Ministry of Environment,
Forestry and Tourism

Report on the Population Survey of the Free-ranging Lions of Northwest Namibia, with Results and Recommendations

2022

PREPARED FOR NAMIBIA'S MINISTRY OF ENVIRONMENT, FORESTRY AND TOURISM

6th November 2022 - 6th January 2023

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RECOMMENDED CITATION

Muzuma, U., Heydinger, J. (2024). Report on the Population Survey of the Free-ranging Lions of Northwest Namibia, with Results and Recommendations, 2022. Namibia Ministry of Environment, Forestry and Tourism. Windhoek, Namibia.

Cover photo: XPL-143, Sesfontein Conservancy.

All photos taken by Technical Team unless otherwise noted.

Concept and Design by John Heydinger and Uakendisa Muzuma.

Revised 10 September, 2023.

Published in 2024 by the Community Conservation Fund of Namibia and Namibia Ministry of Environment, Forestry and Tourism.

Contents

Acknowledgments

This survey was a collaboration between Namibia's Ministry of Environment, Forestry and Tourism, local non-governmental organizations, and eleven communal conservancies. The multi-stakeholder approach relied greatly upon local expertise, as well as the scientific knowledge of the Technical Team and affiliated organizations. This survey would not have been possible without the hard work and support of many people and organizations.

We are grateful to the Minister of Environment, Forestry and Tourism (MEFT) Hon. Pohamba Shifeta and the Executive Director Mr. Teofilus Nghitila for their full support to ensure the free-ranging lion population of northwest Namibia is well-documented. We are grateful for the support of the MEFT Director of Parks and Wildlife Mr. Bennett Kahuure, and MEFT Director of Scientific Services Mrs. Elly Hamunyela for their personal commitment to ensure the survey's success. We thank Deputy Director of Scientific Services Mr. Kenneth /Uiseb and Deputy Director of Parks and Wildlife for the northwest region Mr. Christopher Munwela for their tireless efforts to ensure the evidence-based conservation of Namibia's wildlife. Appreciation also goes to MEFT Regional Services staff, particularly Mr. Andre Burger. Thanks also to Namibia's National Police Force.

The Community Conservation Fund of Namibia provided the major funding this survey. Through its Poverty Oriented Support for Community Conservation in Namibia (POSCCIN) program, CCFN provided food and fuel support. Financing for CCFN is provided by the Federal Republic of Germany through the German Ministry of Economic Cooperation and Development (BMZ) via the KfW Development Bank. We thank Selma Nangolo for her support of this and other initiatives surrounding CBNRM in northwest Namibia. We also thank Tapiwa Makiwa and Janese Vilander. Field support of operational costs came from MEFT NamParks V grant. Additional support was provided by Oliver Adolph and Family, Matiti Safaris, Tourism Supporting Conservation Trust (TOSCO), Ultimate Safaris, and John Reed. Wide Horizons Aerial Technologies, Dr. Nic Elliot, Oliver Adolph, and the University of Minnesota Lion Center are thanked for technical support.

Field support, including staff time and the use of vehicles was provided by MEFT, Ombonde lion research, the Namibian Lion Trust (NLT), as well as Integrated Rural Development and Nature Conservation (IRDNC).

Thanks to Josephine Amwaala and Katharina Dierkes of the Namibia Association of CBNRM Support Organizations (NACSO), who assisted with maps for this report.

Thank you to the staff and management of Etendeka Mountain Camp, Hoada campsite, Hobatere Lodge, Palmwag Lodge, Natural Selection Obias, Save the Rhino Trust-Palmwag, and Wilderness Safaris Hoanib who assisted in a variety of ways. Thanks to numerous communal conservancy residents who assisted with tracking, cooking, and camp security.

Thanks to TOSCO Trust's Lara Potma and Dieter Risser.

We express particular gratitude to the Anabeb, Doro !Nawas, Ehi-rovipuka, ǂKhoadi-||Hôas, Omatendeka, Orupupa, Puros, Sesfontein, Sorris Sorris, and Torra communal conservancies, who availed staff time and resources to support fieldwork.

For the many teams that worked across northwest Namibia during the survey we are grateful for your hard work, dedication, and ongoing commitment to community conservation of free-ranging lions.

Unmarked subadult male, ǂKhoadi-||Hoas Conservnacy

Abstract

From 6 November 2022 to 6 January 2023, we conducted a systematic survey of African lions (*Panthera leo*) across the communal and government-managed areas of northwest Namibia (Kunene Region). The data collected are presented and analyzed here. Findings are contextualized within a regional perspective, with subsequent discussions relevant to the conservation implications of lions in Kunene and Namibia. This is the first-of-its-kind lion population survey for northwest Namibia.

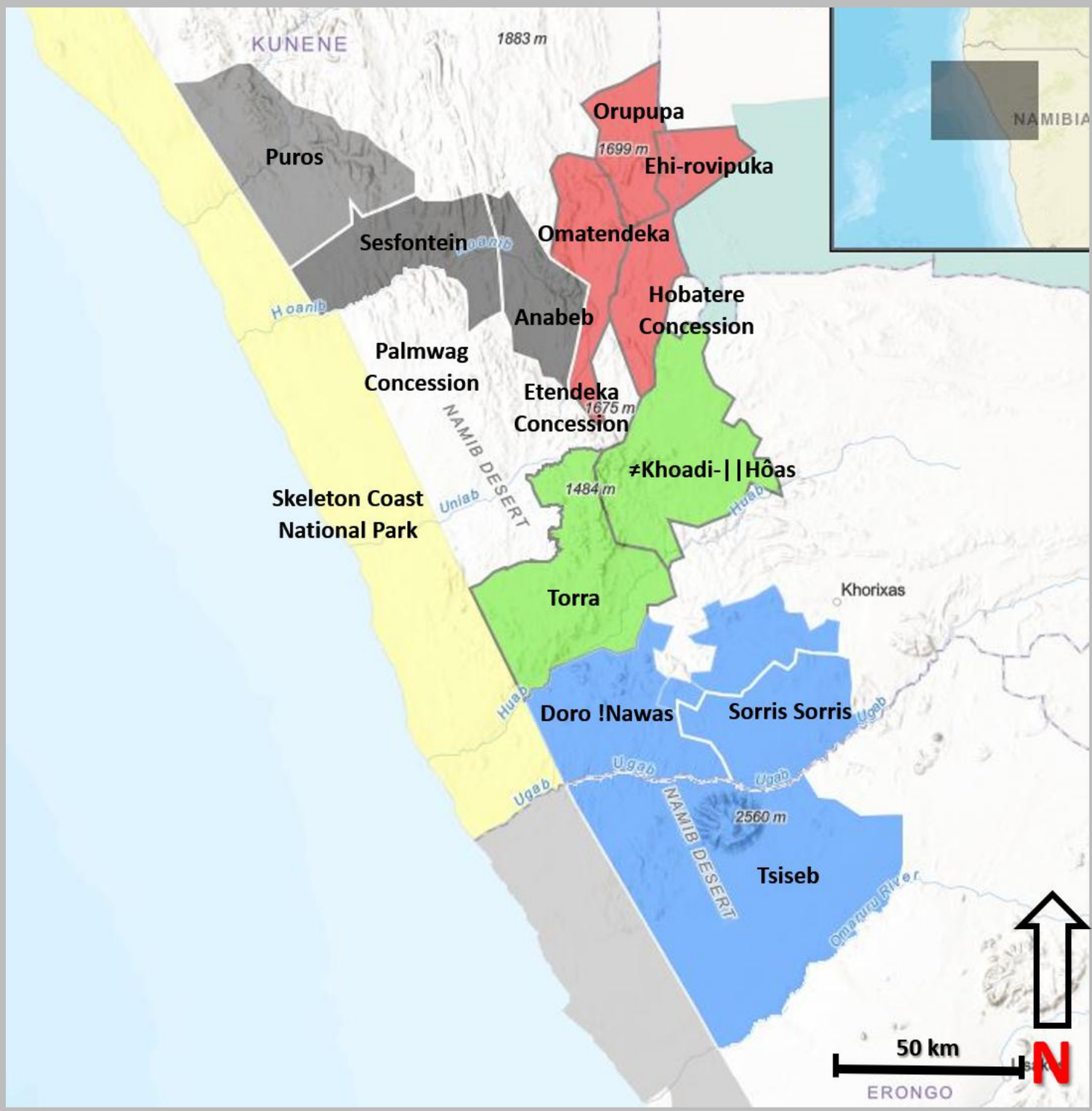
Methods were adapted to the unique challenges of surveying lions in northwest Namibia. Our search was a systematic whole count, attempting to find and identify every individual lion. While it is understood that obtaining total counts of large carnivores is "all but impossible" (Elliot et al. 2021: vii), we believe a nearly complete count has been achieved. Most importantly, the methods and count serve as a baseline for future surveys. Repeating this survey every three to five years will be an important part of conserving and managing the northwest lion population. The methods used were possible due to the local ecological knowledge (LEK) of the Lion Rangers and MEFT staff, as well as the effort of the survey teams.

Since the 1990s, lions in the northwest have ranged across 51,380 km^2 (Stander 2007; 2019). Core lion range is defined here as eleven communal conservancies (Anabeb, Doro !Nawas, Ehi-rovipuka, ǂKhoadi-||Hôas, Omatendeka, Orupupa, Puros, Sesfontein, Sorris Sorris, Torra, and Tsiseb), three tourism concessions (Etendeka, Hobatere, and Palmwag), and the Skeleton Coast National Park from the Hoaruseb drainage in the north to the Huab drainage in the south. This area encompasses approximately 40,000 km^2. Within this landscape, lions were identified by vibrissae (whisker spot) patterns in combination with other demographic markers. Vibrissae have been shown to be individually unique within small-to-medium-sized lion populations (Pennycuick and Rudnai 1970). Our results support the relevancy of this approach.

The northwest lion population is estimated between 57-60 individual adult lions and 14 cubs. At 0.11-0.12 lions/100 km^2 lion density in northwest Namibia is the lowest recorded for a free-ranging, self-sustaining population in Africa. This is also the lowest recorded density for lions in the region – though previous estimates are based on expert opinion. 36 female and 21 male lions were found during the survey, yielding a sex ratio of 1 ♀: 0.58 ♂; within normal bounds for lions. While the population is considered stable and self-sustaining human-lion conflict (HLC) remains the primary cause of lion mortality. Caution is urged in managing the population: there is still little peer-reviewed scientific information about the behavior and ecology of lions in northwest Namibia as well as the drivers of HLC. Greater research and monitoring of lions on communal and government-managed lands is needed.

Based upon the findings of this report, we recommend guidelines for the ongoing monitoring and management of lions in northwest Namibia, relevant to the *National Policy on Conservation and Management of Large Carnivores in Namibia* (GRN 2016). These include:

- Repeating the northwest lion population survey every three to five years
- Upscaling lion research, monitoring, and coordinated activities relevant to communal lands
- Maintaining a lion ID database and disseminating information to conservancies and field staff
- Exercising cautious, proactive conservation and management of an ecologically-unique population
- Limiting HLC as part of supporting rural development and community outreach to improve tolerance for living with lions



Map 1: Northwest Namibia core lion range with conservancy and government-managed area boundaries. Conservancies are colored according to 'Lion Block' designations (see page 41).

Non-Technical Overview

Stable Population

57-60 adult lions (>1 yr old) and 14 cubs across the landscape. Though this may represent a 60% decrease from earlier estimates, it tracks with a declining prey base. Lions' body condition is generally very good (4/5) with encouraging reproduction.

Normal Sex Ratio

At 36 females and 21 males, the sex ratio of all non-cubs was 1.0♀:0.58♂ (compared to a 2010 estimate of 1.0 ♀ :0.18 ♂). This is within the bounds of demographic norms for lions. Rebounding male numbers are augmented by high numbers of subadult males: 10 out 21 (47%) recorded males are non-dispersed subadults.

Extreme Low Density

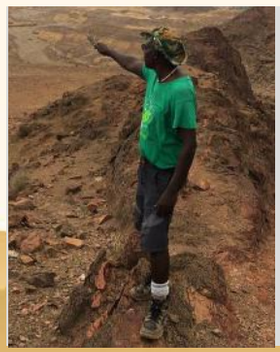
0.11-0.12 lions/100 km^2 makes this Africa's least dense free-ranging lion population. This represents a decreased density estimate for Kunene, from 0.31-0.37 in 2017. The population is likely susceptible to stochastic (unforeseen statistical) events, though may be generally resilient to potential diseases due to arid and semi-arid ecological conditions.

Individual Lion IDs

High-quality, bi-lateral vibrissae (whisker pattern) photos were taken for 54/57 adult lions (94%). These have been collated into a database for Lion ID cards for all individuals, to be updated by researchers on an ongoing basis. ID photos were not taken of one group (three females) who could not be safely approached due to the presence of very young (<4 months) cubs.

Rain in Anabeb Conservancy. Photo: A. Wattamaniuk

Highlights

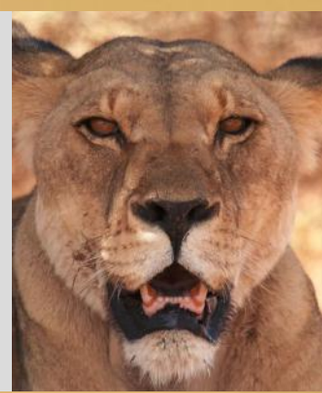


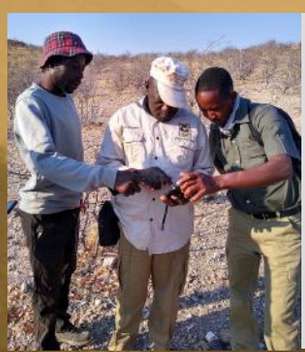
Landscape Coverage

Lion Rangers and MEFT staff covered approximately 40,000 km^2 during the survey, recording ~10,155 km on foot patrol and ~83,290 km by vehicle patrol over a 54 day period. Patrols included 11 conservancies, 3 tourism concessions, and Skeleton Coast National Park.

Lion ID Photos

The technical teams took approximately 6,100 high-quality lion photos during the survey to obtain vibrissae (whisker-pattern) IDs. In addition to contributing to a database of lion IDs, these photos provide a near-comprehensive snapshot of individual lion wellbeing.





SMART Reports

Lion Rangers logged 1,059 patrol reports on the SMART mobile app during the survey. This included more than 80 individual lion sightings as well as landscape-wide presence data on ten prey species, six additional large carnivores, plus elephant and black rhino. This represents the most intensive landscape-wide monitoring of wildlife in Kunene to-date.

Conflict Response and Collaring

Survey teams also responded to human-lion conflict. During the survey, Lion Rangers partnered with MEFT-DSS to collar three lions and translocate one away from trouble. Additionally, the Lion Rangers and MEFT Regional Services staff maintained ongoing patrol schedules and human-lion conflict interventions in Anabeb, Ehi-rovipuka, ≠Khoadi-||Hôas, Omatendeka, Orupupa, Puros and Torra conservancies.

Gamatum riverbed, Puros Conservancy. Photo: A. Wattamaniuk

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Diego Herunga


Survey teams at SRT-Palmwag


Survey teams at Hoada

Glossary

Term	Definitions in the context of this report
Abundance	Total number of individuals within a certain area at a particular time.
Adult lion	Generally those above 5 years of age; males that have dispersed from their natal pride. (All lions above 2 are termed 'adults' for purposes of this report.)
Brand	Unique markings imprinted on lions' rear flanks by permitted researchers for identification purposes.
Body condition	Overall apparent health of individual lions based on visual assessment by researchers and Lion Rangers. Condition scores range from 1 (lowest/poor) to 5 (highest/excellent).
Call-in/playbacks	Sounds broadcast from loud speakers at high volume to attract lions.
Capture	Any individual photographic record of a lion.
Communal Conservancy	Government-recognized conservation area where self-identified local communities maintain limited rights over wildlife.
Core lion-range	Those areas where lions have repeatedly bred and maintained home ranges since the 1990s.
Cub	Lions estimated to be under 1 year of age.
Density	Number of individuals per unit area (e.g. number of lions/100 km^2).
Dispersed	Lions no longer permanently residing with their natal prides.
Drought	Periods when rainfall negatively exceeds normal annual variability.
Dry season	June to December.
Free-ranging	Lions inhabiting fenced areas > 1,000 km^2 or partially or unfenced areas > 500 km^2.
GPS/satellite collars	Collars which periodically record and transmit geographic positions via satellite.
Human-lion conflict	Any event in which lions harm or destroy human life or livestock, or in which wild lions are injured, captured, or destroyed due to perceived or real threat to humans or property.
Isohyet	Area having the same amount of rainfall in a given period.
Lion Blocks	Groups of conservancies partnering to limit HLC and share benefits for living with lions.
Lion Rangers	Community conservationists tasked with monitoring lions in their conservancy and helping limit HLC.
Non-dispersed	Lions residing in their natal pride.
Northwest lion population	Free-ranging lions inhabiting communal and government-protected areas in Namibia's Kunene Region (excluding Etosha National Park).
Northwest Namibia	Communal, government, and private lands within the Kunene Region.
Population closure	Assumption that the examined population does not change during a survey period, either due to demographic (births and deaths) or geographic (immigration and emigration) factors.
Pride	A group of females and their attending males peacefully staying together on a permanent or near-permanent basis.
Protected area	Legally-recognized geographic space dedicated and managed for the long-term conservation of nature and associated services and resources.

