2018), the species is present on rocky slopes, rocky outcrops and hill tops, rarely on sandy planes, and I observed this to be the case during field walks.



Figure 5.50 – Example of African star chestnut (*Sterculia africana*) being prominent on a mountain slope, above Okomutati, Ehi-Rovipuka Conservancy, 15 January 2021.



Figure 5.51 – African star chestnut (*Sterculia africana*) grow thick stems and usually have purple/brown bark, 15 January 2021.



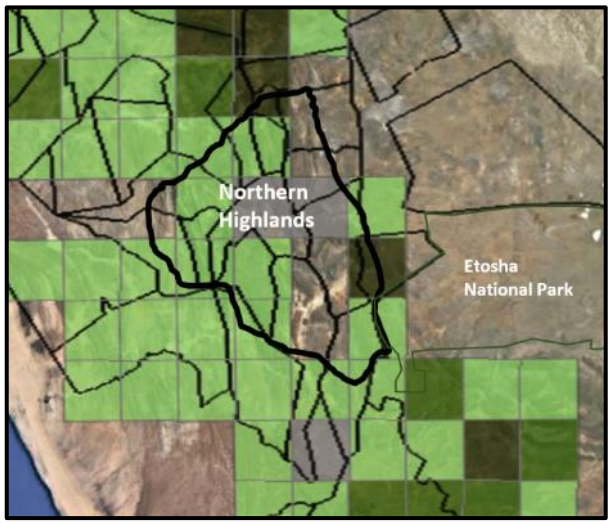
Figure 5.52 – Heart-shaped leaves of the African star chestnut (*Sterculia africana*), 20 March 2021.



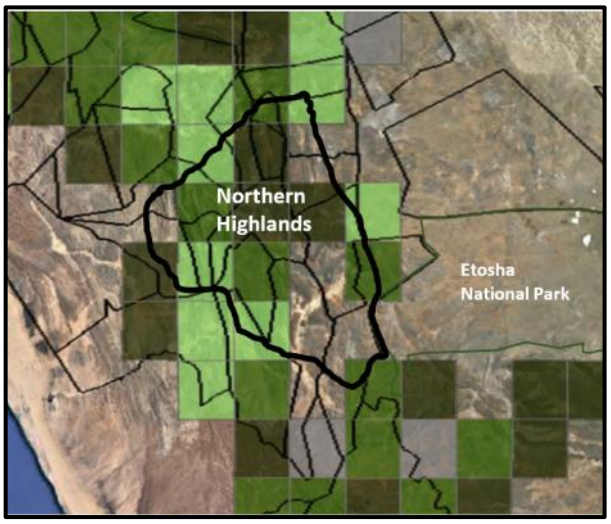
Figure 5.53 – Star-shaped fruit of the African star chestnut (*Sterculia africana*), 16 January 2021.

Based on my observations, *Sterculia africana* has slightly lower abundance than the four main *Commiphora* species in the Northern Highlands, which also grow on the slopes. It has very low abundance relative to mopane trees (*Colophospermum mopane*), which grow mainly in the valleys. The Tree Atlas Project has published distribution maps for tree species in Namibia (NBRI, 2005a), (Figure 5.54). These show *Sterculia africana* to be present in semi-desert areas of northwest and central west Namibia. It is present in much, but not all, of the Northern Highlands, and not common in Etosha National Park (Figure 5.54a).

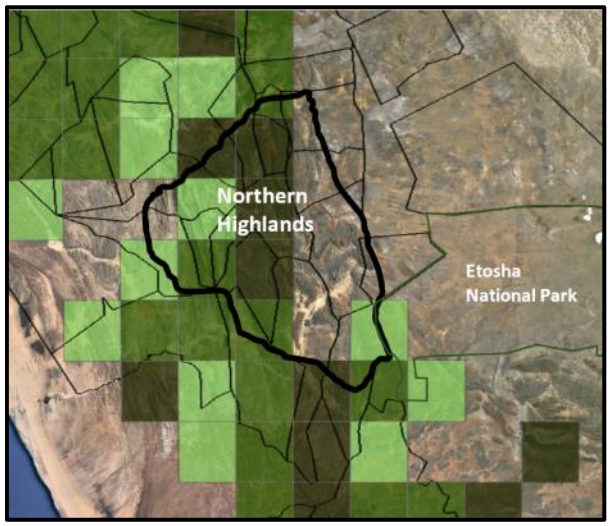
According to the game guards consulted, the African star chestnut (*Sterculia africana*) is the tree species most preferred by elephants in the Northern Highlands. 23 of 34 game guards (68%) included *Sterculia africana* in the Top 5 most preferred, and nine of the 23 game guards put this species as No.1 most preferred by elephants (Figure 5.35). On a weighted scale, it also came out as the most preferred species (Figure 5.36).



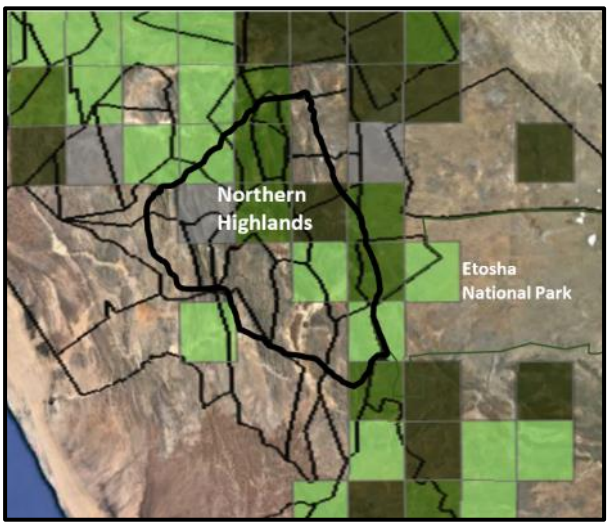
(a) African star chestnut (*Sterculia africana*)



(b) Blue-leaved corkwood (*Commiphora glaucescens*)



(c) Purple-stemmed corkwood (*Commiphora multijuga*)



(d) Tall common corkwood (*Commiphora glandulosa*)

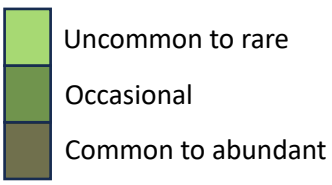


Figure 5.54 - Tree species distribution maps for selected species in 27.5km squares in the Northern Highlands and surrounding area, which I produced using from data as published under the Tree Atlas Project (NBRI, 2005a) and using Google Earth.

(b) Potential elephant behaviour of coppicing trees

There have been several studies on the effects of African savanna elephants (*Loxodonta africana*) on vegetation and habitats (Kohi *et al*., 2011; O'Connor, 2017; Thornley *et al*., 2020). The foundation for some such studies tends to be the concerns that elephants might have a negative impact on tree mortality and habitats, and there have been past policies in Namibia and South Africa to cull elephants to reduce loss of savanna vegetation (Douglas-Hamilton, 1987; O'Connor *et al*., 2007; Owen-Smith, 2010; MEFT, 2021). Elephants have also been described as the "ecosystem engineers of African savanna" (Coverdale *et al*., 2016), with some studies discussing the positive impacts of elephants such as seed dispersal, clearance of pathways and of areas for new vegetation growth (Campoz-Arceiz and Blake 2011; Kohi *et al*., 2011), although such focus is particularly on the Africa forest elephant (*Loxodonta cyclotis*), (Thompson, 2019). The studies on the effects of elephants on the African savanna habitats tend to assume that elephants are coppicing selected trees, without any discussion on whether they are deliberately coppicing to leave a food source for the future (Pretorius *et al*., 2011; Valeix *et al.*, 2011; Teren *et al.*, 2018).

During my field walks in the mountains it was the African star chestnut trees (*Sterculia africana*), and the Purple-stemmed corkwood trees (*Commiphora multijuga*) (in the west of the study area), which I observed more frequently to have been partially eaten by elephants; (I also observed many times *Colophospermum mopane* as partly eaten by elephants, but mainly in valleys). It was particularly my observations of partially eaten African star chestnut trees (*Sterculia africana*) that prompted the inclusion in the consultations with game guards of a discussion point on potential deliberate coppicing. Only once did I observe a *Sterculia africana* to have been damaged to the point where the tree appeared dead. All other times the tree had been partly eaten, sometimes down to near ground level (Figure 5.48 and Figure 5.55).

It is interesting to consider whether elephants might be deliberately keeping trees alive as a future food source by only eating part of the tree, a form of coppicing. On the Likert scale, I asked game guards to consider the statement: "*elephants deliberately do not kill trees but instead ensure part of the tree continues to live and grow to provide a future food source.*" There were mixed responses (Figure 5.56) with a skew more towards agreement. 17 of 34 game guards (50%) either agreed or strongly agreed, eight game guards (24%) disagreed, but none strongly disagreed. Nine game guards (26%) neither agreed or disagreed.



Figure 5.55 – One of many African star chestnut trees (*Sterculia africana*) that I observed in the study area to have likely been partially eaten by elephants, west of Okomutati, Ehi-Rovipuka Conservancy, 26 March 2021.

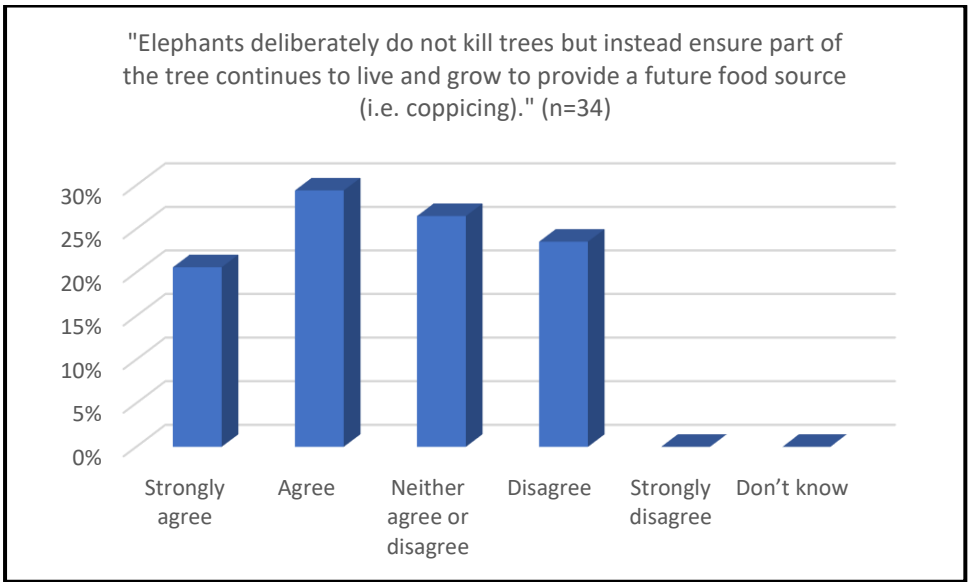


Figure 5.56 – Results from question to game guards on potential coppicing of tree species by elephants

This topic of potential coppicing behaviour by elephants prompted much discussion after I asked the question, particularly with those game guards who neither agreed or disagreed. Game guards do observe trees pushed over by elephants, and such cases often, but not always, result in the death of the tree (and therefore no ongoing future food source for elephants in the longer-term). During the field work, the species of tree that was observed to have been pushed over the most by elephants was mopane (*Colophospermum mopane*) (Figure 5.57). However, most mopane trees that were observed to be pushed over were near villages and water points, where, according to game guards, elephants are more likely to be stressed because of human interactions, and therefore more likely to push over trees. In addition, locations near villages and water points are more likely to be observed by game guards and other people, which might skew the perception that elephants kill trees. Elephants are known to push over trees on occasions to help the younger elephants to eat the leaves (Haynes, 2012), and sometimes push over trees with no attempt to feed (Nkosi *et al*., 2021), potentially to show their strength. A study in South Africa by Smallie and O'Connor (2000) concluded that elephants do coppice *C. mopane* trees, and that this behaviour maintains the availability of the food source, without discussion in that paper on whether this behaviour is deliberate. Some local people take measures to protect trees and maintain shade near their houses (Figure 5.58).



Figure 5.57 – Mopane (*Colophospermum mopane*) pushed over in the village of Otjitoko, Otuzemba Conservancy, 4 January 2023.



Figure 5.58 – Local people use rocks on the ground to protect trees near houses, such as for this Mopane tree (*Colophospermum mopane*), Ehi-Rovipuka Conservancy, 28 January 2023.

Game guards also stated that mopane trees (*Colophospermum mopane*) are often pushed over by elephants so that they can reach the *Tapinanthus oleifolius* (Lighting match mistletoe), which is an epiphytic plant that has high sugar (nectar) levels and one of the few plants to flower in the dry season (SANBI, 2005; Kew Gardens, 2023), (Figures 5.59, 5.60). I had not specifically asked game guards about this plant, but when discussing elephants potentially eating mopane trees, 15 of 34 mentioned it, so it is a well-known factor locally. Six game guards said that elephants will push trees over to get the mistletoe plant. The other species that I observed several times to have been pushed over was the tall common corkwood (*Commiphora glandulosa*), (Figure 5.61). Game guards indicated that elephants and people like to eat the roots of this tree, which contain sweet sap (NBRI, 2005e). During the field work, one or more single bull elephants returned two times to eat part of the large sour plum tree (*Ximenia caffra*) at Okomutati camp site, without killing the tree (Figure 5.62).

My findings are that the theory that elephants are potentially coppicing trees to keep them alive as a future food source is credible, but inconclusive. The opinion of game guards is skewed towards agreement with this concept, and my observations of trees killed by elephants can often be explained by other reasons. However, game guards noted that many of these trees species are resilient in the challenging environment of the northwest Namibia.



Figure 5.59 – *Tapinanthus oleifolius* (Lighting match, mistletoe) in a Mopane tree at Otuzemba village, 7 December 2022.



Figure 5.60 – *Tapinanthus oleifolius* (Lighting match, mistletoe), Windhoek, 15 December 2020.



Figure 5.61 – Tall common corkwood (*Commiphora glandulosa*) pushed over, near Otjondeka, Orupupa Conservancy, 12 December 2022. According to game guards, elephants like to eat the roots of this species.



Figure 5.62 – Large sour plum (*Ximenia caffra*), often visited by elephants at Okomutati camp, Ehi-Rovipuka Conservancy, 5 December 2022. Note the stem of the tree is thicker than would be expected, given the overall size. The branchlets and leaves regrow quickly in the rainy season.

(c) *Commiphora* species

The four trees from the *Commiphora* genus in the short-list of 20 were all identified by game guards as being eaten by elephants. These trees are in the *Burseraceae* (myrrh) family and have aromatic resin, sometimes used to make perfumes (Le Roux and Müller, 2018). The trees have soft wood, used locally to carve items such as bowls and utensils. Desert-adapted elephants have been observed to walk large distances to find *Commiphora* trees (Desert Elephant Conservation, 2023), and documentaries on the desert-adapted elephants have also indicated that elephants like to eat the *Commiphora* trees because of the sugar sap (BBC, 2008; Sky Nature 2020).

According to the identification book, *Trees and Shrubs of Namibia*, there are 19 species of *Commiphora* in northwest Namibia (Le Roux and Müller, 2018). The main four that I identified and observed in the Northern Highlands during the field work are the blue-leaved corkwood (*Commiphora glaucescens*), tall common corkwood (*Commiphora glandulosa*), velvet corkwood (*Commiphora mollis*), and purple-stemmed corkwood (*Commiphora multijuga*), all included in the short-list of 20 tree species discussed with game guards (I identified five other *Commiphora* species during the study, but they were much less abundant in the Highlands). It was important during the Research Project to learn to identify the four *Commiphora* trees and to assess the ability of game guards to identify them.

The *Commiphora glaucescens* is easy to identify because of its golden brown bark (Figure 5.63), and *Commiphora glandulosa* has grey-green peeling bark with spines (Figure 5.64), and is also quite easy to identify. All four of these *Commiphora* species are present mainly on the mountain slopes but *Commiphora glandulosa* also on the valley plains, including to the east of the Highlands (Figure 5.21). This is consistent with the opinion of game guards, half of which described *Commiphora glandulosa* as being present in the mountains and valleys, whereas they described the other three *Commiphora* species as mainly being in the mountains (Table 5.1, Figure 5.45).



Figure 5.63 – *Commiphora glaucescens* with golden bark as a distinct identification feature, 15 January 2021.



Figure 5.64 – *Commiphora glandulosa* with grey-green, peeling bark, 3 January 2023.

Commiphora mollis and *Commiphora multijuga* are quite similar and therefore harder to identify, although the purple bark of the *Commiphora multijuga* helps identification (the bark of *Commiphora mollis* varies in colour and can be purple-brown). Both have compound leaves, with the leaflets of the *Commiphora multijuga* being more elongated / pointed, having a longer petiole, and its leaves often drooping (Le Roux and Müller, 2018), (Figures 5.65 to 5.68).



Figure 5.65 – Velvet corkwood (*Commiphora mollis*) with brown bark, Okomutati, Ehi-Rovipuka Conservancy, 26 March 2021.



Figure 5.66 – Velvet corkwood (*Commiphora mollis*) leaflets are more rounded with short petiole, Okomutati, Ehi-Rovipuka Conservancy, 26 March 2021.



Figure 5.67 – Purple-stemmed corkwood (*Commiphora multijuga*), with distinctive purple bark, although this individual tree is unusual because most trees of this species are single-stemmed, Otjisakamuka, Omatendeka Conservancy, 8 March 2022.



Figure 5.68 – Leaves of the Purple-stemmed corkwood (*Commiphora multijuga*) tend to be drooping, with longer petiole and pointed apex to the leaflets, Otjisakamuka, Omatendeka Conservancy, 8 March 2022.

Based on the time in the field with game guards during the Research Project (including on field walks), I have high confidence in their ability to identify *Commiphora* species and other trees. The *Commiphora* species in particular have different local uses, including medicinal, (Le Roux and Müller, 2018), and generally I noted that there is good knowledge of tree species by the local community, potentially because of the local uses. 10 of the 34 game guards (29%) named one of the four *Commiphora* species as being most preferred by elephants, but five of 34 game guards named one of these species as least preferred, indicating some uncertainty (Figure 5.35). *Commiphora glaucescens* was named the most times out of the four *Commiphora* species in their Top 5 trees preferred by elephants (19 of

34 game guards (55%), (Figure 5.31)), but *Commiphora multijuga* was named most times as No.1 most preferred (4 of 34 game guards (11%), (Figure 5.35)).

14 of 34 game guards (41%) listed the Purple-stemmed corkwood (*Commiphora multijuga*) in the Top 5 trees most preferred by elephants (Figure 5.31). All said that this species only occurs in mountains (Table 5.1). 12 of those 14 game guards are located in the more mountainous conservancies of Ozondundu and the northern part of Omatendeka (Figure 1.16). I observed this species to be abundant in the mountainous areas of the western part of the Northern Highlands, particularly on the steeper slopes in the northwestern part of Omatendeka Conservancy, but I did not observe it in the eastern part of the Northern Highlands. This is confirmed by the distribution map developed under the Tree Atlas Project (NBRI, 2005d), (Figure 5.54c). I observed the other *Commiphora* species across mountainous parts of the study area. The fact that 12 of 14 game guards that included *Commiphora multijuga* in the Top 5 most preferred by elephants are located in villages in the area where this species mainly grows demonstrates confidence in the ability of game guards to properly identify species, particularly given that *Commiphora multijuga* is not easy to identify.

(d) Mopane (*Colophospermum mopane*)

I observed the mopane tree (*Colophospermum mopane*) to be the most abundant in the Northern Highlands, in particular across the valleys (Figure 5.14). The trees were observed generally to be 5-6m tall but some located on the main river lines grow much taller. The species is easy to identify because of its butterfly shaped leaves, and is sometimes referred to as the "butterfly tree" (Figure 5.69). It has been described as the dominant species distributed in several lower woodland areas of southern Africa (Mapaure, 1994; Makhado *et al*., 2017) and also described as dominant on the plains in northwest Namibia (Becker and Jürgens, 2000; Le Roux and Müller, 2018; NBRI, 2005g). It is abundant also in parts of Etosha National Park (Atlas of Namibia, 2022) (Figure 5.70, 5.71). Game guards did indicate that the species sometimes grows on mountain slopes, but mostly on the plains. Mopane is a deciduous tree species that flushes its leaves after the first rains (Makhado *et al*., 2016), in October/November.



Figure 5.69 – Mopane (*Colophospermum mopane*) are the reason that it is sometimes referred to as the "butterfly tree"; photograph taken 1 March 2021.



Figure 5.70 – Mopane (*Colophospermum mopane*) is abundant in some areas of Etosha National Park (photograph taken in August (dry season)), 23 August 2014.

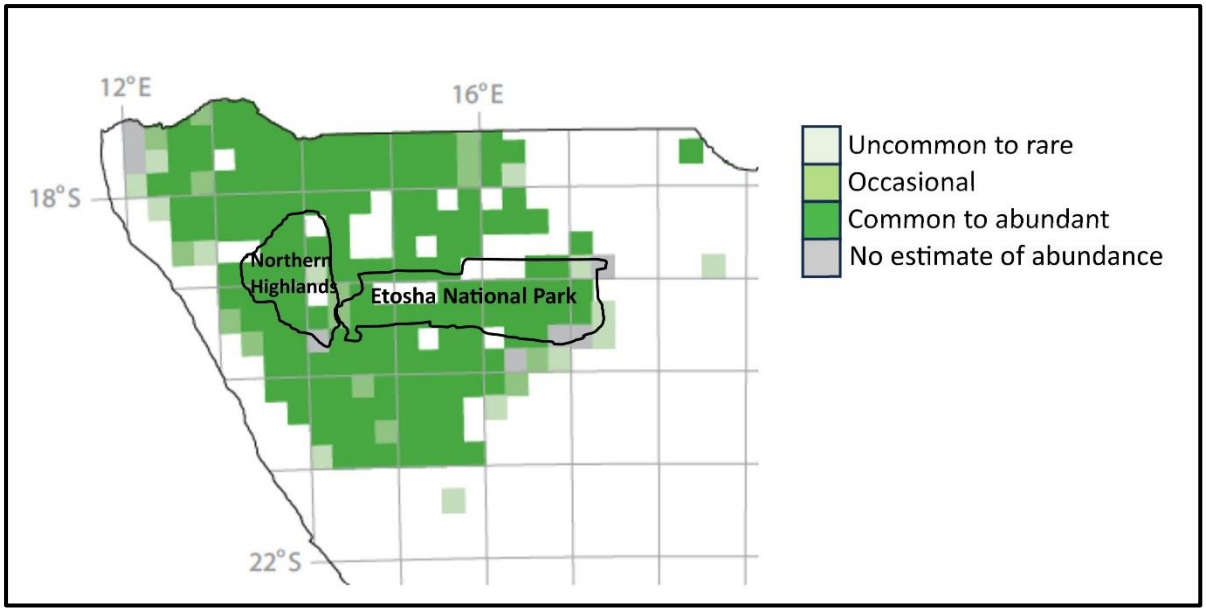


Figure 5.71 - Distribution of *Colophospermum mopane* in northwest Namibia, as published by the Tree Atlas Project (NBRI, 2005g)

There have been some studies on wildlife feeding on mopane, and they have confirmed that mopane is browsed by several herbivores, including elephants (Harris *et al*., 2008; Kos *et al*., 2012; Makhado *et al*., 2016). In his book that compiled his observations and records of early explorers, Shortridge stated that in northwest Namibia "elephants feed on the branches of the mopane tree, whether in leaf or not. The bark is consumed, but parts of the chewed wood are dropped on the paths", (Shortridge, 1934, p.369).

Mopane trees are nutritious (Codron *et al.*, 2007), but are interesting because they produce secondary metabolites such as tannins and phenols in their leaves as defence against browsing, particularly in the rainy season when the leaves are green (Cooper & Owen-Smith 1985; Wessels *et al*., 2007; Makhado *et al*. 2016; MEFT, 2021). Based on the discussions during the consultations, the perception of game guards is that *Colophospermum mopane* was the second most preferred species when the answers of preferred trees in the Top 5 are weighted (Figure 5.36). 17 of 34 game guards (50%) included mopane in Top 5 most preferred, and only one in Top 5 least preferred (Figures 5.31, 5.32).

Although many game guards consider that mopane trees are an important food source for elephants, some believe they do not eat it so much because of the tannins, and all game guards said that elephants eat mopane trees only at certain times of the year. Some game guards suggested that elephants push some mopane trees over to get to the higher leaves when fresh (Figure 5.72). I also asked the 34 game guards whether elephants eat bark, leaves or both the bark and leaves of mopane trees. 19 of 34 (56%) said elephants eat bark and leaves; nine said bark only (26%), five said leaves only (15%), and one game guard didn't know. Out of the 24 that said elephants do eat mopane leaves, 17 said they only eat leaves when they are fresh, around October. Out of the 28 that said elephants eat mopane bark, 11 told me that this is only in the dry season or when leaves are starting to grow, when there is much sugar in the bark. This perception of the game guards ties in with the findings of a study on the seasonal diet of elephants, which concluded that elephants eat a higher proportion of mopane in the dry season (Kos *et al.*, 2012). Reference guides on tree species

indicate that elephants eat mopane leaves only when they are young (SANBI, 2004; Le Roux and Müller, 2018). Mopane is one of the first tree species to grow leaves at the end of the dry season (October to November). During my field work, including many field walks, I observed mopane bark to have been eaten on many occasions (Figures 5.13), often with a white stick or branch left on the ground with the bark stripped (Figure 5.73).



Figure 5.72 – Mopane (*Colophospermum mopane*), Etosha National Park, 27 December 2020.



Figure 5.73 – Bark of Mopane (*Colophospermum mopane*) is eaten by elephants and the bare branch or stick left on the ground, 10 January 2021.

(e) Tress that are less preferred by elephants

I observed leadwood trees (*Combretum imberbe*) to be less abundant than some species, and tend to be growing near the main river beds (Figure 5.16). The leadwood grows very slowly, into tall trees, and has hard wood (Le Roux and Müller, 2018). It was named by the most game guards as the tree that elephants least prefer in the Northern Highlands. Seven of 34 game guards (21%) named this as the No.1 least preferred tree (Figure 5.35). It might be that the hard wood is difficult for elephants to eat and digest. During the field work, I observed no leadwood trees that had been partly eaten by elephants. It is interesting to note that Viljoen, who studied the desert-adapted elephants to the west of the Northern Highlands, including field observations of utilised tree species, concluded that the most important woody food plants for elephants in that area included *Combretum imberbe* (Viljoen, 1989b), therefore contradicting the perceptions of most game guards in the Highlands.

I observed the Herero sesame bush (*Sesamothamnus guerichii*) to be quite abundant on the rolling hills and in the valleys, but less on higher or steep slopes (Figure 5.22). I did not observe this species to have been eaten by elephants during the field studies. This is confirmed by the perception of game guards, six of whom stated that this species is the No.1 least preferred by elephants (Figure 5.35) and 19 of 34 (56%) included the species in the Top 5 least preferred by elephants (Figure 5.32).

The two trees included the most by game guards in the Top 5 least preferred were from the *Boscia* genus, both of which were included in the Top 5 least preferred by 22 of 34 game guards (62%), (Figure 5.32). These were the Shepherd's Tree (*Boscia albitrunca*) and the Smelly Shepherd's Bush (*Boscia foetida*). I observed these species in mountains and valleys

(Figures 5.74, 5.75), as perceived by the majority of game guards consulted (Table 5.2). During field visits I never observed the two *Boscia* species as having been eaten by elephants, but I did see goats eating the leaves, and it is understood from game guards that giraffe also eat the leaves.

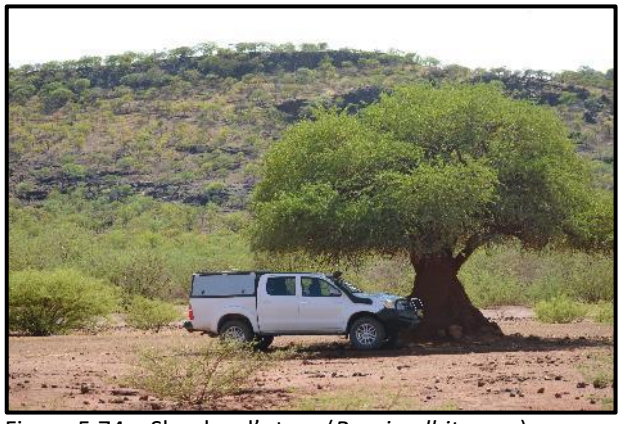


Figure 5.74 – Shepherd's tree (*Boscia albitrunca*), Okangundumba Conservancy, January 2021. Note the flat bottom of the crown of the tree, at the maximum height that can be reached by goats.



Figure 5.75 – Smelly shepherd's bush (*Boscia foetida*) in valley near Ekoto, Orupupa Conservancy (January 2021)

5.5 Conclusions

Given the levels of protection of elephants and water availability in the Northern Highlands are now more similar to those inside Etosha National Park, one potential additional reason for elephant movements from the Park to the Northern Highlands might be preferences for the vegetation in the Highlands. There have been minimal published studies on elephant preferences for vegetation species in northwest Namibia, and those published related to the desert-adapted elephants, in the drier area that has much lower vegetation coverage, to the west of the Northern Highlands (Viljoen, 1989b; Viljoen and Bothma, 1990; Leggett *et al*., 2003c).

My research on the vegetation preferences and the influence of vegetation type on movements involved detailed consultation individually with 34 game guards across the Northern Highlands and over 100 hours of field walks to identify evidence of elephant movements, including trees browsed by elephants. The consultations included an exercise for game guards to select from a short-list of 20 abundant trees in the Northern Highlands their perception of the Top 5 trees that elephants most prefer and the Top 5 trees that they least prefer.

The results from local ecological knowledge about elephant movements and general food preferences confirmed the common findings from studies across elephant ranges in Africa (Owen-Smith and Chafota, 2012; Leggett, 2019) that they will eat most types of vegetation when food is sparse (e.g. during droughts), and they move large distances in the rainy season to find fresh vegetation. My detailed results distinctly showed that, in the perception of game guards, there are specific species of trees in the Northern Highlands that elephants prefer and specific species that they dislike. In particular, the common result from the perception of game guards is that elephants prefer the African star chestnut tree (*Sterculia africana*) and the main species of *Commiphora* trees that are present in the Northern Highlands, the blue-leaved corkwood (*Commiphora glaucescens*), tall common corkwood (*Commiphora glandulosa*), velvet corkwood (*Commiphora mollis*) and purple-stemmed corkwood (*Commiphora multijuga*).