Glossary (cont.)

Term	Definitions in the context of this report
Resident lions	Lions consistently occupying an area as either their primary or secondary residence.
Subadult lions	Non-dispersed lions between two and approximately five-six years of age.
Spoor	Any visible physical sign denoting the presence of lions or other wildlife.
Technical Team	Survey design leadership team: responsible for developing methods, overseeing data collection, performing analysis, and write-up (J. Heydinger and U. Muzuma).
Tourism concession	Legally-recognized geographic space dedicated to nature conservation for tourism purposes which excludes human settlements.
Trail camera	Motion-activated cameras used to remotely record the presence of lions or other wildlife.
Two-tailed t.test	Statistical measure used to assess whether data sets differ significantly relative to a defined parameter.
Vibrissae	Dark spots on lions faces forming four to five parallel rows caudal to the mid-nose line between the upper lip and nose
Wet Season	January to May.
Wildlife Credits	A payment for conservation performance program whereby conservancies receive monetary compensation for living alongside lions.

Abbreviations and Acronyms

Term	Definition
AWT	African Wildlife Tracking
CBNRM	Community-based natural resource management
CCFN	Community Conservation Fund of Namibia
cm	centimeters
COVID-19	Coronavirus disease 2019 caused by the virus SARS-CoV-2
DLC	Desert Lion Conservation
♀	Female sex (lion)
GPS	Global positioning system
GPTF	Game Products Trust Fund of Namibia
GRN	Government of the Republic of Namibia
HLC	Human-lion conflict
ID	Identification
IRDNC	Integrated Rural Development and Nature Conservation
IUCN	International Union for the Conservation of Nature
km	kilometers
Large Carnivore Plan	*National Policy on Conservation and Management of Large Carnivores in Namibia*, 2016.
LEK	Local ecological knowledge
♂	Male sex (lion)
MEFT	Namibia Ministry of Environment, Forestry and Tourism
MEFT-DSS	MEFT Directorate of Scientific Services
MPI	Max Planck Institute of Animal Behaviour
NACSO	Namibia Association of CBNRM Support Organizations
NDVI	Normalized difference vegetation index
NGO	Non-governmental organization
NLT	Namibian Lion Trust
NPL-##	Alpha-numeric moniker for NLT-research area *Panthera leo*
NW Lion Plan	*Human Lion Conflict Management Plan for North West Namibia*, 2017.
OPL-##	Alpha-numeric moniker for Ombonde-research area *Panthera leo*
POSCCIN	Poverty-Oriented Support for Community Conservation in Namibia
SCNP	Skeleton Coast National Park
SECR	Spatially-explicit capture-recapture
SMART	Spatial Monitoring and Reporting Tool
SOPs	Standard operational procedures
SRT	Save the Rhino Trust
TOSCO Trust	Tourism Supporting Conservation Trust
VCF	Veterinary control fence ("Red Line")
VHF	Very-high frequency
WH	Wide Horizons Aerial Technologies
XPL-##	Alpha-numeric moniker for Khorixas/DLC-research area *Panthera leo*

XPL-136, Palmwag Concession

Chapter 1

Background

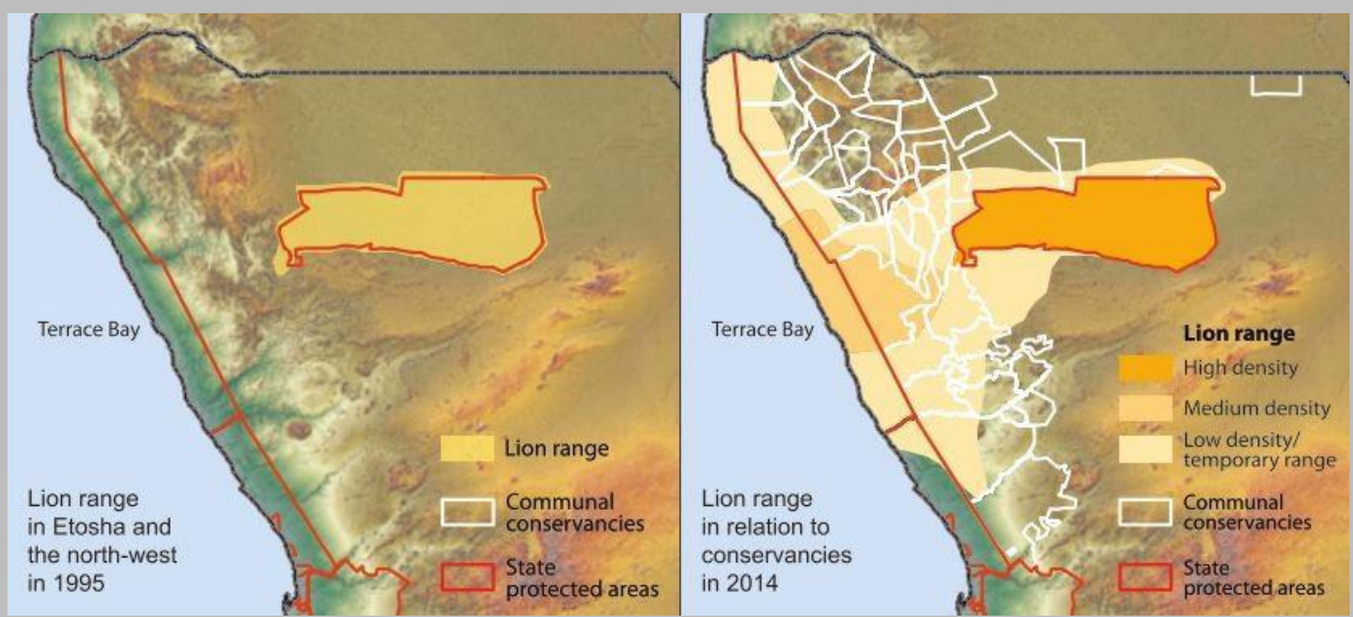
The African lion (*Panthera leo*) population of northwest Namibia has been internationally recognized as an important part of maintaining the survival of free-ranging lions across the continent (Jacobson and Riggio 2018; IUCN 2018). However, little information has been published about the population. While the population of lions in neighboring Etosha National Park has been systematically surveyed in recent years (Kilian and Moeller 2015; Goelst et al. 2018), no population survey of lions west of Etosha has been undertaken. This lack of information limits the evidence-based management of the population.

The African lion is classified by the International Union for Conservation of Nature (IUCN) as 'Vulnerable,' meaning it faces a high risk of extinction in the wild. During the twenty-first century lion range has been reduced to approximately 10% of their historically-recorded range. From 1993-2014 lion numbers declined by 43% across Africa, where there are currently an estimated 20,000-30,000 free-ranging lions. As many as half of these reside in East Africa, primarily within the Serengeti or other grassland ecosystems (IUCN 2018). Information on lions inhabiting resource-limited areas, such as the arid and semi-arid areas of Kunene, is extremely limited (but see: Funston 2011; Stander 2018). Furthermore, lions are thought to be rapidly declining across Africa, except within intensively-managed protected areas (Bauer et al. 2015). Lions inhabiting fenced protected areas are significantly closer to estimated carrying capacities than are unfenced populations (Packer et al. 2013).

One notable exception to these worrying trends has been the recovery of northwest Namibia's free-ranging lion population. From a low of perhaps twenty individuals in the late 1990s, by 2015 Namibia's Ministry of Environment, Forestry and Tourism (MEFT) estimated the population as high as 180 individuals (GRN 2017). During this period northwest Namibia was one of the few places where free-ranging lion numbers were increasing outside of fenced protected areas. This dramatic recovery coincided with the growth of Namibia's communal conservancy system, as well as a period of relatively plentiful rainfall.

However, population estimates since the 1990s, and during earlier periods (Owen-Smith 1971; Viljoen 1980; Heydinger 2021), have been based primarily upon expert opinion. While intensive lion monitoring has taken place in the Palmwag Concession, as well as across the western conservancies of Anabeb, Puros, Sesfontein, and Torra, and within parts of Skeleton Coast National Park (SCNP) since 1999 (Stander 1999), no systematic survey of lions across northwest Namibia was undertaken.

Though it is apparent that the region's lion population increased from 1997-2015, high levels of human-lion conflict (HLC), resulting in lion mortalities, were also being recorded. From 2005-2015, 343 HLC incidents were recorded in Anabeb, Puros, Sesfontein, and Torra conservancies alone, resulting in no fewer than 37 lion mortalities (GRN 2017). Additionally, from 1975-2010, a mean-average of 29 lions were destroyed along Etosha's borders each year (Heydinger et al. 2022). Recorded lion



Map 2: Lion range expansion in northwest Namibia from 1995 to 2014. Reprinted from: NACSO 2016: 40

mortalities on communal lands were particularly concerning because of the observed effect on the survival of males. By 2010, the sex ratio among a subset of the northwest population was estimated at 1 ♀: 0.18 ♂ (Stander 2010), well below the expected ratio of approximately 1 ♀: 0.45 ♂ (Packer pers. comm. 2023). This was particularly worrying due to the heightened propensity of males to die from HLC, and selective trophy hunting of males (Stander 2010). From 1999 to 2010, "[t]he major cause of mortality" among monitored lions, "was the killing (by local people during HLC) and trophy hunting of adult and sub-adult males" (Stander 2010: 15). While a national lion conservation management plan was drafted in 2008 (GRN 2008), no species-specific policy concerning the management of northwest Namibia's lions was implemented during this period.

In 2016, MEFT released the *National Policy on Conservation and Management of Large Carnivores in Namibia* (Large Carnivore Plan) (GRN 2016). Among other needs, the Large Carnivore Plan highlighted a lack of clear guidelines and procedures for the general management of large carnivores due to the need for increased research and monitoring at a species-specific level (Section 2.4).

Following upon this report, in 2017, MEFT released the *Human-Lion Conflict Management Plan for North West Namibia* (NW Lion Plan) (GRN 2017), in response particularly to ongoing high levels of lion mortality stemming from HLC in the northwest. Recognizing the important effects of HLC on the region's lion population, the stated goal of the NW Lion Plan was "[t]o provide measures and approaches to manage and reduce [HLC] in NW Namibia" (GRN 2017: 15). This was to be achieved through the creation of a standardized monitoring system, establishing best practices for mitigating HLC, developing mechanisms to reduce HLC, and clarifying the issue of compensation received by locals suffering from HLC incidents. Social surveys of communal pastoralists undertaken in a subset of conservancies in 2017, revealed that lions had been responsible for a mean household loss of approximately N$55,000 (2023 value) during this period (Heydinger et al. 2019).

Simultaneously, the lion population was considered to have declined by 22-37% from 2015 to 2017 (GRN 2017; Stander 2018). These conservation and livelihood challenges coincided with an extended drought in Kunene. From 2011-2019 indicator prey species (gemsbok (*Oryx gazella*), springbok (*Antidorcas marsupialis*), and mountain zebra (*Equus zebra*)) numbers declined by as much as 60%, while livestock numbers declined by as much as 67% (Heydinger et al. 2019). While the entirety of the northwest lions' range falls within the ≤ 200 mm isohyet, it also falls within an area experiencing ≥ 60% annual rainfall variability. As the entire Kunene Region is projected to experience a 2-3°C temperature increase by 2060, concerns over the effects of increased aridity and temperature are pressing (Atlas of Namibia Team 2022).

By early 2021, chronic drought appeared to be affecting the region's lion population. In the western conservancies of Anabeb, Doro !Nawas, Sesfontein, and Torra, lions were appearing at farms in poor or critical body condition, resulting in certain individuals being removed from the area under MEFT direction. During recent years, certain prides had also 'rediscovered' available prey along the Skeleton Coast in the form of marine food items (Stander 2019). These related issues – the effects of drought, diminished lion body condition in certain areas, and some prides altering their diet – indicated the northwest lion population may be undergoing a period of considerable strain. In May 2021, MEFT mobilized local stakeholders to perform a rapid assessment of individual lion wellbeing across the landscape (MEFT unpublished). This rapid assessment found that lions in the western areas were struggling from the effects of chronic drought, while the eastern segment of the population appeared healthy. Following the rapid assessment report, MEFT's Directorate of the Scientific Services (MEFT-DSS) requested the first-ever comprehensive lion population survey west of Etosha National Park. This report details the results of that survey. Discussion and recommendations speak to the priorities outlined in the 2016 Large Carnivore Plan, including the importance of long-term targeted and sustained research and monitoring of lions in the northwest (GRN 2016).

Collared male lion in Anabeb Conservancy. Photo: A. Wattamaniuk

Chapter 2

Goal, Objectives, and Planning

Survey Goal and Objectives

Goal

To conduct the first comprehensive population survey of free-ranging lions in northwest Namibia on communal and government-managed lands, providing decision makers with baseline information for management, setting a standard for future northwest lion population surveys, and strengthening support for community-centered lion conservation in the region.

Objectives

1. Individually identify all lions (non-cubs) inhabiting communal and government-managed lands in northwest Namibia (west of Etosha National Park) and estimate their number.
2. Use practical, repeatable, and efficient methods to set a baseline for future northwest lion population surveys.
3. Center the work of the Lion Rangers and other local experts for inclusive methods and to develop capacity for lion monitoring going forward.
4. Address research and monitoring needs for lions in the northwest as laid-out in the Large Carnivore Plan (GRN 2016), while making evidence-based management recommendations.
5. Contribute to the development of a national lion management plan.

Objectives are reported upon in Chapter Eight.

Survey Area: Core lion range in northwest Namibia

Since the 1990s, lions in northwest Namibia have occupied 51,380 km^2 (Stander 2007). Core lion range encompasses an area of approximately 40,000 km^2, including eleven communal conservancies (Anabeb, Doro !Nawas, Ehi-rovipuka, ǂKhoadi-||Hôas, Omatendeka, Orupupa, Puros, Sesfontein, Sorris Sorris, Torra and Tsiseb) as well as the Hobatere, Etendeka, and Palmwag tourism concessions, and a portion of the Skeleton Coast National Park, from the Hoaruseb drainage in the north to the Huab drainage in the south. Core lion-range is defined as those areas where lions have repeatedly bred and maintained home-ranges since the 1990s.

The northwest is dominated by the Namib Desert, and includes Nama karoo along the western African escarpment containing inselbergs, merging into highland savanna further east. It is bisected by east-to-west ephemeral riverbeds. The soil is typically basaltic, shallow, rocky, and unproductive (Atlas of Namibia Team 2022). Rainfall generally increases along a west-to-east gradient, though the entire area falls within the $\leq$ 200 mm isohyet; it also falls within an area experiencing $\geq$ 60% annual rainfall variability. During the wet season (January-May) rains fall in brief, localized downpours. Prey species, including gemsbok, mountain zebra, giraffe (*Giraffa camelopardalis*), springbok, and kudu (*Tragelaphus strepsiceros*) maintain seasonal movements responding to patchy rainfall and subsequent available grasses and browse. During the dry season (June-December) prey often congregate in riverbeds. Due to an intensive government borehole-drilling program during the 1970s, much of the region is considered grazing-, not water-limited (Bollig 2020). From 2000 to 2010, the region experienced a relatively wet period, resulting in wildlife and livestock increases. From 2011 to 2017, extensive drought caused the decline of indicator prey species by as much as 60% and livestock by as much as 67% (Heydinger et al. 2019). The area is bisected by Namibia's Veterinary Control Fence (VCF), colloquially known as the "Red Line," which runs from 28 km west of the coast across Namibia.

Core lion range conservancies are home to approximately 19,300 rural residents, primarily Otjiherero- and Damara-speaking peoples. Most are small-scale pastoralists for whom drought and predation represent significant threats to livelihoods. Lions alone account for approximately 20% of livestock losses in certain areas (Heydinger et al. 2019). Household incomes are generally low and insecure. Forty percent of Kunene Region residents earn $\leq$ US$1/day, while 23% earn $\leq$ US$0.73/day (NNPC 2012). Livelihoods have been further hampered by a downturn in tourism-based income stemming from the COVID-19 pandemic (Lendelvo et al. 2020). Additionally, Kunene has Namibia's highest school drop-out rate: only 55% of residents complete primary school by age seventeen (UNICEF 2013).

Chapter 2

Methods Review

Lions and other large carnivores are difficult to count and results are frequently affected by local conditions (IUCN 2018), including behavior differences among individuals and spatial heterogeneity. Additionally, methods are constrained by time and resource availability. Methods considered included expert opinion, track surveys, call-in/playback surveys, spatially-explicit capture-recapture, and whole count. Elliot et al. (2021) provide a thorough review of available methods for estimating lion abundance and density; this section distills their review and applies it to the case of northwest Namibia.

Expert Opinion

Expert opinion has been the standard for estimating abundance and density of lions in northwest Namibia to-date (Stander 2007, 2010, 2018; GRN 2017). The values derived from this approach have been integral for management strategies. However, this approach is considered highly subjective, and does not yield reliable abundance or density estimates or repeatable methods (Moqanaki et al. 2018).

Track Surveys

Track surveys rely upon a known relationship between track density and lion density. The assumptions underlying this method (e.g. Elliot and Gopalaswamy 2017) and statistical analysis of the approach have been examined (Gopalaswany et al. 2015). The method is briefly described in Elliot et al. 2021 in which it is shown to rely upon the following assumptions: a) accurate knowledge of abundance at a small scale; b) random placement of transects; c) similar probability that each animal crosses a transect; d) each set of tracks is detected; e) individuals are accurately enumerated; f) tracks are clearly visible and preserved for a minimum known period.

In northwest Namibia, assumption a) is not met due to insufficient knowledge of the population. Given the variety of substrates (see Survey Area section), particularly rocky plains and mountains, assumptions d) and f) are also not met. Finally, track surveys have been criticized for providing neither accurate nor precise estimates of lion densities (Belant et al. 2019), while existing approaches to index-calibration are problematic (Dröge et al. 2020).

Call-in/playbacks

Call-in/playback surveys rely on lions responding to different sounds broadcast from loudspeakers so they may be counted by observers. Sounds are typically broadcast at night, meaning lions are directly observed, but may not be individually identified. Double counting is possible. Additionally, detection probability varies among individuals (Dolrenry pers comm. 2023). Yet, call-in/playback surveys have been used to great effect in Etosha National Park in recent years (Kilian and Moeller 2015; Goelst et al. 2018). Given the methods used in Etosha, and assuming a relatively accessible and homogeneous landscape, approximately 356 call-in stations would be required to achieve similar coverage in northwest Namibia (estimated at 40%). Were the time and resources available, the heterogeneity of northwest Namibia's environments precludes a reliance on this approach.

Spatially-explicit capture-recapture (SECR)

Population surveys in open environments should account for differences between the observation process (how individuals are detected) and state process (the abundance, distribution, and density of the focal population). There is no guarantee that a present individual will be detected. Hierarchical models such as SECR account for differences in the observation process and state process. SECR is reliant upon individual identification, in which animals are sighted and re-sighted, while the location of each sighting is recorded along with the effort of the survey team. Taken together this information is used to estimate the probability of individual detection, including an estimate of how many individuals were not seen, providing an estimate for the whole population (Elliot et al. 2021). SECR approaches rely on certain assumptions, including: a) population closure; b) known detection probability of individuals within differing environments; c) known spatial information relevant to both observation and state processes d) inferred activity centers based-upon spatial encounter histories; and e) ability for teams to sight and re-sight individuals within given areas throughout a specific period. When properly implemented, SECR provides accurate, precise, comparable, and repeatable methods for estimating lion numbers and density (Elliot and Gopalaswamy 2017; Elliot et al. 2020).

Among the methods considered, SECR is considered the most theoretically sound and statistically robust. In recent years, SECR developments, as well as wider use of Bayesian approaches alongside maximum likelihood approaches for data analysis, are increasing the accuracy and precision of large carnivore population surveys (e.g Elliot and Gopalaswamy 2017; Roffler et al. 2019). However, time and resource constraints, landscape topography, and repeatability challenges precluded us from taking this approach. Additionally, lion abundance and density across the massive northwest landscape called into question whether an SECR approach was efficient, let alone feasible. While the Kenya survey was our inspiration, this operation took place over 718 field days, across ten separate protected areas encompassing 42,994 km^2, making use of 45 vehicles, resulting in 2,634 lion 'captures' (detections). Results revealed lion densities ranging from 0 to 18.4 lions/100 km^2 (Elliot et al. 2021). The northwest Namibia lion population survey sought to cover an area approximately as large as the Kenya survey, using ten vehicles or fewer, in less than one-tenth the time. Based on expert estimates, lion density within the landscape would nowhere exceed 3.0 lions/100 km^2. This combination of factors rendered a strict adoption of the SECR/Kenya approach infeasible.

Lion Rangers/LEK Whole Count Approach

Whole counts are based upon direct observation of individual lions within a relatively limited timeframe, otherwise the population closure (limited immigration and birth, or emigration and death) requirement is violated. The primary assumption in this approach is that all lions are counted. Whole count approaches of lion populations have proven effective as part of long-term monitoring programs in Serengeti and Ngorongoro Crater (Packer 2023). It may seem paradoxical to apply a whole count approach to an area as massive, rugged, and difficult to access as northwest Namibia. However, one consideration that has been largely overlooked in relevant literature and other, similar surveys, is the contribution that local ecological knowledge (LEK) can make to surveying large carnivore populations. LEK has been found to be most effective when knowledge holders are directly engaged as active participants in biodiversity conservation (Charnley et al. 2007). When many local experts are available it is expedient to make use of their knowledge: the use of well-trained locals to conserve and monitor lions engaged in high levels of HLC has been shown to be effective for acquiring high-quality knowledge of lion movements (Stander et al. 1997; Hazzah et al. 2014) while also reducing lion mortalities stemming from HLC (Dolrenry et al. 2016). While Elliot et al. (2021) used trained locals for lion tracking and identification in certain areas, the geographic scope of their survey – including national parks where locals are absent – precluded a widespread reliance on LEK. Given the time and resource constraints of the northwest lion population survey, in combination with the LEK available in the form of the Lion Rangers and MEFT staff, we believe this method was the best available. Details of this approach are given in Chapter Three.

Lion Rangers at training, Waterberg Plateau Park. Photo: M. Brassine

Chapter 2

Planning Workshops

From January to June 2022, the Technical Team reviewed existing literature relevant to surveying lions and other large carnivores in extensive, unfenced areas. From 21-22 July, MEFT convened a workshop in Swakopmund that brought together key stakeholders working on lion conservation and HLC mitigation in the northwest. Among the agenda items was planning the northwest lion population survey. During that workshop different survey methods were discussed. Of particular interest was the use of a spatially-explicit capture-recapture (SECR) approach, which had been used in a recent national survey of Kenya's lion population (Elliot et al. 2021). Central to this approach was the ability of teams to sight, re-sight, and consistently identify individual lions. Based upon the work of Pennycuick and Rudnai (1970), lions in small-to-medium-sized populations are known to be individually identifiable by vibrissae (whisker spot) patterns when these are combined with other demographic characteristics. The Technical Team was tasked with assessing the applicability of the methods from Kenya for a population survey of lions in northwest Namibia. During this period, technical equipment (e.g. high-quality cameras with zoom 600mm lenses, tripods, binoculars, low-light binoculars) for identifying and recording individual lions were purchased, with the support of the Community Conservation Fund of Namibia (CCFN).

A follow-up meeting took place in Swakopmund from 21-22 October. Here the Technical Team presented the SECR approach as the most robust for executing an effective population survey. It was agreed by all attendees that this method needed to be adapted to the northwest Namibia environment and expected low density of lions. As such, a strict SECR approach was deemed infeasible. Consensus was reached that researchers, the Lion Rangers, and local MEFT staff possess a near-complete knowledge of lion movements in their respective areas and that the survey should draw-upon this local expertise. This approach would have the added benefit of serving as a platform for further capacity development of survey participants, while dovetailing with the strategic objective of working with local stakeholders to create opportunities for enabling lion conservation at the landscape level (Large Carnivore Plan, Section 2.4.7, GRN 2016). Consensus was also reached that, based on the LEK of the Lion Rangers and MEFT staff, individual identification of all, or nearly-all, lions in northwest Namibia was possible in the eight to nine weeks available to complete the survey.

Survey planning at Puros Conservancy office

The agreed-upon survey approach possessed four key virtues relevant to the goals and objectives laid-out by MEFT in the Large Carnivore Plan (GRN 2016).

1. By relying upon the Lion Rangers' and MEFT staff expertise, it placed local communities at the center of population survey methods, providing a platform for stakeholder engagement (Large Carnivore Plan, Section 2.4.5).
2. By covering the entire landscape, it provided locals with a high degree of confidence that possible HLC threats in their area would not be overlooked (Large Carnivore Plan, Section 2.4.4).
3. By photographing all individuals, it would create a complete roster of all lions, including a visual record of their body condition, contributing to landscape-wide conservation of the population (Large Carnivore Plan, Section 2.4.7). The resulting Lion ID cards (see Appendix 1) can be disseminated to conservancy staff and relevant stakeholders to build a greater familiarity and sense of ownership over lions in their area.
4. The survey would further develop the Lion Rangers' capacity for monitoring lions, and increase their local and national visibility as conservancy members managing HLC for local and national gain (Large Carnivore Plan, Section 2.3.8).

Prior to the survey commencing, the Technical Team convened a meeting with the Lion Rangers and representatives from partnering organizations at the Puros Conservancy office on 5 November. At this meeting the survey plan was presented and agreed-upon by those in attendance. At this time the Technical Team worked with the MEFT staff and the Lion Rangers to draw up a survey workplan for three survey sessions of three weeks each, covering the landscape in a generally north-to-south direction.

Chapter 3

Methods and Implementation

Methods

The Lion Rangers/LEK whole count approach relies upon a reciprocal process, placing local practitioners at the center of survey efforts, while also using the survey to grow local knowledge and capacities. Chief among targeted outcomes is the survey's contribution to limiting HLC, which is central to sustainably managing the northwest lion population.

Placing local conservationists at the center of survey efforts draws-upon the successes of community-based natural resource management (CBNRM) (see: Stuart-Hill et al. 2005; Jacobsohn 2019) in northwest Namibia. We adopt Charnley et al.'s (2007: 15) definition of LEK, which is "knowledge, practices, and beliefs regarding ecological relationships that are gained through extensive personal observation of and interaction with local ecosystems, and shared among local resource users." Based upon the experiences of the Technical Team implementing LEK through the Lion Rangers for lion monitoring and conservation interventions, we view LEK as complimentary to, rather than inherently differing from, "western" or "scientific" methods (Liebenberg 1990). In many places rural residents have in-depth knowledge of the wildlife inhabiting their landscape. As such, they can contribute important information about cryptic or rare animals. As noted by Dolrenry et al. (2016), "[c]arnivore research is typically difficult due to rough terrain and the nocturnal habits, wide-ranging movements, and wariness of animals" – each of these describes part of the challenge of surveying lions in northwest Namibia. However, they continue, "[l]ocal human communities have generations of experience with lions due to their tradition of hunting them to protect livestock, and they know the region intimately because they move their herds seasonally over a very large area" (Dolrenry et al. 2016: 2). This too is the case within communal lands in northwest Namibia.

The northwest lion population survey presented a chance for equitable and transparent methods to not only foster cooperation, but also strengthen partnerships around lion population management (see: Heydinger et al. in press). HLC is a form of "conservation conflict" whereby differently positioned parties come into conflict over wildlife presence and/or management policies (Redpath et al. 2013). Large carnivore species competing with people for space and resources are unlikely to persist without human tolerance of their presence (e.g. Coleman 2003; Jędrzejewski et al. 2017; Nijhuis 2019). HLC has been a pressing challenge in northwest Namibia for decades (Heydinger 2021), causing rifts between local communities and lion conservationists as well as government. Ultimately, human social factors play an important role in a community's willingness to conserve (Dickman 2010).

Lion Rangers

The Lion Rangers are community conservationists and livestock owners, chosen and employed by their conservancy to receive specialized training and equipment, for the purpose of monitoring lions and limiting HLC (lionrangers.org). Lion Rangers are selected by their communities based-upon their knowledge of wildlife within their respective areas. Rangers receive subsequent training in lion biology and behavior, as well as tracking methods and other field skills to deepen their expertise. Rangers also receive first aid and law enforcement assistance training to operate safely in remote Kunene environments. Following the directives of the NW Lion Plan and MEFT, the Lion Rangers program was re-activated in late 2017. Based on successful CBNRM programs such as the Conservancy Game Guards and Save the Rhino Trust (SRT) trackers in Kunene (Hearn 2003; Owen-Smith and Jacobsohn 2003; Muntifering et al. 2017), as well as the Lion Guardians in Kenya and Tanzania (Hazzah et al. 2014; Dolrenry et al. 2016), the Lion Rangers program applies the four pillars of CBNRM to achieve socially-inclusive results merging sustainable lion conservation and supporting rural livelihoods. These pillars are: sustainable use as a conservation paradigm; economic instrumentalism; devolution; and collective proprietorship (Jones and Murphree 2001; Heydinger et al. in-press). The goal of the program is to support a sustainable lion population on communal lands in northwest Namibia. Objectives to reach this goal include limiting HLC to support local livelihoods and promote the continued existence of the local lion population.

Each Lion Ranger monitors lion movements and provides timely information to farmers and conservancy personnel regarding lion presence, behavior, and ecology, while supporting local livelihoods by helping keep farmers' livestock and families safe from HLC. Among other objectives outlined in the NW Lion Plan, the Lion Rangers and affiliated researchers

have been tasked with developing a standardized monitoring system, establishing best practices for HLC mitigation, and creating new mechanisms for reducing HLC on communal lands. Currently, the program oversees the training, equipping, and deployment of 49 Lion Rangers, across all eleven core lion range conservancies. The role of the Lion Rangers, their extensive field deployments over the past five years, and high-quality LEK regarding numerous aspects of lion movements, behavior, and ecology, can scarcely be overstated for their contribution to the survey; not least of which is making a whole count approach feasible.

Data Collection

In consideration of the life histories of lions and specificities of their living in northwest Namibian environments, the length and timing of the population survey needed to maximize the likelihood of population closure (Dupont et al. 2019). Based upon MEFT and Lion Rangers' other responsibilities and existing workplans, nine weeks were available to complete data collection.

The survey was divided into three sessions, with each session divided into three weeks (see below). Survey personnel were divided into four teams. Each week, every team was responsible for a specific geographic area, the boundaries of which overlapped to ensure landscape coverage. Moving in a generally north-south direction during Sessions A and B, the teams covered the western extent of northwest lion population range, from the Hoaruseb river catchment in the north to the Ugab river in the south, mostly staying west of the D3707 (Sesfontein-Puros), C-43 (Sesfontein-Bergsig), D2625-D2633-D2650 (Erwee-Khorixas), and C35 (Uis-Khorixas) roads and running to the Skeleton Coast. During Session C, three teams covered the eastern area, moving in a generally south-north direction, from the VCF between Palmwag and Werda, east of the C-43, and south of D3710 (Warmquelle-Okamborombonga) roads, to the western boundary of Etosha National Park. Throughout the survey there was no indication of any (non-Etosha) lions outside the survey area.

Each team was composed of at least one Technical Team member and/or Team Leader, two vehicles fitted with satellite communication 'rovers' plus drivers, and three to five Lion Rangers. Two of the teams (Team 1 and Team 2) were overseen by Technical Team members, who were responsible for capturing lion photographs. When the other teams (Team 3 and Team 4) found lions, a member of the Technical Team was called to capture photographs. A support team of MEFT staff provided fuel and re-supplies for all teams throughout the survey.

Within their respective geographic areas, each team was tasked with finding and identifying as many lions as possible, while covering all areas lions were known to inhabit or visit, with a focus on maximizing landscape coverage. This was achieved using two complimentary protocols: structured foot- and vehicle-based searches and GPS/satellite collar response. These protocols were frequently used in combination.

Structured foot- and vehicle-based patrols

Teams systematically searched survey areas for lions and signs of lions such as spoor and fresh carcasses of prey species. Work typically began at daylight and continued throughout the day, with adjacent teams coordinating which areas would be covered by vehicles and which hard-to-reach areas would be covered on foot. Each day the goal was to cover as much of the landscape as possible looking for lion spoor. When spoor were identified, they were tracked by Lion Rangers while the Technical Team and Team Leaders queried lion collar locations. Lions were photographed by the Technical Team for vibrissae (whisker spot) patterns. If lions were known to already have been photographed, they were nevertheless tracked and identified; the adage being: 'the best way to find unknown lions is to find known lions.'

Teams recorded search effort via the SMART application (see Appendix 2), using a customized package developed specifically for this operation and installed on the Lion Rangers, Team Leaders, and Technical Teams GPS-enabled smartphones. Walking and driving effort were continuously recorded by taking a GPS point every minute. Teams sought to uniformly cover the landscape, excepting areas deemed inaccessible to lions – such as steep slopes or gorges, though entrances and exits to these areas were investigated. The Technical Team and local area Lion Rangers regularly advised teams which areas needed particular attention.