Similarly, there were clear results from game guards on their common perception that elephants dislike specific tree species such as the leadwood tree (*Combretum imberbe*), Herero sesame bush (*Sesamothamnus guerichii*), shepherd's tree (*Boscia albitrunca*), and smelly shepherd's bush (*Boscia foetida*). I confirmed these perceptions from game guards through my observations in the field. I observed several times tree species such as *Sterculia africana* and *Commiphora glaucescens* as having been partly eaten by elephants, whereas I never saw species such as *Boscia albitrunca* and *Boscia foetida* with indications of being eaten by elephants during the field walks.

The interesting aspect is that the African star chestnut tree (*Sterculia africana*), and three of the four *Commiphora* species, grow on the steep rocky slopes up the mountains, and not in the valleys of the Northern Highlands. All the game guards consulted said that elephants walk up steep slopes to find their preferred vegetation. This is unusual behaviour for the African savanna elephant (Wall *et al*., 2006), a large and heavy mammal often associated with flat African plains. I include more analysis on elephant movements in Chapter 6.

The small population of elephants in the Northern Highlands has a very low population density of about one elephant per 40 km^2 (Thouless *et al*., 2016). This means that on my field walks it was unusual to observe the elephants, but I made regular sightings of trees that have been partially eaten by elephants, and elephant dung and footprints. During my research activity in the field, I identified many trees up steep, rocky slopes, which had been partly eaten by elephants. On one occasion, I observed an elephant in the mountains eating part of an African star chestnut tree (*Sterculia africana*), the species identified by game guards as most preferred by elephants, in Ozondundu Conservancy (Figure 5.76).

My findings for this component of the Research Project are based on local ecological knowledge and field observations. My extensive activities of field observations helped to cross-check the results from game guards, and confirmed their knowledge. The game guards averaged over 10 years of experience in the role. I assessed their capacity for tree identification to be a high standard during my field walks, many of which were carried out with game guards. For example, the *Commiphora mollis* and *Commiphora multijuga* are similar trees and could be mistakenly identified. *Commiphora multijuga* mainly grows in the western more mountainous areas of the Highlands, and the game guards demonstrated ability to identify these species. Overall, my consultations and field observations provided confidence in the local ecological knowledge of the game guards.

I observed many trees, particularly the *Sterculia africana* and *Commiphora* trees, as being partially eaten by elephants and almost never killed. This point created much discussion with game guards, with half the game guards in agreement with a theory that elephants might be deliberately ensuring trees continue to live and grow to provide a future food source. Such discussion on the potential for deliberate coppicing is never going to be conclusive, and the trees in the semi-desert area of the Highlands are very resilient. The discussion on these aspects, and field observations, did identify several factors related to elephant behaviour. For example, I observed several mopane trees (*Colophospermum mopane*) having been pushed over and killed by elephants (and therefore not showing coppicing behaviour). However, most of these observations were near villages and water points, in places where elephants are more likely to become stressed and show strength, because of human interactions.

Mopane trees (*Colophospermum mopane*) are by far the most abundant tree species in the Northern Highlands, dominant in the flat valleys and also occurring on the lower slopes (Becker and Jürgens, 2000; Le Roux and Müller, 2018). I made several observations of mopane trees that had been partly eaten by elephants, particularly the bark. The general perception of game guards was that elephants eat the leaves of *Colophospermum mopane* only when they are fresh, because the tree builds up tannins in their leaves as defence against browsing. Some mopane trees have an epiphytic plant growing on the branches, lighting match mistletoe (*Tapinanthus oleifolius*), which has high sugar levels and is one of the few plants to flower in the dry season. According to game guards, elephants sometimes push over mopane trees to eat the *Tapinanthus oleifolius* plants. These points demonstrate that there are a number of different factors influencing elephant behaviour related to vegetation preferences.

I conclude with high confidence that elephants are walking up steep slopes to higher elevations in the Northern Highlands to eat their preferred *Sterculia africana* and *Commiphora* tree species. Given the similar availability of water resources and more similar levels of protection in the Northern Highlands and inside Etosha National Park, I conclude also with some confidence, that those elephants that are moving from the Park to the Highlands are doing so to find their preferred vegetation. *Sterculia africana* and *Commiphora* tree species are much less common in Etosha National Park (NBRI, 2005a; Le Roux and Müller, 2018; Atlas of Namibia, 2022). Etosha National Park has some similar vegetation species to the Highlands such as trumpet thorn (*Catophractes alexandri*) and mopane (*Colophospermum mopane*), as well as some species of *Acacia* trees and shrubs that are less common in the Highlands. The Park has been described as equivalent to the "edge of range" vegetation and conditions for elephants (MEFT, 2021), which is a theory that the environment in the Park is only just suitable for their habitation. The elephant density in the Park is about one elephant per 8 km^2 (Thouless *et al*., 2016).

The density of up to one elephant per 40 km^2 in the Northern Highlands compares to a density of approximately 1-2 elephants per km^2 in the Zambezi Region of northwest Namibia (Thouless *et al*., 2016; MEFT, 2021). It can be assumed that at this time there is low risk from the elephants related to the carrying capacity in the Northern Highlands. In an early study on the influence of desert-dwelling elephants on vegetation in the northern Namib desert, to the west of the Northern Highlands, Viljoen and Bothma (1990) concluded that the desert-adapted elephant population in that area, which has much less vegetation coverage than the Northern Highlands, is well below the carrying capacity.

In order to increase further the confidence in the conclusions that elephants are moving to the Highlands from Etosha National Park and walking up slopes to find their preferred tree species, more study is required on the browse selection behaviour of elephants in the Park. In addition, the influence of vegetation species on elephant movements would benefit from more study on comparison with abundance of these vegetation species between the Northern Highlands and Etosha National Park. These further studies would be enhanced by support to community game guards, including provision of equipment (e.g. binoculars, spotlights, reference books, etc) so that the studies can benefit from their involvement and local ecological knowledge.

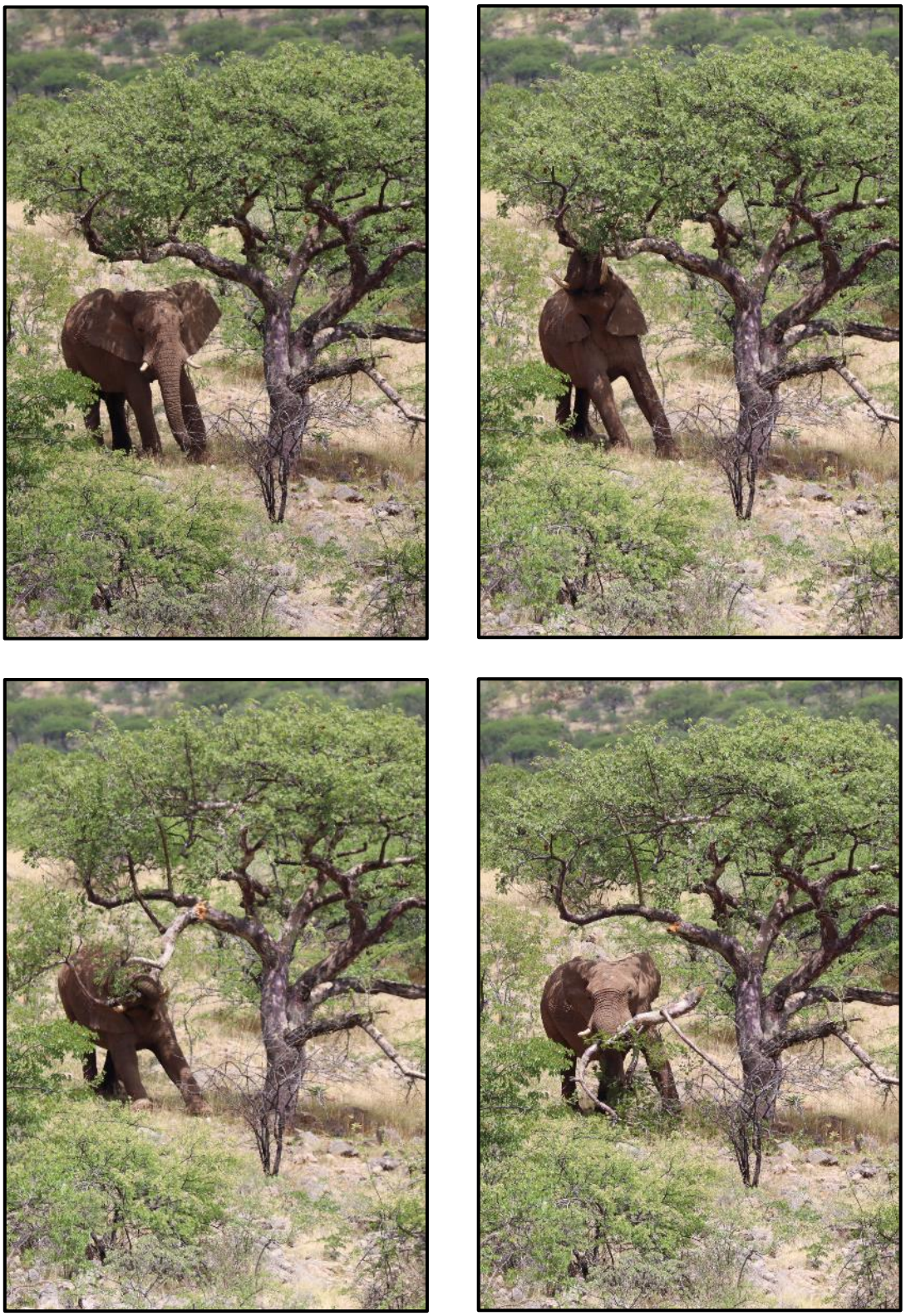


Figure 5.76 - One of the few times during the field walks when I observed an elephant, it did break and eat part of a branch of an African star chestnut tree (*Sterculia africana*) in Ozondundu Conservancy, 25 January 2023.

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Chapter 6 - Elephant movements and factors affecting movements in the Northern Highlands

This Chapter covers research on elephant movements in the Northern Highlands, building on results of earlier chapters, e.g. on the hotspots of human-elephant conflict (Chapter 4).

6.1. Context

Reliable information related to elephant movements in the Northern Highlands would provide an important foundation for planning measures to protect the species and reduce human-elephant conflict. In particular, information on the factors affecting elephant movements is needed.

Elephant movements depend on different factors, including water availability, food availability, location of villages and roads, level and enforcement of protection. As discussed in Chapter 5, there are many research papers, covering Namibia and other range countries, which confirm that African savanna elephants tend to move seasonally, linked to rainfall and vegetation (Viljoen, 1989a; Lindeque and Lindeque, 1991; Leggett, 2006a; Harris *et al.*, 2008; Loarie *et al*., 2009a; Young *et al*., 2009; Birkett *et al*., 2012; Tsalyuk *et al*., 2019; Wall *et al*., 2021). For example, Purdon *et al*. (2018) carried out detailed studies on elephant movements in several countries in southern Africa, including Etosha National Park in Namibia, and concluded that elephant movements correspond to wet and dry seasons. Garstang *et al*. (2014) studied movements of nine elephants with GPS collars in northwest Namibia and concluded that there were significant changes in movements prior to, or at the start of, the rainy season.

The elephants in northwest Namibia are spread over a very large area of at least 41,000 km^2 (Thouless *et al.*, 2016). These elephants are living mainly outside national parks, in arid conditions among rural communities. As discussed in Chapter 3, since the 1980s there has been detailed research on the population and movements of desert-adapted elephants, to the west of the Northern Highlands (Viljoen 1987; Viljoen, 1989a; Viljoen and Bothma, 1990; Leggett *et al.*, 2011; Leggett, 2019; Brown and Ramey, 2022). Before my Research Project, minimal information had been published on elephants elsewhere in northwest Namibia, including on the elephant population and movements in the Northern Highlands.

In Chapter 3 of this Research Project, my analysis concluded that the current population in the Northern Highlands is estimated to be between 78 and 212 elephants (with a best estimate 128 elephants). This was based on my interviews to collate the local ecological knowledge of game guards on known groups of elephants. Since the year 2000, four aerial surveys have been carried out in northwest Namibia. The estimated populations provided in the survey reports indicate an increase in population over that time period (Blanc *et al.,* 2002; MET, 2005, 2011; Craig and Gibson, 2016; Craig *et al.,* 2021; MEFT, 2021). Local feedback during my scoping activities in the field for this Research Project also indicated that elephant numbers have been increasing in the Northern Highlands and that some elephants have moved back into the Highlands from Etosha National Park (Wenborn *et al.,* 2022a). It is likely that elephants are moving into the Highlands to browse their preferred tree species,

particularly in rainy season (as I conclude in Chapter 5). In the past, the elephant range in the northwest has been as far north as the Kunene River (Figure 1.2), on the border with Angola (Viljoen, 1987), and it is believed that the range is expanding again in that direction (MEFT, 2021).

The landscape and climate in northwest Namibia affect elephant movements (Viljoen, 1987; Owen-Smith, 2010; MEFT, 2021; Wenborn *et al.*, 2022c). The semi-desert habitat of the Northern Highlands is a remote landscape that includes rolling hills and rugged mountains, many with rocky slopes. Some valleys are narrow and steeply cut, and some larger valleys are wider and flatter. The altitude is typically over 1,000m a.s.l. in the valleys, with mountain peaks up to 1,800m a.s.l. The landscape across the study area from east to west shows an abrupt change from flat plains to mountains to the west of Etosha National Park (Figure 6.1). Rainfall is sporadic in the Northern Highlands and typically 50 to 200 mm per year, with a much lower average rainfall in the west of the area (NSA, 2013; Namibia Meteorological Service, 2023; Weather and Climate, 2024). The rains can start in November but generally the main rains are in March/April. For some years there are minimal or no rains. The ephemeral rivers (Figure 1.2) tend only to flow for a few days or weeks of the year, and have standing water in a few places in the river beds for a few weeks after that, which is likely to influence the movement of elephants. There are several permanent natural springs in the Northern Highlands.

The location of human settlements and roads also affects elephant movements (Harris *et al.*, 2008). The estimated human population in the Northern Highlands is less than 10,000 (NACSO, 2024), mainly in small villages. The main livelihood is livestock farming. The largest towns in the northwest are Opuwo, just to the north of the Northern Highlands study area, and Sesfontein to the west of the study area (Figure 1.2). The main C35 tarred road passes north-south alongside the western boundary of Etosha National Park, and there are a few gravel roads in the Highlands, which are mainly well-maintained (Figure 6.1). A network of boreholes has been developed for use as community water points near most villages. Elephants drink at some of the water points, as well as from the springs.

As the human population of Africa grows, and the area of natural habitat decreases, there are growing concerns about the connectivity between elephant populations (Roever *et al.*, 2012). A recent monitoring report on the small-populations of desert-adapted elephants, to the west of the Highlands in the lower Hoanib and lower Hoarusib rivers (Figure 1.2), emphasised the risks to those elephants because of the potential lack of connectivity with other populations in the northwest (Brown and Ramey, 2022). The strategic objectives in Namibia's National Elephant Conservation and Management Plan include protection of the elephants and their habitats in northwest Namibia, and the Plan specifies that the development and implementation of protection strategies needs more research on the factors affecting the movements of elephants in the northwest (MEFT, 2021).

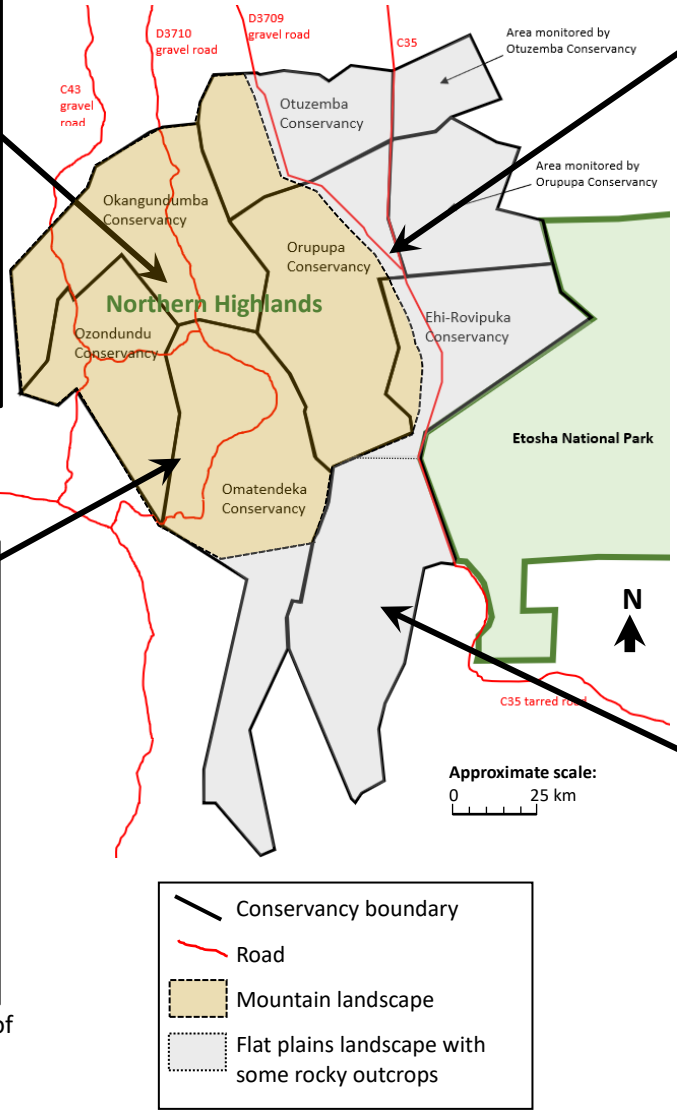
Given that in such a remote, mountainous landscape, it is challenging to monitor the movements of elephants through surveys on the ground, the game guards present an opportunity to collate their local ecological knowledge on elephant movements, and factors that have affected the movements over time.



Okahua, Okangundumba Conservancy, showing flat valley with steep mountain slopes, typical of several areas of the Northern Highlands (12 January 2021).



Above Omutirapo Spring in Omatendeka Conservancy is typical of the much steeper areas of the Highlands, with narrower valleys, steep rocky slopes and cliffs, in the west of the Northern Highlands (26 January 2023).





Orundu, looking north across Orupupa Conservancy, showing the edge of the flat plains landscape and start of the Highlands to the west (2 March 2022).



The typical landscape near Hobatere in southern Ehi-Rovipuka is mainly flat with some rocky outcrops; the photograph is taken looking west with the Highlands in the distance (5 March 2022).

Figure 6.1 - Examples of different landscapes in the core six conservancies of the Northern Highlands

6.2. Research objectives on elephant movements

The objectives of this component of my Research Project were to:

- Carry out a detailed literature review on previous research on elephant movements in northwest Namibia;
- Investigate current movement patterns of elephants in the Northern Highlands through collation of local ecological knowledge and observations in the field;
- Assess the findings from literature review, local knowledge and field observations to identify the likely factors affecting the movement of elephants in the Northern Highlands.

6.3. Method

I carried out a detailed desk-based literature review of previous research on elephant populations and movements in northwest Namibia during this Research Project. This included web-based searches for published information plus meetings with senior stakeholders in Windhoek to obtain unpublished reports. Chapter 3 includes results on elephant population from this literature review. There is some historical information in publications and unpublished reports on movements in the northwest, which is important to identify factors affecting the movement of elephants in the area, but recent publications on elephant movements in the northwest are limited. As for other components of this Research Project, I identified during scoping activities in the field that the local ecological knowledge of game guards is a valuable resource of information on elephant movements in the Northern Highlands.

My interviews with game guards for this Research Project covered several topics, including information on the conservancy, background on the experience of the game guards, information on water points and vegetable gardens, elephant populations, elephant movements and human-elephant conflict. My survey design included open questions on elephant movements that covered reasons for movements, time spent in the mountains and valleys, movements during rainy and dry seasons, distances and directions moved, and perceptions of the water points and vegetable gardens most visited by elephants. In addition, I included a question on the connectivity between elephants in the Northern Highlands and the small population of desert-adapted elephants in the lower Hoanib and lower Hoarusib rivers. The topics and questions for the semi-structured interviews were explained further in Chapter 2 (Method) and the questions are included in Appendix A2.

One component of the consultations was that I asked the game guards to draw their perception of the main movements of their known groups of elephants on a map of the conservancy, including the main water points visited by the elephants (Figure 6.2). Based on my time with game guards, I had concluded that they do have good knowledge of the map of their conservancy. They have been trained in their role, which includes recording locations of wildlife sightings and incidents using grid squares on the conservancy map, and therefore they are familiar with the map layout and locations of villages and water points on the map. I therefore had some confidence in this participatory mapping approach.



Figure 6.2 – Interview with game guard (with translator) at Okazorongua in Orupupa Conservancy on 9 January 2023, including activity to draw elephant movements on a map of the conservancy.



Figure 6.3 – Examining elephant tracks on foot patrol near Ohungu mountain, Orupupa Conservancy, 24 January 2023.

During the field walks and site visits (e.g. to water points) with game guards, we would informally discuss elephant movements and look for evidence of elephant movements in the mountains and valleys, including elephant dung, footprints (Figure 6.3), and trees that had been eaten partly by elephants. This helped me to cross-check the feedback and mapping of elephant movements by game guards.

Some analysis from other chapters also provides a basis for the assessment of elephant movements in this Chapter. For example, my analysis of locations of incidents of human-elephant conflict, as recorded in Event Books, provides information on hotspots that have the most visits of elephants (Chapter 4).

6.4 Literature review on elephant movements in northwest Namibia

Historical information on elephant movements and range is useful as an indication of factors affecting their movement. As discussed in Chapter 1, most information before the 1980s on elephant populations and movements was recorded in travel journals and hunting reports. These records indicated that elephants covered a large range in the 1800s from the Kunene River, on the northern border with Angola, down to the Ugab River (Figure 1.2), about 200 km south of the Northern Highlands (Viljoen, 1987). The book by Shortridge (1934) included a map of elephant range at that time (Figure 6.4). This also indicated that elephants were moving throughout northwest Namibia up to the northern border, but not in the driest desert areas of the Skeleton Coast.

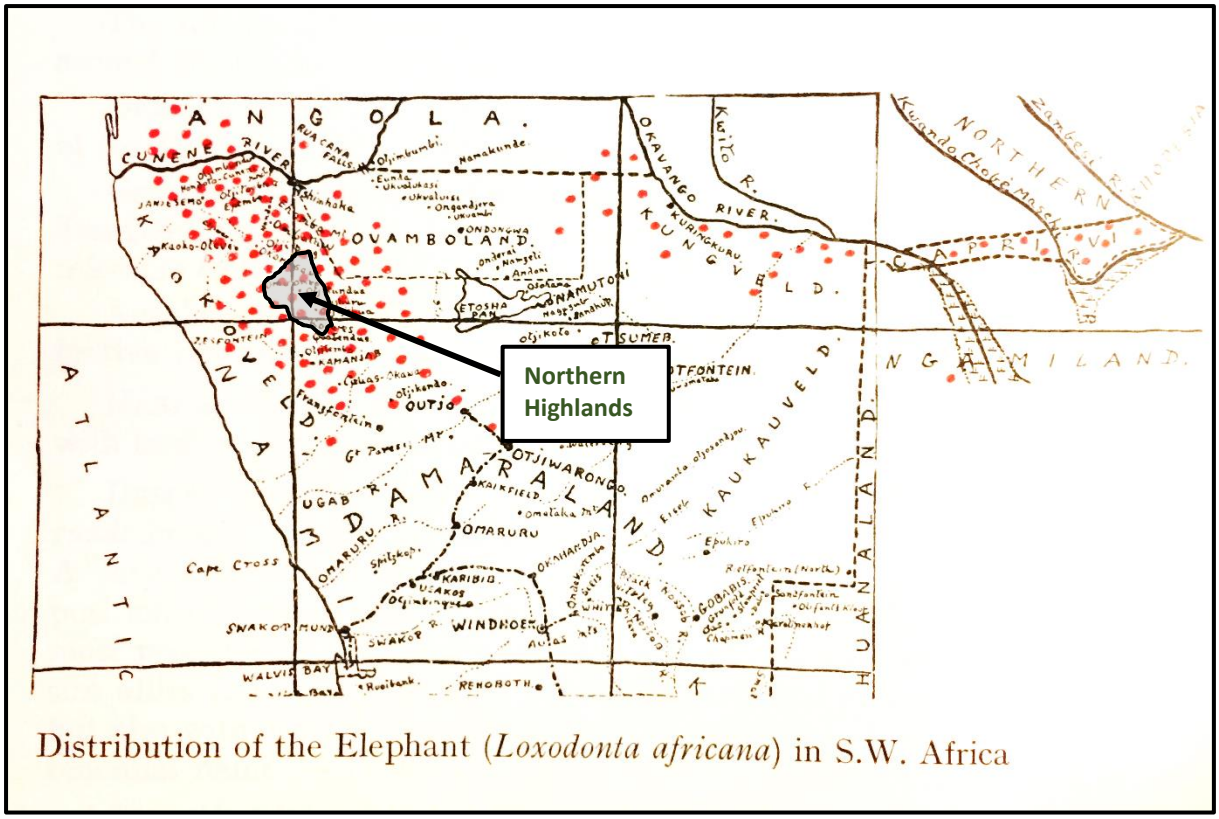


Figure 6.4 - Sketch by Shortridge (1934) of the distribution of elephants in Namibia, based on records of explorers and hunters (the red dots indicate the distribution).

The number of elephants in northwest Namibia has changed at different times since records began, as described in Section 3.4.1 of this thesis. In the 1960s and 1970s many artificial water points were drilled in more areas of the northwest, in line with the policy of the South African government of expanding livestock farming (i.e. making more grazing areas accessible because there were more water points), (Berry, 1997; Bollig and Schwieger, 2014; Heydinger, 2021b). Artificial water points mean that livestock can be kept for much longer in dry seasons in areas of good grasslands (Loarie *et al.*, 2009b), but this policy potentially created new areas of competition with wildlife and resulted in more widespread over-grazing (Owen-Smith, 2010). Artificial water points also affect elephant movements. A study in 2002 concluded that the drilling of artificial water points in part of the lower Hoanib resulted in more permanent elephant populations in that area whereas they would have previously only visited the area in rainy season (Leggett, 2006b).

The policies of the South African Administration on protected areas, the limitations of enforcement of those policies, and other local factors, would have affected elephant populations and movements as described in Section 3.4. Drought years have also had an impact on elephant movements, for example the severe drought of 1980-1981 (MEFT, 2021). During droughts, water is still available from some community water points and some natural springs, so it tends to be the lack of vegetation that kills the wildlife and livestock. Elephants tend to move away from drought areas at these times, including into Etosha National Park (Viljoen, 1989a; Owen-Smith, 2010). By the mid-1980s, the number of elephants in the northwest had greatly reduced and most of the remaining population had moved back to Etosha National Park where there was then better protection and

enforcement (Owen-Smith, 2010; Bollig and Olwage, 2016). It is considered that the last elephants in the Kunene River were poached in the late 1980s (Ramey and Brown, 2019; MEFT, 2021).

The community conservancy programme was set up in the 1990s as a core conservation policy of the Government of Namibia (MET, 1995). Most of the area of the Northern Highlands is now designated as conservancies (Figure 2.2). The conservancy programme has fostered a change in attitude in the communities to protect elephants and other wildlife, and has had a role in the increase in wildlife populations in the region, including elephant movements back out of Etosha National Park (Owen-Smith, 2010; Boudreaux and Nelson, 2011; Jacobsohn, 2019; Störmer *et al.,* 2019; MEFT/NACSO, 2022; Wenborn *et al*., 2022b).

Movements of elephants from Etosha National Park reflect the seasonal vegetation growth in the Northern Highlands. The Park provides sub-optimal habitat with generally quite saline water, and therefore there are some movements of elephants out of the Park in the rainy season (MEFT, 2021). The boundary fence of Etosha National Park has had the potential to affect elephant movements, and the fencing strategy in northwest Namibia has changed over time. For example, the enclosure of Etosha National Park was attempted in 1973 with a 2.6m fence along most of the 850 km boundary. About 130 km was upgraded to elephant-proof cable fencing and later electric fences in strategic sections. Much of the 1973 fence was inadequate as warthog (*Phacochoerus africanus*), lions (*Panthera leo*) and elephants could get through (Berry, 1997). By the time of independence in 1990 the implementation of the fencing infrastructure was suspended. Repairs and improvements to the Etosha fencing continue, including along the western boundary of Etosha, however, my observations in the area indicate that much of the Etosha fence would be easy for elephants and some other animals to pass through (Figure 6.5), and a more detailed earlier study of breaks in the fence had also shown this (Hoole and Sullivan, 2024). The foot and mouth epidemic in 1961 led to construction of the veterinary fence along the southern boundary of Etosha (Berry, 1997), and the veterinary control fence was installed in Kaokoveld in 1976 (MEFT, 2021). That fence runs east to west across the Kaokoveld, to the south of the Northern Highlands.



Figure 6.5 – Example of Etosha fence on western side of the park. In several places the fence is in a better state-of-repair than the section of fence in this photograph, but in most areas it would be easy for elephants to move out of the park; photograph taken 15 February 2023.

There have been two studies published that involved the use of GPS collars and satellite tracking of elephant movements in northwest Namibia. Both studies mainly focused on the desert-adapted populations. The first study involved satellite tracking and was carried out for six months covering the rainy season 1987-1988 (Lindeque and Lindeque, 1991). Only female-led herds of elephants were included in the study. The results demonstrated elephant movements in Kaokoveld that were larger than any known ranges at the time in Africa (MEFT, 2021). It suggested a reason for the longer distances moved was likely to be the harsh environment that has more limited food and water than many habitats in elephant ranges elsewhere in Africa. It showed movements of desert-adapted elephants between the lower Hoanib and the Hoarusib rivers, to the west of the Northern Highlands, but the collared elephants did not move much further east than Sesfontein, staying out of the Northern Highlands (Figure 1.2). The study also concluded that elephants responded rapidly to the onset of distant rain, resulting in sudden changes in their distribution.

In the second study on movements, using GPS collars on two female and six male elephants in 2002-2003 (Leggett, 2006a), the recorded movements were over a longer distance than those identified in the study in the late 1980s by Lindeque and Lindeque (1991). Recorded distances moved by male elephants were up to 625 km in five months. The conclusions in the paper included that there was likely at that time to be a gene flow between the desert-adapted elephants and those in the Northern Highlands and Etosha National Park. A male elephant collared at Purros moved near the Hobatere Concession (through the Khowarib Gorge) and overlapped with four elephants collared in the Concession (Figure 1.2). The study

also showed that the onset of rains triggered elephant movements over longer distances than in the dry season.