Vehicle-based patrols in Torra Conservancy

Chapter 3

SMART data collection consisted of:

- Patrol effort (distance, location, and duration), tracked using GPS software.
- Sighting records for lions, indicating whether signs (such as tracks) or the animals were seen.
- Number of male and female adult lions, along with body condition and other identifying characteristics.
- Number of cubs, along with body condition and other identifying characteristics.
- Smartphone photographs of lions as available.
- Supporting environmental information such as presence and number of herbivore and other large carnivore species, presence and number of livestock, infrastructure information, and any records of human-wildlife conflict.

Lion Rangers using SMART. Photo: M. Brassine.

GPS/satellite collar response

Beginning in 2021, MEFT, the Lion Rangers, and affiliated researchers began an intensive lion collaring effort in northwest Namibia. By November 2023 there were 45 active GPS/satellite collars deployed across the landscape. At the time this was estimated to cover approximately 70% of the population; 90% of groups having at least one collared individual. Drawing upon these data, teams assessed where lions were currently known to be, and where they had resided in recent years: this helped target survey team efforts.

During each survey session, Technical Teams focused on repeatedly visiting all collared lions within an area. While Lion Rangers systematically covered the landscape searching for lion sign, the Technical Teams drove to GPS/satellite collar locations to capture photographs of all lions present at the collar location. All collared lions were photographed during the survey. In numerous cases collared lions and their pride-mates were photographed on multiple occasions, particularly when a pride member was thought to be absent during the initial visit. Collar locations also enabled survey teams to double-check for known lion presence within an area. For example, when lion spoor were found a GPS position was taken. This position was compared to all collared lion movements within the area for the previous two weeks. This enabled teams to focus their efforts on the movements of unknown, uncollared lions.

While responding to collar locations and while photographing lions GPS points were also recorded every minute in SMART.

XPL-83 with GPS/satellite collar, Palmwag Concession

Call-in/playbacks

Where lions could not be viewed but were known to be present, call-in/playbacks were available to attract lions for photographs. Though the necessary equipment to carry out this approach was available to survey teams, it was not used for individual lion identification.

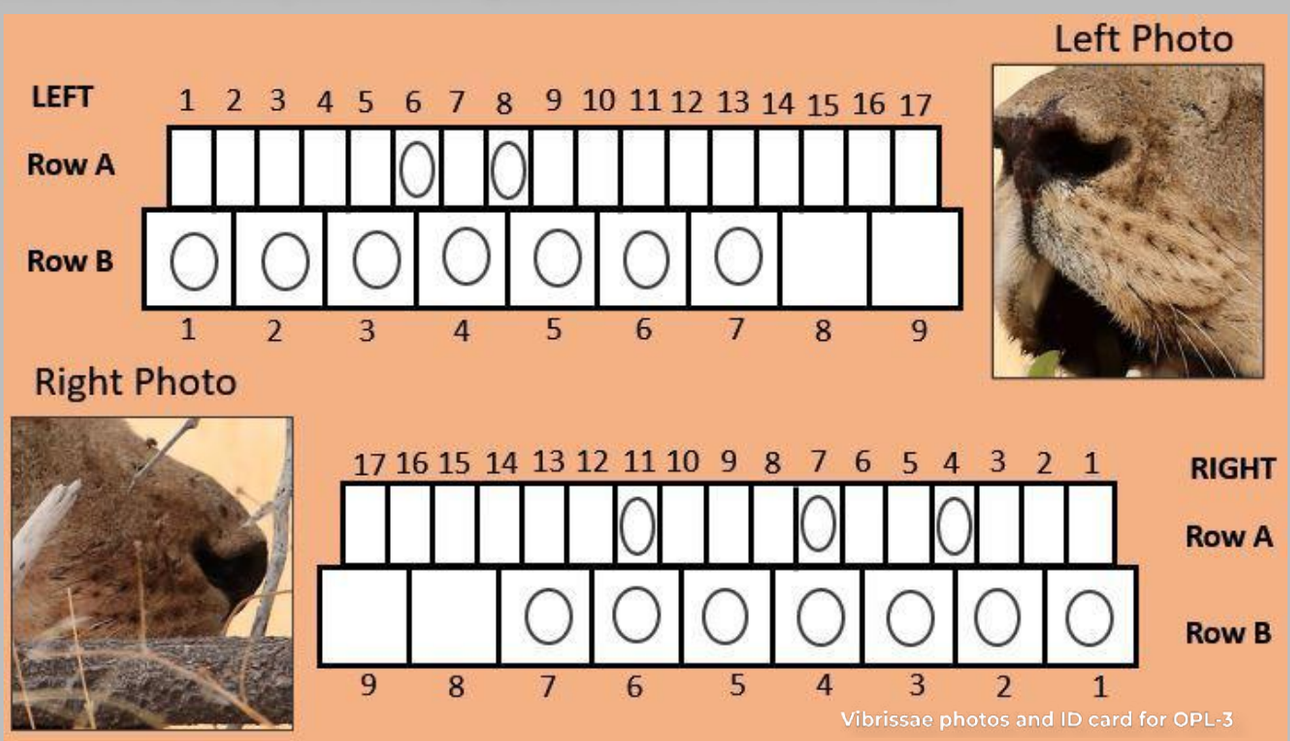
Individual lion identification

To identify individual lions, photos of vibrissae (whisker spots) were taken of both sides of the face as described by Pennycuick and Rudnai (1970). Vibrissae are dark spots forming four to five parallel rows caudal to the mid-nose line located between the upper lip and nose, typically extending six to eight cm backwards. Though four to five rows are present, only the top two rows – Row A and Row B – are used for identification. The uppermost row (Row A) is usually the shorter of the two, containing irregularly spaced spots. The second row (Row B) is typically longer, with seven to ten near-regularly-spaced spots. The spots of Row B are consecutively filled, forming a baseline for the number and location of the upper, irregularly spaced spots of Row A, numbering between zero and six (see Results and Appendix 1).

The vibrissae pattern for each side of a lion's face was determined first by placing Row B spots into a grid starting from the anterior end, beginning with spot one, until all spots were assigned a unique position. Nine possible positions were available for Row B spots (one lion, NPL-33, had ten). Spots from Row A were then assigned a location either above or between two spots in Row B, with each position either containing or not containing a spot. There were seventeen possible positions for Row A spots (eighteen for NPL-33). All available photos of each lion were scrutinized and compared to assess spot locations for that individual. One pride (Etendeka pride) could not be approached due to the presence of young cubs. Otherwise, both sides of all adults were photographed and analyzed. As shown by Pennycuick and Rudnai (1970), no change in spots is evident once lions exceed one year old. Because cubs (< one year old) are not included in lion population estimates due to high mortality rates (Packer 2023), only individuals estimated over one year based on size and other physiological characteristics were photographed for vibrissae, though photographs of all cubs were captured (see Appendix 1).

When analyzed as a composite (both sides of the face together) the number and location of whisker spots are unique within small-to-medium sized populations. In combination with other physiological characteristics, such as ear tears, dental wear, scaring, age and sex, whisker spots can be used to confidently identify individual lions. For every lion photographed, an individual ID card was created (see Appendix 1). In addition to whisker spot patterns, these cards record a lion's individual ID (alpha-numeric identifier), sex, age, pride name and size, home range area(s), collar ID number, whether the individual is known to cause HLC, brand ID, other identifying features, body condition, date(s) the photos were captured, GPS location of photo captures, and other pertinent notes.

All photos were taken using Canon EOS 80D digital cameras with 150-600 mm zoom lenses.



Vibrissae photos and ID card for OPL-3

Chapter 3

Data Management

Data were collected via smartphones and digital cameras. Data from smartphones were collected via the SMART mobile application, using a custom package designed for the survey. Data from SMART were uploaded via the cellular network or WIFI to a central database, where it was received by the Lion Ranger Program Administrator. Data from digital cameras were collected and stored by the Technical Team, who uploaded images to laptops and backed-up external hard drives at the end of each day. All images were sorted into folders grouped according to survey session, survey week, date, technical team member, lion group composition, location of sighting, and name of group (if known).

For example:

Folder Name: Session A
→ Week 1
→ 8 November 2022
→ UM
→ 1Female
→ Okongue (Puros)
→ XPL150group

Following the survey, individual lion folders were created to house identification photos for each lion.

Taking lion ID photos, Torra Conservancy

Chapter 3

Implementation and Survey Teams

The Technical Team oversaw all aspects of the survey. Survey teams were led by members of the Technical Team or other experienced lion monitoring and conservation practitioners from the area.

Survey Workplan: Session A: Hoaruseb to Uniab (6-24 November)

Team 1 (T1): U. Muzuma (Technical), K. Kapi, K. Musaso, K. Tjauira
Team 2 (T2): J. Heydinger (Technical), J. Kavetu (Team Leader), Z. Dandu, N. Karizemi, P. Kasupi, J. Tsaneb, R. Tjavara
Team 3 (T3): Al. Uararavi (Team Leader), B. Hiriua, K. Karutjaiva, S. Kasaona
Team 4 (T4): Am. Uararavi (Team Leader), U. Karutjaiva, U. Katjirumbu, V. Schomburg, J. Uazunga, L. Xamseb
Support: A. Natangwe (Team Leader), A. Amutenya

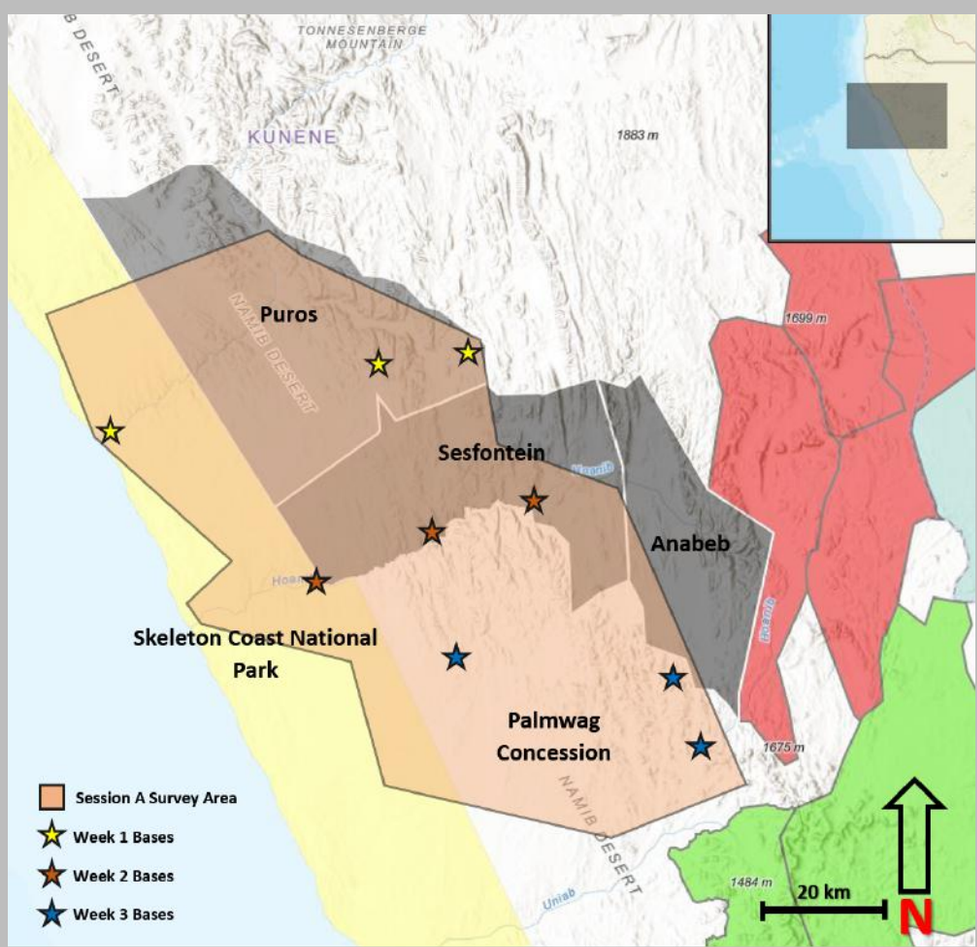
5-6 November: Training and Protocol – all session teams. Base: Puros Conservancy Office

7-12 November (Week 1): Hoaruseb to Giribis
Bases: T1 & T3 Möwe Baai, T2 Okongue, T4 Tomakas

13-20 November (Week 2): Obias to Oruvao
Bases: T1 & T3 Wilderness Hoanib, T2 Obias, T4 Elephant Song

21-24 November (Week 3): Hunkap to Uniab
Bases: T1 & T3 Kai Ais, T2 Upper Barab, T4 Mbakondja

24 November: Depart. Meeting point: SRT – Palmwag



Map 3: Session A Survey Area

Chapter 3

Survey Workplan Session B: Southern and western areas (27 November-16 December)
Team 1 (T1): U. Muzuma (Technical), E. Matundu, U. Nguezeeta, E. Rhyn, R. Tjavara, F. Tourob
Team 2 (T2): J. Heydinger (Technical), J. Kavetu (Team Leader), K. Kapi, K. Karutjaiva, K. Rutavi, K. Uaruoa
Team 3 (T3): L. Mbomboro (Team Leader), I. Gariseb, E. Gewers, P. Kasupi, M. Tjiseua
Team 4 (T4): T. Hoth (Team Leader), V. Tjivikua (Team Leader), Z. Dandu, M. //Gaseb, D. Herunga, L. !Hoxobeb, M. Kangombe
Support: A. Natangwe (Team Leader), A. Amutenya

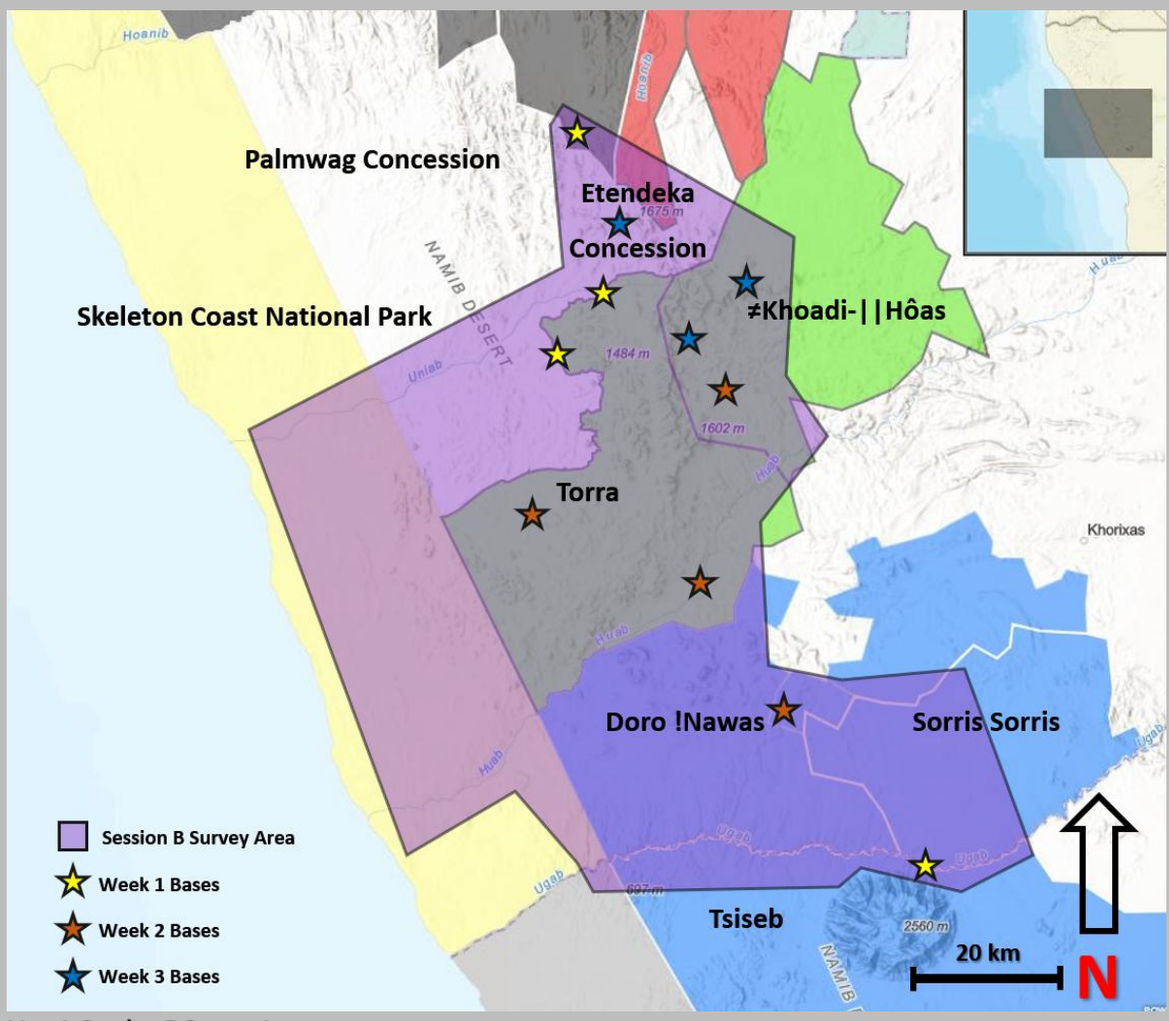
26-27 November: Training and Protocol – all session teams. Base: SRT – Palmwag