The most comprehensive monitoring of movements of elephants in the northwest has been by Dr Laura Brown and Dr Rob Ramey of Desert Elephant Conservation. They have carried out field-based monitoring of the desert-adapted elephants, to the west of the Northern Highlands, for a few weeks each year for most years since 2006 (Desert Elephant Conservation, 2023). The monitoring indicated that desert-adapted elephants in the lower Hoarusib have a traditional migration to the lower Hoanib (Figure 1.2) for the Ana Tree pods (*Faidherbia albida*). The elephants tend to make the journey of about 70 km in one night. This used to be female-led herds, but now tends to be just the individual male elephants that migrate (Ramey and Brown, 2019).

It is expected that male elephants would migrate longer distances than female-led herds because baby elephants have to drink more often and this restricts the movements of female herds with babies. This has been shown in several relevant studies (Leggett, 2006a; Garstang *et al.*, 2014; Ramey and Brown, 2019), although Purdon *et al*., (2018) did not find much difference in distances moved between individual male elephants and female-led herds. Although earlier studies of movements of the desert-adapted elephants have indicated that this population was unlikely to be isolated (Lindeque and Lindeque, 1991; Leggett, 2006a), more recent assessment has raised concern about the viability of the desert-adapted populations in the lower Hoanib and Hoarusib rivers (Brown and Ramey, 2022), (Figure 1.2).

The earlier study on movements did also involve collaring of elephants in Etosha National Park, which moved north out of the western part of the Park, into the Omusati Region (Figure 2.2), but did not cross the C35 road (Figure 6.1) into the Kunene Region and the Northern Highlands (Lindeque and Lindeque, 1991). The Ministry of Environment, Forestry and Tourism (MEFT) did implement collaring programmes for elephants in Etosha National Park between 2009 and 2015. Details of the number of elephants collared are not available, but it is understood that there was less movement out of western Etosha than might be expected, with only one male elephant moving west out of Etosha across Ehi-Rovipuka, Orupupa and Omatendeka Conservancies (MEFT, 2021).

The Namibia University of Science and Technology (NUST) has been collaring elephants to monitor movements around commercial farms near Kamanjab and south of Etosha (Figure 1.2). It was developing plans to collar elephants nearer the Northern Highlands, as of March 2023.

6.5. Collating knowledge of game guards and field observations on elephant movements in the Northern Highlands

6.5.1 Baseline data on locations of villages, water points, springs, roads

My field work included data collection on some aspects that are likely to affect elephant movements, including locations of villages, cattle posts (Figure 6.6), community water points and natural springs (Figure 6.7). Out of the 65 community water points that I visited in the Northern Highlands study area, only four have separate dams that are currently operating for elephants, located 0.5 to 1 km from the main community water point (Figures 6.8 and 6.9). Based on the data collected in my field visits to water points and villages during the Research Project, including taking GPS co-ordinates and noting the state-of-repair of the water points, I created the map of water points and springs (Figure 6.10). The map includes the locations of the water points with a separate dam for elephants. The information on the map was not previously available before the Research Project and I have provided the map and the detailed data collected to the Ministry of Environment, Forestry and Tourism as well as the Ministry of Agriculture, Water and Land Reform and relevant NGOs. The information in the map in Figure 6.10 is needed as a baseline for assessment of elephant movements.



Figure 6.6 – Example cattle post at Omunuandjai, Okangundumba Conservancy, 12 January 2021. There are usually only a few houses at cattle posts, which tend to be lived in for a few months of the year. The photograph shows elephant dung in the foreground.



Figure 6.7 – Example of a natural spring Otjondeka, Orupupa Conservancy, 5 March 2021. This is one of the larger springs in the study area, and one of the few springs located on the flat landscape, near the D3709 road.



Figure 6.8 –The water point at Okauua cattle post has a solar pump and a separate holding dam nearby, but also a separate dam specifically for elephants, 0.5 km from the water point. The intention is to reduce interactions of elephants with people and livestock. Photograph taken 28 February 2022.



Figure 6.9 – Separate water dam for elephants at Okauua in Orupupa Conservancy, 0.5km from the borehole in Figure 6.8. This has had some success in keeping elephants away from the community water point. Photograph taken 28 February 2022.

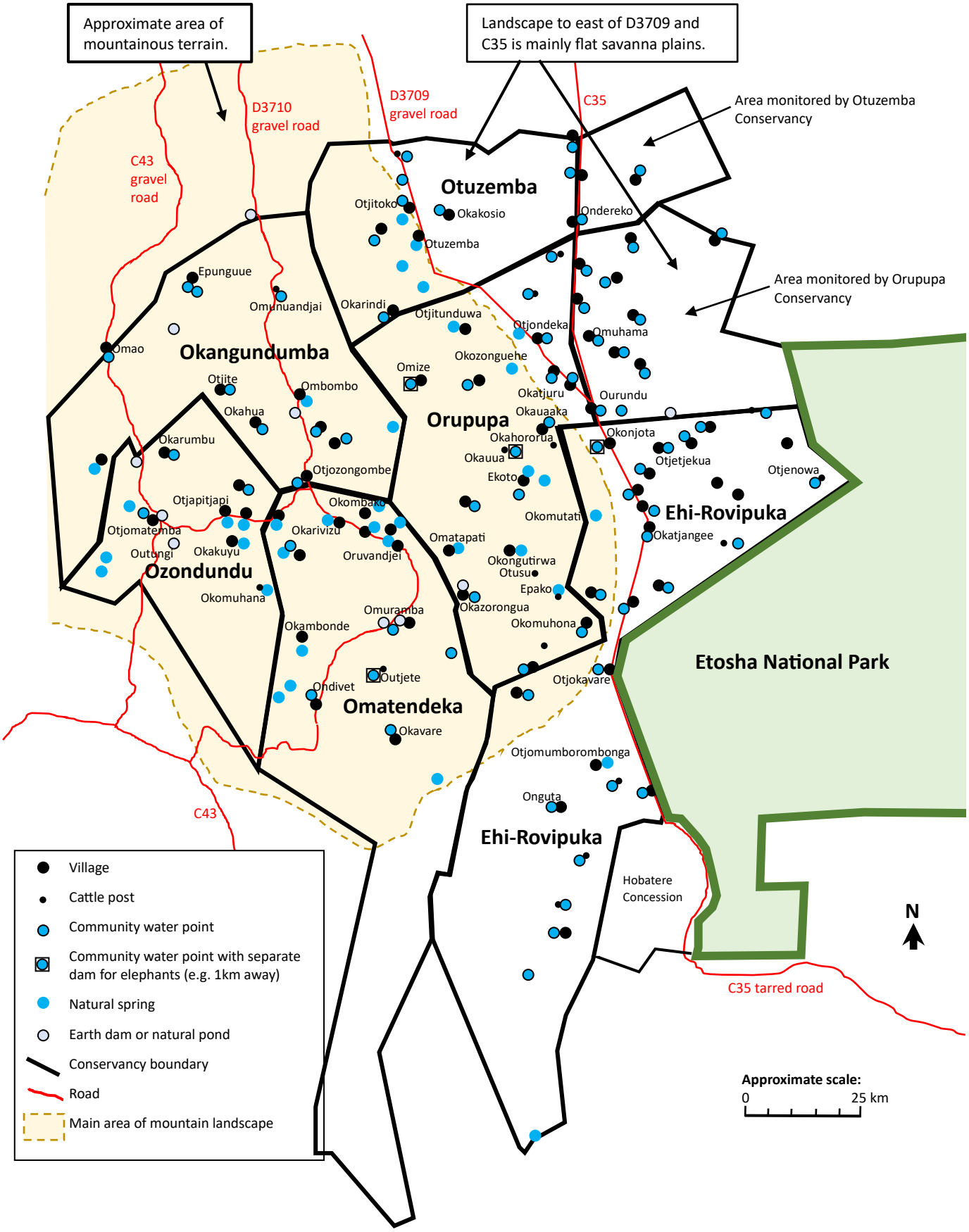


Figure 6.10 – Map the main six conservancies in the Research Project with villages and water resources

The map in Figure 6.10 indicates that more villages are located on the main roads, particularly the C35 tarred road in northern Ehi-Rovipuka and Orupupa. The main roads run north-south in the Northern Highlands, although traffic levels are very low (Figures 1.17 and 1.18). There are several villages in Orupupa and Otuzemba near the D3709, and the main villages in Okangundumba (Ombombo) and Omatendeka (Otjozongombe, Oruvandjei, Omuramba) are on the D3710 gravel road. The villages away from the roads, such as Okahua and Epunguue in Okangundumba, tend to be smaller, and accessed on 4x4 tracks. Nine game guards during consultation mentioned that families have been moving to live nearer the main roads in the last 20-30 years, and villages, particularly near the tar road, have been growing. The location of water points, schools and clinics also affects the choice of where people like to live, according to game guards. The mobile phone network is expanding in the study area, but there are many parts with no network. It does also influence where people stay, for example according to game guards, the number of houses in Otjomatemba has increased because it is the only village in Ozondundu Conservancy with good network, and it is on the C43 main road. The locations of villages influence elephant movements in that higher human population and activity is likely to keep elephants away (Harris *et al*., 2008), whereas the community water points and vegetable gardens in those villages are likely to bring elephants into the areas.

The Herero people that live in the Northern Highlands are semi-nomadic in that some migrate seasonally to cattle posts (Figures 6.11 and 6.12). Typically cattle posts have a water resource and the livestock farmers move there after the rains to benefit from fresh grasses away from their village. Depending on the amount of rainfall in the rainy season, they might stay about three months at the cattle post.



Figure 6.11 – Example of households at Okozonguehe village in Orupupa Conservancy, 9 September 2018.



Figure 6.12 – Example of a cattle post abandoned because the water source dried out, at Okahororua in Orupupa Conservancy, 28 February 2022.

6.5.2 Local feedback on factors affecting movements

The common feedback from game guards during this Research Project was that the elephant population in the Northern Highlands steadily increased in the 2000s and has more rapidly increased since about 2012 (Chapter 3). There is also a common perception among the game guards who I interviewed that elephants used to move into the Northern Highlands area from Etosha but stayed only for the rainy season, for example in the 2000s, but since 2012 more elephants are spending more of the year in the Highlands. This is concluded from one of the questions that I asked using the Likert scale, on which 27 of 34 game guards (79%) agreed or strongly agreed with statement "*Elephants used to move into the area from Etosha and go back, but now spend most of the time in the Highlands*." All 10 game guards interviewed from Ozondundu and Okangundumba Conservancies agreed (four game guards) or strongly agrees (six) with the statement. These two conservancies are the furthest from Etosha National Park out of the six core case study conservancies (Figure 6.10). Game guards who disagreed with the statement, and said that elephants have been in the area all their lives, were from conservancies nearer the Park. This implies that potentially in the 2000s some elephants were leaving the Park into the furthest conservancies and returning towards the Park, but not necessarily all returning into the Park. It ties in with the results from my analysis of Event Books for which Okangundumba is the only Conservancy that clearly shows an increase in incidents involving elephants from 2012 to 2021 (Figure 4.34). Potentially elephants were only visiting Okangundumba Conservancy in the rainy season in the 2000s and are now becoming more permanent throughout the year.

The increase in elephants in the Northern Highlands, and the perceived changes in that they are more permanently present in the area throughout the year, are likely to be because of several factors. In particular, water resources have become more permanently available in the Northern Highlands as the Government of Namibia has implemented a programme over the last 25 years to upgrade community water points. The upgrade works have included replacement of diesel pumps with solar pumps and addition of concrete holding dams, which ensures water is more permanently available for people and elephants (Chapter 4). This is additional to the water availability for elephants in the natural springs. Figure 6.10 shows that water resources are available in several areas every 10-15 km, and in most areas every 20-25 km. Figure 4.35 shows the results of my analysis of data in Event Books on incidents involving elephants for the whole of the Northern Highlands, and Figure 4.39 for Okangundumba and Ozondundu Conservancies (the furthest of the six conservancies from Etosha National Park). These charts of incidents by month show that there are more incidents at water points in the dry season, which supports the game guard perceptions that many elephants are now staying in the Northern Highlands for the dry season. This is aligned with other research studies, for example Loarie *et al.* (2009b) carried out a detailed study of elephant movements through GPS collaring in 12 locations across southern and eastern Africa, tracking movements during the six-year study. One of their main conclusions was that the areas with increased artificial water points were affecting dry season movement, allowing elephants to stay in certain areas that they would have moved away from in the dry season if the water points had not been installed.

My conclusions in Chapter 5 of this Research Project were that elephant movements are also influenced by their preferences for trees that are associated with the higher altitude rocky

slopes in the Highlands, compared to Etosha, where the vegetation is described as having nutritional deficits for elephants (MEFT, 2021).

The focus of my analysis on elephant population in Chapter 3 was on developing an estimate of the number of elephants in the Northern Highlands through local knowledge on known groups of elephants. However, one of my key findings was the confirmation with a high level of confidence that known groups are moving all around the Northern Highlands. This is because the known groups of about 20 and 30 elephants have been identified by game guards based in different locations across several conservancies. For example, the same group has been identified at Otjitoko in Otuzemba Conservancy and Okakuyu in Ozondundu Conservancy, which are over 80km on a direct route.

The open discussion with game guards during the interviews provided me with confidence that at least some game guards are able to identify elephants that have come from Etosha or other flatter sandy areas to the east of the Highlands. In particular, game guards state that elephants from sandy areas tend to have more cracks in their feet (Figure 3.18 is a photograph of a cracked foot of an elephant taken in the desert areas of the west near the Skeleton Coast National Park). Elephants that spend more time in the Highlands have fewer cracks because the rocks have made their feet smoother (Figure 6.13). Also, elephants tend to splash mud and dust on their backs (Figure 6.14) for cooling and protection from the sun and insects (Ramey and Brown, 2019). Game guards mentioned that the colours of the dust and mud on elephants can indicate that they have moved recently from Etosha or other flat sandy areas (Figures 6.15 and 6.16), where the colours are different. For example, an experienced game guard with 13 years of service based in Okazorongua in Orupupa Conservancy, and one who had 30 years of experience as a game guard based in Okomuhona in the same conservancy, were both confident that they could identify elephants that were visiting from Etosha because of the different footprints. They were also confident that they could identify elephants from Etosha because of the lighter colour of dust on their backs.



Figure 6.13 – Example of smooth footprints of an elephant. According to game guards this elephant is likely to spend time in the Highlands because its feet have been smoothed by the rocks in the Highlands (compared to elephants that spend time in sandy areas, which tend to have more cracked feet); Okomutati, Ehi-Rovipuka Conservancy, 21 December 2020.



Figure 6.14 – Example of elephant splashing mud for protection, Etosha Heights, 25 December 2020.



Figure 6.15 – Example of elephant dusting at Etosha Heights, showing the lighter coloured dust in Etosha National Park, which game guards say is a distinguishing feature when they identify elephants that have recently moved from Etosha, 26 December 2020.



Figure 6.16– Example of red dust colour that is in some areas of northwest Namibia, outside Etosha National Park, photograph taken near Ugab river, 26 January 2021.

The perception of all game guards that I interviewed was that rainfall is a major factor in influencing elephant movements as they look for fresh vegetation. This is in agreement with the results of many research studies in Namibia and elsewhere (e.g. Birkett *et al*., 2012; Garstang *et al*., 2014; Purdon *et al*., 2018), discussed in Section 6.1. My observations during the field work demonstrated the rapid change of colour of the landscape from the fresh vegetation after rains (Figures 5.27, 5.28 and 6.19).



Figure 6.19 – Example of trees flushing fresh leaves before rain, with no fresh grass observed at that time; photo taken in the mountains west of Ondiwet, 26 January 2023.

Game guards indicated that the rains result in some elephants moving large distances. For example, if there has been rain in their conservancy then this attracts elephants from elsewhere, or if their conservancy has had no rain then elephants would move out of the Conservancy to another area that has had rainfall. They also indicated that the rains also influence the shorter daily movements of elephants. 29 of 34 game guards (85%) said that elephants tend to spend more time in the mountains in rainy season. According to game guards, this is partly because the leaves are out on their preferred tree species (Chapter 5), and partly because there is often standing water in parts of the river beds after rains so they do not need to visit community water points in the valleys (Figures 6.20 and 6.21).

During discussions, 24 of 34 game guards (71%) said that another reason for time spent in mountains in rainy season is that elephants stay away from sandy/silty areas in valleys when the ground is wet because they are concerned about becoming stuck in the wet mud (Figure 6.22). Some elephants do spend some time in the valleys, including in rainy season, for example 14 of 34 game guards (41%) said that elephants do like the shade of the taller trees along the river beds in the valleys during the day (Figure 6.23). The feedback was that, during the hot season (October to April), elephants tend to be eating in the mountains in the mornings, and move to valleys in the middle of hot days, which ties in with results from studies on movements of the desert-adapted elephants to the west of the Highlands (Leggett, 2009b; Leggett 2019). As the rains finish, and when there is less standing water available elsewhere, elephants tend to return to drink at community water points during the dry season, mainly visiting at night because there are fewer interactions with people and their livestock. There is some indication of this in the results of my analysis of incidents at water points, which, over the 10 years (2012 to 2021), have tended to be lower during the main rainy season months of March and April, and the following few months when there would be standing water in the river beds after good rains (Figure 4.35). The results in Figure 4.35 also indicate the high number of incidents involving elephants at vegetable gardens in the rainy season. The influence of water availability and vegetable growing season on elephant movements is further discussed in the next sub-sections of this chapter.

During the interviews and field visits, game guards provided several stories and anecdotal information, particularly the more experienced ones. For example, a game guard in Omatendeka Conservancy who had just retired in early 2023 at the time of the interview, after 21 years of service, strongly believes that the "older elephants have a map in their heads of where their forefathers have moved for good vegetation and water." He made all the points above, in common with several other game guards, for example elephants avoiding sandy/muddy areas after rains, and also indicated that elephants will move long distances and might not be seen for months during times of severe drought.



Figure 6.20 – Elephant in the hills in Ozondundu Conservancy, during a period of rains, 25 January 2023.



Figure 6.21 – Standing water in the hills of Ehi-Rovipuka Conservancy after rains, 24 March 2021.



Figure 6.22 – Example of deep foot print of elephant in flat valley during a period of rains, near Okomuuore, Otuzemba Conservancy, 4 January 2023.

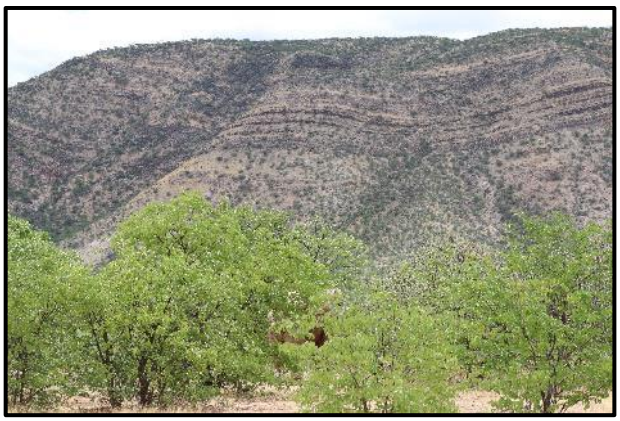


Figure 6.23 – Elephants in the afternoon in January 2023 using the mopane trees (*Colophospermum mopane*) as shade, near Okambonde, Omatendeka Conservancy. Photograph taken 20 January 2023.

6.5.3 Hotspots of reported incidents of human-elephant conflict

The system under the conservancy programme of recording by community game guards the reported incidents involving elephants in Event Books provides an important data set. It helps to identify elephant movements and prioritise mitigation measures. It enables hotspots to be identified where the most incidents have occurred. In my analysis of Event Book data, I categorised the incidents into those at water points, at vegetable gardens, and a category of "other" incidents, which includes damage to property and infrastructure (e.g. houses, kraal fences) and death or injury to livestock (Chapter 4).

Figure 4.29 provides locations of hotspots, from my analysis of Event Book data, showing the total number of incidents involving elephants reported in the six core conservancies over the 10 years (2012-2021). The main hotspots indicate elephant movements and include Ombombo, Otjozongombe and Omuramba, which are larger villages on the main gravel road, and Epunguue, Okarumbu and Okarindi, small villages away from main roads.

The records in Event Books include the location of incident, so for each conservancy I carried out analysis on trends in different parts of each of the six conservancies. This analysis is provided in Appendix C1. Figure 6.24 is an example for Okangundumba. The dates of incidents are also recorded in Event Books so Figure 6.24 is presented as an average per month basis. It shows that most incidents are in the central part of the conservancy, covering the villages of Epunguue, Otjite and Okahua. It clearly shows that incidents at vegetable gardens at Okangundumba Conservancy are mainly from February to May (i.e. during or just after the rainy season), and more incidents at water points in the dry months from June to the end of the year.

These maps and charts of human-elephant conflict are discussed in more detail in Chapter 4, but they do help build a picture of elephant movements. For example, feedback from game guards and field visits indicate that Okangundumba has particularly steep slopes and narrow valleys in the western part, and the slopes are particularly rocky (Figures 6.25 and 6.26) and elephants apparently are rarely seen to the west of the C43 road in this conservancy. There have been 139 incidents reported at Epunguue over the 10 years and 36 at Okahua in central Okangundumba, but 20 incidents reported at Omao on the C43 road, and only two incidents in Otjikukutu in the southwest (Figure 6.24).



Figure 6.25 –Steep landscape in western Okangundumba, west of C43 road. Photograph taken 16 April 2019.

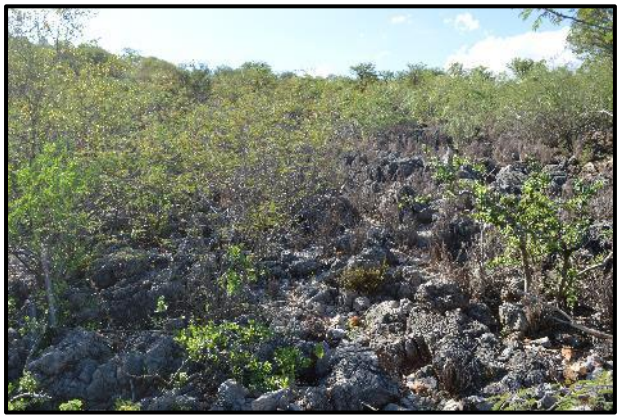


Figure 6.26 – Slopes are particularly rocky in western Okangundumba, which is likely to constrain elephant movements. Photograph taken 16 April 2019.

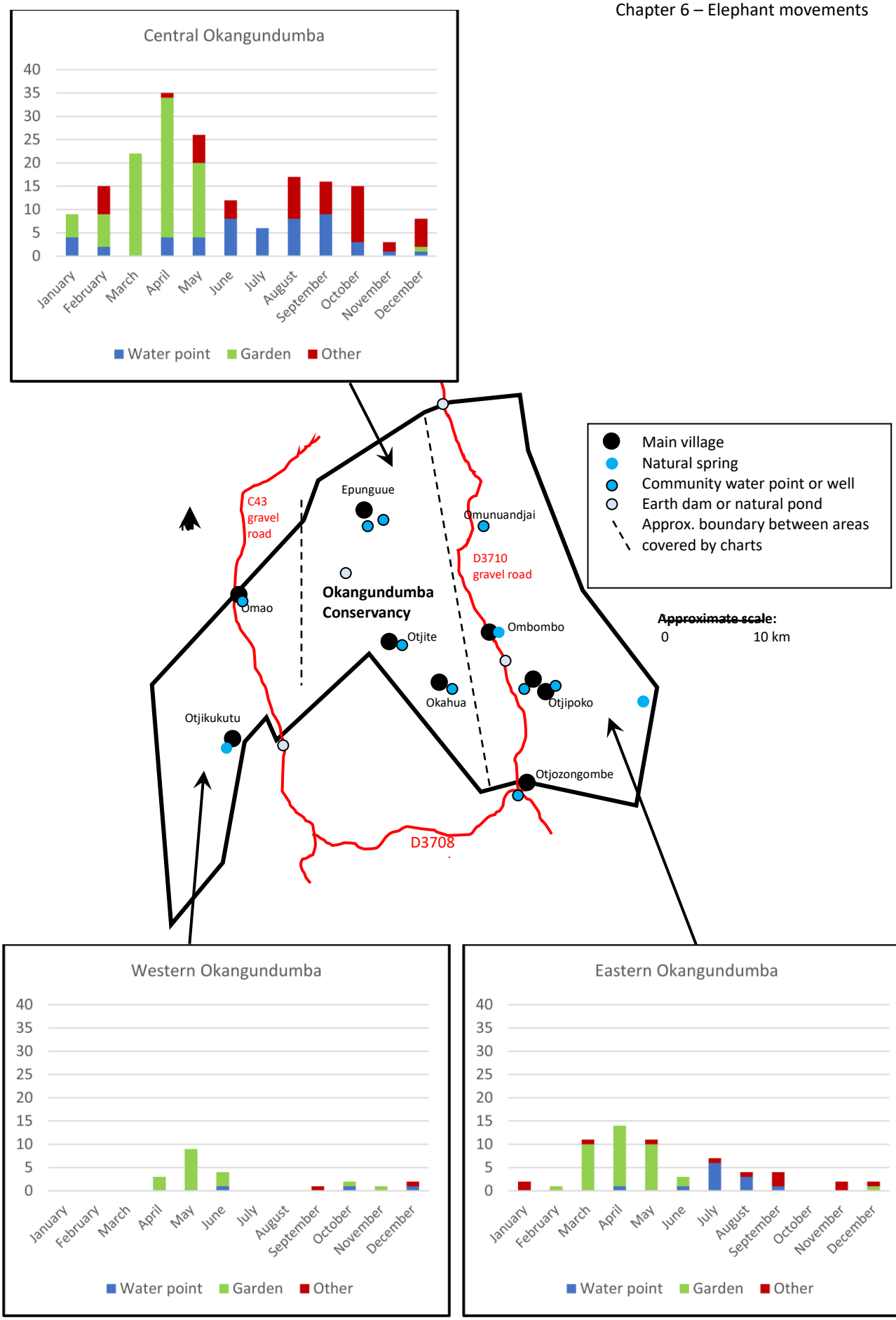


Figure 6.24 - Total incidents involving elephants recorded in Event Books in Okangundumba Conservancy by month (2012-2021)

6.5.4 Elephant visits to water points and springs

The knowledge of community game guards, as well as the data in Event Books on hotspots, provide useful information on the movement of elephants to water resources. The data in Event Books provides information on incidents (e.g. damage) reported at water points, but elephants also visit many of the springs in the Northern Highlands (Figure 6.10) (and incidents are rarely reported at springs unless there is interaction with livestock farmers). To add to the information from my analysis of Event Books, during the interviews I asked game guards about their perception of the Top 5 water points or springs visited by elephants over the last three years. The overall results for this question, and the same question for vegetable gardens visited (Section 6.5.5) are presented in Figure 6.27 for all six conservancies. The results from the analysis of this is presented in Appendix C1 for individual conservancies. Figure 6.27 shows that in Otuzemba, Orupupa and Ehi-Rovipuka Conservancies, local knowledge indicates that elephants are likely to be visiting the springs more than community water points. In Okangundumba Conservancy, there are relatively few springs and, according to game guards, it is the community water points that are visited by elephants, in particular the cattle post at Omunuandjai. There were few incidents reported in Event Books at the water point at Omunuandjai cattle post (Figure 4.30) (three incidents over 10 years), but the game guards at Okangundumba consider it to be the most visited water resource in the Conservancy. This demonstrates the additional value of the question in the interview on game guard perceptions, enhancing the information on elephant movements in addition to the hotspots from Event Book analysis. In Omatendeka Conservancy, there are many springs, but the indication from game guards is that elephants mainly visit the community water points (e.g. Otjozongombe, Okavare, Omuramba) rather than springs (Figure 6.27).

Four community water points have been upgraded to include a separate dam for holding water for elephants, typically about 1km from the community water point, with the objective to separate elephants from the community and the livestock farmers. These are annotated on Figure 6.10 and include one at Okauua (Figure 6.8 and 6.9) and Omize in Orupupa Conservancy, Okonjota in Ehi-Rovipuka Conservancy, and Outjete in Omatendeka Conservancy. Game guards perceive that Okonjota and Okauua are often visited by elephants, but Omize and Outjete less often (Figure 6.27).

Ozondundu Conservancy recorded relatively higher incidents at water points in Event Books and there is some uncertainty in the data. It was therefore useful to compare the Event Book analysis with the perception of game guards on water resources visited (Figures 6.28 and 6.29). My Event Book analysis indicates the majority of incidents are at Okarumbu and Otjomatemba water points. The feedback from game guards is the same and also that elephants often visit Okomuhana spring, where there have been no incidents reported in Event Books, as might be expected because there is no village (just a seasonal cattle post).

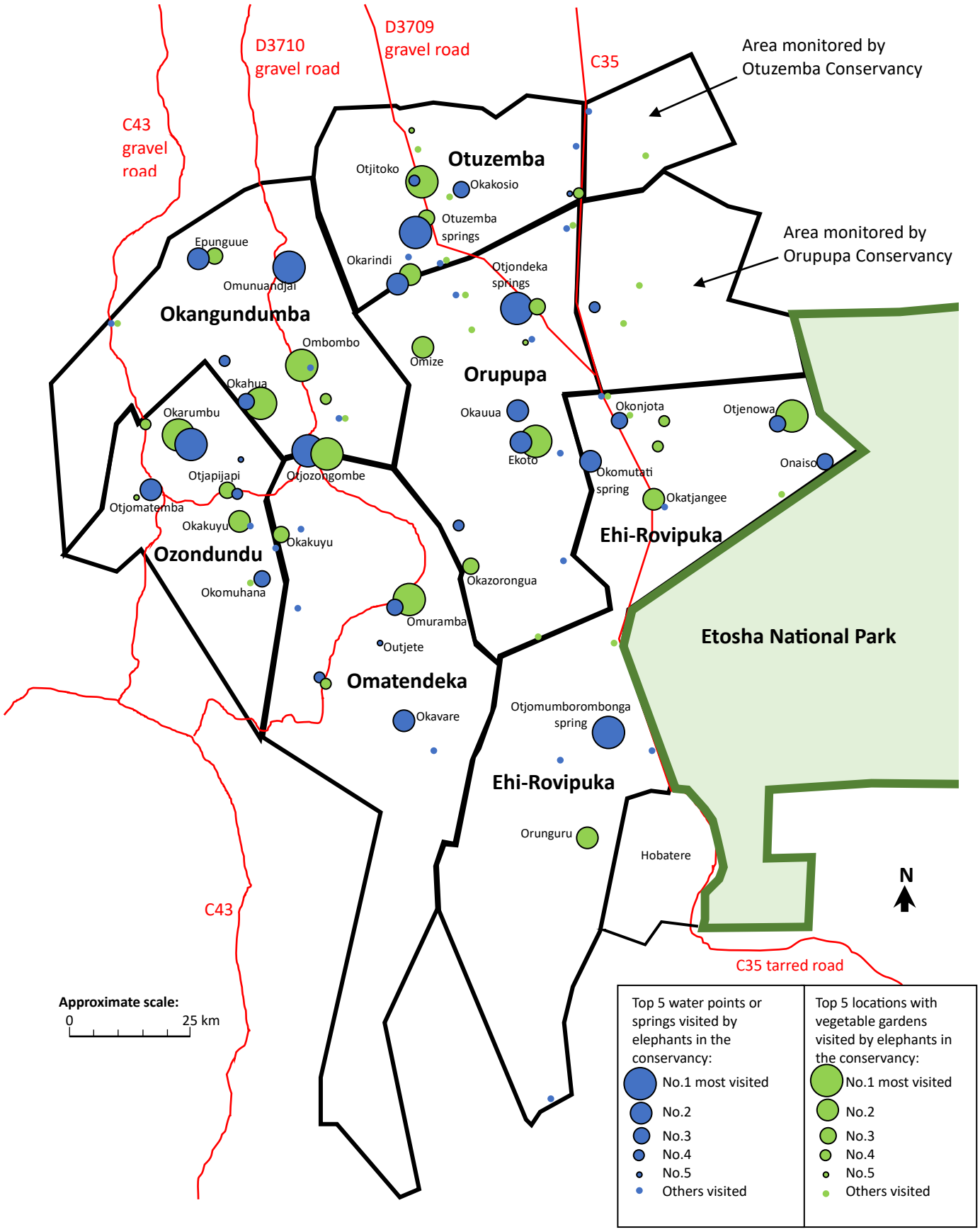


Figure 6.27 - Perceptions of community game guards (n=32) on main water points and locations of vegetable gardens visited by elephants in the six community conservancies (the map shows results for individual conservancies).

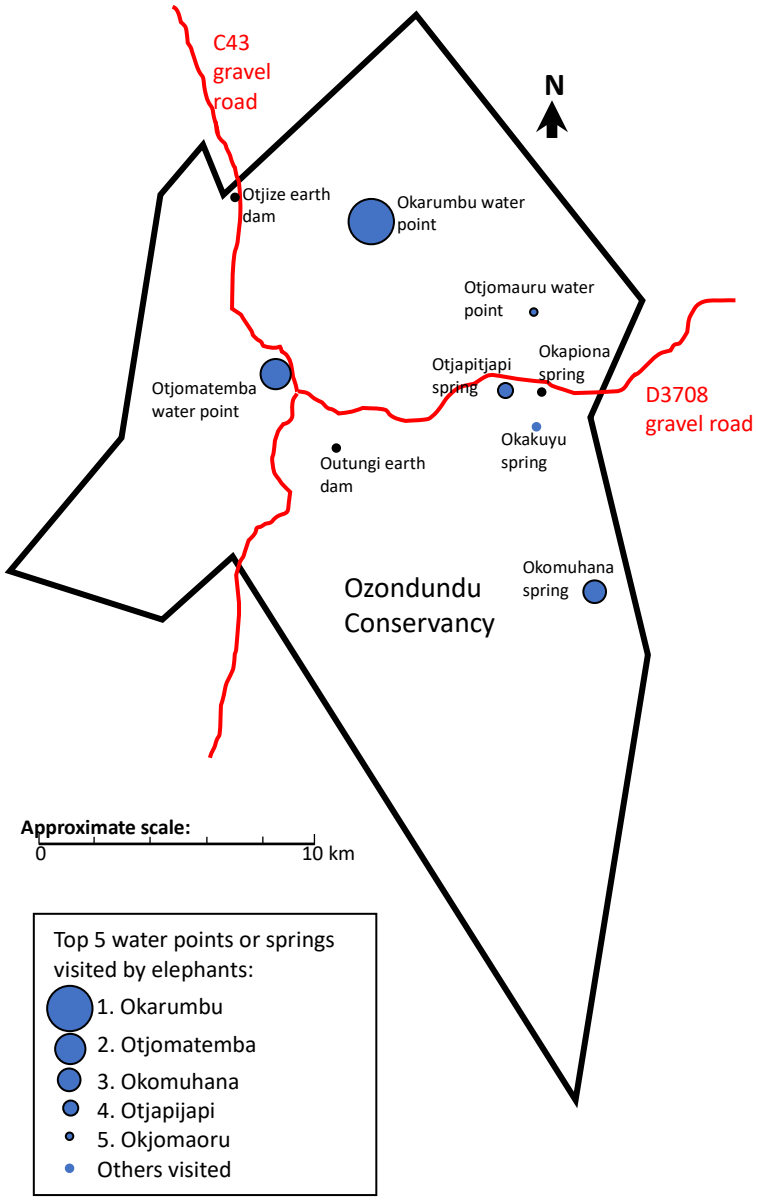


Figure 6.28 - Perceptions of community game guards (n = 6) on main water sources visited in Ozondundu Conservancy

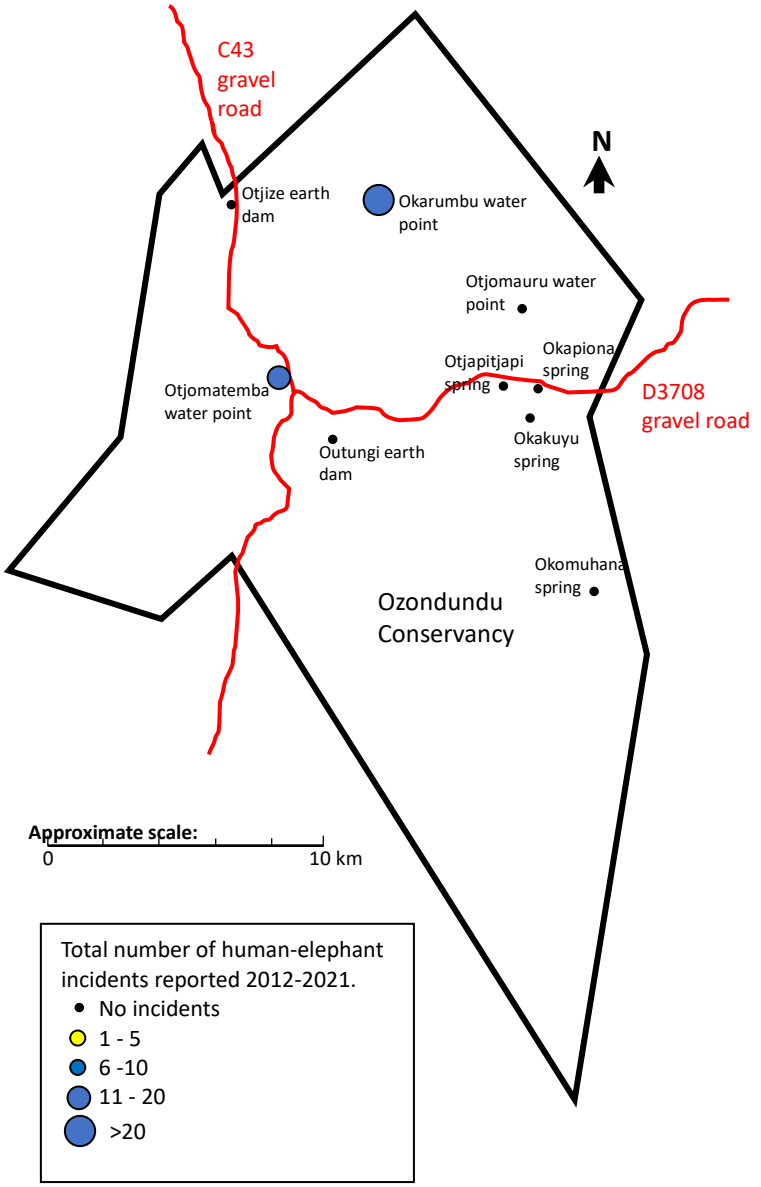


Figure 6.29 - Incidents at water points involving elephants, reported in Event Books in different villages in Ozondundu Conservancy (2012-2021)

The two types of maps, hotspots of incidents and game guard perceptions, do help identify likely elephant movements, but different factors and details on the ground need to be taken into account, such as the fact that Ekoto village in Orupupa has several nearby springs and a community water point. This is again why the many site visits (e.g. to 107 water points and springs), which I carried out with game guards, were so important for this Research Project. There is also a changing dynamic with the water points, for example in Orupupa Conservancy (Figure 6.10) the water point at Okazorongua is now only used in dry months because of the affordability of diesel fuel (Figure 6.30 and 6.31), the cattle post at Okahororua is no longer used because the water resource (well) has dried out (Figure 6.12), the water point at Okatjuru village was upgraded in November 2022 (Figures 6.32 and 6.33).



Figure 6.30 – Protection wall broken by elephants at Okazorongua in Orupupa Conservancy. The water point is no longer used for livestock by the community when they can use the rainwater collected in the nearby earth dam (Figure 6.31), because of the costs of diesel fuel for pumping, 24 January 2023.



Figure 6.31 – Earth dam at Okazorongua, Orupupa Conservancy, 6 February 2023, used for collecting rain water for livestock. It can hold water for 4-5 months after a good rainy season, during which time the community needs less often to pay for diesel fuel to pump at the community water point (Figure 6.30).



Figure 6.32 –The water point at Okatjuru had not been used for many years, Orupupa Conservancy. Photograph taken 24 March 2021.



Figure 6.33 – The water point at Okatjuru was reconstructed in November 2022 with a solar pump, which minimises operational costs for the community and ensures that the water is more permanently available in the concrete dam. Photograph taken 12 December 2022.

My observations of elephant behaviour whilst drinking at Okomutati Spring in Ehi-Rovipuka Conservancy in the Northern Highlands (Figures 6.34 and 6.35), and at waterholes in Etosha National Park (Figures 6.36 and 6.37), outside the study area, has shown that elephants prefer to drink cleaner water. I asked game guards about the statement "*elephants prefer*

fresh water at the source of a natural spring, rather than standing water in waterholes". 28 out of 34 game guards agreed or strongly agreed with the statement (83%). During the visits to community water points in the study, some had particularly dirty / stagnant water in the holding dams (Figures 6.38 and 6.39). It is likely that the state of water in springs and waterholes also affects elephant movements.



Figure 6.34 – Okomutati springs, 20 January 2018. The point where the spring water appears from the ground is on the left of the photograph, where several elephants are gathering for drinking.



Figure 6.35 – Elephants were observed to prefer to drink the cleaner water at the source of the spring, rather than the standing water in the waterhole, Okomutati springs, 20 January 2018.



Figure 6.36 – Elephant observations at Etosha Heights showed their preference for drinking the cleaner water at the source of a waterhole, 26 December 2020.



Figure 6.37 – Same waterhole as in Figure 6.36. I observed elephants to use the standing water at the waterhole for cooling/washing, but less for drinking, as they would wait for their turn to drink the cleaner water from the source, 26 December 2020.



Figure 6.38 – Stagnant, unclean water at Otjipoko, Okangundumba Conservancy, 16 December 2022.



Figure 6.39 – Clean water at Okavare, Omatendeka Conservancy, 7 January 2023.

6.5.5 Influence of vegetable gardens on elephant movements

As I discussed in Chapter 4, there has been a changing situation in relation to human-elephant interactions because in 2020 there was a step increase in the number of vegetable gardens set up by the local communities of the Northern Highlands. During my more open questions and discussions with game guards, they had a common perception that elephants used to stay away from community water points during, and for a while after, good rains because of the standing water in other areas, and they tended not to risk coming near to villages for water. This dynamic has changed because there are now many more vegetables grown during these months. Figure 4.35 shows the much higher number of incidents reported in Event Books at vegetable gardens in the months of March, April and May (the vegetable growing season) and Figure 4.16 shows the step increase in total incidents reported at vegetable gardens in 2020 and 2021 for the six conservancies.

Figure 4.31 shows the hotspots of incidents reported at vegetable gardens, plotted from my analysis of data in Event Books for the six core conservancies in this Research Project. The maps of hotspots for individual conservancies are provided in Appendix C1. In addition, I asked the game guards during interviews to identify their Top 5 locations of vegetable gardens visited by elephants over the last three years. I also plotted these results on conservancy maps (Appendix C1), and also on an overall map for the six conservancies (Figure 6.27), which identifies locations where mitigation measures might be targeted. For example, they might be targeted as a priority at the small settlement of Otjenowa in northern Ehi-Rovipuka Conservancy, and Ekoto in Orupupa Conservancy, (Figures 6.40 and 6.41). Otjenowa is near the boundary of Etosha National Park, where the local community during my visit told me that elephants were often moving for short time periods out of the Park for crop raiding and then quickly returning into the Park.



Figure 6.40 – Large vegetable garden Otjenowa, near the boundary of Etosha National Park, 26 March 2021.



Figure 6.41 – Vegetable garden Ekoto, where the community has been expanding their gardens since 2019; photograph taken 28 February 2022.

Figures 6.42 and 6.43 compare game guard perceptions of locations of vegetable gardens visited by elephants with incidents involving elephants at vegetable gardens reported in Event Books, for Orupupa Conservancy as an example. It shows that perceptions of locations visited are broadly similar to the main locations for which incidents are reported, but with a different emphasis in terms of the perceived highest number of incidents. The game guards perceive that the most visits are to Ekoto (Figure 6.42), whereas the Event Book data indicates that Okozonguehe and Okomizoma have the highest number of incidents (Figure 6.43). More detailed analysis indicates that 14 incidents were reported at vegetable gardens in Ekoto over the 10 years of 2012 to 2021, 13 of which were in 2020 and 2021. My visits to Ekoto, and discussion with the game guard based there, confirmed that their vegetable gardens are important to the community and, unlike some villages who have been growing fewer vegetables in 2021 and 2022 because of the problems with elephants in 2020, the community at Ekoto is expanding their vegetable gardens (Figure 6.44).

The map for Orupupa of perceptions (Figure 6.42) provides additional information on the hotspots, and shows the small, remote villages of Ekoto and Omize in Orupupa Conservancy are likely to be impacted by elephants at vegetable gardens. The data from Event Books (Figure 6.43) provides the best indication for identifying priority locations for mitigation measures at vegetable gardens. However, also planning mitigation at locations that are important to the community or have recently had a step up in incidents, as for Ekoto and Omize, might motivate local people to step up their commitment to elephant conservation. The different local situations need to be considered when planning mitigation. For example, one game guard suggested that water storage tanks, observed at only a few vegetable gardens, need to be separated from the garden because the water itself might attract elephants (Figure 6.45).

Comparative analysis of the game guard perceptions with reported incidents at vegetable gardens in Event Books shows the only main discrepancy to be in Ozondundu. Game guards perceive there to be many incidents at vegetable gardens in Okarumbu and yet there have been no incidents reported in Event Books.



Figure 6.44 – Evidence of a visit by an elephant to vegetable gardens at Ekoto, Orupupa Conservancy. Photograph taken 28 February 2022.



Figure 6.45 – Vegetable garden at Enduu Cattle Post, Ehi-Rovipuka Conservancy, includes a water storage tank, which is not common for gardens in the area. Photograph taken 5 March 2022

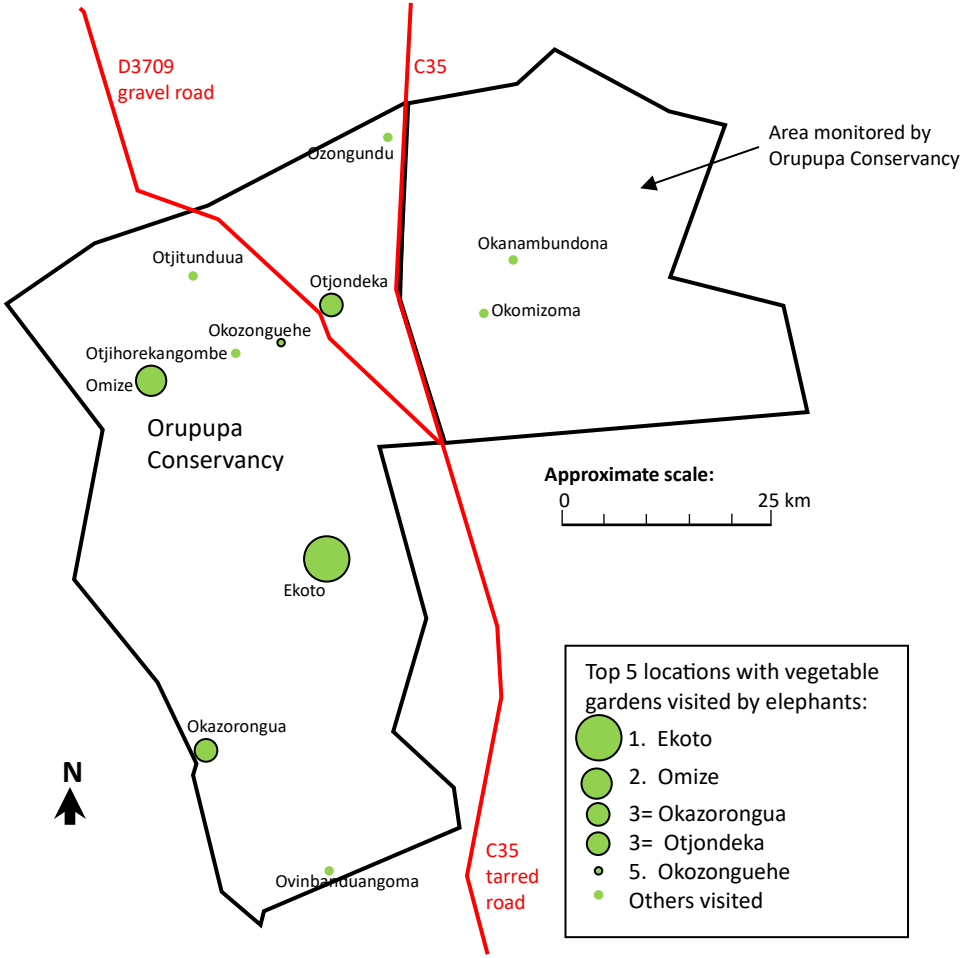


Figure 6.42 - Perceptions of community game guards (n=6) on main locations of vegetable gardens visited in Orupupa Conservancy

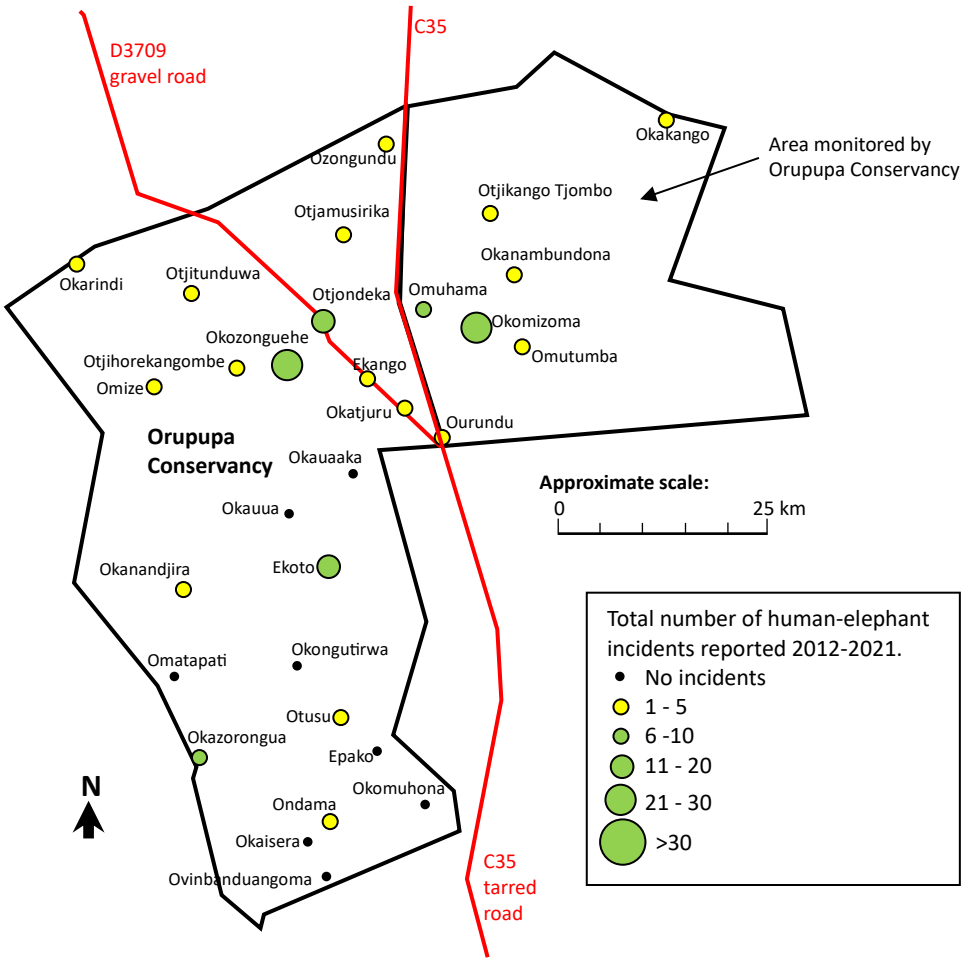


Figure 6.43 - Incidents at vegetable gardens involving elephants, reported in Event Books in different villages in Orupupa Conservancy (2012-2021)

6.5.6 Influence of vegetation on elephant movements

As noted in Section 6.1, the movement of elephants during the rainy season to find fresh vegetation has been extensively researched in previous studies in Africa. This was also confirmed by the game guards in the Northern Highlands. In Chapter 5, my analysis demonstrated that elephants selectively prefer to browse certain species of tree that are present mainly at higher altitudes, often on rocky slopes, such as the African star chestnut tree (*Sterculia africana*) (Figures 6.46 and 6.47), and the main species of *Commiphora* trees that are present in the Northern Highlands, including the blue-leaved corkwood (*Commiphora glaucescens*) and purple-stemmed corkwood (*Commiphora multijuga*). This conclusion was based on local ecological knowledge and my observations in the field. The results also indicate that elephants are more selective in the rainy season, and less so in the dry season when they do eat other species, such mopane trees (*Colophospermum mopane*), which is the most abundant species in the Northern Highlands area and is present mainly in the valleys and lower slopes.

This finding on tree species selection, combined with my observations from field walks with game guards in the mountains, confirmed that elephants are walking up the steep slopes to eat their preferred tree species, as discussed in Chapter 5. Figures 6.48 to 6.51 provide additional examples of elephant activity on slopes in the mountains through my observations of elephant dung and trees partly eaten by elephants. All the game guards consulted said that elephants walk up steep slopes to find their preferred vegetation. As discussed in Chapter 5, this is unusual behaviour for a large mammal often associated with flat African plains (Skinner and Chimimba, 2005; Wall *et al*., 2006).



Figure 6.46 – African star chestnut (*Sterculia africana*), partially eaten by elephants, in the mountains above Omutirapo, Omatendeka Conservancy. Photograph taken 26 January 2023.



Figure 6.47 – Elephant eating African star chestnut (*Sterculia africana*), southeast of Otjomatemba, Ozondundu Conservancy. Photograph taken 25 January 2023.

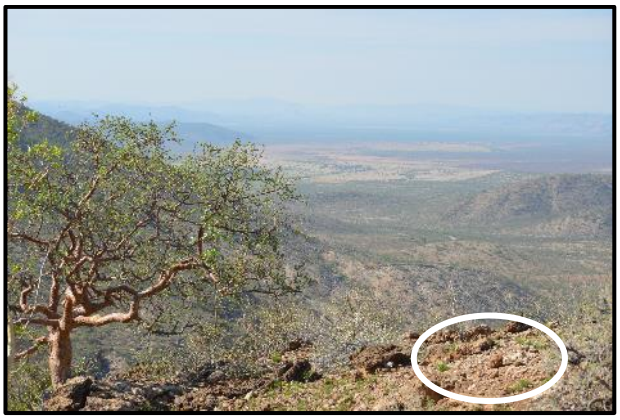


Figure 6.48 – Elephant dung (circled) observed at high altitude above a cliff near Okovimbara spring, Omatendeka Conservancy, and near the *Commiphora glaucescens* tree, which is one of the species that elephant prefer. Photograph taken 2 April 2021.



Figure 6.49 – Partly eaten *Commiphora glaucescens* tree to the left of the photograph, up mountain above Orupara spring, Omatendeka Conservancy, and I also observed elephant dung (circled), 7 February 2023.



Figure 6.50 – Elephant dung (circled) observed on a mountain path on the cliff above Ekoto village (4 March 2021) showing elephants are taking pathways on steep slopes in the mountains.

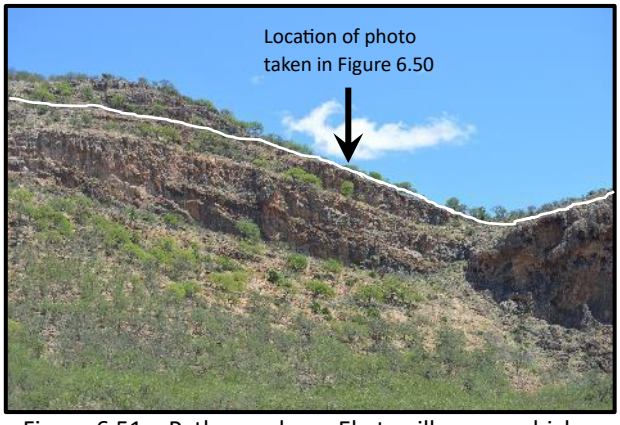


Figure 6.51 – Pathway above Ekoto village on which I observed elephant the dung in Figure 6.50, 4 March 2021. This point was measured at about 90m above the valley floor.

One interesting aspect is to compare the number of incidents involving elephants reported in the mountainous area of the Northern Highlands with the number of incidents in the relatively flat area of land between Etosha and the start of the mountainous area. The plains landscape of Etosha National Park continues from east to west across most of northern Ehi-Rovipuka, and the eastern areas of Orupupa and Omatendeka. Figure 6.1 provides a map of the Northern Highlands area, with photos of the landscape, showing the approximate boundary between the mountainous area and the flat plains to the east, including Etosha National Park. The D3709 road provides an approximate dividing line between the flat sandy areas and the rocky slopes of the Northern Highlands, as shown in Figure 6.52. Figure 6.53 shows the same map as Figure 6.1 with charts from my analysis of reported incidents of human elephant conflict over 10 years, comparing the number of incidents in the flat areas to those in the mountains.

In Figure 6.53 the southern parts of Omatendeka and Ehi-Rovipuka Conservancies are indicated. These areas have fewer settlements, water points and vegetable gardens, and therefore the results show fewer reported incidents of human-elephant conflict, as expected

(22 incidents reported over 10 years of 2012-2021, equivalent to about 1.3 incidents per 100 km^2 over the 10 years). It is more interesting to compare the number of incidents in the flatter areas in the north of Ehi-Rovipuka and eastern Orupupa and eastern Otuzemba, annotated in Figure 6.53, with the incidents in the mountainous area. Based on my field observations and site visits, there are a similar number or more settlements, water points and vegetable gardens in these flatter areas compared to in the mountains. However, there are far more incidents (829 incidents reported over 10 years (about 18.6 incidents per 100 km^2)) in the mountainous areas than the flatter areas (145 reported over 10 years (about 6.5 incidents per 100 km^2)). This analysis is another aspect that supports the observations and local feedback that elephants spend much time in the mountainous areas.

The analysis becomes even more interesting when presenting the data on the total number of incidents by months of the year over 10 years (Figure 6.54). This shows the higher number of incidents in March to May because of the vegetable growing season. The particularly interesting aspect is the low number of incidents in the flatter areas in the north of Ehi-Rovipuka and eastern Orupupa and eastern Otuzemba in the drier months from June to December. However, there are incidents in those months in the mountainous areas, supporting the common perception of game guards that elephants are now staying in the mountains in the dry season, whereas in the 2000s local feedback is that more elephants used to return to Etosha National Park in the dry season.



Figure 6.52 – Photograph taken (2 March 2022) in Orupupa Conservancy on the junction of the C35 road and D3709 (Figure 6.53), looking north, showing the abrupt change in landscape from the flat plains to the Northern Highlands. The generally flat landscape continues east for hundreds of km across Etosha National Park and further across Botswana. The Northern Highlands start on the left of the photograph and continue west for up to 100 km until an escarpment where the landscape slopes down steadily to the Skeleton Coast.