27-2 December (Week 4): Uniab to Torra and Ugab
Bases: T1 Big Spring, T2 Mbakondja, T3 SRT Palmwag, T4 Ugab

3-10 December (Week 5): Klip, Huab, and Mickberg
Bases: T1 Klip River, T2 Slangpos, T3 Springbok River, T4 Twyfelfontein

11-16 December (Week 6): Hunkap to Uniab
Bases: T1 & T3 Klip River, T2 Etendeka, T4 Tafelberg

16 December: Depart. Meeting point: Hoada Campsite



Map 4: Session B Survey Area

Chapter 3

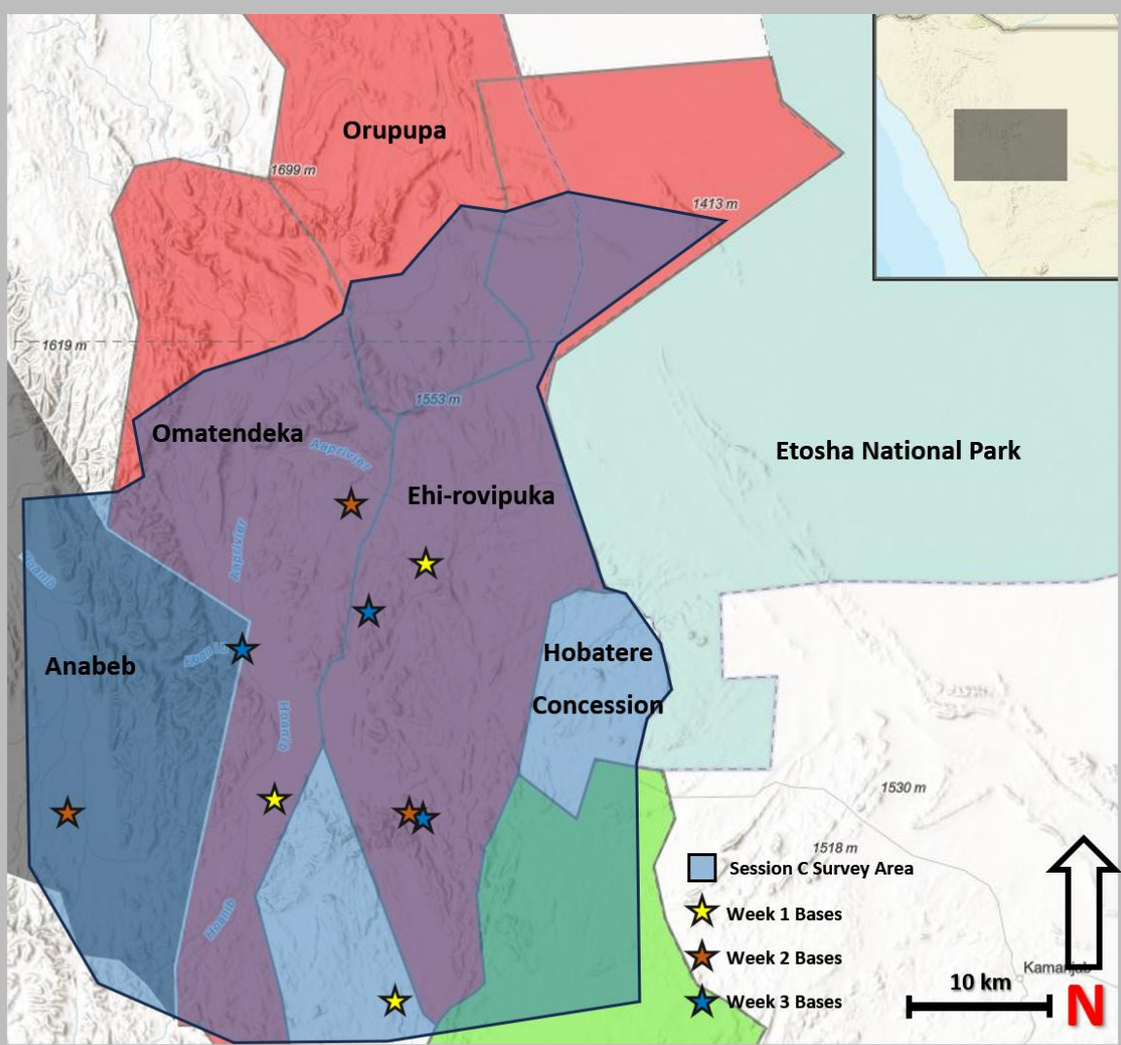
Survey Workplan Session C: Mountains and eastern areas (21 December-6 January 2023)
Team 1 (T1): U. Muzuma (Technical), E. Matundu, R. Tjauira, D. Tjivahe, H. Undari
Team 2 (T2): J. Heydinger (Technical), J. Kavetu (Team Leader), J. !Hoaeb, U. Katjirumbu, K. Musaso, U. Nguezeeta, K. Rutavi
Team 3 (T3): O. Akudhenga (Team Leader), B. Hiriua, T. Musaso, T. Tjiseua
Support: A. Natangwe (Team Leader), A. Amutenya, H. Swartbooi

20-21 December: Training and Protocol – all session teams.
Base: Ombonde Ranger Camp

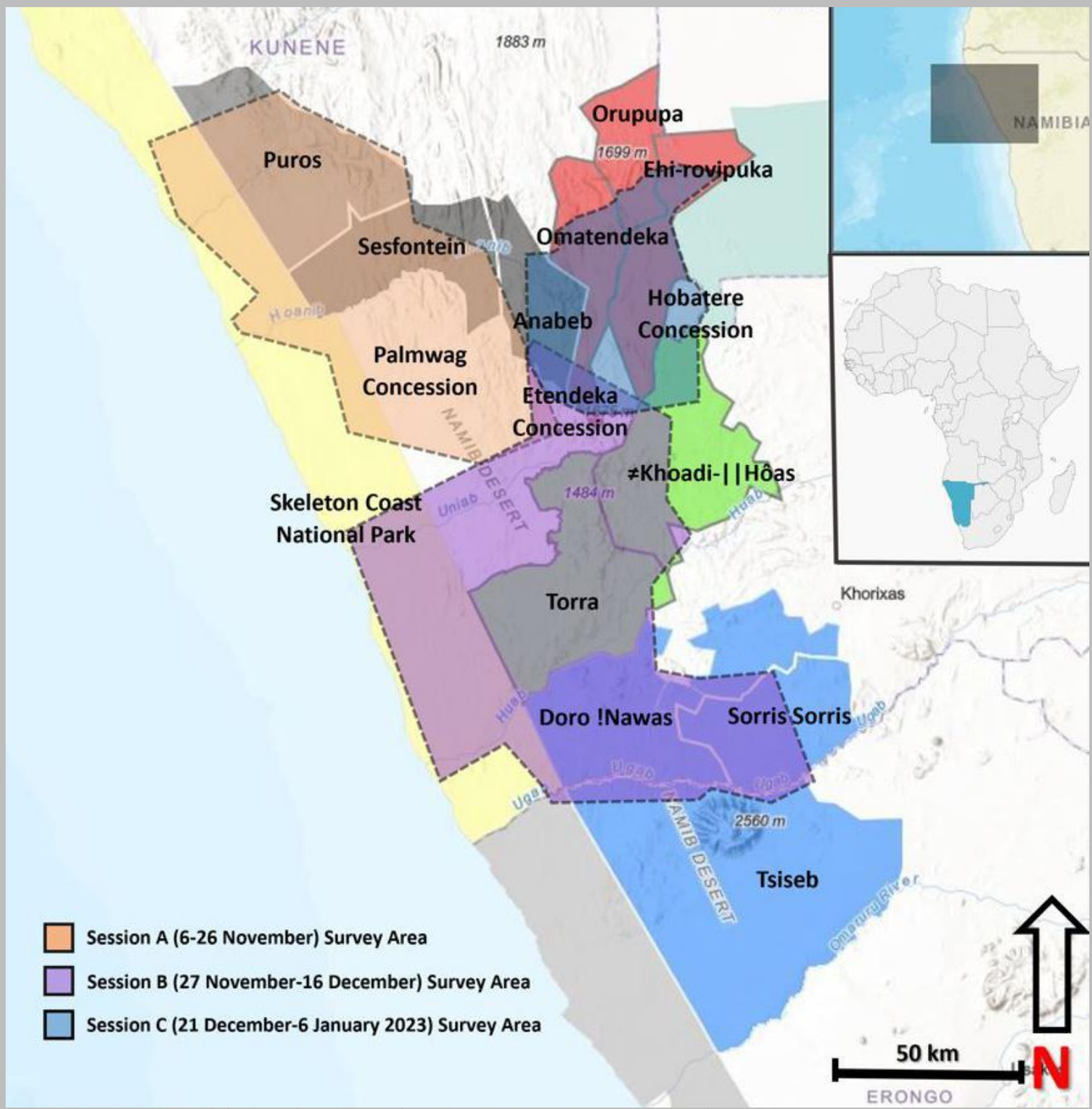
21-27 December (Week 7): Southern Omatendeka and Ehi-rovipuka
Bases: T1 Onguindi, T2 Otjomumbonde, T3 Onguta

28 December-1 January (Week 8): Ombonde landscape and Hobatere
Bases: T1 Ombonde, T2 Otjondumbu, T3 Omuramba

11-16 December (Week 9): Omukutu and Ehi-rovipuka farming areas
Bases: T1 Ombonde, T2 Ohambaikiha, T3 Okavare



Map 5: Session C Survey Area



Map 6: Northwest Namibia core lion range with survey areas, separated by session

Chapter 4

Landscape Results

Abundance and Density

A total of 57 individual adult lions were found and identified during the survey, which encompassed approximately 40,000 km². Past anecdotal evidence suggests a further three females may reside in the area, though no evidence of these individuals was found during the survey or follow-up investigation; their deaths remain uncertain. Of the lions found, 36 were female and 21 were male, yielding a sex ratio of 1 ♀: 0.58 ♂ - within the bounds of expected adult lion sex ratios (Schaller 1972). Of the 57 individuals, complete vibrissae pattern photos were taken of 54 lions. The Etendeka pride (OPL-16 plus two unmarked females) could not be safely approached due to the presence of small cubs, resulting in their extreme wariness of vehicles.

32 lions (18 ♀ and 14 ♂) were found on conservancy lands, while 25 lions (17 ♀ and 8 ♂) were found within tourism concessions or SCNP. This ratio (1 : 0.78) belies the fact that conservancy lands encompass an area nearly 2.5 times that of government-managed lands (1 : 0.42). Lions are effectively twice as common within tourism concessions and SCNP, as a whole, then they are within conservancies. The average estimated age of males within conservancy lands (n = 13) was 5.04 years, while the average estimated age of males within government-managed lands (n = 8) was seven years; this difference was statistically significant (p = 0.018, two-tailed t.test). The average estimated age of all females within conservancy lands (n = 19) was 6.24 years, while the average estimated age of all females within government-managed lands (n = 17) was 7.26 years (p = 0.053). The average estimated age of all lion (non-cubs) within conservancy lands was 5.75 years, while the average estimated age of all lions within government-managed lands was 7.18 years (p = 0.002).

Recorded lion density across the landscape was 0.11 lions/100 km² (0.12 lions/100km² if one includes the possibility of three lions surviving near the Ugab River). Density by conservancy ranged from zero (five conservancies) to 0.42 (Anabeb) lions/100 km². Within tourism concessions and SCNP density ranged from 0.025 (SCNP) to 2.33 (Hobatere) lions/100 km². Density on all conservancy lands (excluding tourism concessions and SCNP) was 0.09 lions/100 km², while total density for tourism concessions and SCNP was 0.17 lions/100 km². As no lions were found in the Blue Block conservancies (Doro !Nawas, Sorris Sorris, and Tsiseb), when these conservancies are removed from analysis, density on all lands increases to 0.16 lions/100 km², while on conservancy lands alone it increases to 0.15 lions/100 km². Follow-up investigation in the Ugab River (boundary of Sorris Sorris and Tsiseb conservancies) and surrounding landscape, previously considered part of core lion range, confirmed the absence of lions, though the area previously inhabited by three adult females. See Chapter Six for block-by-block analysis.

Group Size

The mean size for all prides was 3.1 individuals. Within conservancy lands, mean pride size was 2.83 individuals. Within government-managed lands, mean pride size was 3.67 individuals; these differences were not statistically significant (p = 0.36). When analyzed separately from the three tourism concessions, SCNP mean pride size was 1.33 individuals, while mean pride size for the tourism concessions was 3.75 individuals. Because many prides move between conservancy and government-managed areas, these differences are illustrative.

There was no evidence to suggest that group size significantly differed along the C-43 (Bergsig-Sesfontein) and D3707 (Sesfontein-Puros) roads (p = 0.2), which historically have been an informal boundary between research areas. Nor that it significantly differed on either side of the veterinary control fence (VCF) (p = 0.16). It is noteworthy that only four prides were found south of the VCF, three of which contained a single individual (Obab, nomad, and Nuchas).

One female (OPL-25) died during the survey. She is not included in the total count, though bi-lateral vibrissae photos were taken and have been included in vibrissae analysis.

An additional 14 cubs were identified, all within tourism concessions or SCNP. Eight cubs were identified in Hobatere, four in Etendeka, and two in SCNP. One cub has died since the survey.

Survey area	~40,000 km²
Approx. area inhabited by lions	36,390 km²
Lions found	57
Sex ratio	36♀ : 21♂ (1 : 0.58)
Cubs found	14
Lion density within conservancies	0.09/100 km²
Lion density within government areas	0.17/100 km²
Total lion density	0.11/100 km²
Population estimate	57-60

Table 1: Overview of survey results

Chapter 5

Results: Prides and Individuals

Lion prides are composed of groups of females and their attending males peacefully staying together on a permanent or near-permanent basis (Schaller 1972). It is widely recognized that lions demonstrate fission-fusion dynamics, with the time individuals spend apart perhaps exacerbated in northwest Namibia due to limited resource-availability (Stander 2018). For the purposes of this report, survey results were combined with known lion movements – based on available collar data as well as researchers' and Lion Rangers' expertise – to identify separate prides. It is widely understood that pride members may spend extended periods of time apart while still maintaining sociability among one another. Further research will interrogate pride dynamics in the region.

While we primarily sought to survey the population at the landscape level, understanding lions' landscape use – which conservancies and government-managed areas they primarily inhabit – is relevant to population management-related programs such as Wildlife Credits and trophy hunting.

Key Concepts

Pride Names
Pride names are assigned based upon known landscape use by the pride. Such designations are informal, but are useful for researchers, Lion Rangers, and government staff when monitoring individuals and/or prides, and managing the population.

Identifying Lions' Resident Areas
It is recognized that lions do not limit their movements based-upon human-created landscape demarcations: they move largely unimpeded across the landscape. Yet, prides and individual lions maintain home ranges generally falling within certain conservancies and/or government-managed areas. Distinguishing the core of an individuals' range from areas it infrequently visits requires longitudinal temporal data. Though individuals and prides periodically venture into neighboring areas, they will maintain more permanent tenure elsewhere. For the purposes of this report each lion was assigned to one or two resident conservancies and/or government-managed areas based upon survey sightings, and known movements from collar data, as well as researchers' and Lion Rangers' LEK. Where available, collar data particularly play an important role in identifying lion movements and resident areas. Forthcoming analysis will interrogate lion landscape use based upon collar and Lion Rangers SMART data; this may also contribute to population management.

Alpha-numeric Identifiers
Once collared, lions in northwest Namibia are assigned unique, sequential alpha-numeric identities. The naming convention traces to work performed in western Etosha during the late 1980s-early 1990s (Stander 2018). Since 1999, lions in Kunene collared and monitored by Desert Lion Conservation (DLC) have received 'XPL-#' identifiers, with 'X' referring to the Khorixas district and 'PL' referring to lions' scientific name of *Panthera leo*. Lions receiving XPL identifiers originate from west of the D3707 (Sesfontein-Puros) and C-43 (Sesfontein-Bergsig) roads. Since 2011, other identifiers have been added. Lions collared by the Namibian Lion Trust (NLT), receive 'NPL-#' identifiers; 'N' designating the NLT research area centered within Ehi-rovipuka and ǂKhoadi-||Hôas conservancies. Since 2021, lions marked by MEFT and the Ombonde Research Team, whose work centers around the Ombonde river catchment, primarily east of the D3707 and C-43, have received 'OPL-#' identifiers; 'O' designating the Ombonde area. These identifiers indicate where lions are collared and thought to originate, though their primary use is to provide individuals with a unique identity for communication among research and management partners.

ID Cards
ID card numbers refer to identification cards created for each individual lion and groups of cubs following this survey (see Appendix 1).