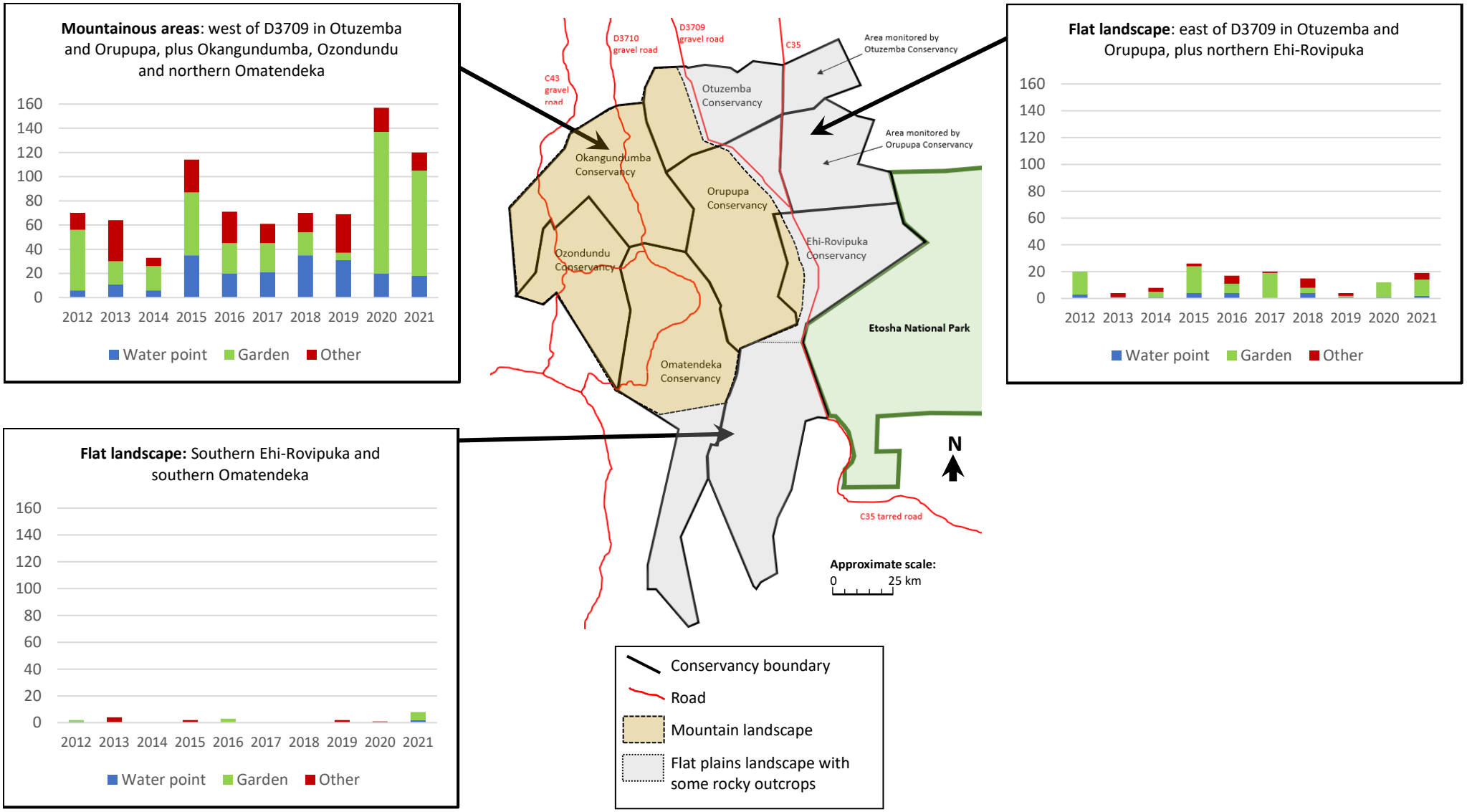


Figure 6.53 - Comparison of incidents involving elephants reported in Event Books in mountainous areas and flat areas of the six conservancies

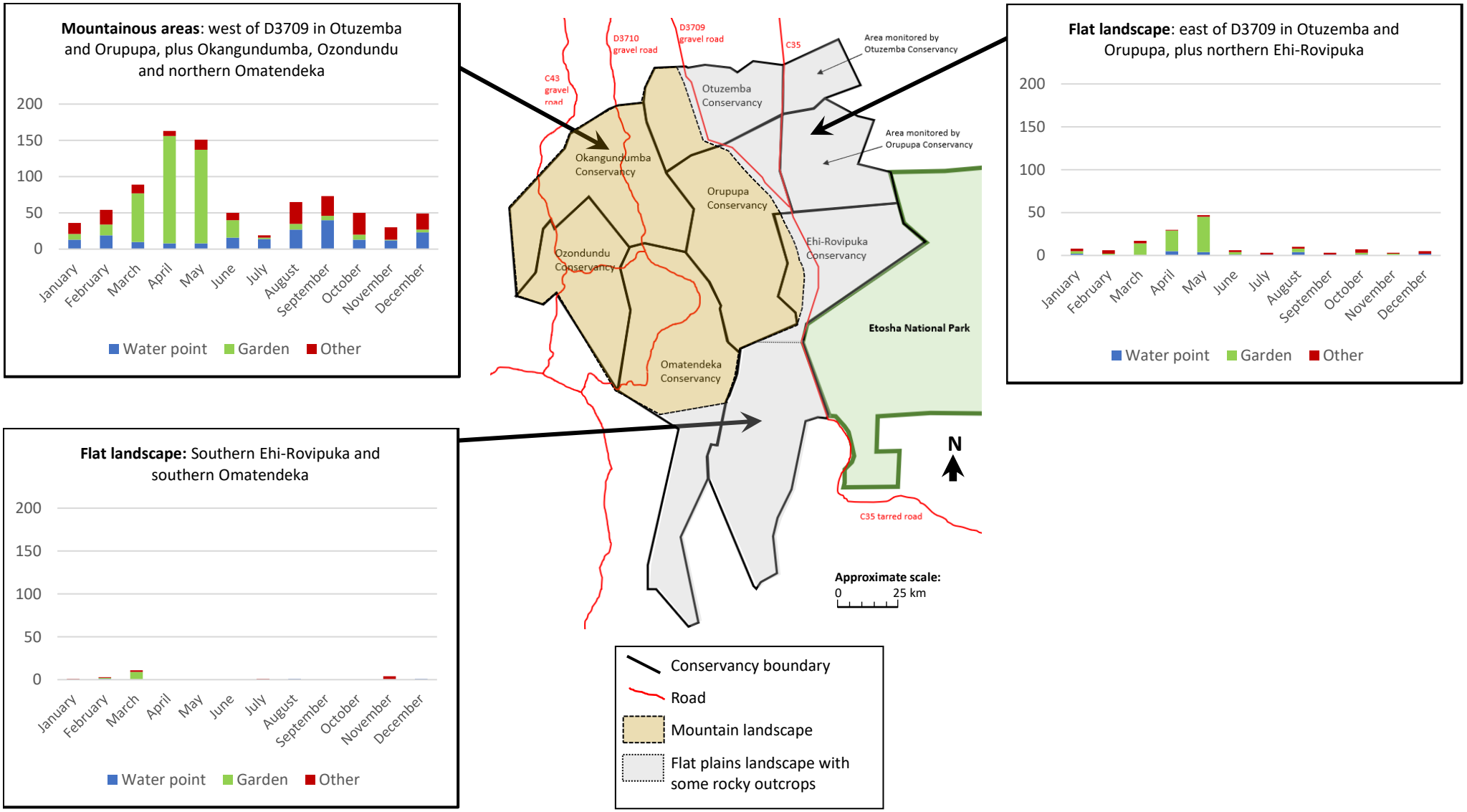


Figure 6.54 - Comparison of incidents involving elephants (by month) reported in Event Books in mountainous areas and flat areas of the six conservancies

6.5.7 Movement patterns of elephants in the Northern Highlands

(a) Game guard perceptions on directions of movement

My experience from the interviews is that game guards tend particularly to know about elephant movements in their area (i.e. around their village and neighbouring villages). They know some points on elephant movements elsewhere in their conservancy, because of their discussions at team meetings of game guards (which take place for each conservancy at least monthly). The individual game guards made the point during interviews that they tend to know less about elephant movements outside of their conservancy.

The perception given from the open discussion in the interviews is that elephants tend to be in the area of a village and water point for up to two weeks, visiting the water point at night in the dry season and usually keeping in the hills or valleys away from the village during the day, and then moving a longer distance to be near another feeding area and community water point or spring after about two weeks. A game guard might not then observe the group for many months, and would not be aware of the distance travelled. This pattern tends to apply for female-led herds and for individual males or small groups of males. My discussion with game guards and analysis of known groups (Chapter 3) demonstrated that groups do move large distances across the Highlands, because the same groups were identified by game guards in different places across the six conservancies. Figure 6.55 provides another illustration of the difficulty for game guards to be confident about elephant locations and movements, even near their village, because of the vast expanse of the Highlands landscape.



Ekoto vegetable gardens, located on the edge of the village, 4 March 2021.



Ekoto water point, 28 February 2022.

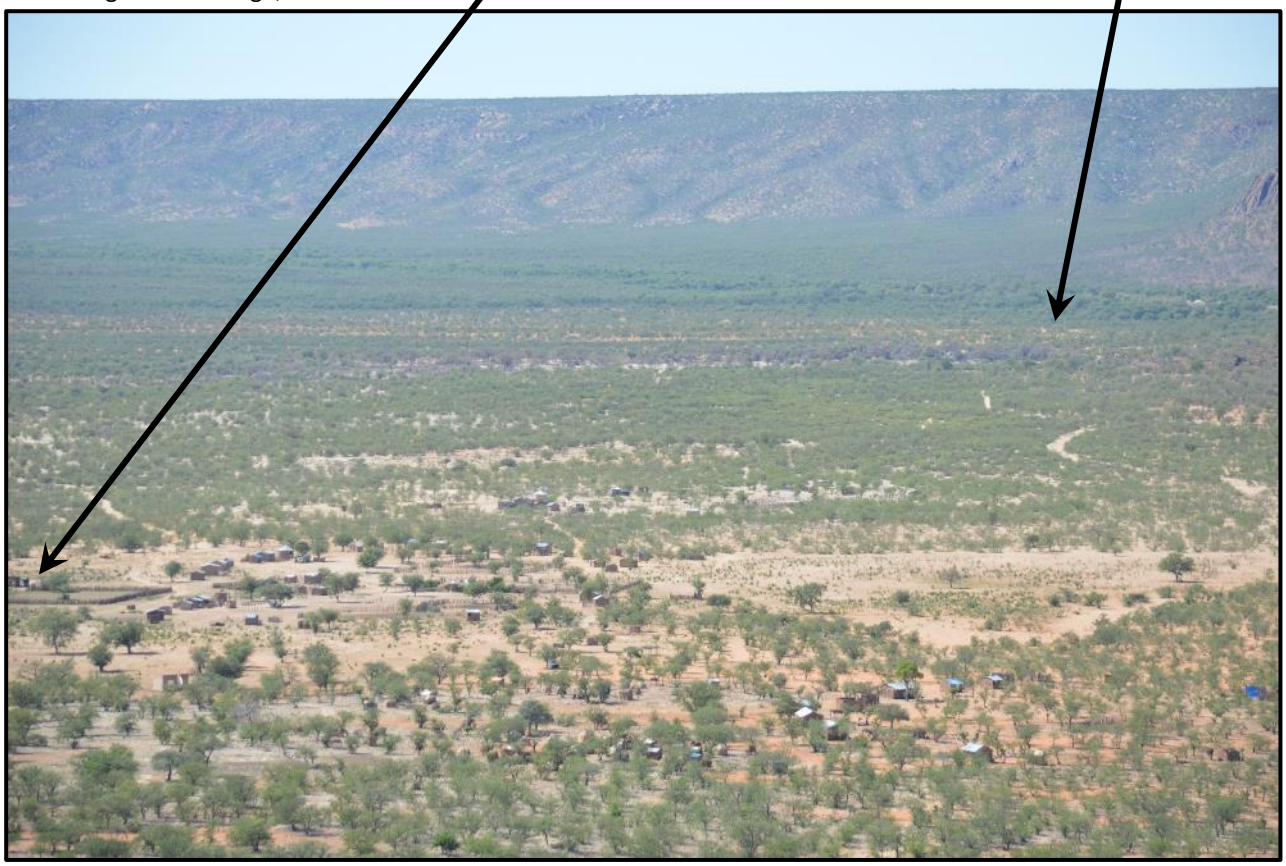


Figure 6.55 – Ekoto is typical of villages in the Northern Highlands in that it is located in a valley and there is space for the households to be quite spread out, but Ekoto is different to many other villages because its water point is located further away (3 km) from the village, partly because there are springs near to the village. This photograph, taken from the top of Ekoto cliff (Figure 7.12) on 4 March 2021, shows that after elephants visit the springs or vegetable gardens at Ekoto at night, then there are many places in the hills and across the valleys where they could eat and rest in shade during the day, and the photograph demonstrates the difficulty for game guards in knowing about daily locations and movements of elephants.

I asked game guards details about the elephant groups with which they are familiar (Chapter 3). For the groups that they know, I then asked them to draw on a map of their conservancy the main area where they think each group spends time, and the typical movements of each group (Figure 6.56 provides an example of a map drawn by a game guard in Omatendeka Conservancy).

I obtained such maps from 30 game guards in total across the six conservancies. I analysed and collated the directions of movement drawn for each conservancy. My visual analysis of the maps showed that the majority of the arrows of movements drawn on a map tended to be from one area towards a community water point or spring. Some game guards also drew arrows for movement of some groups out of the conservancy, but my analysis using the overall map of the six conservancies (Figure 6.10) indicated that those movements also tended to be drawn in the direction of a water point or spring in the neighbouring conservancy. Therefore, I could prepare maps for each conservancy of movement patterns according to game guards. The maps over the next few pages show the results from this participatory mapping on routes of elephants as perceived by game guards for each of the six core conservancies, with the thickness of each movement line indicating the number of game guards drawing a movement of elephants in that direction.

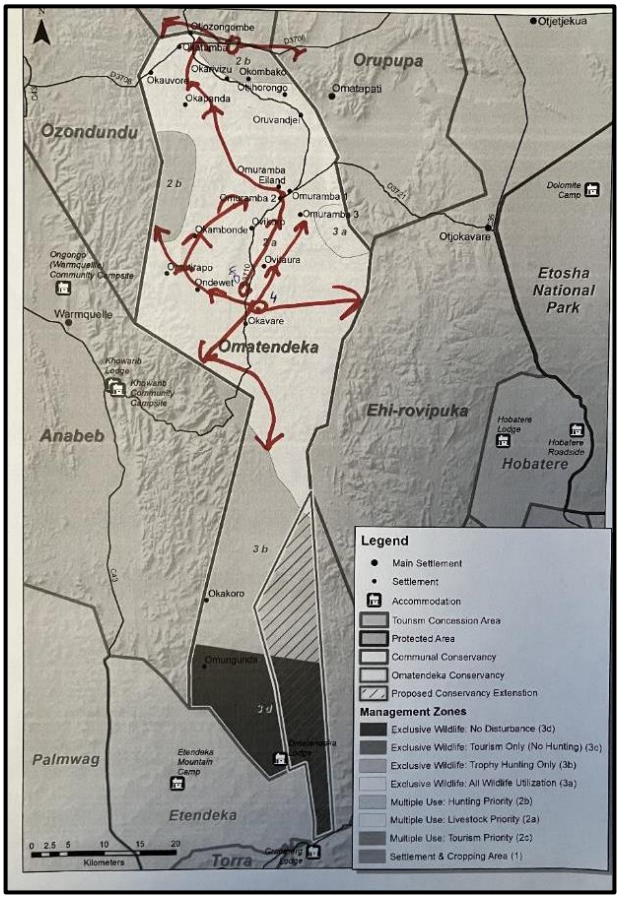


Figure 6.56 – Example map of typical movements of elephant groups, in Omatendeka Conservancy, drawn by a senior game guard who has 12 years of service and is based in Okavare, 7 January 2023.

Comparisons of the results on movements on the conservancy maps with the general feedback from game guards on movements, and particularly with my field observations

during the Research Project, are very interesting. I summarise these comparisons below for each conservancy:

In **Ozondundu Conservancy** (Figure 6.57), there is a strong indication shown on the map of movements of a route of elephants in an arc from Okarumbu through Ojomatemba, which both have community water points a distance of about 500m from the houses, and to the spring and dug well at Okomuhana cattle post. There is less movement to the springs and vegetable gardens around the Otjaptijapti and Okakuyu area. This ties in with the general feedback from game guards in the conservancy and the data in Event Books which shows hotspots at Okarumbu and Otjomatemba. Taking into account the maps drawn by game guards in neighbouring conservancies, it is likely that elephants mainly leave the Conservancy from Okarumbu to Okahua or Otjite in Okangundumba Conservancy and from Okomuhana towards Okapanda in Omatendeka Conservancy (these villages are shown in a combined map of the six conservancies in Figure 6.73). Game guards said that sometimes elephants move south to the springs in Otjondunda in Anabeb Conservancy (Figure 6.57), but tend to return and not move further towards Sesfontein (Figure 1.2).

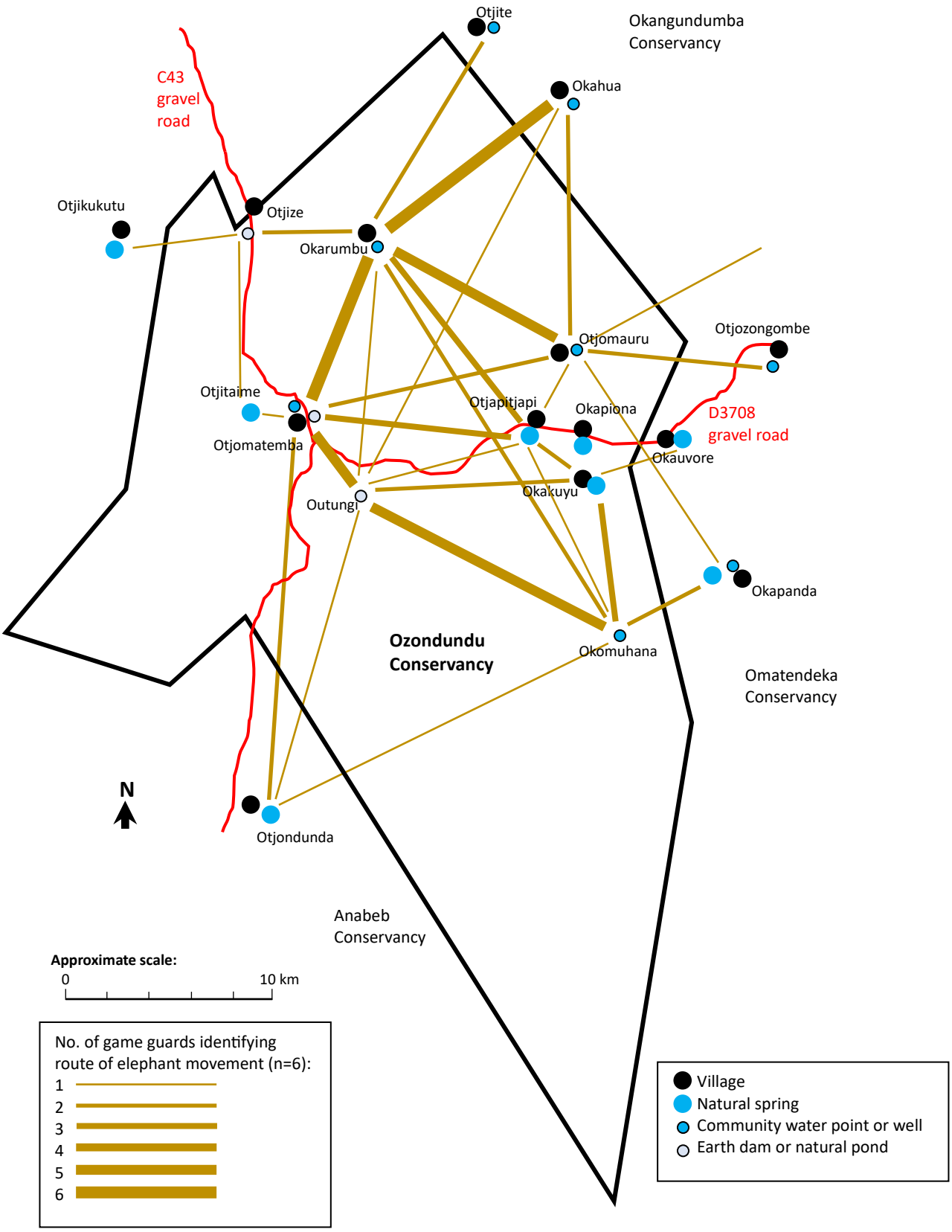


Figure 6.57 - Routes of elephant movements, collated from drawings on conservancy map by game guards of Ozondundu Conservancy (number of game guards = 6)

In **Omatendeka Conservancy** (Figure 6.58), the general feedback from game guards was interesting in terms of where elephants do not tend to go, which is to the set of villages and springs along or near the D3710 in the northeast part of the conservancy (Oruvandjei, Okozonduno, Otjihorongo, Okombako and Okarivizu), (Figure 6.59). All these villages do have springs nearby (Figure 6.60), or in the hills above (with water piped down to the village). The village of Okombako in particular has relatively large vegetable gardens, at which the vegetables are grown for more of the year using spring water (Figures 6.61). The elephant routes from the participatory mapping (Figure 6.58) confirm this common perception and that the elephants avoid these villages and are instead moving in between Omuramba and Otjozongombe on a route to the west via Okapanda. The D3710 between Oruvandjei and Okarivizu has many bends (Figure 6.59) and some parts of the valley have steep sides and this risk in terms of vulnerability because of the terrain, as well as the close proximity of several settlements, are likely to be reasons that elephants generally avoid this area. The map for Omatendeka Conservancy also supports my field observations that elephants visit the water point at Okavare village (Figure 6.62) and the one at Outjete cattle post (which has a separate dam for elephants (Figure 6.58)).

The game guards at Ondiwet and Okavare in Omatendeka Conservancy also had the perception that elephants are spending time in the mountains west of Ondiwet, where there are several springs but no settlements and therefore local knowledge is more limited. Based on my longer field walks in that area during the Research Project, this was confirmed through my observations of elephant dung and partially eaten trees up particularly steep slopes (Figures 6.48 and 6.49).

My assessment of the maps of neighbouring conservancies indicates it is likely that elephants leave Omatendeka Conservancy from Otjozongombe into Okangundumba (e.g. to Okahua, Otjipoko and Ombombo) (Figure 6.73). They also move to Ozondundu Conservancy from Okapanda to Okomuhana, to Orupupa Conservancy from Omuramba and Ondendati to Okazorongua and Omatapati, and east to southern Ehi-Rovipuka from Okavare to Onguta and potentially then a route into Etosha National Park.

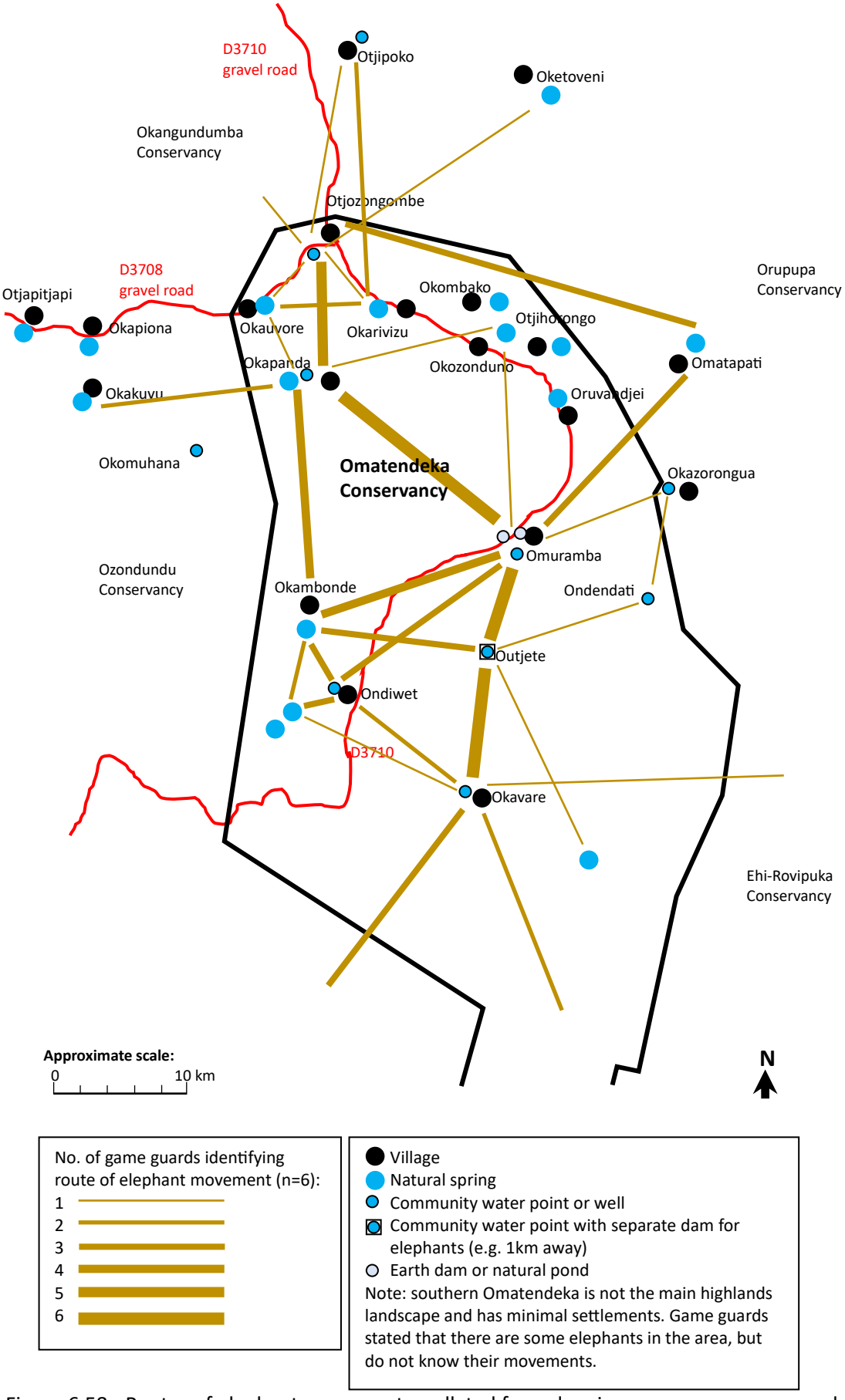


Figure 6.58 - Routes of elephant movements, collated from drawings on conservancy map by game guards of Omatendeka Conservancy (number of game guards = 6)



Figure 6.59 – Elephants avoid the area around the D3710 between Oruvandjei and Okarivizu in Omatendeka Conservancy, despite several springs and vegetable gardens in the area; photograph taken 23 January 2023.



Figure 6.60 – Spring near D3710 road and Okarivizu village; photograph taken 31 March 2021. No elephant dung or footprints were observed during the site visit.



Figure 6.61 – The large vegetable garden at Okombako in Omatendeka Conservancy tends not to be visited by elephants, according to local people consulted and Event Book data; photograph taken 8 January 2023.



Figure 6.62 – Elephant dung observed at Okavare water point, Omatendeka Conservancy; 9 February 2023.

In **Okangundumba Conservancy** (Figure 6.63), the elephant movements according to game guards tend to be in the central and eastern parts of the Conservancy, including Epunguee, Okahua, Ombombo and Otjozongombe, which ties in with the results on hotspots of incidents (Figure 6.24). The map of movements also indicates that elephants are moving to the water point at Omunuandjai cattle post. This is interesting because the game guards at Otuzemba Conservancy indicated the movement towards Omunuandjai is a main route of elephants out of that Conservancy (Figure 6.64). Omunuandjai has a solar pump and therefore more permanent water in the concrete dam, and as a cattle post has fewer people than at water points in villages, and therefore likely to have less disturbance for elephants and fewer incidents reported. I often drove past Omunuandjai on the D3710 road and stopped to observe the area around the water point, and I often observed quite fresh elephant dung (Figure 6.6).

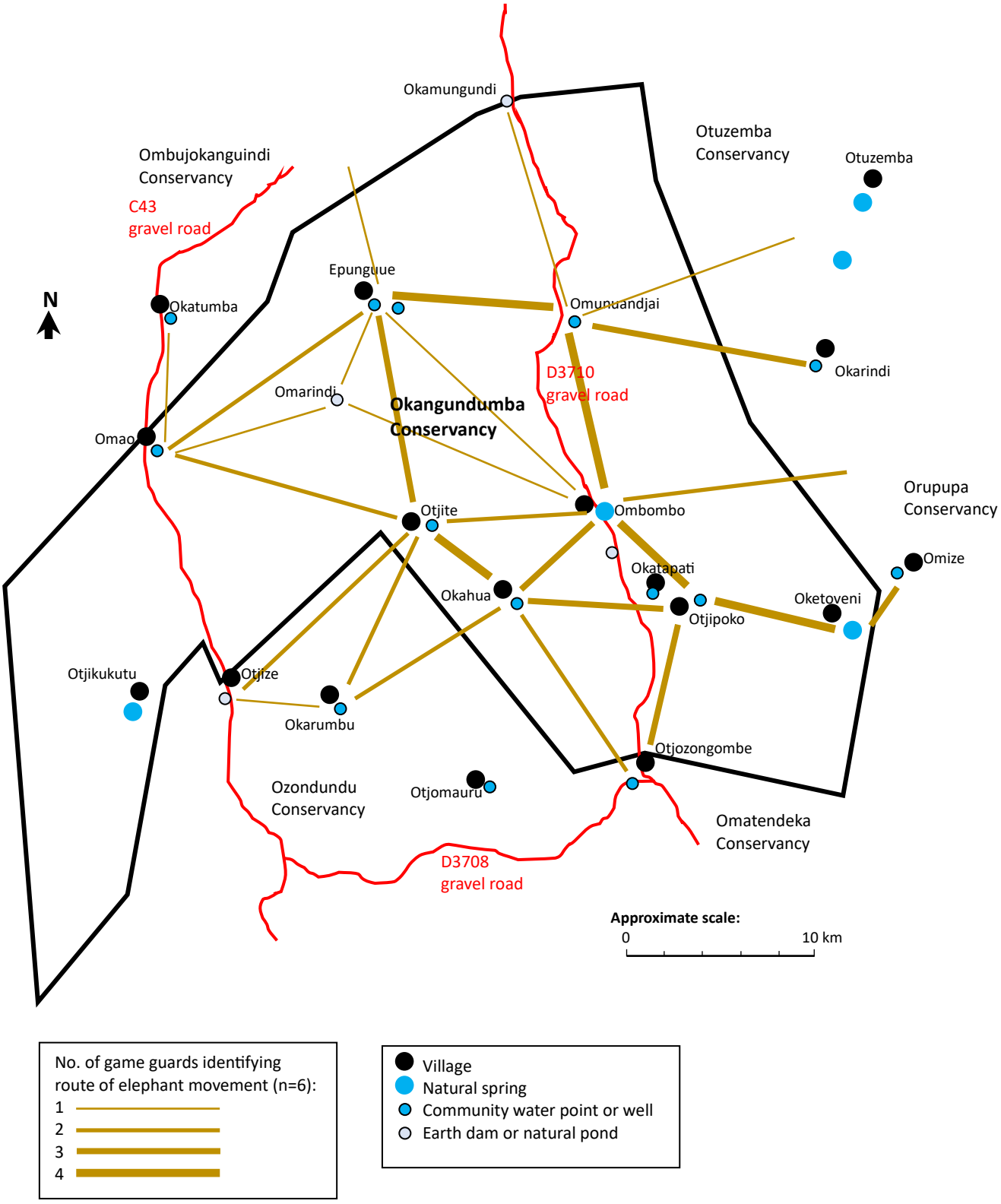


Figure 6.63 - Routes of elephant movements, collated from drawings on conservancy map by game guards of Okangundumba Conservancy (number of game guards = 4)

In **Otuzemba Conservancy** (Figure 6.64), there are several springs and, according to the maps by game guards, elephants in particular tend to visit the southern and eastern parts of the Conservancy around Otuzemba springs and Okarindi water point, which is consistent with my field observations of elephant dung at those water sources (Figures 6.65 and 6.66). The map of movements does indicate routes towards Omunuandjai in Okangundumba Conservancy. The game guards of Otuzemba Conservancy and the one game guard interviewed in each of Okongoro Conservancy to the north and Otjombande Conservancy to the northwest, all indicated that elephants do move in the directions of Okongoro and Otjombande Conservancies, but not so often as to Orupupa and Okangundumba.

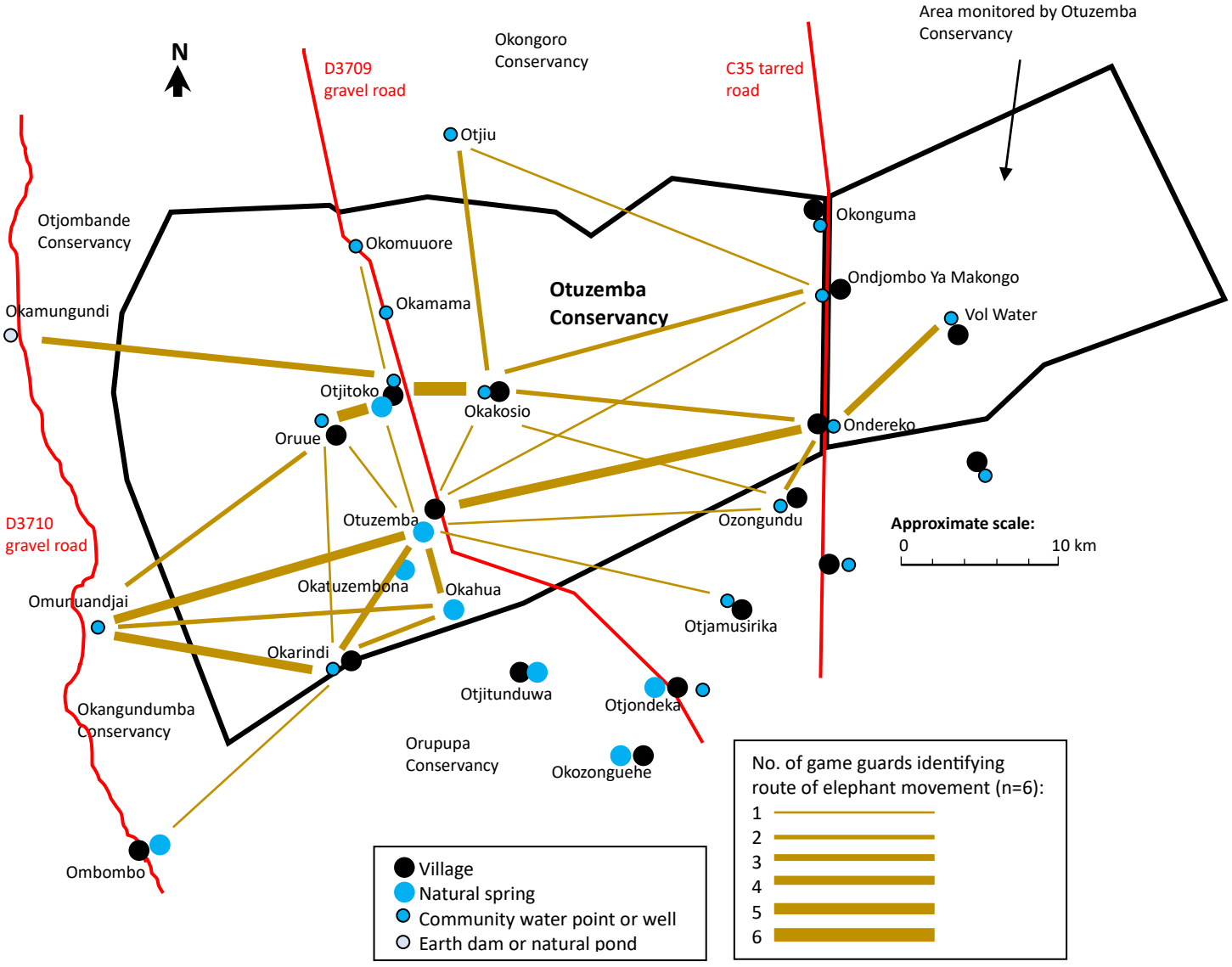


Figure 6.64 - Routes of elephant movements, collated from drawings on conservancy map by game guards of Otuzemba Conservancy (number of game guards = 6)



Figure 6.65 – Elephant dung observed at Otuzemba Spring, 9 September 2018.



Figure 6.66 – Elephant dung at Okarindi water point, 13 January 2021.

Orupupa Conservancy also has several springs and the perceptions of game guards on elephant movements on the map (Figure 6.69) indicate more elephant movements in the area of the Conservancy that is more mountainous and has more springs to the west of the D3709 and C35 roads, compared to the flat area with no springs (but with many community water points) to the east of the D3709 and C35. The map shows an elephant route between Okarindi in the northwest of the Conservancy and Okazorongua in the southwest, via a series of springs down the central part of the conservancy (Otjitunduwa, Otjondeka, Okozonguehe, Ekoto and Okongutirwa). This result is also consistent with my observations in the field (Figures 6.67 and 6.68). The route includes the water point at Okauua cattle post (Figures 6.8 and 6.9), which has a separate dam for elephants about 0.5 km from the community water point.



Figure 6.67 – Elephant dung at Otjondeka Springs, 5 March 2021.



Figure 6.68 – Elephant dung at Ombingugohenda Spring above Ekoto, 28 February 2022.

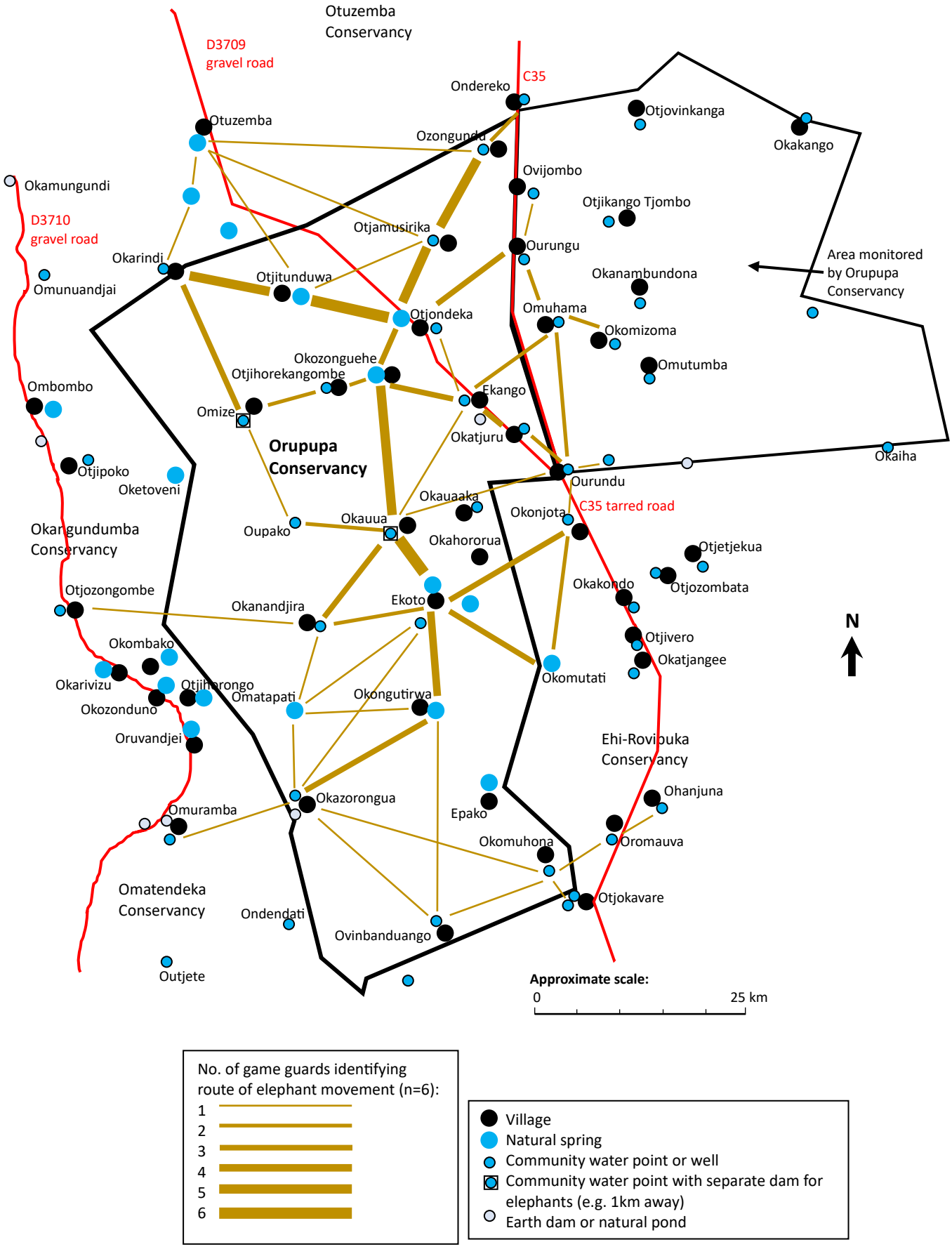


Figure 6.69 - Routes of elephant movements, collated from drawings on conservancy map by game guards of Orupupa Conservancy (number of game guards = 6)

The map of elephant movements in **Ehi-Rovipuka Conservancy** (Figure 6.72) is based on the perceptions of only two game guards. It does indicate that elephants are moving in and out of Etosha National Park in the northeast of the Conservancy, to the water points of Otjenowa, Orondjize, Okakutu and Onaiso, and to the large vegetable gardens at Otjenowa (Figures 6.70 and 6.71). In these cases the feedback is that some elephants move out of the Park just for short distances over short time periods, and then return to the Park. In the north of Ehi-Rovipuka, the Highlands area starts to the west of the C35 road. The map and general feedback from the two game guards was that some elephants move out of Etosha and longer distances across the flat areas into the Highlands via the water points in the north of the Conservancy, often via Okonjota, which has a separate water point for elephants. There is also a potential route out of Etosha in the south of the Conservancy, via Otjomumborombonga springs and Onguta water point towards Okavare and Outjete in southern Omatendeka (Figure 6.73).



Figure 6.70 – Large vegetable garden at Otjenowa, near Etosha National Park, Ehi-Rovipuka Conservancy, 26 March 2021. According to game guards and to the local family who I met informally when I visited Otjenowa, elephants are often moving in and out of the Park to raid the vegetables and visit the water point.



Figure 6.71 – The water point at Otjenowa has no protection wall around the diesel pump and drinking water tank.

I produced an overall map of the main routes for the six conservancies combined, on which I plotted routes that were drawn by more than 50% of the game guards in each conservancy (Figure 6.73).

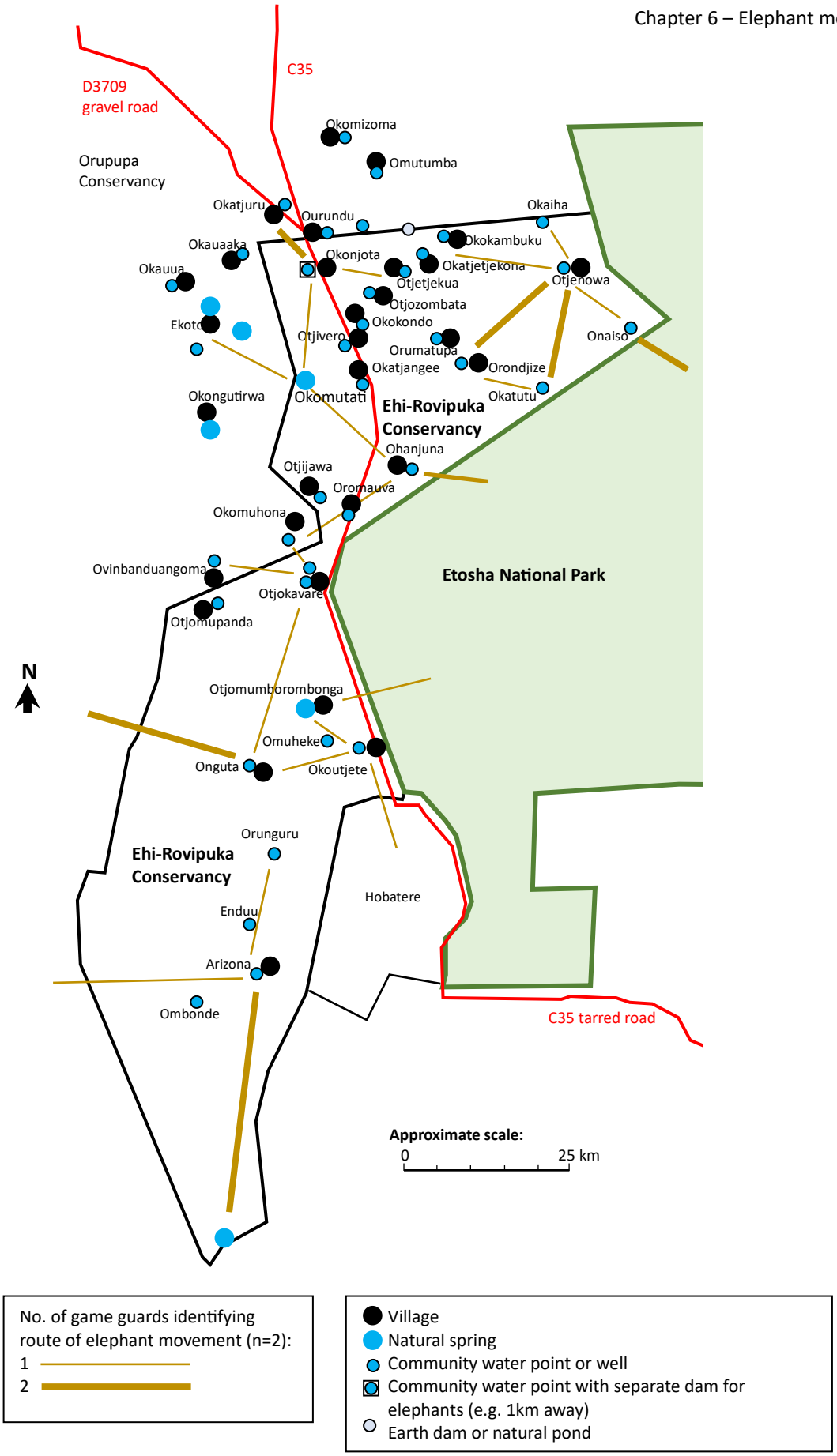


Figure 6.72 - Routes of elephant movements, collated from drawings on conservancy map by game guards of Ehi-Rovipuka Conservancy (number of game guards = 2)

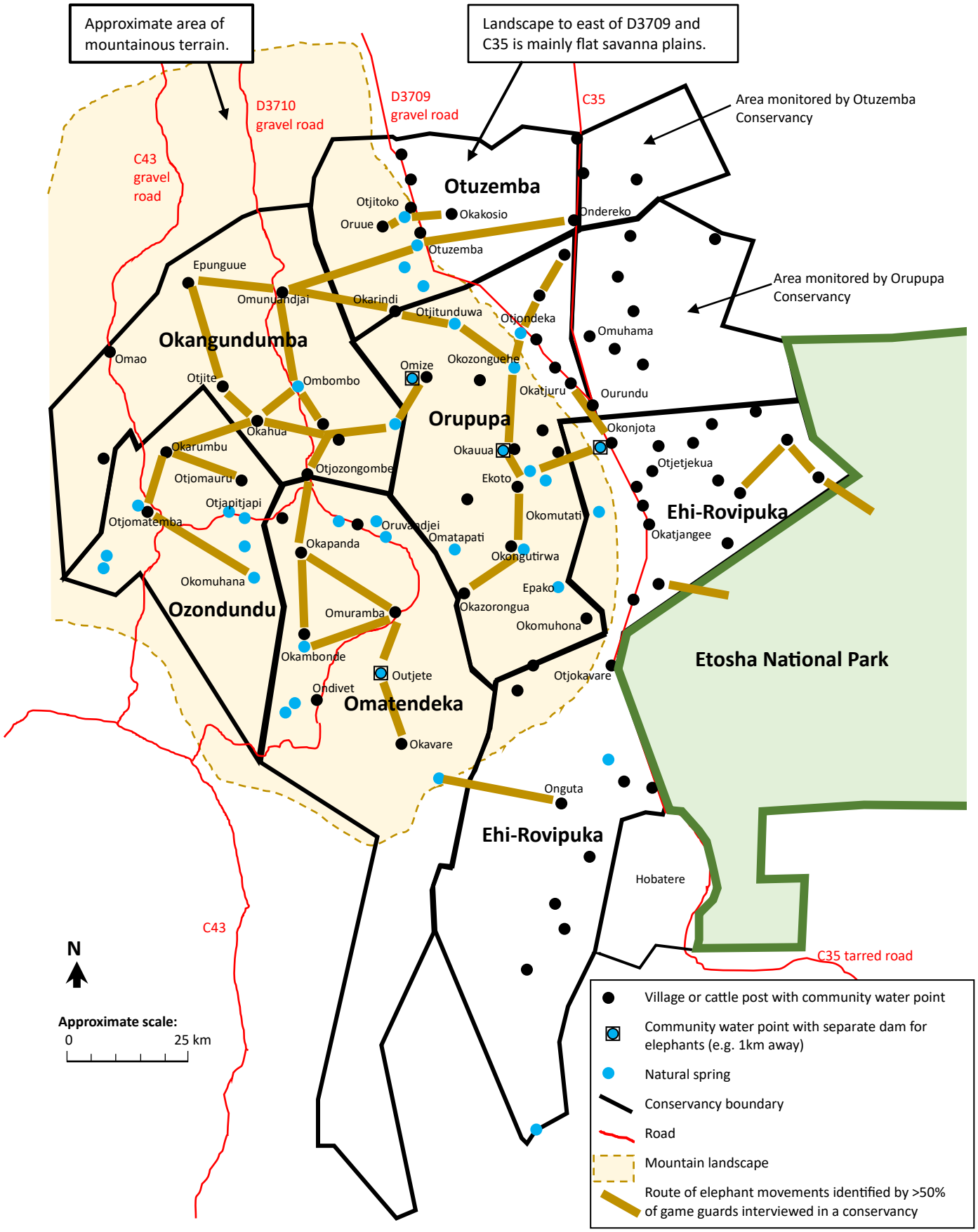


Figure 6.73 - Main routes of elephant movements, collated from drawings on conservancy maps by game guards of six conservancies (number of game guards = 30)

(b) Comparison of movement patterns of elephant herds and individual male elephants

Most studies have shown that individual male elephants move longer distances than female-led herds (for example Leggett, 2006a; Garstang *et al.*, 2014; Ramey and Brown, 2019). This is potentially because the babies in the female-led herds need to drink more often and there are risks of not finding water if a herd moves longer distances. Two game guards (in Ehi-Rovipuka and Okangundumba Conservancies) suggested that the female-led herds move more often than individual male elephants, but the herds move shorter distances, as they are moving to new feeding areas. Also, they noted that the movement of female-led herds is influenced by the need to protect any baby elephants in the herd. The head game guard from Okangundumba Conservancy, with ten years of experience, has the opinion that groups will often send forward one elephant from the group, potentially to look for food and water, and the rest of the group will follow later.

(c) Elephant movements up steep slopes

All 34 game guards said that elephants spend time in the mountains in the Northern Highlands and agreed or strongly agreed with statement: "*the main reason that elephants walk up steep slopes is to find their preferred vegetation*" (Chapter 5). All game guards also strongly agreed or agreed with the statement: "*Elephants are good at finding the easiest gradient pathways for walking up slopes*," (Figure 6.74). I once observed elephants moving down a steep slope below Okomutati spring, and I particularly noted the speed and agility of the elephant movements (Figures 6.75 to 6.77). It is interesting to assess how unusual this behaviour of elephants walking up mountains might be. Perhaps the most well-known story of elephants in mountains is General Hannibal's trek with elephants over the Alps in about 200 BC (Khamsi, 2006; Ball, 2016). Based on an assessment of scientific papers and reports on the movement of African savanna elephants up mountains, I identified several examples of elephants present at high altitudes, but also identified one published study titled "*Elephants avoid costly mountaineering*" (Wall *et al*., 2006). That study used GPS to track elephants in northern Kenya and concluded that elephants avoid moving up slopes because of the high energy use, given that an elephant is such a large mammal.

In addition to the Highlands of northwest Namibia, example studies of African savanna elephants that are present in mountain ranges include the Udzungwa Mountains and Mount Kilimanjaro in Tanzania, Mount Elgon in Kenya and Virunga Mountains in Rwanda (where their range overlaps with the African forest elephant (*Loxodonta cyclotis*), (Twahirwa *et al.*, 2023). In the forests of the Udzungwa Mountains in central/eastern Tanzania, elephant dung has been observed on several occasions near summits above 2,000 m a.s.l. (Nowak *et al.*, 2009, 2010; Jones and Nowak, 2012; Smit *et al.*, 2019). A paper by Grimshaw *et al.*, (1995) on mammals of Mt Kilimanjaro is a compilation of earlier records and their own observations. They observed evidence of elephants up to 2,900 m a.s.l., but they also reference earlier accounts of elephant remains seen at 4,875 m a.s.l. in the 1940s. Elephants are also present in the Mount Elgon area, on border of Kenya and Uganda. Most of the focus of studies on these elephants is on their movements into the caves on Mount Elgon, such as Kitum Caves, which are at about 2,350 m a.s.l. (Redmond, 2016; Mount Elgon Foundation, 2024). The Northern Highlands are up to about 1,800 m a.s.l.

The main studies of the desert-adapted elephants in northwest Namibia, to the west of the Northern Highlands study area, noted their occasional movement up mountains. Viljoen noted that elephants spend time in the mountains during his studies on the habitat selection of the desert-adapted elephants (Viljoen, 1989b; Viljoen and Bothma, 1990). In later studies of movements of the desert-adapted elephants, Leggett notes the movement of elephants into mountainous areas at the onset of rains (Leggett, 2006a). In the book on early records on mammals in South West Africa, as Namibia was called at that time, (Shortridge, 1934), the section on elephants includes a few pages on observations of elephant distribution and behaviour in different areas of the country. The pages on elephant behaviour in the Kaokoveld (northwest Namibia) include interesting observations such as:
"*in mountainous areas, elephants show an astonishing aptitude for climbing*"; "*humans crossing mountains cannot do better that to follow [the elephant paths]*"; and "*elephants always choose the easiest gradient*" (Shortridge, 1934, p.369).

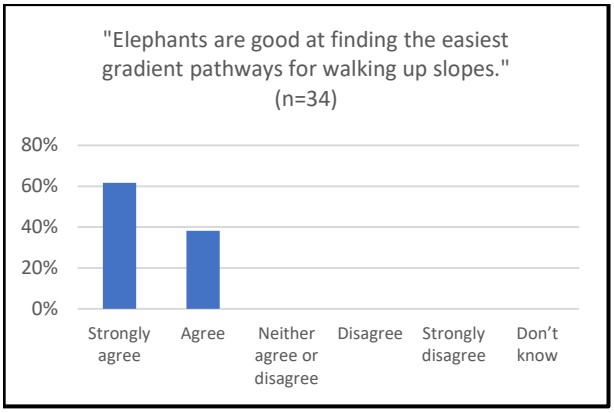


Figure 6.74 – Results of game guard response on elephant movements up gradients.



Figure 6.75 – Female elephant guiding a young baby down the steep slope below Okomutati spring, 20 January 2018.

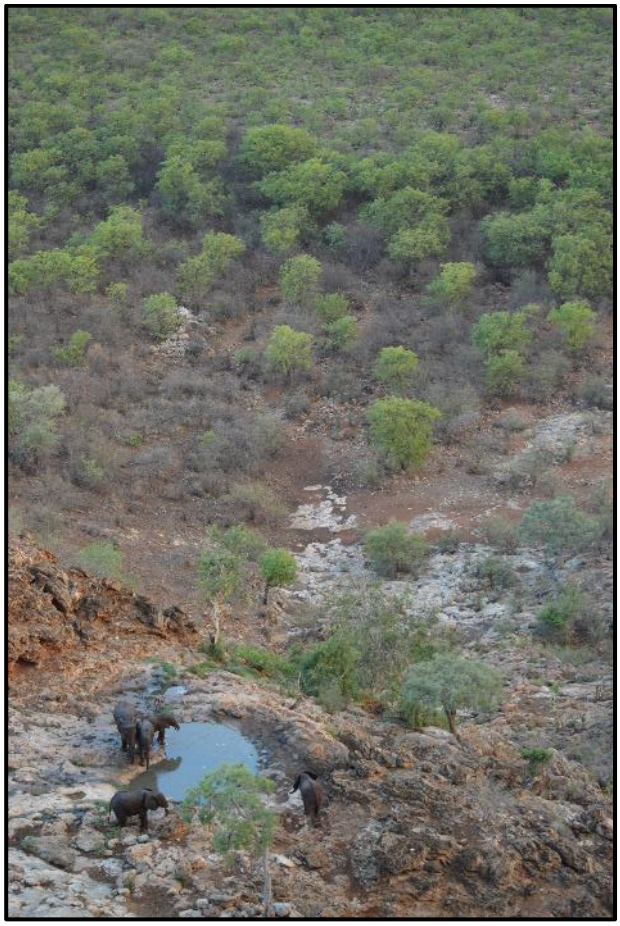


Figure 6.76 – Elephants at Okomutati spring, which is below a cliff and up a steep slope from the valley, 20 January 2018.



Figure 6.77 - Elephants were observed to be surprisingly quick and agile in descending the steep, rocky slope to the valley, 20 January 2018.

(d) Elephant pathways

My field observations showed that elephants often take the same routes, and in these cases they create tracks. The clearest track that I observed during the field work was the elephant pathway to Okavare water point (Figure 6.78). Elephants also move along man-made tracks where they can, as I observed by evidence of dung and footprints during my driving and field walks in the Highlands during this Research Project (Figure 6.79 and 6.80).

According to game guards, elephants do create pathways through areas of thicker thorn bushes, through their breaking of branches (Figure 6.81). These pathways are perceived by some local people as one of the benefits of elephants, with 31 of the 34 game guards (91%) agreeing or strongly agreeing with the statement: "*elephant pathways are useful for people and their livestock as walking tracks.*" 26 of the 34 game guards (76%) strongly agreed and five (15%) agreed.



Figure 6.78 – Elephant dung provides clear evidence of a well-used elephant pathway at Okavare in Omatendeka Conservancy, 9 February 2023.

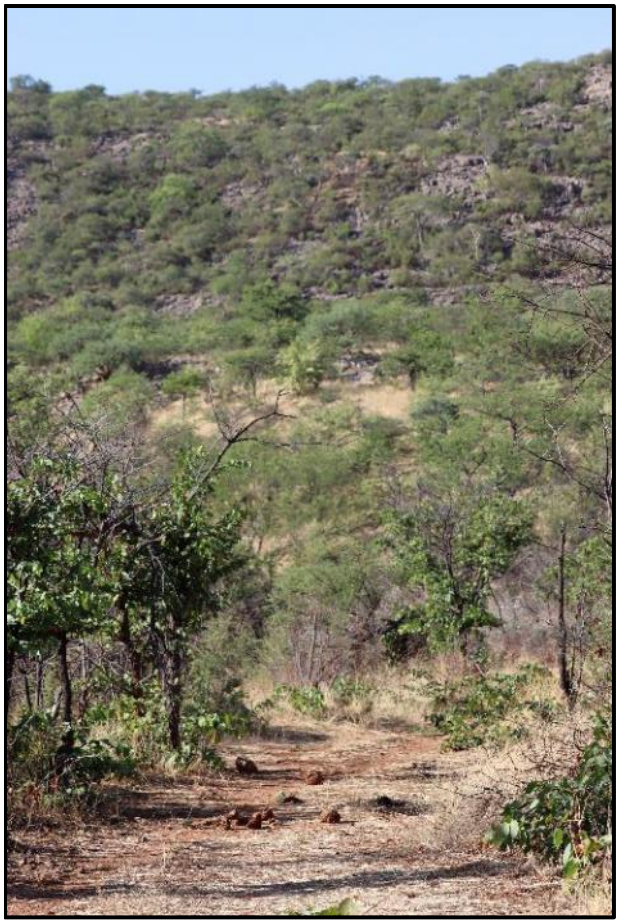


Figure 6.79 – Elephant dung on track between Okatjovosandu in Orpupa Conservancy and Okomutati in Ehi-Rovipuka Conservancy, 13 January 2023.

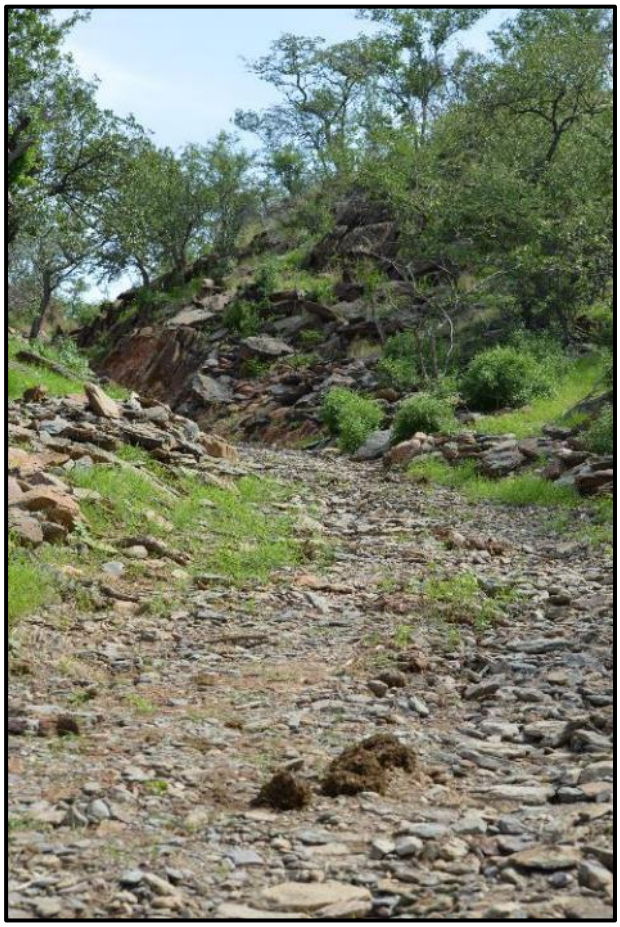


Figure 6.80 – Elephant dung on a steep track up to Ombingugohenda Spring, above Ekoto, 28 February 2022.



Figure 6.81 – Game guards said that elephants had, over time, created this track below Ombingugohenda Spring, near Ekoto, Orupupa Conservancy. Note the elephant dung in the foreground, and branches of trees that had been broken by elephants. The game guards said that some people now also use this track. Photograph taken 28 February 2022.

(e) Connectivity between elephants in the desert areas of the lower Hoanib and lower Hoarusib rivers with elephants in the Northern Highlands

There have been concerns for some time over the connectivity of the desert-adapted elephants in the lower Hoanib and lower Hoarusib (Figure 6.82), to the west of the Highlands (Leggett *et al.*, 2011; MEFT, 2021; Brown and Ramey, 2022). Because of the high-profile of the desert-adapted elephants, I found this to be a much-discussed topic when I consulted Namibian wildlife specialists.