Age Estimates
Age estimates are derived based upon demographic markers such as manes (for males), tooth wear, and nose pigmentation. Age estimates are relevant during the survey period.

Chapter 5

Body Condition

Extended visual observation enables researchers and Lion Rangers to assign an overall health score to each lion. Body condition scores range from 1 (lowest/critical) to 5 (highest/excellent). These scores are subjective, though they provide a useful metric for assessing an individual and prides' overall wellbeing (Heydinger 2023).

Condition 5 (Excellent): Lion has good muscle tone – perhaps verging on obese, full stomach, and no visible ribs or backbone. It displays plenty of energy, interacts normally with pride members, maintains an extensive range, and demonstrates normal nighttime movements. Males are dominant in their area with extensive breeding opportunities; females can provision cubs as needed. May be sluggish when hunting.

Condition 4 (Good): Lion has very good muscle tone, appears to be eating regularly, displays plenty of energy, interacts normally with pride members, has shiny fur and well-maintained coat, maintains an extensive range, and demonstrates normal nighttime movements. Males maintain a near-exclusive core home range; females may fall pregnant and/or can provision cubs as needed. Hunts large prey with relative ease.

Condition 3 (Fine): Lion has decreased but adequate muscle tone, has slightly visible rib cage and spine, has an empty stomach, with dullish fur and unkept coat. Nighttime movements may be increased as individuals struggle to capture large prey items. Males may struggle to maintain dominance when encountering condition 4 or 5 males. Females may have some problem provisioning cubs or falling pregnant. Prides in this condition will still be able to hunt with relative ease; individuals may struggle to secure large prey items. Lions will return to condition 4 or 5 when securing adequate prey.

Condition 2 (Some concern): Lion has decreased muscle tone, including on rear legs and has visible rib cage and spine; the hip and femur bones are slightly visible. The fur looks dull; patchy in places. Nighttime movements may be curtailed. Individuals and prides will continue to demonstrate high fear of people. Males will struggle to maintain dominance. Females will struggle to provision cubs and are unlikely to fall pregnant. Prides in this condition can likely still hunt large prey items; individuals will struggle to secure large prey items. Lions will return to condition 4 only after securing extensive prey items.

Condition 1 (Poor): Lion has clearly visible hip and pelvic bones, as well as completely visible ribs and vertebrae. Individuals will appear disoriented, demonstrating reduced fear of people. Inability to raise head while walking. At rest individuals will likely appear sick. Lions in this condition have struggled to secure adequate prey for an extended period of time and/or are ill. They will display severely diminished nighttime movements and may be unable to cover adequate territory to secure prey. They may be unable to hunt. Prides appearing in this condition should be suspected of being ill. If adequate prey is secured lions will return to condition 3 or 4 only after extended periods of adequate provisioning.

Collars

Three types of GPS/satellite collars are currently used for monitoring and performing research on the northwest lion population. African Wildlife Tracking (AWT) collars are programmable to provide timely GPS/satellite fixes and geofence alerts to Lion Rangers. Max Planck Institute collars (MPI) are manufactured by Vectronic Aerospace and partnering researchers at the Max Planck Institute of Animal Behaviour for monitoring lion group dynamics in partnership with the Ombonde Research Team. These programmable collars provide timely GPS/satellite fixes and geofence alerts to Lion Rangers. Wide Horizon Aerial Technologies (WH) collars are programmable to provide timely GPS/satellite fixes and geofence alerts to Lion Rangers, they also are compatible with Early-Warning Towers placed at key HLC hotspots. When these collars come into line-of-sight contact with Early-Warning Towers they activate a series of lights and sirens to alert nearby farmers to lions' presence. All three types of GPS/satellite collars have VHF capabilities.

Brands

Hot brands are imprinted on lions' rear flanks during collaring operations. Branding was restarted in 2022, to enable Lion Rangers to identify individual lions more easily, for monitoring purposes and to limit HLC. Different branding patterns (Ombonde, Hobatere, and Palmwag) indicate a lion's area of origin. All brands are imprinted on lions by MEFT-approved researchers under the supervision of a licensed veterinarian.

XPL-150, Puros Conservancy

Chapter 5

Human-lion Conflict (HLC)
Individuals are considered to be active HLC threats if there are documented cases, either by Lion Rangers or researchers, in which a pride or individual is known to have caused human injury or considerable livestock mortalities.

Monitoring
Lion monitoring is performed by MEFT Regional Services staff, permitted researchers, and Lion Rangers. Currently researchers from DLC, the Ombonde Research Team, and NLT are the only MEFT-permitted researchers in northwest Namibia. Lion Rangers monitor lions in their area as part of their responsibility for limiting HLC and in partnership with MEFT staff and permitted researchers.

The Prides

Okongue Pride: XPL-150
The lioness XPL-150 is solitary. Her movements are confined to the Puros Conservancy, primarily spanning from the Okongue waterhole to the Hoaruseb riverbed area. Visual evidence and reports by Lion Rangers consistently find her in good (4) to excellent (5) body condition. She was collared (WH GPS/satellite) in September 2022 by Desert Lion Conservation. She is unbranded. Her age is estimated from 5-6 years old. She is not known to cause HLC. She is primarily monitored by DLC and the Puros Conservancy Lion Rangers.


XPL-150, Puros Conservancy


XPL-106 and cubs, SCNP

Floodplain Pride: XPL-106, plus cubs, and XPL-109
Two lionesses compose the Floodplain pride. Their movements are primarily confined to the lower reaches of the Hoanib and Hoaruseb rivers. The age of both females is estimated to be over 8 years. Visual evidence consistently finds them in good (4) body condition. XPL-106 was collared (WH GPS/satellite) in May 2021, XPL-109 was collared (WH GPS/satellite) in December 2019 by DLC. Both are unbranded. XPL-106 gave birth to three cubs mid-2022, two females and one male. One female survives. The pride is not known to cause HLC. They are primarily monitored by DLC.

Lower Hoanib Pride: XPL-114
The lioness XPL-114 has been solitary since the death of the lioness XPL-69 and is known to have lost two cubs in mid-2022. She was collared (WH GPS/satellite) in August 2022 by DLC. She is unbranded. She is estimated to be over 8 years old. Visual evidence consistently shows her to be in fine (3) to good (4) body condition. She primarily keeps to the lower reaches of the Hoanib riverbed, not far from Wilderness Safaris' Hoanib Skeleton Coast Camp where she is frequently seen by tourist vehicles. She is not known to cause HLC. She is primarily monitored by DLC.


XPL-114, Palmwag Concession

Chapter 5

Hoanib Pride: XPL-103, XPL-113, and XPL-143

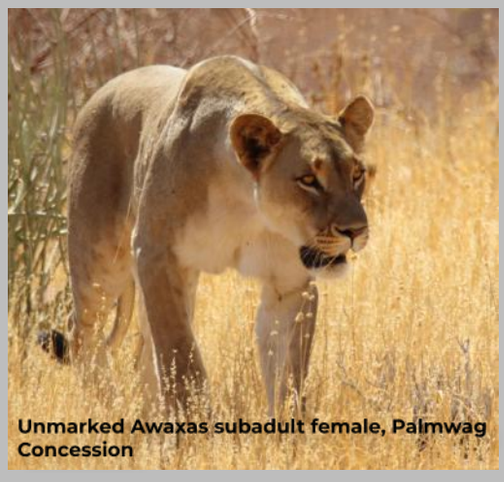
The Hoanib pride consists of two females XPL-103 and XPL-113, and a non-dispersed subadult male XPL-143. They primarily inhabit the Hoanib and Ganamub riverbed areas, though have been known to move eastward to Otjikondavirongo Conservancy where the lioness XPL-140 was killed in 2022. XPL-103 and XPL-113 are estimated to be 6 to 8 years old. XPL-143 is estimated to be 2 to 3 years old. Visual evidence consistently shows them in fine (3) to good (4) body condition. The two females were collared (WH GPS/satellite) in May 2022, XPL-143 was collared in June 2023 by DLC and the Lion Rangers. Given his age XPL-143 is likely to disperse from the pride in 2024-5. All three are unbranded. The pride is not known to cause HLC. They are primarily monitored by DLC and the Sesfontein Conservancy Lion Rangers.

XPL-103 and XPL-113, Sesfontein Conservancy

Awaxas Males, Palmwag Concession

Awaxas Males: XPL-136 and XPL-141

Two Awaxas males are considered part of the Awaxas pride (below), though they are assessed separately here. They primarily inhabit the Palmwag Concession and southern reaches of Anabeb Conservancy and are normally found together. XPL-136 is estimated above 7 years old. XPL-141 is estimated slightly younger, from 5-6 years old. Visual evidence shows them in fine (3) to good (4) body condition. XPL-136 was collared (WH GPS/satellite) in June 2021 by DLC and XPL-141 was collared in March 2022 by DLC, MEFT, and the Lion Rangers. Both are unbranded. They are not known to cause HLC. They are primarily monitored by DLC and the Anabeb Conservancy Lion Rangers.



Unmarked Awaxas subadult female, Palmwag Concession

Awaxas Pride: XPL-83, unmarked Awaxas adult female (deceased), and unmarked Awaxas subadult female

Two females form the Awaxas pride, a third was killed in Anabeb in late January 2023. They are often seen with the Awaxas males (above), though are considered separately here. They primarily inhabit the Palmwag Concession and southern reaches of Anabeb Conservancy and are normally found together. XPL-83 is estimated above 7 years old, with the unmarked subadult female considered to be her offspring. The deceased unmarked adult female was at least as old as XPL-83, likely older based on photos. Visual evidence shows them in good (4) body condition. XPL-83 was collared (WH GPS/satellite) in June 2021 by DLC. All three are unbranded. They are not known to cause HLC. They are primarily monitored by DLC and the Anabeb Conservancy Lion Rangers.

Chapter 5

Uniab Pride: OPL-23, OPL-24, XPL-142 (deceased), and XPL-102

Two adult females OPL-23, XPL-102, and one non-dispersed subadult male OPL-24 form the Uniab pride. A third adult female XPL-142 was killed from apparent poisoning in Torra Conservancy in July 2023. During the population survey the pride was seen with the adult male XPL-107 (below), who primarily stays with the Etendeka Pride (below). They primarily inhabit the Palmwag Concession, northern Torra Conservancy near Otjihavera, and western ǂKhoadi-||Hôas in the Klip River area. OPL-23 and XPL-102 are estimated above 7 years old, while OPL-24 and XPL-142 are estimated from 4-5 years old and of unclear parentage. Visual evidence consistently shows them in good (4) body condition. XPL-142 was collared (WH GPS/satellite) by DLC, MEFT and the Lion Rangers in June 2022. OPL-23 and OPL-24 were both collared (WH GPS/satellite) and branded by MEFT and the Lion Rangers in December 2022. XPL-102 was formerly collared by DLC. XPL-142 and XPL-102 are unbranded. This group was likely responsible for HLC incidents in northern Torra in late 2022-early 2023. The result being increased deployment of Lion Rangers in the area and erection of Early-Warning System Towers at Otjihavera and Palm Pos. They are primarily monitored by the MEFT/Ombonde Research Team and Torra Conservancy Lion Rangers.

Uniab Pride and XPL-107, Torra Conservancy

XPL-107, Etendeka Concession

Barab Male: XPL-107

XPL-107 is a solitary adult male primarily associated with and considered part of the Etendeka Pride (below); he also associates with the Uniab Pride (above). Though initially collared in the Upper Barab in Palmwag Concession by DLC, he primarily inhabits the Etendeka Concession and northern Torra Conservancy. He is the likely father of four cubs of the Etendeka Pride. Visual evidence consistently shows him in good (4) body condition. He was most recently recollared (WH GPS/satellite) in February 2022 by MEFT and the Lion Rangers. He has an old brand on his rear flanks that is no longer readily visible. He is estimated to be at least 8 years old. He was responsible for HLC in Ehi-rovipuka Conservancy in July 2023. He is primarily monitored by the MEFT/Ombonde Research Team and Torra Conservancy and Doro !Nawas Conservancy Lion Rangers.

Nomad: OPL-25 (deceased)

OPL-25 was a solitary adult female who may have been associated with either the Etendeka Pride (below) or Uniab Pride (above). She was first seen during the population survey following a HLC incident near Otjihavera in northern Torra at which point she was collared (WH GPS/satellite) by MEFT and the Lion Rangers in December 2022. Following a further HLC incident she was translocated by MEFT and the Lion Rangers away from the area, though she returned soon thereafter. Based upon repeated HLC incidents and considering her body condition (3) and solitary status, she was removed from the area by MEFT in December 2022. This was done in consultation with researchers and field staff. She was branded on her rear flanks. She was estimated from 5-7 years old.

OPL-25, Torra Conservancy

Chapter 5

Etendeka Pride: OPL-16, unmarked Etendeka adult female 1, unmarked Etendeka adult female 2, and four cubs
Three adult females compose the Etendeka Pride. They primarily reside in southern Etendeka Concession, northern Torra Conservancy, and western ǂKhoadi-||Hôas Conservancy in the Klip River area. They are currently rearing four cubs from two litters produced by two individuals, both likely sired by XPL-107 (above). During the population survey, the two litters were estimated at 3 months and 6 months of age. Due to the young age of the cubs and apparent wariness of the pride to be approached during the population survey diagnostic vibrissae photos were not obtained. Identification is based on collar information, trail camera images, and video recordings taken by the Technical Team. Visual evidence shows them in good (4) body condition. All adult females are estimated above 7 years old. OPL-16 was collared (WH GPS/satellite) by MEFT and the Lion Rangers in March 2022. All three females are unbranded. They are not known to cause HLC. They are primarily monitored by the MEFT/Ombonde Research Team and Torra Conservancy and Doro !Nawas Conservancy Lion Rangers.


Etendeka Pride, Etendeka Concession


Etendeka Pride cub, Etendeka Concession


OPL-16, Etendeka Concession


Unmarked Etendeka females, Etendeka Concession


XPL-108, Torra Conservancy

Obab Pride: XPL-108
XPL-108 is a solitary adult female formerly associated with the adult females XPL-97 and XPL-105, the last of whom died in August 2022. She primarily inhabits the SCNP from the Uniab mouth to the lower Huab in western Torra Conservancy, and is known to have spent substantial time near Torra Bay where she forages on marine life (Stander 2023). Visual evidence shows her in fine (3) to good (4) body condition. She was last collared (WH GPS/satellite) in November 2022 by DLC and is unbranded. She is estimated above 8 years old. She is not known to cause HLC and is primarily monitored by DLC.

Chapter 5

Okavariona Pride: OPL-4, OPL-5, OPL-7, OPL-8, and OPL-15

The Okavariona Pride is composed of three adult females OPL-4, OPL-5, and OPL-15 all estimated above 6 years of age and two adult males OPL-7 and OPL-8 estimated from 5 to 7 years of age. Visual evidence consistently shows them in good (4) body condition. The pride primarily moves between the Otjiapa-Okavariona-Otjatjekupe waterhole complex to the Omirembue-Otjomumbonde waterhole area of Omatendeka Conservancy as well as the adjacent mountains. The two males are known to have dispersed from Hobatere Concession around March 2022. There is no evidence they will return to Hobatere and are now considered part of the Okavariona Pride due to their consistent proximity to the females. Based on GPS/satellite collar data, OPL-18 (below) occasionally associates with them, though she is considered solitary. OPL-4 (WH GPS/satellite), OPL-7 (WH GPS/satellite – malfunctioned), and OPL-8 (AWT GPS/satellite) were recollared by MEFT and the Lion Rangers in September 2022 all three are branded on their rear flanks. OPL-15 was collared (WH GPS/satellite) by MEFT and the Lion Rangers in October 2021 and is branded on her rear flanks. OPL-5 was collared (WH Early-warning – malfunctioned) by MEFT and the Lion Rangers in May 2021 and is unbranded. The pride is not known to cause HLC. They are primarily monitored by the MEFT/Ombonde Research Team and Lion Rangers from Ehi-rovipuka, ǂKhoadi-||Hôas, and Omatendeka conservancies.

Okavariona Pride, Etendeka Concession

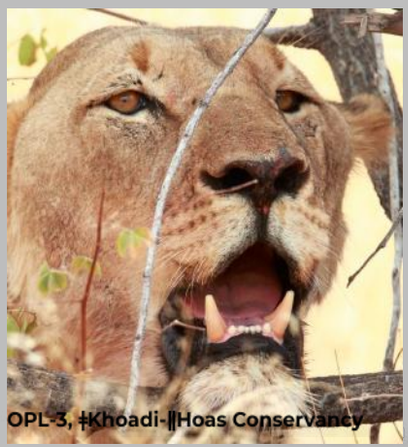
Okaruikongava Pride: OPL-18 (ID Card: Appendix 1)

OPL-18 is a solitary adult female who occasionally associates with the Okavariona Pride (above). She primarily inhabits the mountainous area of Omatendeka Conservancy, moving into neighboring areas in Ehi-rovipuka Conservancy, including Ondjuvira, Palmfontein and the Ombonde-Otjivasandu confluence. She was collared (WH GPS/satellite) in November 2022 by Desert Lion Conservation, MEFT, and the Lion Rangers and is unbranded. She is estimated from 5 to 7 years old. Visual evidence shows her in good (4) body condition. She is not known to cause HLC. She is primarily monitored by the MEFT/Ombonde Research Team and Lion Rangers from Ehi-rovipuka, ǂKhoadi-||Hôas, and Omatendeka conservancies.