One of my research questions on elephant movements during the interviews related to this connectivity. As expected, those in the eastern conservancies (Figure 6.10) had limited knowledge of these movements to the west, and 20 game guards (59%) were unable to provide an answer. The information received was from the game guards in the more western conservancies. Three game guards in Ozondundu Conservancy said that elephants move south to Otjondunda in Anabeb Conservancy but do not go further on this route to Sesfontein and the lower Hoanib (Figure 6.57). Two game guards in Okangundumba Conservancy indicated that the group of about 30 elephants that they can identify (Chapter 3) had moved to the area of the desert-adapted elephants in 2020, and they believe that the group stayed in that area for two months. One of the game guards had visited Sesfontein at that time and observed the group in that area, and the other game guard had heard that the group had also been seen by game guards near Purros (Figure 6.82). There is a potential route for elephants to the lower Hoanib via Khowarib gorge, in Southern Omatendeka, which provides a flat route for elephants as the gorge passes through a particularly steep mountain range (Figures 6.83 to 6.85). Three game guards from Omatendeka said that elephants used to move through the gorge to Sesfontein and beyond into the lower Hoanib but are likely to be restricted by the increased settlements in and around Warmquelle, which is at the western end of the gorge. During field observations I did note elephant dung near springs in the Khowarib Gorge in January 2021 (Figure 6.83), but this does not mean elephants passed through the western exit of the gorge. Other reasons given by game guards for the potential lack of connectivity varied, but included perceptions that the Sesfontein area is too hot for elephants from the Highlands, and that the desert-adapted elephants do not move to the Highlands because there are more people there and because they do not like the sharp stones on the ground.

Dr Brown and Dr Ramey have been carrying out annual visits to monitor the desert-adapted elephants since the mid-2000s. They conclude that, during their study, elephants from the upper Hoanib catchment (upstream of Khowarib gorge) in Anabeb and Omatendeka Conservancies, or from the mountains in Ozondundu Conservancy, have not recently overlapped in range with the desert-adapted elephants in the lower Hoanib west of Sesfontein (Brown and Ramey, 2022). They note that would have been historic movements between these areas, including through the Khowarib Gorge, but Dr Brown and Dr Ramey conclude that the desert-adapted elephants in the lower Hoanib and elephants in the Highlands are now separate populations. They are concerned about the loss of older elephants in the in desert-adapted population that had long-acquired knowledge of the landscape and migration routes.

The game guards in Omatendeka Conservancy consider that one potential route from the Highlands to the west is over the steep mountains to the west of Ondivet (Figure 6.86 and

6.87). I noted elephant dung and trees partly eaten by elephants on my field walks high up in the mountains in that area. Figure 6.82 shows these villages, and potential routes of elephants (historic and current), but there might be other unknown routes taken (e.g. from Okangundumba Conservancy down the escarpment to Purros). Therefore, my findings from the field visits and interviews indicate that there still could be some connectivity, even if it is now less likely to be via the Khowarib gorge.

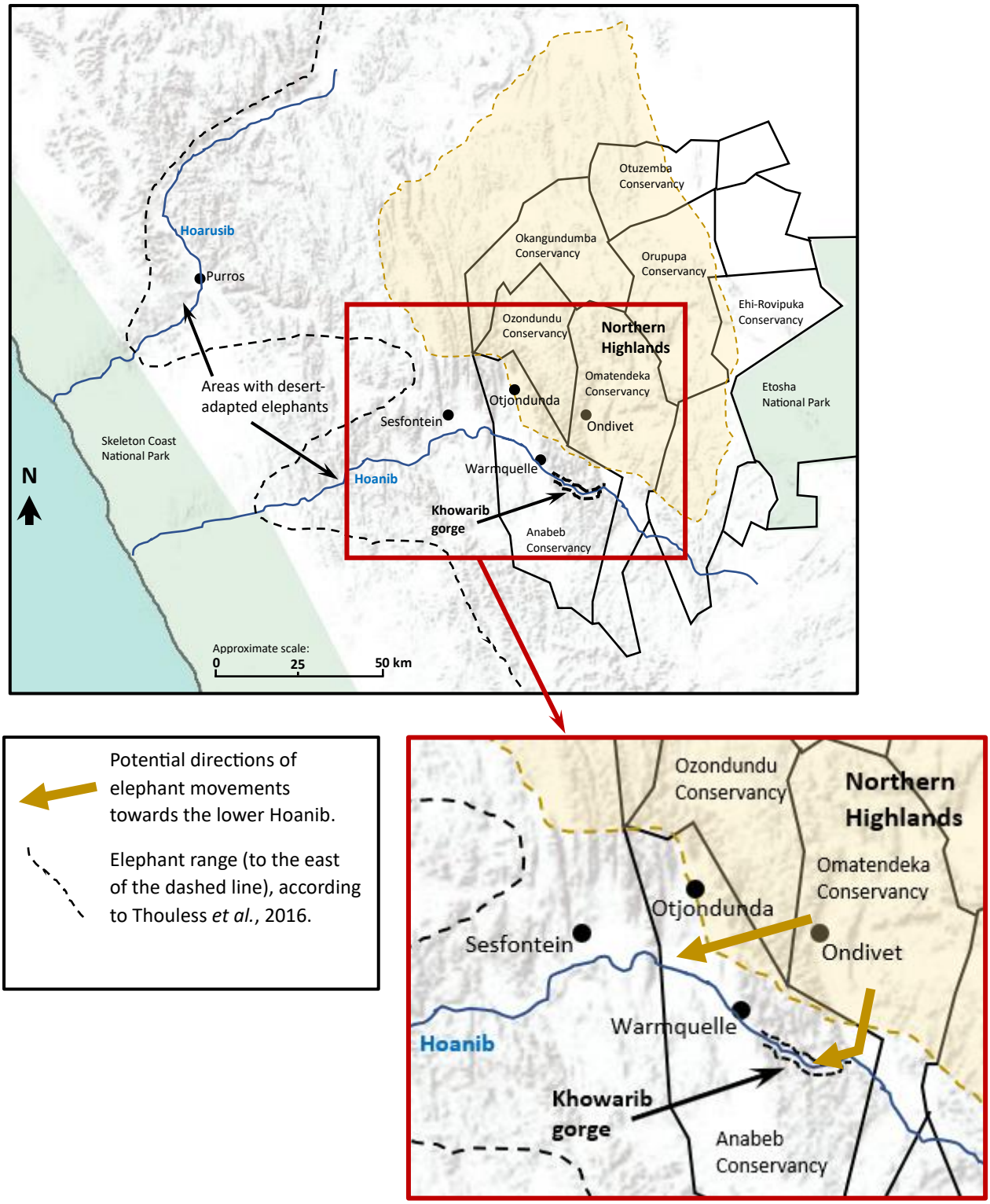


Figure 6.82 - Map showing potential routes and constraints to connectivity between the elephants in the Northern Highlands and the desert-adapted elephants

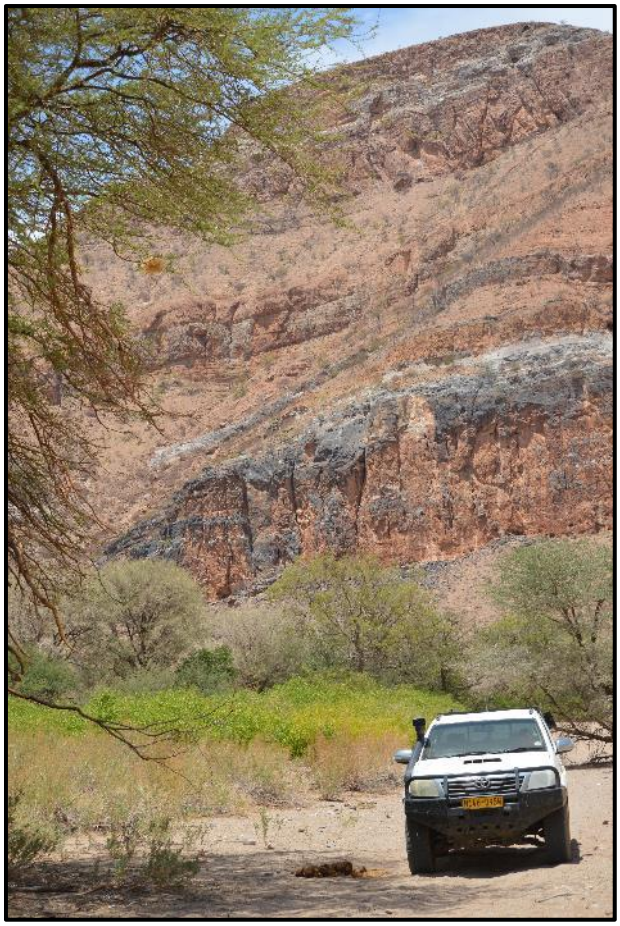


Figure 6.83 – Feedback from game guards in the west of the Highlands is that elephants used to connect to the lower Hoanib through Khowarib Gorge, but that this no longer happens. During a scoping visit in the 4x4 vehicle through Khowarib Gorge, Anabeb Conservancy, 28 January 2021, I observed elephant dung, as shown in this photograph, to the left of the vehicle.

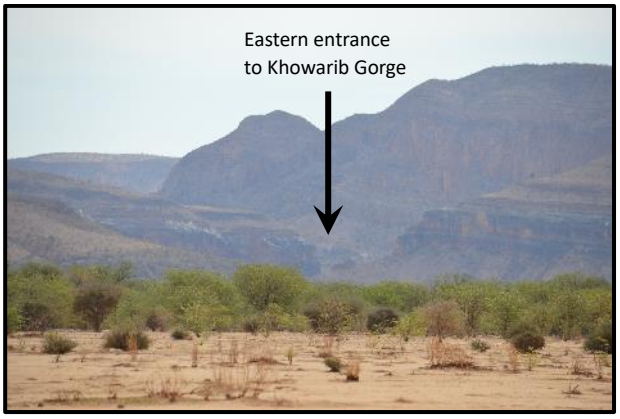


Figure 6.84 – Entrance to Khowarib Gorge from the east, showing the steep mountain landscape, 28 January 2021.



Figure 6.85 – Spring at the western exit to Khowarib Gorge, 24 January 2018. Despite the fresh water source, local feedback is that elephants are rarely seen in this area, potentially because of the expanding settlement of Warmquelle near to this western exit. There is also a spring about half way through the gorge.



Figure 6.86 – Photograph taken 1 April 2021 above Orupara spring, west of Ondivet, looking in a westerly direction towards Sesfontein and the lower Hoanib range of the desert-adapted elephants. The photograph shows the steep mountain landscape, which is rarely crossed by people but, according to game guards, elephants might now be crossing this landscape rather than passing through the Khowarib Gorge.



Figure 6.87 – Example of a steep slope in the landscape west of Ondiwet, described in Figure 6.86. Photograph taken above Omutirapo spring on 2 April 2021.

6.6. Conclusions

The planning of measures for the conservation of the elephant population and reduction in human-elephant conflict in the Northern Highlands requires reliable information on elephant movements. There had been minimal published research prior to my Research Project on elephant movements in the Northern Highlands, with the few studies on movements largely focusing on the small population of desert-adapted elephants to the west of the Highlands. Those studies had concluded that some elephants do move large distances (Lindeque and Lindeque, 1991; Leggett, 2006a).

The application of GPS collars to a sufficient number of elephants to provide information on typical movements would entail high costs, and following elephants on foot in the highlands landscape is not practical. Therefore, my approach was to collate the knowledge of game guards in the study area on the movement of elephants and the factors affecting their movements.

Much of the information that I collated from game guards, and also from my analysis of Event Book data on locations of incidents involving elephants, is best presented on maps. However, before my Research Project there were no baseline data or maps available on the locations of villages, water points or springs. During my times spent in the study area I visited over 100 water sources and collected data on types of infrastructure, state-of-repair, GPS co-ordinates and observations on elephant dung nearby. This enabled me to produce maps to show the results of the research, and also provide the relevant ministries and conservancies the information for their future use.

Research on elephants elsewhere in Namibia and other Africa range countries has indicated that one of the main factors influencing their movements is the location of rainfall, with elephants moving large distances to find fresh vegetation where it has rained. The common perception from the 34 game guards who I consulted aligned with this point.

Based on the local knowledge, I conclude that elephants used to move from Etosha National Park into the Northern Highlands in the rainy season, to benefit from fresh vegetation, but then returned to Etosha for the dry months. This would apply for the time period of about 2000 to 2012. Since 2012, many elephants are staying more permanently in the Northern Highlands, despite overall there being lower rainfall in the Highlands than in Etosha National Park. As well as the common feedback from game guards to support this conclusion, the data from Event Books show that incidents involving elephants continue in the dry months (June to December) in the Highlands, implying many elephants have remained there throughout the year.

Elephants are likely to be staying in the Northern Highlands for more months of the year because of a number of different factors. My conclusion is that the key factors are that water is more permanently available (because of the installation of solar pumps at some community water points) and there has been improved protection of the elephants over the last 20 years through the community-based conservancy programme. It is likely that the cleanliness of water in springs and waterholes also affects elephant movements.

Comparison of the number of incidents reported in Event Books in the mountainous areas against those in the flat areas in between the Northern Highlands and Etosha National Park is interesting as there have been many more incidents in mountainous areas (over 10 years from 2012 to 2021). This again implies that elephants are staying in the mountainous areas on a more permanent basis. As concluded in Chapter 5, elephants have a preference for the tree species in the Highlands that are associated with the higher slopes, such as *Sterculia africana* and the *Commiphora* species.

Most game guards talked about a pattern in which elephant herds tend to stay around the location of a village with a water resource for about two weeks. During that time, they mostly remain away from the village during the day, and visit the water source on some nights. After about two weeks, the elephant herd would typically move away, after which the game guards might hear about the movements of that herd through other game guards and other people in other nearby villages in the conservancy, but generally the game guards are not aware of movements outside of the conservancy. One of the more interesting set of results from my semi-structured interviews was on the component on participatory mapping, for which I asked game guards to draw lines for typical directions of elephant movements of known groups on a map of their conservancy. I plotted my analysis of the common routes on maps and these indicated specific routes that did tie in with observations from my field visits and foot patrols. For example, according to the game guard maps of movements, elephants in Omatendeka Conservancy stay away from a set of villages along a stretch of main road from Okarivizu to Oruvandjei, despite the presence of several springs and vegetable gardens. I did not observe elephant dung near the water sources in this area during my field visits. On the other hand, game guard maps did show elephant movements in an arc between Okazorongua to Okarindi in Orupupa Conservancy, via a number of water sources, at which I did observe elephant dung on several occasions (e.g. Ekoto, Okauua, Okozonguehe).

These results are supported by results from other components of the research, for example the map of hotspots of incidents involving elephants reported in Event Books (Figure 4.29). The hotspots from my analysis of Event Books are consistent with the main routes drawn by game guards. For example the five hotspots for which the most incidents have been reported by game guards are Okarindi, Epunguue, Okarumbu, Otjozongombe and Omuramba, which are all on the most common routes from the results of participatory mapping.

According to game guards, some locations are visited by elephants but few incidents are reported, for example at the cattle post at Omunuandjai in Okangundumba there tends to be fewer people nearby compared to water points at villages, and fewer incidents reported. Likewise, there are few conflict incidents reported at springs. The map of hotspots therefore does not provide a full picture of elephant movements. The results of my question to game guards on Top 5 water points or springs visited by elephants in their conservancy adds important information on movements. The results show that places like Otjondeka springs, Otuzemba springs, and Omunuandjai cattle post are additional places often visited by elephants (Figure 6.27), and this is consistent with the maps of movements drawn by game guards (Figure 6.73).

If there has been no rain in their conservancy, but rain elsewhere, game guards stated that elephants will move out of their conservancy for some time. If there have been rains in the conservancy, then the elephants will tend to visit the community water resource less often because there is standing water in the mountains and particularly in places along the main river lines. According to game guards typically elephants will eat their preferred trees in the mountains at night and in the morning, and spend time in the shade of the larger trees in the river valleys during hot times in the middle of the day. There has been a changing dynamic since 2019 when communities set up more vegetable gardens, after the loss of livestock in the drought of 2018-2019. Having tended to stay away from villages in the rainy season, elephants are tending now to visit villages more often because the vegetables are ripening during that time.

My research on elephant movements in the Northern Highlands is an important start. Much more research is needed on movements to enable the Government of Namibia to consider measures such as increasing the level of protection for movement corridors. For example, further desk-based research is needed using GIS baseline data to compare the maps developed through participatory planning in my Research Project with potential factors such as topography and hydrology.

As with the conclusions to Chapter 3, this research has shown the potential value of local ecological knowledge, which would be enhanced if the game guards were given better equipment (in particular binoculars and spotlights), and a structured method (with training) to identify known groups and work with other game guards to record their movements. This would help plan conservation measures over the longer-term and would also provide useful information for planning further research (e.g. GPS collaring).

In addition, more information on movements of elephants into and out of the Northern Highlands will facilitate assessment on the viability of the small, high-profile population of desert-adapted elephants in terms of potential connection with other elephant populations in the northwest.

Chapter 7 – Community-based conservation in the Northern Highlands (synthesis chapter)

7.1 Introduction

The community-based approach to wildlife conservation has been a central aspect of this thesis, in particular related to the role of the community game guards and their local ecological knowledge. The objective of this short synthesis chapter is to collate the points coming out of earlier chapters on community-based conservation and the role of the game guards so as to recommend priorities and future recommendations for protection of the wildlife and habitats of the Northern Highlands. This chapter therefore covers wider aspects than the conservation of the elephants.

The chapter initially draws on my previous research, and additional findings from this Research Project, on the conservancy programme (Section 7.2). It then discusses the local ecological knowledge of the game guards and the potential for expanding their role (Section 7.3). The risks to the fragile landscape and habitats are then discussed as part of the case for raising the protected status of the Northern Highlands (Section 7.4). Concluding points are provided in Section 7.5.

More details on the concepts in this chapter are included in two publications for which I was lead author (Box 7.1). The two publications are included also in Appendix 7.1.

Box 7.1 – Relevant publications on the concepts in this chapter

Wenborn, M., Svensson, M.S., Katupa, S., Collinson, R. and Nijman, V. (2022b). 'Lessons on the Community Conservancy Model for Wildlife Protection in Namibia', *The Journal of Environment & Development*, 31(4), pp.375–394.

Wenborn, M., Collinson, R; Muzuma, S, Kangombe, D., Nijman, V. and Svensson, M. S. (2024). 'Communities and elephants in the northern highlands, Kunene Region, Namibia', in Sullivan, S., Dieckmann, U. and Lendelvo, S. (ed.) *Etosha Pan to the Skeleton Coast: Conservation Histories, Policies and Practices in North-west Namibia,* Chapter 11. Open Book Publishers. [In press].

7.2 Lessons on the community conservancy programme for wildlife protection

The community conservancy model on wildlife protection in Namibia empowers rural communities to decide on the use of their wildlife, for example through joint venture agreements with private investors and operators in wildlife tourism. The intention is for this to provide opportunities for alternative livelihoods (Figure 7.1). Also, the joint venture agreements are set up so that an agreed percentage of revenues is provided to the conservancies for wildlife protection activities (e.g. salaries of game guards) and for benefit distribution to conservancy members (e.g. to repair local water points, invest in schools, or contribute to community events (e.g. funerals)). The model aims to increase the perceived value of wildlife and to raise the commitment of local communities to wildlife conservation (Adamowizc *et al.*, 2011; Snyman, 2012; Cooney *et al.*, 2016; Nilsson *et al.*, 2016; MEFT/NACSO, 2022; Wenborn *et al*., 2022b).

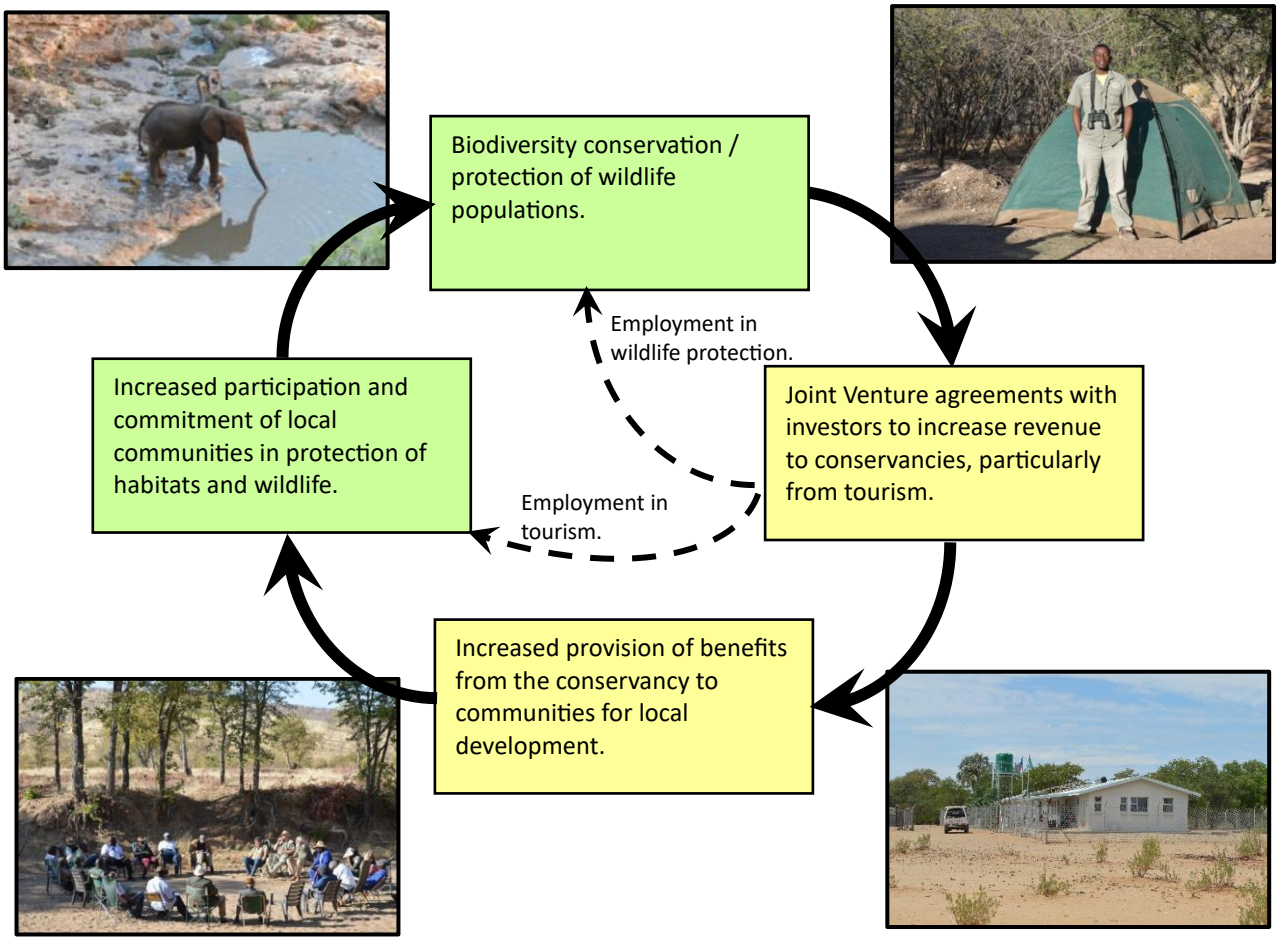


Figure 7.1 - Main components of the community conservancy model

As discussed in Chapter 3, in the 1970s and 1980s there had been a serious decline in wildlife populations, because of poaching during the conflict in northern Namibia and several drought years (Berry, 1997; Owen-Smith, 2010; Bollig and Olwage, 2016). The community conservancy model was first planned in northwest Namibia from the early 1990s to address the reduction in wildlife, initially through an informal system of community game guards, funded by donors (Humavindu and Stage, 2015; Jacobsohn, 2019). The first conservancies were gazetted in 1998, eight years after the country's independence. Most of the first conservancies were in the northwest. Since then, the total land area of the community conservancies has increased to about 20% of the total land area of the country (NACSO, 2024). This compares to the area of about 140,000 km^2 (17%) designated as National Parks in Namibia (MEFT, 2024).

In 2018, I carried out research on the conservancy programme in northwest Namibia as part of the MSc Conservation Ecology with Oxford Brookes University. My objective for that policy-focused research was to identify lessons on the conservancy programme from which other countries with similar challenges in rural areas might benefit. My method involved case study evaluations of six conservancies[8] in northwest Namibia. Previous research on the conservancy model in Namibia had tended to focus on the institutional and economic aspects (for example: Silva and Mosimane, 2012; Bollig and Schwieger, 2014; Humavindu and Stage, 2015; Morton *et al.*, 2016). These are important aspects, but the impacts on wildlife populations are also important performance indicators as wildlife conservation is a core objective of the model (MET, 1995; Owen-Smith, 2010; MET, 2013a, 2013b). One of the drivers was to add to other research because I considered that my review provided a more rounded assessment that included ecological aspects alongside institutional and socio-economic aspects. In 2022, I published a review paper, with co-authors who included local specialists in Namibia, based on my case studies (Wenborn *et al*., 2022b). From our assessment of wildlife data from Annual Game Counts (NACSO 2020, 2021a, 2021b) and interviews with the conservancy chairpersons or other senior committee members for the six case study conservancies, we concluded that wildlife numbers had recovered and stabilised in the 1990s and early 2000s, and, although wildlife had been impacted by several drought years in northwest Namibia in the 2010s, the conservancy programme has had a positive impact on wildlife populations. For example, the elephant population in northwest Namibia has been increasing following many decades of poaching of elephants (Chapter 3), and the conservancy programme has been a major factor (Owen-Smith, 2010; Craig *et al.*, 2021; MEFT, 2021; MEFT/NACSO, 2022). The core reason for this success of the conservancy programme was the improved awareness and higher commitment of local communities to wildlife protection (Boudreaux and Nelson, 2011; Angula *et al.*, 2018; Jacobsohn, 2019; Störmer *et al*., 2019). The conservancy programme has been supported by several wildlife NGOs (e.g. WWF, IRDNC, NACSO[9]). This sustained support has been a major factor in the positive outcomes.

As described in Chapter 1, the rural communities in the Northern Highlands are some of the poorest in Namibia (Atlas of Namibia, 2022). There is low formal employment in the

[8] Sesfontein, Anabeb, Omatendeka, Orupupa, Ehi-Rovipuka and Ozondundu

[9] WWF World Wide Fund for nature
IRDNC Integrated Rural Development and Nature Conservation
NACSO Namibian Association of CBNRM Support Organisations

Northern Highlands, and the drought in 2018-2019 caused a high loss of livestock, which has added to the problems with poverty (Inman *et al.,* 2020b). There are now 38 conservancies gazetted in the Kunene Region (NACSO, 2024), 13 of which have part or some of their area in the Northern Highlands study area (Figure 2.2). There is no published data on tourism visits to northwest Namibia[10] but, based on my observations from 6 months in the area during this Research Project (Figures 7.2 to 7.5), and on feedback from local communities, the levels of tourism are still very low in the northwest, and minimal in the Northern Highlands. As indicated in reports of audits of conservancies carried out by IRDNC, the revenues from tourism for most conservancies remain low (NACSO, 2023a). Trophy hunting has been another source of revenue for some conservancies, but the hunting quotas, which are also provided in conservancy audit reports (NACSO, 2023a), have been restricted by the government in the northwest (it is potentially more applicable in the conservancies in the northeast of the country (Hewitson and Sullivan, 2021)). Despite the positive contributions of the NGOs involved in community-based wildlife conservation in northwest Namibia, one finding from my consultation with game guards is that the NGOs and their part-time consultants have sometimes not properly managed expectations of conservancies related to revenues with some conservancy members expecting rapid increases in tourism. It should be noted that the tourism sector was also greatly impacted in Namibia in 2020 and 2021 during the Covid-19 pandemic (WTTC, 2023).

The combination of the loss of livestock in the droughts of 2018-2019, the lack of benefits from tourism, and ongoing human-wildlife conflict, is eroding the commitment of local communities to wildlife protection and presents a risk to the sustainability of the conservancy programme in northwest Namibia (Wenborn *et al.*, 2024). There is a priority need for a step change in the conservancy programme to build on the successes and focus on short-term and long-term increases in revenues from tourism.

Even if employment and revenues from tourism can be increased in northwest Namibia, the situation across Namibia during the Covid-19 global travel restrictions demonstrates the risk of reliance on tourism. During the work in the field for this thesis, minimal opportunities for other livelihoods for local people have been identified, other than from tourism and farming. There are some activities of a mining company in exploration in the area, with some associated local employment, and some people travel to Opuwo during the week for employment in the town. Opportunities to make income from nature-based livelihoods, such as making perfume products from *Commiphora*, have been piloted by NGOs (IRDNC, 2024), but are limited by the costs of transporting long distances to market. One interesting option that has been discussed is research-based “tourism”, where field visits of international students are organised to obtain data for their undergraduate or masters projects, with potential for associated local employment in terms of guides and hospitality.

[10] The Namibia Tourism Board mainly collects data at tourist entry points to the country (MEFT, 2023), and any data on overnight stays from tourism facilities is not published for commercial reasons.

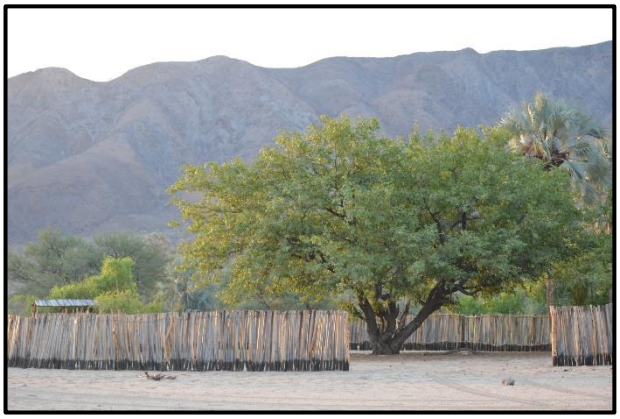


Figure 7.2 – Otjikongo camp site, northwest of the Northern Highlands, was set up in 2018 and the community made much effort to create shaded camping areas, but did not have the funds to install water supply for bathroom blocks, which is a critical aspect of attracting self-drive tourists. These tourists often open camp (no bathrooms, but no fees), so would not pay to stay in a camp site that has no water / bathroom blocks. Photograph taken 25 March 2019.



Figure 7.3 – More recently, Okozonguehe camp site has been set up in 2022 in Orupupa Conservancy in the Northern Highlands, and water supply has been included so that the camp site is functional. However, according to the local game guard, during my time in the area over the three months from December 2022 to February 2023 no tourists stayed at that site. One problem is that the site is 15 minutes drive from the D3709 road and no signpost for the camp had been installed on that road. More importantly, there has been no central marketing of the site. Photograph taken 12 December 2022.