OPL-18, Omatendeka Conservancy

Nomadic male: OPL-3 (deceased)

OPL-3 was a solitary adult male formerly associated with the male OPL-1 who was killed by poisoning near Palmfontein in Ehi-rovipuka Conservancy in October 2021. OPL-3 was also apparently affected by this poisoning, though did not die at that time. Following this poisoning OPL-3 lost his mane resulting in his easily being mistaken for a female. He primarily inhabited the areas of southern Ehi-rovipuka and western ǂKhoadi-||Hôas conservancies, though was known to move into Omatendeka and eastern Anabeb conservancies. He was re-collared (WH GPS/satellite) by Desert Lion Conservation, MEFT, and the Lion Rangers in June 2022. He was unbranded. In April 2023 he died of apparent poisoning near the Four Palms area of Ehi-rovipuka. Suspects were arrested in connection with bone trafficking, thanks to the work of MEFT and Lion Rangers. He was not known to cause HLC. He was estimated from 6 to 8 years old and was primarily monitored by the MEFT/Ombonde Research Team and Lion Rangers from Ehi-rovipuka, ǂKhoadi-||Hôas, and Omatendeka conservancies. Available evidence showed him in fine (4) body condition at time of death.



OPL-3, ǂKhoadi-ǁHoas Conservancy

Chapter 5

Omirembue Pride: NPL-38 and unmarked Omirembue subadult male
One female and her subadult male offspring form the Omirembue pride. They were often seen with the Omirembue Male (NPL-33) who is now deceased, though were considered separate. They primarily inhabit the Omatendeka and Ehi-rovipuka conservancies. NPL-38 is estimated above 8 years old while the unmarked subadult male is estimated at 3 to 4 years old. Visual evidence shows them in good (4) body condition. NPL-38 was collared (AWT GPS/satellite) in March 2022 by NLT. Both are unbranded. They are not known to cause HLC. They are primarily monitored by NLT and Lion Rangers from Ehi-rovipuka, ǂKhoadi-||Hôas, and Omatendeka conservancies.


Unmarked Omirembue subadult male, Omatendeka Conservancy


OPL-33, Omatendeka Conservancy

Omirembue Male: NPL-33 (deceased)
NPL-33 was a solitary adult male primarily associated with the Omirembue Pride (above) and likely sired two cubs with NPL-33, one of whom survives as the unmarked Omirembue subadult male. He primarily moved within Omatendeka and Anabeb conservancies. Visual evidence showed him in good (4) body condition. He was collared (AWT GPS/satellite) in July 2021 by NLT and was unbranded. He died in the Omauua area of Anabeb Conservancy in January 2023. He was not known to cause HLC. He was primarily monitored by NLT and Lion Rangers from Ehi-rovipuka, ǂKhoadi-||Hôas, and Omatendeka conservancies.

Klip River Pride: NPL-42, unmarked Klip adult female, unmarked Klip subadult male 1, unmarked Klip subadult male 2, and unmarked Klip subadult male 3
The Klip River pride is composed of two adult females NPL-42 and an unmarked adult female both estimated over 7 years of age, and three undispersed unmarked subadult males estimated between 2 and 3 years old. The subadult males are of unknown parentage. They primarily reside in the Klip River and Nuchas areas of ǂKhoadi-||Hôas Conservancy, but occasionally move into eastern Torra Conservancy. Visual evidence shows all five in good (4) body condition. NPL-42 was collared (AWT GPS/satellite) by NLT in April 2022. All five lions are unbranded. Based upon available evidence, the subadult males dispersed together in mid-2023. They are not known to cause HLC. They are primarily monitored by NLT and MEFT/Ombonde Research Team.

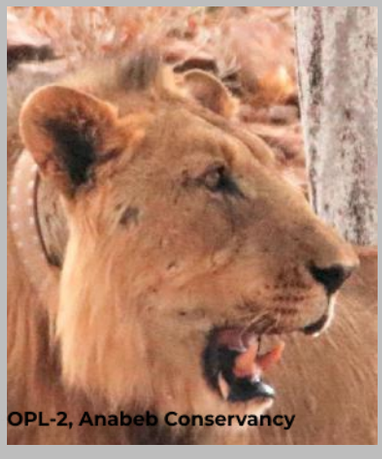

Unmarked Klip River subadult males, ǂKhoadi-‖Hoas Conservancy

Chapter 5

Nuchas Male: NPL-28

NPL-28 is a solitary male who primarily resides in the Nuchas and Klip River areas of ǂKhoadi-||Hôas Conservancy, but occasionally moves into eastern Torra Conservancy. It is unclear to what extent he is associated with the Klip River Pride (above), including whether he sired the subadult males. Visual evidence shows him in good (4) to excellent (5) body condition. He was recollared (AWT GPS/satellite) by NLT and the Lion Rangers in April 2023. He is branded on his rear flanks. He is estimated to be at least 8 years old. He is not known to cause HLC. He is primarily monitored by NLT and ǂKhoadi-||Hôas Conservancy Lion Rangers.

NPL-28, ǂKhoadi-||Hôas Conservancy



OPL-2, Anabeb Conservancy

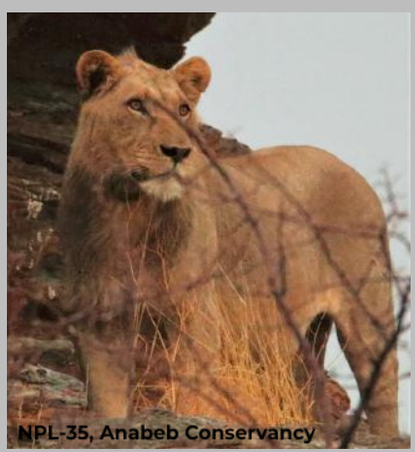
Otjondumbu Male: OPL-2

OPL-2 is a solitary adult male primarily associated with the Okomimunu Pride (below), who is also associated with the Southern Anabeb Pride (below), and may have sired the Omukutu Pride (below) near the Otjiapa-Okavariona-Otjatjekupe waterhole complex. Visual evidence consistently shows him in good (4) to excellent (5) body condition. He was recollared (WH GPS/satellite) by MEFT and the Lion Rangers in June 2022. He is branded on his rear flanks. He is estimated to be at least 8 years old. Though staying near farms, he is not known to cause HLC. He is primarily monitored by the MEFT/Ombonde Research Team and Anabeb Conservancy Lion Rangers.

Okomimunu Pride: XPL-137, XPL-138, and XPL-139

Three adult females estimated from 5 to 7 years of age compose the Okomimunu Pride. They primarily reside in the farming areas of Anabeb Conservancy, though will move into the core wildlife area of Omatendeka. Though they spatially overlap with the Southern Anabeb Pride (below) the prides are distinct. They are frequently seen with the solitary adult male OPL-2 (above). Consistent visual evidence and monitoring by the Lion Rangers show them to be in good (4) body condition. All three were collared in November 2021 by MEFT and the Lion Rangers. All three have functioning collars (WH GPS/satellite). XPL-137 and XPL-138 are unbranded, XPL-139 was branded when re-collared in July 2023. Though staying near farms, they are not known to cause HLC. They are primarily monitored by the MEFT/Ombonde Research Team, Anabeb Conservancy Lion Rangers and MEFT-Sesfontein office.

XPL-137, Anabeb Conservancy



NPL-35, Anabeb Conservancy

Southern Anabeb Pride: NPL-34, NPL-35, unmarked Southern Anabeb subadult male 1, and unmarked Southern Anabeb subadult male 2

The Southern Anabeb pride is composed of an adult female NPL-34 estimated 6 to 8 years old and three subadult males known as NPL-35 and unmarked Southern Anabeb males 1 and 2, all estimated 4 to 5 years old. All three subadults were likely sired by OPL-2 (above). They primarily reside in south-eastern Anabeb and western Omatendeka conservancies. Visual evidence shows them in good (4) body condition. NPL-34 (AWT GPS/satellite) and NPL-35 (AWT GPS/satellite) were collared and branded on their rear flanks by MEFT and the Lion Rangers in June 2022. Based on their age, it is likely all three subadult males will disperse in 2024 or early 2025. They are not known to cause HLC. They are primarily monitored by the MEFT/Ombonde Research Team, NLT, and Anabeb Conservancy Lion Rangers.

Chapter 5

Omukutu Pride: OPL-21, OPL-22, OPL-26, OPL-27, OPL-28, and OPL-29

The Omukutu pride consists of a single adult female OPL-29 estimated over 7 years, four subadult females OPL-21, OPL-22, OPL-27, and OPL-28, and one non-dispersed subadult male OPL-26, all of whom are estimated from 3 to 5 years. It is highly likely the subadults came from separate litters, and likely separate mothers including perhaps NPL-32 who was killed by poisoning in Omatendeka Conservancy in July 2022. The pride primarily resides in Khowarib/Ombonde river areas of Anabeb and Omatendeka conservancies, and the mountainous area west of Klein Serengeti in Omatendeka. Visual evidence from researchers and the Lion Rangers consistently shows them in good (4) body condition. All six were collared with experimental MPI research and GPS/satellite collars in May 2023 by MEFT and the Lion Rangers. All six are branded on their rear flanks. Based on estimated age, the subadult male is unlikely to disperse before 2025. They are not known to cause HLC. They are primarily monitored by the MEFT/Ombonde Research Team and Anabeb Conservancy Lion Rangers.

OPL-22, Anabeb Conservancy. Photo: G. Finnerty

Hobatere Pride: OPL-6, OPL-9, OPL-10, and eight cubs

The Hobatere pride consists of three adult females and eight cubs. OPL-6 is estimated over 6 years with two cubs estimated at 6 months. OPL-9 is estimated over 6 years with four cubs estimated at 2 months. OPL-10 is estimated over 8 years with two cubs of 14 months. The pride primarily limits their movements to Hobatere Concession but will occasionally cross into neighboring Ehi-rovipuka and ǂKhoadi-||Hôas conservancies. Visual evidence from the Lion Rangers and Hobatere Lodge staff consistently shows all adults and cubs in good (4) body condition. OPL-6 was collared (WH GPS/satellite) by MEFT and the Lion Rangers in June 2022. OPL-9 (WH GPS/satellite) and OPL-10 (WH GPS/satellite) were collared by MEFT and the Lion Rangers in August 2022. All adult females are branded on their rear flanks. They are not known to cause HLC. They are primarily monitored by MEFT.

OPL-6 and cubs, Hobatere Concession

OPL-19, Hobatere Concession

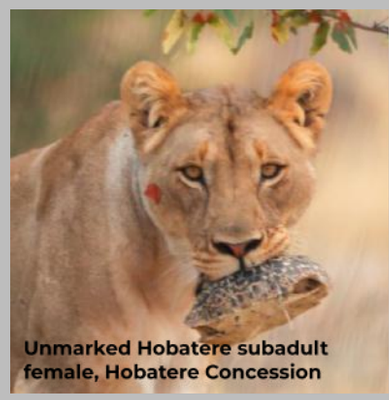
Hobatere Males: OPL-19 and OPL-20

Two males are frequently found with the Hobatere pride (above), though are considered separately here. They primarily inhabit the Hobatere Concession, though occasionally cross into neighboring Ehi-rovipuka and ǂKhoadi-||Hôas conservancies. They likely dispersed from Etosha National Park in March 2022, at which point they appear to have displaced OPL-7 and OPL-8 (Okavariona Pride, above). They are both estimated over 7 years old. Visual evidence from the Lion Rangers and Hobatere Lodge staff consistently show them in good (4) to excellent (5) body condition. OPL-19 (WH GPS/satellite) and OPL-20 (WH GPS/satellite) were collared by MEFT, the Lion Rangers, and Etosha staff in June 2022. Both are branded on their rear flanks. They are not known to cause HLC. They are primarily monitored by MEFT.

Chapter 5

Kaross (likely Etosha vagrant): unmarked Hobatere subadult female

A previously unrecorded solitary subadult female was photographed with OPL-19 during the survey. She is likely a vagrant from Etosha National Park, perhaps of a pride residing near Kaross that dispersed from the eastern mountains of Ehi-rovipuka in late 2021. Four of these lions were collared, the two adult males OPL-11 and OPL-12 are known to inhabit Kaross, while the adult females OPL-13 and OPL-14 died following HLC in the Arizona area of Ehi-rovipuka Conservancy in early 2022. This unknown female is estimated from 3 to 5 years old. She is uncollared and unbranded. She has not been seen since the survey though is not suspected to cause HLC.



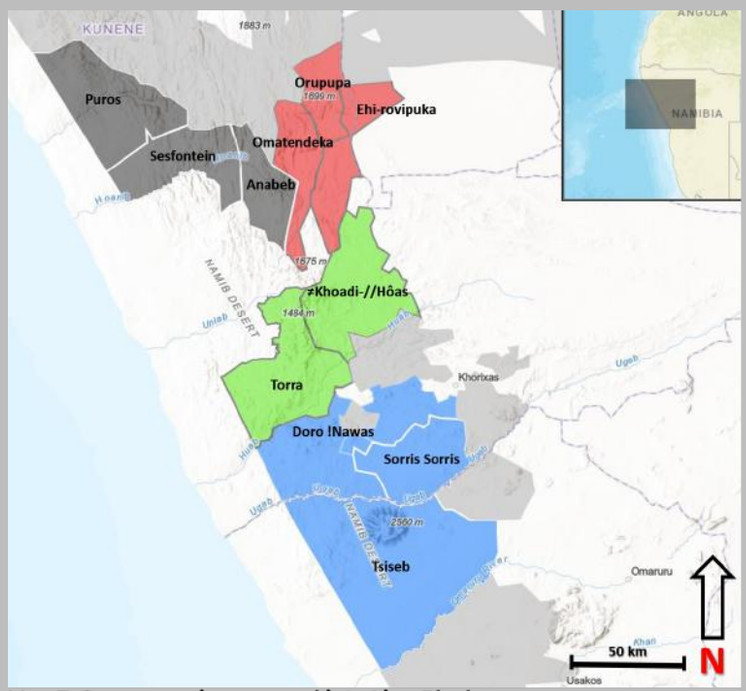
Unmarked Hobatere subadult female, Hobatere Concession

XPL-114, Palmwag Concession

Chapter 6

Results: Lion Blocks

Lion Blocks group neighboring conservancies together based on landscape use by lions, as well as by communities of affiliated interests among conservancy residents. Because lions do not recognize human-designated boundaries, inter-conservancy cooperation more accurately reflects lions' landscape use. Formalizing cooperative structures also encourages neighboring conservancies to align lion-related conservation activities, as well as potentially lowering administrative costs, and reducing redundancy of effort. The four blocks were designated as part of the Kunene Lions Wildlife Credits program, whereby communities receive monetary benefits from living alongside lions (Conservation Namibia 2023). This program has been spearheaded by WWF-Namibia, in partnership with the leadership from each conservancy, and lion researchers in the area. This program was one of the motivating factors for Northwest Lion Population Survey. Details on program implementation are forthcoming, though payment mechanisms are based-upon Heydinger et al. (2022).



Map 7: Conservancies grouped into Lion Blocks

CONSERVANCY	HUMAN POPULATION	AREA (KM²)
Anabeb	1402	1570
Puros	641	3562
Sesfontein	1491	2465
Ehi-rovipuka	1846	1980
Omatendeka	1985	1619
Orupupa	2024	1234
ǂKhoadi-‖Hôas	4308	3364
Torra	1064	3493
Doro !Nawas	1242	3978
Sorris Sorris	950	2290
Tsiseb	2415	7913

Black Block

The Black Block consists of Anabeb (gazette date: 2003), Puros (2000), and Sesfontein (2003) conservancies. In total these conservancies cover 8,655 km², and consist of 5,328 people (NACSO 2023). Anabeb and Sesfontein both border the Palmwag Tourism Concession and Anabeb borders the Etendeka Tourism Concession. All three border the SCNP. Major drainage lines in these conservancies include the Khumib, Hoaruseb, and Hoanib ephemeral rivers. Each of these conservancies is located north of the VCF.