Figure 7.4 – A camp site was set up with donor funding in Okangundumba Conservancy in the Northern Highlands in the early 2010s, with a signpost on the C43 road. However, the site was one hour drive on a rocky and steep 4x4 track, and received virtually no tourists. The site was closed after flooding, and overall provided minimal benefits to the community. The fact that the sign promised fresh bread at the site, demonstrates the potential for over-ambition. Photograph taken 17 April 2019.



Figure 7.5 – Otjisakamuka camp in Omatendeka Conservancy in the Northern Highlands is a site with high tourism potential if it is marketed correctly. It has had private investment and includes water supply. However, I stayed about 30 nights at the site in total during my research and there were never any tourists staying and no others signed into the guest book in between my stays. This demonstrates the local shortfalls in capacity for marketing and communication. Photograph taken 30 March 2021.

7.3 Potential for enhancing the role of the community game guards

One of the most essential aspects of the community-based approach to wildlife protection is the role of the game guards. Enforcement of wildlife conservation regulations by MEFT officers is very difficult in such a remote area as the Northern Highlands, so the role of community game guards is important in terms of raising awareness, monitoring and reporting. Despite their important role, they have a low salary and lack of equipment (e.g. binoculars), which is a reflection of the weak financial state of most conservancies. However, throughout this Research Project I noted the potential benefits from the knowledge of game guards and the opportunities to enhance their role.

The core results of my research in this thesis are based on the local ecological knowledge of game guards. In several places in the thesis I have provided assessments of different aspects of their knowledge, and it is appropriate to summarise these assessments here in this section on enhancing their role. I carried out interviews with 34 game guards, all of which were over four hours; I carried out 10 field walks with game guards, again all for over four hours, and several shorter walks; and I visited over 100 water points with game guards, driving them in my vehicle. During all these activities (Figures 7.6 to 7.9), all the time with game guards meant we had prolonged informal discussions on elephants, on the local communities, on wildlife conservation, etc. This enabled me to make judgements on their levels of knowledge and capacity, and a summary is provided in Box 7.1.



Figure 7.6 – Interview with a game guard, 7 January 2023, plus translator, Okavare, Omatendeka Conservancy (photograph shows that the meeting was next to a tree that had branches broken by elephants).



Figure 7.7 – Visit with game guard to Okauaaka water point in Orupupa Conservancy, 28 February 2022.



Figure 7.8 – Tracking elephants with game guards, 9 February 2023, near Okavare, Omatendeka Conservancy.

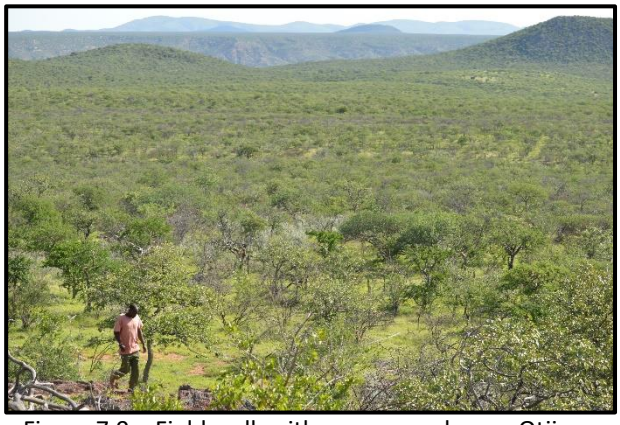


Figure 7.9 – Field walk with game guard, near Otjivero, Ehi-Rovipuka Conservancy, 27 February 2022, looking for evidence of elephant movements.

Box 7.1 – Summary of assessment of local ecological knowledge of game guards

Positive aspects

- The variety of roles of game guards facilitates their gaining of knowledge over time. The roles include recording wildlife sightings and incidents of human-wildlife conflict in Event Books; carrying out foot patrols (in most cases at least two per week of up to 15 km); participation in conservancy meetings, in the Annual Game Count, and in the Full Moon Surveys; and raising awareness in the community and encouraging commitment to wildlife protection.
- Seven of the 34 game guards that I interviewed had over 20 years of experience, and 10 game guards had between 10 and 20 years in their role.
- The average time in their role of the 34 game guards was 10.3 years.
- I found that most game guards were motivated by the aspect of the role of supporting the communities. Whenever we stopped to talk to local people in villages, the game guards were well-known and welcomed. They proactively support the community and take pride in their roles.
- Game guards use conservancy maps that have village names and grid squares to record the locations of sightings and incidents (Chapter 4). The NGOs have trained the game guards in recording in the Event Books and the use of the maps. My assessment was that the mapping knowledge of game guards was much higher than might be expected for people from rural communities in Africa.
- Each conservancy has a formal meeting of game guards once per month, and conservancies also organise joint foot patrols (one or two per month). Game guards therefore learn from each other during these activities.
- It was my time in the field with game guards tracking elephant movements that indicated their particular knowledge. I learned to identify many tree species in the Northern Highlands and then verified that most game guards have good knowledge of tree species. I observed that game guards have a strong ability to track elephants from footprints, dung and trees and shrubs that have been browsed.
- Observations by game guards over time have given them much knowledge of elephant behaviour, and I noted that several game guards have interesting stories about elephant behaviour and community interactions with elephants.
- Some of the above points focus on local ecological knowledge on elephants, but game guards also have knowledge of other species, especially the predators (because of record-keeping in Event Books on conflict incidents involving predators).

Limitations

- Despite their important role in the community, the game guards have a very low salary (typically £50 to £75 per month) and therefore some would inevitably have low motivation at times.
- Based on my 34 interviews, one game guard seemed unsatisfied with his role, and two were inappropriate in their behaviour on the day originally planned for the interview (on one of those occasions we postponed the interview and instead we used that time to visit water points). In reality, I might have expected more game guards to be unmotivated or not properly carrying out their roles.
- The remote nature of their job means that monitoring and supervision is difficult.
- Game guards have minimal equipment (many now have uniforms and some have walking boots, but none have binoculars), and they also do not have wildlife identification / reference guide books or tools. This constrains their role, for example reduces the ability to count and identify wildlife.
- The NGOs have provided effective training, but additional training will be needed if their roles are to be expanded.
- The weak financial status of the conservancies and the lack of opportunities at present to increase their revenues, constrains the recruitment of additional game guards.
- The game guards have good knowledge to identify trees, potentially because the community uses different tree species for medicinal and other purposes (Le Roux and Müller, 2018), but most game guards have limited knowledge of bird species.
- The knowledge of the game guards mainly relates to their local area, and they tend to have less experience of wider strategic planning at regional level.

My conclusion is that there is much potential for continuing to utilise the local ecological knowledge as a basis for further research and planning conservation management measures. This includes knowledge on the population of elephants, which would help to plan how to reduce human-elephant conflict and protect elephants in the Northern Highlands.

Elephants are a good example of the level and area of knowledge of game guards. They tend to know aspects about elephants when they are in the area of the village of the game guard, such as where the elephants are drinking and sometimes where they spend the daytimes. This is often through discussions in the community, and sometimes sightings. When the elephants leave the area, the game guards know less, but do sometimes get information from other game guards in the conservancy about directions of movement of the elephants. When the elephants leave the conservancy, the game guards then are usually not aware of where the elephants move.

For the conservation of elephants, expanding the monitoring activities of game guards to include identification and recording of specific elephant herds would improve knowledge of the elephant population and movements (Chapter 3). This information could be used for planning conservation measures on a regional and local level, for example it could also be integrated into an early warning system between villages about elephant movements. The game guards would need the necessary equipment for elephant identification, and some training. The Namibian NGO Elephant-Human Relations Aid (EHRA), has developed a protocol for elephant identification (EHRA, 2020) and is testing the method in elephant ranges to the south of the Northern Highlands. Lessons could also be learned from rhino monitoring activities to the south of the highlands by the Namibian NGO Save the Rhino Trust.

The scenic and remote landscape of the Northern Highlands, with a diversity of wildlife and cultural heritage, has a high potential for tourism. This was identified at an early stage in the planning of the conservancy programme. However, tourism has not increased in the area to a level that would positively impact a significant number of local people in terms of employment and other benefits. Diversifying livelihoods away from livestock farming has for some time been a development objective of the Government of Namibia (MET, 2013a). Wildlife tourism, planned in a controlled manner to protect habitats and wildlife, has been identified by the government as an opportunity to benefit some of the communities in Kunene Region (MET, 2018). The elephants in the Northern Highlands could be a core driver of tourism in the area. As well as potentially expanding the role of game guards in monitoring and research, there is an opportunity to generate revenue as game guards could be trained and developed into local guides for wildlife tourism. Expanding their role into elephant rangers could build on their knowledge of elephant movements and behaviour, and their stories on elephants: these are not only useful as anecdotal information for research but would be of interest to tourists. The potential new revenue would enhance the income of game guards and could also be used to buy equipment for game guards. Additional revenue could be used by the conservancies to provide benefits to communities, thereby encouraging ongoing commitment to wildlife conservation.

There are frameworks already in place to facilitate a system of elephant rangers. The community conservancies already have systems for revenue collection and financial management and reporting. There are several Namibian NGOs with a remit to promote wildlife tourism and/or wildlife conservation, including TOSCO[11], IRDNC, WWF Namibia, EHRA and NACSO, who work together and with the MEFT to support communities in the northwest. There are commercial travel agents at a central level that organise the bookings of accommodation and guides, and their roles could be expanded to book elephant rangers through the conservancies, in particular for self-drive tourists but also guided groups. At a practical level, the mobile phone network has been expanding in recent years in the north-west which would enable efficient booking of elephant rangers. In addition, most current game guards speak English to an adequate level for such tourism guiding. My thinking is that tourists could make a booking and meet the elephant ranger at a specified time and place. Some drives would often cross conservancy boundaries, and there are several examples of conservancies already cooperating to share responsibilities on wildlife tourism and to share revenues. IRDNC in particular has a strong track record in fostering and co-ordinating such cooperation. These ideas are further elaborated in the book chapter on conservation in northwest Namibia (Wenborn *et al.*, 2024).

7.4 The case for raising the protected status of the Northern Highlands

7.4.1 Risks to the landscape, habitats, wildlife and people of the Northern Highlands

To the west of the Northern Highlands, an escarpment drops down to the Namib Desert, which runs along the length of the Namibian coast (Figure 1.3). As discussed in Chapter 1, the Highlands has low rainfall (typically 50 to 200 mm per year) (NSA, 2013; Namibia Meteorological Service, 2023). The rainy season tends to be from January to April, with most of the rains in March and April. However, some areas receive no rainfall for several years at a time. When it occurs, rainfall tends to be highly localised and intense, in places mobilising large quantities of sediment leading to soil erosion. This process has been exacerbated due to over-grazing in the area (Leggett *et al.,* 2003a; NACSO, 2017; Heydinger, 2021a), highlighting the dynamic and complex relationship between climate and human activity. Vegetation is more sparse just to the west of the Highlands, and game species tend to migrate with the rain to search for fresh grasslands. While much of northwest Namibia is not fit for extensive agricultural development (Schoeman, 2010; Heydinger, 2021a), livestock farming continues to be the main focus of the community for their livelihoods. Access to grazing and water resources are a major priority in terms of local livelihoods and culture.

Water resources are therefore a critical component of community life in the Northern Highlands as livestock need to be within walking distance of a water source, such as a groundwater borehole or sometimes an earth dam that collects water in rainy season. Periods of drought tend to come in cycles over several years. As well as the serious droughts

[11] Tourism Supporting Conservation Trust

in some years between 2013 and 2020, severe impacts were reported from the major droughts in the late 1970s and early 1980s (Schnegg and Kiaka, 2018; Jacobsohn, 2019), with estimated loss of about 90% of livestock (Bollig and Schwieger, 2014).

The habitat in the Northern Highlands is highly sensitive to the droughts and to intense rainfall events, and to impacts from human development. Southern Africa is forecast to warm twice as fast as the global average (Turpie *et al.*, 2010; Niang *et al.*, 2014; WMO, 2021). Therefore climate change is likely to have a particular impact on the fragile ecosystem of the Northern Highlands, with the potential future risks of more severe droughts and higher intensity rain storms. Such events would further increase competition between humans and wildlife for natural resources. All these challenges are putting a strain on the commitment of local people to wildlife protection and are a risk to the community conservancy programme. There are serious risks in future for the sustainability of the landscape, wildlife and communities in the Northern Highlands.

7.4.2 Areas of northwest Namibia with protected status

Before the 1960s, exploration of much of northwest Namibia by outsiders had been minimal, and until 1978 permission was needed for visitors to enter the area (Owen-Smith, 2010). Much of the area has had some protected status at different times since 1907. By 1970, however, much of protected status had been removed (Figure 3.4). The Skeleton Coast National Park is the only area today to the west of Etosha with national park status. Other large areas do have some level of protection, for example the three tourism concession areas in the Damaraland of Palmwag, Hobatere and Etendeka, and the wildlife conservancies across northwest Namibia, provide some community-based protection.

In recent years four community conservancies, the Ministry of Environment, Forestry and Tourism (MEFT), the relevant Traditional Authorities and Namibian wildlife NGOs have been planning the Ombonde People's Park (OPP) (IRDNC, 2021); an area of about 2,000 km^2 to the southwest of the Northern Highlands, and potentially an additional protected area around the lower Hoanib catchment. This would provide protected status for part of a potential wildlife migration corridor from Etosha National Park to Skeleton Coast National Park (historically, wildlife has tended to migrate east-west following the river valleys (Figure 1.2), (Owen-Smith, 2010; MEFT, 2021)). However, the main missing gap in that corridor in terms of protected status would be the area of the Northern Highlands. The boundaries of the planned Ombonde People's Park remain under discussion with Ehi-Rovipuka, Omatendeka, Anabeb and Sesfontein Conservancies (Figure 6.82).

7.4.3 Tourism opportunities in the Northern Highlands

There are several opportunities for tourism in the Northern Highlands, which are needed to increase income to the conservancies and support the local communities (e.g. livelihoods), but also would bring in revenues that would contribute to the costs of maintaining protected area status, should that be granted. First time tourists to Namibia tend to mainly visit the national parks (e.g. the wildlife in Etosha National Park and the Sossusvlei sand dunes in Namib-Naukluft National Park in southern Namibia). Wildlife tourism is the most applicable priority for the short-term in the Northern Highlands, with a major attraction for returning

tourists being the viewing of wildlife outside national parks. However, tourists would be attracted by a number of other aspects, particularly the remoteness and scenery of the landscape, local culture, and activities such as walking trails. These are explained below (and in Figures 7.10 to 7.13).

(a) Wildlife tourism

The fragile ecosystem of the Northern Highlands includes a surprisingly wide variety of wildlife. High-profile species include elephants, giraffe (*Giraffa camelopardalis angolensis*), and several predators. The populations of game species, such as mountain zebra (*Equus zebra hartmannae*), kudu (*Tragelaphus strepsiceros*), oryx (*Oryx gazella*), springbok (*Antidorcas marsupialis*), and the endemic black-faced impala (*Aepyceros melampus petersi*) have fluctuated over many years, with serious reductions from poaching until the 1990s when the community-based conservation policies were being developed (MEFT/NACSO, 2022). The region also has a particularly diverse bird life, with several species that are endemic to northwest Namibia and southern Angola. These include Rüppell's parrot (*Poicephalus rueppellii*) (Figure 7.13) and Bare-cheeked babbler (*Turdoides gymnogenys*), (Newman, 2010). As well as the elephant tracking opportunities, bird-watching tourism presents a major opportunity for the Highlands.



Figure 7.10 – My positive experiences on field walks with game guards has demonstrated their suitability for a role as elephant rangers and walking guides. Photograph taken 24 January 2023, Orupupa Conservancy.



Figure 7.11 – Homestead in Okangundumba Conservancy, 17 April 2019. The Herero communities of the Highlands provide opportunities for cultural tourism, in particular stories of their living alongside wildlife such as predators and elephants.



Figure 7.12 – Ekoto cliff in Orupupa Conservancy. The cliff is tufa deposit, which has unique geological interest (Grünert, 2013). There are several tufa deposits in the Northern Highlands area (I have seen or visited four large cliffs at Ekoto, Okomutati, Otjisakamuka, and near Otjihorongo). Photograph taken 14 February 2023.



Figure 7.13 – Rüppell's Parrot (*Poicephalus rueppellii*), is near-endemic to northwest Namibia (also in southwest Angola) (Newman, 2010), and is an example of the many species of potential interest to bird-watching tourists in northwest Namibia. Photograph taken at Okomutati in Ehi-Rovipuka Conservancy on 23 March 2019.

(b) Landscape, remoteness and geology

Two of the largest river catchment systems in northwest Namibia are the Hoanib and Hoarusib Rivers (Figure 1.2), and river valleys in the Northern Highlands are part of these catchments. Water flows in the ephemeral rivers for only a few days or weeks per year (or not at all in a severe drought year). The water flows extend all the way to the coast only once every nine years on average (Strohbach, 2008). The wide variety of geological and geomorphic formations (e.g. basalt, dolomite, limestone, granite, schist and tufa cliffs) have created highly scenic features such as canyons, perennial springs, open plains, dry riverbeds, and mountain panoramas. With a human population density of about one person per km^2, tourists would be attracted by the remoteness of the area, as well as the scenery. The area also includes old rock art, highlighting the cultural heritage of the region (Figure 3.2). Geotourism has previously been proposed as a potential additional tourism opportunity for Namibia (Dowling and Pforr, 2021).

(c) Local culture

There is some cultural tourism north of the Highlands, in Opuwo and towards the Angola border, related to the Himba communities, but the Herero communities of the Northern Highlands also provide opportunities for cultural tourism. Tourists are likely to be interested in historical and current stories related communities living alongside elephants and other wildlife in the challenging environment. Several wildlife enthusiasts would also be interested in the community-based approaches to wildlife protection under the conservancy programme.

(d) Activities

The Northern Highlands area would attract tourists with a more adventurous attitude, and therefore has opportunities for walking trails in particular, as well as mountain biking.

7.5 Conclusions

There is a strong case for raising the protected status in some or all areas of the Northern Highlands. The protection of the landscape has become a particular priority given the likely ongoing impacts related to climate change and the need for alternative livelihoods away from livestock farming. Protected status could cover particularly sensitive habitats, natural water sources, river valleys and other wildlife corridors, geological features and important cultural sites (e.g. rock art); all of which display tourism potential. For some time, Namibia has been developing a new legal instrument, the Protected Areas and Wildlife Management Bill, in line with its Revised National Strategy on Wildlife Protection and Law Enforcement (MEFT, 2020). The consultation and adoption of the draft Bill is in its final stages in Namibia. It includes a provision on categories of Protected Area and the Act, when adopted, will facilitate the designation of protected areas by the Minister.

Revenue would be needed for costs associated with the protected status, including management and monitoring costs and some infrastructure. The managed expansion of tourism presents an opportunity to bring in investment and revenue, and to create alternative livelihoods. The remote and highly scenic landscape of the Northern Highlands is an attraction for tourists, enhanced by diverse wildlife, but only a small fraction of tourists in Namibia currently visit the area. The focus of the tourism is likely to continue to be the wildlife, and the elephants in the region present a specific opportunity just as rhino tourism has expanded in recent years to the south of the Highlands (in Damaraland (Figure 1.2)), helping to protect the black rhino population (IRDNC, 2020a). The strong local ecological knowledge of most game guards in the Northern Highlands means that they could play a particularly important role in future as elephant rangers and wildlife guides to support the expansion of tourism. Other specialised wildlife tourism, such as bird-watching tours, present a good opportunity. In time, expanding tourism to include activities, such as walking trails and mountain biking, and a focus also on local culture, all present opportunities, as well as geotourism.

The wildlife conservancy model has been largely successful in terms of protection of wildlife and stopping the decline in populations. However, several conservancies have been operating for over 20 years with limited funding and no investment in tourism. There is a risk that local people are becoming less motivated to protect wildlife. Encouraging investment in tourism through designating protected areas would step up the commitment of the conservancies and their local communities. The conservancy model provides the foundation for local communities to be engaged in planning and as custodians of areas with protected status under supervision of MEFT. It also provides the framework for local communities to benefit directly from the employment and revenues generated by the protected areas. Traditional Authorities representing all local groups must be included throughout the planning and consultation process. There has been significant work since 2016 on identifying tourism opportunities in northwest Namibia (MET, 2018; IRDNC, 2020b; IRDNC, 2021), but detailed ongoing work is needed to identify priority areas for protection in terms of wildlife corridors, landscapes, geological features, etc.

The opportunities to raise the profile to the tourism sector of the wildlife, cultural aspects and landscape features in the Northern Highlands include promoting the aspect of people (and their livestock) living alongside unique wildlife in a challenging and scenic landscape (Figure 7.14). The approaches recommended in this Chapter could contribute to the long-term sustainability of the communities and wildlife in the Northern Highlands, and the game guards could play a core role in increasing tourism.



Figure 7.14 – The Northern Highlands has the quite unique situation of people (and their livestock) living alongside wildlife, such as giraffe (*Giraffa camelopardalis angolensis*) in a challenging and scenic landscape. These aspects are likely to be of interest to some tourists.

Chapter 8 – Conclusions

The Northern Highlands is a very remote landscape to the west of Etosha National Park. Human population density is low in the area (about 1 person per km^2), and there is a strong traditional culture of livestock farming, despite the challenging environment. The rural communities are some of the poorest in Namibia. They live alongside a small population of elephants and this is causing additional challenges because of damage by elephants to water points and vegetable gardens. African savanna elephants (*Loxodonta africana*) are classified as Endangered in the IUCN Red List of Threatened Species, and this small population of elephants is quite unique because they walk up steep slopes in the mountains, behaviour that is unusual for such a large and heavy mammal. As a flagship species that moves large distances, protection of the elephants will have positive effects in terms of protection of areas of habitat. However, the planning of applicable protection measures needs to be informed by credible information on the population and movements of elephants. Although there has been much detailed research on the high-profile desert-adapted elephants near the Skeleton Coast National Park, to the west of the Northern Highlands, there had been minimal specific research on the elephants in the Northern Highlands prior to this Research Project.

The community-based wildlife conservation approach under the conservancy programme has had considerable success in northwest Namibia in terms of increasing the commitment of local people to wildlife protection. However, the ongoing success of the conservancy programme is at risk because of the lack of investment in tourism and therefore the programme is not generating the expected benefits and alternative livelihoods for the community. The ongoing challenges with human-wildlife conflict are also eroding the commitment of local people to wildlife protection. There are major challenges in monitoring and research of the elephants in the Northern Highlands, particularly because of the low overall density of elephants but also because of the mountainous and remote landscape. However, the conservancy programme involves the employment of game guards, and this provides opportunities for cost-effective research through their local ecological knowledge.

The objective of my Research Project was to build a knowledge base on the population, behaviour and movements of the elephants in the Northern Highlands and particularly to identify factors affecting the population and movements of the elephants.

The important point about the method is that it involved a mix of semi-structured interviews with the game guards, with the results cross-checked through extensive time in the field. This included visits to over 100 water points with game guards, and over 100 hours of field walks to identify evidence of elephant movements. The interviews included a mix of methods, such as open and closed questions, use of the Likert scale, exercises to select trees preferred by elephants (from printed cards of common trees), and drawing on maps for participatory mapping of elephant movements. Informal discussions with game guards continued during the field visits and field walks. The game guards interviewed had an average of just over 10 years of experience in their role.

Based on local ecological knowledge of known groups, I estimate the number of elephants in the Northern Highlands study area in 2022 to have been between 78 and 212, with a best

estimate of 128 elephants. The estimate is based on the knowledge of game guards on the size of groups of elephants that they know (local people refer to elephant herds as "groups"), and on distinguishing features of elephants in the groups (e.g. broken tusks, torn ears). Based on much time in the field and on the interviews, I estimated that there are up to ten groups of elephants with ten or more elephants in the group. These estimates are for elephants that are more permanently in the Northern Highlands. Some elephants do also enter the area from Etosha National Park and from other areas for short time periods. My method did also confirm with high confidence that elephants are moving long distances across the Northern Highlands, with the same groups having been seen by game guards in different conservancies (e.g. over 80 km apart). This aligns with wider previous research that concludes elephants move long distances in northwest Namibia.

There is uncertainty in these population estimates, for example because it is difficult for game guards to count the number of elephants in a group (they do not have binoculars or spotlights, and they have to keep a safe distance from the elephants). Group sizes change as adult male elephants often move in and out of a group. However, despite the uncertainties, the method provides low-cost estimates that are based on many years of experience of game guards, compared to the high-cost aerial surveys that provide a snapshot estimate once every few years (and there is uncertainty in the estimates from aerial surveys because the elephant density is low). One of the research objectives was to test this method, and I recommend that the known group method would be highly applicable if a more structured approach (e.g. with some more precise questions on distinguishing features of known elephants) was implemented, and if the game guards were provided with training and equipment.

According to game guards, one of the main concerns of the people in the Northern Highlands has been the human-elephant conflict, including at water points and including concerns over the safety of people. Recently there has been more concern because of a step-up in incidents at vegetable gardens. This change has happened after the severe droughts of 2018-2019, when many people started new vegetable gardens following the loss in livestock. Since before 2012, game guards have used a consistent method of recording incidents of human-elephant conflict in Event Books. The NGOs involved in wildlife conservation have analysed the data in Event Books at a high level, for human-wildlife conflict including elephants and predators. I have carried out much more detailed analysis on human-elephant conflict, identifying from the data in the Event Books both hotspots of damage to water points and hotspots of crop raiding at gardens. This has prioritised places where mitigation measures should be implemented. Event Books also include temporal data and my analysis of reported events has confirmed that there are many more incidents at vegetable gardens in the growing season of April and May, and more incidents at water points in the dry season. Although in most places incidents at community water points are rare, when they happen they can result in serious difficulties for the community because it takes much time and cost to repair, and the people would then have to rely on water from another village, which in many cases tends to be over 10 km away. The Government of Namibia has been implementing a programme of upgrades to water points, with about 40% of the water points that I visited now having protection walls around the drinking water tanks, concrete dams for holding water for livestock (elephants drink out of these dams) and solar pumps, which importantly keep the water available in the dams for people and

elephants (at minimal operating cost compared to diesel pumps). It is the common opinion of game guards that the number of serious incidents at water points has been decreasing as a result of these upgrades. The measures needed to reduce incidents at water points are proven and need to be rolled out at additional water points that have not been upgraded. However, there has been minimal testing of measures at vegetable gardens and pilot projects need to be implemented to test and research cost-effective measures, in particular burning of chillies. Electric fences are likely to be the most effective measure, but are not practical in terms of the high costs.

One of the common findings from my interviews with game guards was that 15-20 years ago elephants used to move from Etosha into the Northern Highlands in rainy season, and return to the park, whereas now many are staying more permanently in the Highlands. Given that the levels of wildlife protection and water availability in the Northern Highlands study area have improved over the last 10-20 years so that they are approaching the levels inside Etosha National Park, it was interesting to investigate whether the different types of vegetation are influencing elephant movements into the Highlands. My method combined local ecological knowledge of game guards with extensive observations in the field. Game guards are highly familiar with tree species, partly because the community has several medicinal and other uses for several tree species. The findings indicate a clear selection preference of elephants for African star chestnut (*Sterculia africana*), and *Commiphora* species such as blue-leaved corkwood (*Commiphora glaucescens*) and purple-stemmed corkwood (*Commiphora multijuga*). These species grow higher on steep, rocky mountain slopes and the elephants are climbing such slopes to browse those species. In this thesis I have included several photographs from my field observations up the mountains to confirm these findings. The results also indicate that some tree species are clearly much less preferred, most of which tend to be located in valleys or lower slopes. The results suggest that a major factor in the increase in elephant population in the Northern Highlands, including movement from Etosha, is the preferred vegetation available on the mountain slopes of the Highlands compared to the vegetation on the mainly flat savanna landscape of Etosha. Further research should focus on vegetation preferences inside Etosha, and on the relative abundance of the preferred species in Etosha (which has a few rocky hills in the south and west).

The common perception of game guards is that elephants tend to visit community water points at night and walk up the steeper slopes for their preferred vegetation, and often spend the middle of hot days in the valleys in the shade of the taller trees near the river beds. In the past the elephants made fewer visits to the water points in villages in the rainy season, because of standing water elsewhere, but now they do visit villages at the end of the rainy season because of the vegetable gardens. Elephant herds tend to spend about two weeks in one area, and then move a longer distance to another area near a different water point. Game guards tend to have good knowledge of elephant movements when in their area, and some knowledge of movements elsewhere in the conservancy through their frequent meetings with other game guards. When elephants move outside of their conservancy, game guards have less knowledge of typical movements. The participatory mapping exercise in this Research Project was particularly useful to identify common movement directions of elephants within conservancies. Through their training and use of maps for recording locations in Event Books, game guards are familiar with the maps of their

conservancies. The results of the participatory mapping clearly show that there are common routes taken by elephants and areas of the conservancy that elephants mostly avoid, and I verified some of these findings through field observations (e.g. observations of dung at water points and springs). Another particularly interesting finding on movements is that there are many more incidents involving elephants throughout the year in the mountainous area compared with the flat area between Etosha National Park and the Highlands, despite there being at least as many villages, water points and vegetable gardens in the flat area. This confirms that elephants are likely to be spending more time in the mountainous area, potentially because of their preferred vegetation. These results on movements, combined with results on hotspots, are important for prioritising mitigation measures at water points and vegetable gardens. They are potentially also useful for considering raising the level of protected status for part or all of the Northern Highlands, including the specific movement corridors. The results would be enhanced by comparison with topographical and other baseline data using GIS, and by future research using GPS collars for tracking elephant movements.

The objective of my Research Project was to build a knowledge base on the elephants in the Northern Highlands. My research has generated estimates of the population of elephants and tested a method based on the number of elephants in known groups from local ecological knowledge. The research has identified a growing trend in elephant population in the Northern Highlands, and identified factors affecting movements of elephants into the Northern Highlands and within the area. It has identified hotspots of incidents of human-elephant conflict at water points and vegetable gardens. The results and conclusions will be useful for planning protection measures, including reducing human-elephant conflict, and as the baseline for monitoring the performance of the protection measures.

The local ecological knowledge on elephants was found to be at a much higher and more useful level than would be expected for rural communities. In future, the community game guards could provide opportunities to bring in much-needed revenues for the conservancy programme through training them to be elephant guides for tourism. Throughout this Research Project I have tried to raise the profile of the game guards in meetings with high-level stakeholders and by including them as co-authors on publications. The further research that I have recommended would be enhanced by support to community game guards, including provision of equipment (e.g. binoculars, spotlights, reference books, etc) so that the studies can benefit from their involvement and local ecological knowledge.

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