Survey Results

During the population survey, 18 lions (12 ♀ and 6 ♂) were found in the Black Block, primarily (14/18) within Anabeb Conservancy. Based on GPS/satellite collar data and monitoring by the Lion Rangers, there are 32 lions residing in the Black Block, meaning these lions inhabit at least one of the three conservancies as their primary or secondary residence. Lion density within the Black Block is 0.34 lions/100 km². This is the second highest lion density among blocks, behind the Red Block. Of these 32 lions, 21 are females and 11 are males, a sex ratio of 1♀: 0.52 ♂, approximately in-line with the population sex ratio of 1 ♀: 0.58 ♂. Of the 11 males, 5 are non-dispersed subadults at relatively high risk of mortality following HLC (Stander 2010). There is only one known cub residing in the Black Block, which was found with XPL-106 in SCNP.

Of the 32 lions residing in the Black Block, 25 have active GPS/satellite collars, one adult female (OPL-5) and one adult male (OPL-7) have malfunctioned collars. Four are uncollared: two non-dispersed subadult males, one adult female (now deceased), and one subadult female.

Mortalities

Since the population survey, one adult male (NPL-33) and one adult female (unmarked Awaxas adult female) have died killed following HLC.

Chapter 6

Community Perceptions

Social surveys regarding the effects of lions and other predators on residents' livelihoods were performed in late 2017 (Heydinger et al. 2019), with follow-up surveys performed in late 2021-early 2022 (Heydinger 2022). During the initial survey, 84% (n = 70) of respondents stated they do not benefit from living with lions, while 75% (n = 63) stated they want lions to persist in their conservancy. During follow-up surveys 72% (n = 75) stated lions are "very common" or "common" in their conservancy. It is worth noting that residents consider lions to be very common or common, not in regards to pan-African lion densities, but relative to local historical numbers (Heydinger et al. in press). When asked when they last lost livestock to lions, 28% (n = 29) stated they had lost livestock to lions within the past half year, 39% (n = 39) stated they had lost livestock to lions in the past year or few years, while 33% (n = 34) stated they had never lost livestock to lions.

Follow-up surveys found 43% (n = 45) of respondents stated lions were among the most problematic carnivores. 53% (n = 52) of respondents said they have never been compensated for losing livestock to predators.

Anabeb Conservancy

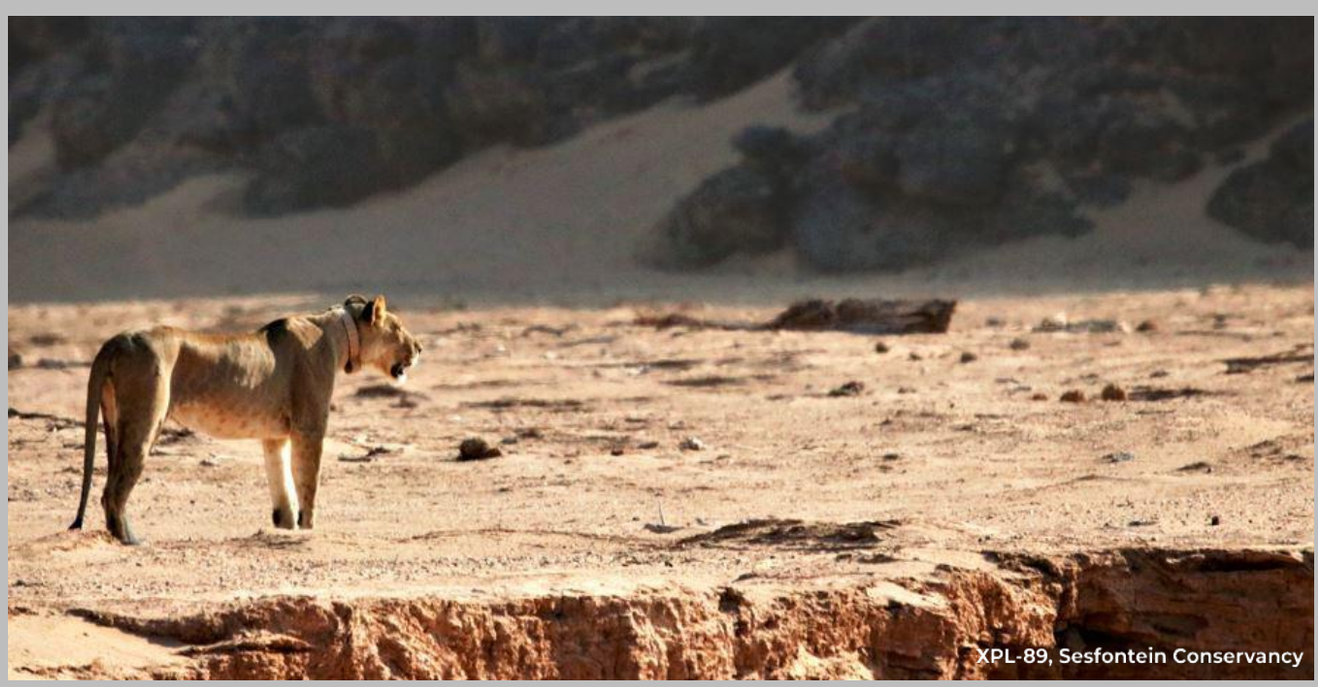
Fourteen lions were found in Anabeb Conservancy during the population survey. Based on GPS/satellite collar data and monitoring by the Lion Rangers, a further nine lions are considered Anabeb Conservancy residents. Anabeb lion density is 0.74 lions/100 km^2, the highest density in the Black Block. Many of these lions cross between Anabeb and Omatendeka Conservancies and Palmwag and Etendeka Concessions. Two subadult males of the Southern Anabeb Pride are uncollared. Two lions, one adult male (NPL-33) and one adult female (unmarked Awaxas adult female) have been killed in Anabeb following HLC since the population survey. Two males and one female residing in Anabeb are uncollared. None are considered active HLC threats.

Puros Conservancy

During the population survey one lioness (XPL-150) was found in Puros Conservancy. Based on GPS/satellite collar data and monitoring by the Lion Rangers, a further two adult females are considered Puros Conservancy residents. These are XPL-106 and XPL-109. Puros lion density is 0.08 lions/100 km^2, the lowest density in the Black Block. No lions residing in Puros are uncollared. None are considered active HLC threats.

Sesfontein Conservancy

Three lions were found in Sesfontein Conservancy during the population survey. Based on GPS/satellite collar data and monitoring by the Lion Rangers, a further three lions, all adult females are considered Sesfontein Conservancy residents. These are XPL-106, XPL-109, and XPL-114. Sesfontein lion density is 0.24 lions/100 km^2. These lions are largely confined to the Hoanib and Ganamub ephemeral riverbeds. No lions residing in Sesfontein are uncollared. None are considered active HLC threats.



XPL-89, Sesfontein Conservancy

Chapter 6

Red Block

The Red Block consists of Ehi-rovipuka (gazette date: 2001), Omatendeka (2003), and Orupupa (2011) conservancies. In total these conservancies encompass 4,833 km^2 and consist of 5,855 people. Since 2011, the Namibian Lion Trust (NLT) has been performing HLC monitoring and research within Ehi-rovipuka and Omatendeka conservancies. Ehi-rovipuka borders the Hobatere tourism concession, while Omatendeka borders the Etendeka tourism concession. Ehi-rovipuka also borders Etosha National Park. Major drainage lines in these conservancies include the Ombonde and Otjovasandu rivers. Each of these conservancies is located north of the VCF.

Survey Results

During the population survey, four lions (2♀ and 2♂) were found in the Red Block, all within Omatendeka Conservancy. There are 30 lions residing in the Red Block, meaning these lions inhabit at least one of the three conservancies as their primary or secondary residence. The discrepancy between the number of lions found during the survey versus the number considered to reside within the Block is due to the relatively high number of Red Block resident lions encountered in Anabeb Conservancy, Hobatere and Etendeka concessions during the survey. Lion density within the Red Block is 0.56 lions/100 km^2. This is the highest lion density among blocks. Of these 30 lions, 18 are females and 12 are males, a sex ratio of 1 ♀: 0.66 ♂, a relative surplus of males, though five of these are non-dispersed subadults at relatively high-risk of mortality following HLC (Stander 2010). There are eight known cubs residing in the Red Block, all found in Hobatere Concession during the survey.

Of the 30 lions residing in the Red Block, 24 have active GPS/satellite collars. One adult female (OPL-5) and one adult male (OPL-7) have malfunctioned collars. Three non-dispersed subadult males and one adult female, likely a vagrant from Etosha, are uncollared.

Mortalities

Since the population survey two adult males (OPL-3 and NPL-33) have died. OPL-3 was killed in Ehi-rovipuka Conservancy in April 2023 and NPL-33 died in Anabeb Conservancy, in January 2023.

Community Perceptions

Social surveys regarding the effects of lions and other predators on residents' livelihoods were performed in late 2021-early 2022 (Heydinger 2022). During the surveys 48% (n = 41) stated lions are "very common" or "common" in their conservancy. Residents may contextualize lion numbers regarding proximity to Etosha National Park, as well as in comparison to historical numbers (Heydinger et al. in press). When asked when they last lost livestock to lions, no respondents stated they had lost livestock to lions within the past half year, 74% (n = 62) stated they had lost livestock to lions in the past year or few years, while 26% (n = 22) stated they had never lost livestock to lions. 53% (n = 45) of residents identified lions among the most problematic carnivores. 67% (n = 56) said they have never been compensated for losing livestock to predators.

Ehi-rovipuka Conservancy

During the population survey, no lions were found in Ehi-rovipuka Conservancy. Based on GPS/satellite collar data and monitoring by the Lion Rangers, ten lions are considered Ehi-rovipuka Conservancy residents. These lions primarily reside in Hobatere Concession or move between Ehi-rovipuka and Omatendeka conservancies. Ehi-rovipuka lion density is 0.50 lions/100 km^2. Two lions residing in Ehi-rovipuka Conservancy are uncollared. These are the unmarked Omirembue subadult male and the unmarked Hobatere female, considered a vagrant from Etosha National Park though counted during the survey. Ehi-rovipuka Conservancy experiences relatively frequent vagrant lions from Etosha.

Omatendeka Conservancy

During the population survey, four lions were found in Omatendeka Conservancy. Based on GPS/satellite collar data and Lion Rangers' monitoring, 23 lions are considered Omatendeka residents. These lions primarily reside in the Omatendeka core wildlife areas of the Otjomumbonde-Omirembue waterhole complex, along a mountainous corridor bordering the Klein Serengeti area, or move between Anabeb and Omatendeka conservancies. Omatendeka lion density is 1.43 lions/100 km^2, the highest density among conservancies. Five lions residing in Omatendeka Conservancy are uncollared. These include the unmarked Omirembue subadult male, two unmarked Southern Anabeb subadult males, as well as the male OPL-7 and female OPL-5 whose collars have malfunctioned.

Orupupa Conservancy

During the population survey, no lions were found in Orupupa Conservancy. Based on GPS/satellite collar data and monitoring by the Lion Rangers, no lions are considered Orupupa Conservancy residents. However, lions residing particularly in Ehi-rovipuka Conservancy, as well as Omatendeka, may be vagrants into Orupupa. The conservancy frequently experiences vagrant lions from Etosha.

Chapter 6

Green Block

The Green Block consists of ǂKhoadi-ǁHôas (gazette date: 1998) and Torra (1998) conservancies. In total these conservancies encompass 6,857 km^2 and consist of 5,372 people. Both were among the 'first four' conservancies to be recognized by government. Torra has long been recognized as a key part of the core-range of the desert-adapted lion subpopulation. Torra borders the Etendeka and Palmwag tourism concessions. ǂKhoadi-ǁHôas borders the Etendeka and Hobatere tourism concessions, as well as the southwestern-most corner of Etosha National Park. Major drainage lines in these conservancies include the Klip, Koigab, and Huab ephemeral rivers. Both conservancies are located south of the VCF.

Survey Results

During the population survey, ten lions (4♀and 6♂) were found in the Green Block, seven within ǂKhoadi-ǁHôas and three within Torra. There are 22 lions residing in the Green Block, meaning these lions inhabit at least one of the two conservancies as their primary or secondary residence. The discrepancy between the number of lions found in the Block versus the number considered to reside within the Block is due to the relatively high number of lions found in Hobatere and Etendeka concessions during the survey, but considered to reside within the Green Block on a more permanent basis. Lion density within the Green Block is 0.32 lions/100 km^2. Of these 22 lions, 13 are females and nine are males, a sex ratio of 1 ♀: 0.69 ♂, a relative surplus of males, though four of these are non-dispersed subadults at relatively high-risk of mortality following HLC (Stander 2010), and another, OPL-3, was killed in April 2023. There are 12 known cubs residing in the Green Block, eight in Hobatere Concession and four in Etendeka Concession.

Of the 22 lions residing in the Green Block, 14 have active GPS/satellite collars, while eight are uncollared. The relatively high proportion of uncollared lions is explained by the three non-dispersed unmarked Klip River subadult males, plus one unmarked Klip River adult female, XPL-102 who was previously collared by Desert Lion Conservation, two unmarked adult females of the Etendeka Pride, plus the unmarked Kaross (Hobatere) female considered to be a vagrant from Etosha National Park.

Mortalities

Since the population survey, the adult male OPL-3 has been killed in Ehi-rovipuka Conservancy in April 2023. In July 2023 the adult female XPL-142 was killed along the Torra-ǂKhoadi-ǁHôas border.

Community Perceptions

Social surveys regarding the effects of lions and other predators on residents' livelihoods were performed in late 2021-early 2022 (Heydinger 2022). During the surveys 75% (n = 70) stated lions are "very common" or "common" in their conservancy. This perspective is likely informed in comparison to historical lion numbers in the area (Heydinger et al. in press). When asked when they last lost livestock to lions, 15% (n = 13) stated they had lost livestock to lions within the past half year, 62% (n = 54) stated they had lost livestock to lions in the past year or few years, while 23% (n = 20) stated they had never lost livestock to lions. Surveys found 71% (n = 67) of residents stated lions were among the most problematic carnivores. 54% (n = 48) of respondents said they have never been compensated for losing livestock to predators.

ǂKhoadi-||Hôas Conservancy

During the population survey seven lions were found in ǂKhoadi-||Hôas Conservancy, all within the Klip River area. Based on GPS/satellite collar data and monitoring by the Lion Rangers, 16 lions are considered ǂKhoadi-||Hôas Conservancy residents. These lions primarily reside in the Etendeka and Hobatere tourism concessions or within the Klip River area. ǂKhoadi-||Hôas lion density is 0.47 lions/100 km^2. Seven lions residing in ǂKhoadi-||Hôas are uncollared. These include one adult female and three subadult males in the Klip River area, two unmarked adult females of the Etendeka pride, plus the unmarked Kaross (Hobatere) female considered to be a vagrant from Etosha National Park.

Torra Conservancy

During the population survey, three lions were found in Torra Conservancy: two near the Palm Pos area and one in the Huab ephemeral riverbed near Pieter's Pool. Based on GPS/satellite collar data and monitoring by the Lion Rangers, 15 lions are considered Torra Conservancy residents. These lions primarily reside in the Etendeka and Palmwag tourism concessions or within the Klip River area. Torra lion density is 0.32 lions/100 km^2. Seven lions residing in Torra Conservancy are uncollared. These include one adult female and three subadult males in the Klip River area, two unmarked adult females of the Etendeka pride, plus XPL-102 of the Uniab pride, formerly collared by DLC.

Chapter 6

Blue Block

The Blue Block consists of Doro !Nawas (gazette date: 1999), Sorris Sorris (2001), and Tsiseb (2001) conservancies. In total, these conservancies encompass 14,181 km^2 and 4,607 inhabitants. Though these conservancies currently contain no permanently-residing lions, they are considered among core lion range conservancies due to recorded lion movements since the 1990s. Doro !Nawas and Tsiseb conservancies border SCNP. The major drainage line is the Ugab ephemeral river, though the Aba-Huab (flowing into the Huab) is also significant. Each of these conservancies is located south of the VCF and Tsiseb (falling south of the Ugab) is within the Erongo Region.

Survey Results

During the population survey, no lions were found in the Blue Block, and no lions are considered to use any part of the three conservancies as their primary or secondary residence. These results are despite extensive searches for sign in the area, centered around the Ugab ephemeral riverbed, Aba-Huab drainage, and other areas where lions were formerly known to occur.

Lions were previously known to inhabit the area surrounding Ugab ephemeral riverbed, particularly on the north and western sides of the Brandberg Mountain. No lions were found in this area during the survey. Follow-up conversations with community members, conservancy management, the tourism industry, and other knowledgeable conservation staff returned no solid evidence of lions in the area. In June 2023, Lion Rangers and a member of the Technical Team surveyed the area intensively for one week finding no evidence of lions in the area. 27 trail cameras were subsequently deployed at key waterpoints and along known movement corridors. Although these cameras were deployed for approximately one month (late June to late July 2023), they captured no images of lions. Nevertheless, there has been no confirmation of mortality for the females who previously inhabited the area.

Community Perceptions

Social surveys regarding the effects of lions and other predators on residents' livelihoods were performed in late 2021-early 2022 (Heydinger 2022). During the surveys 15% (n = 8) stated lions are "very common" or "common" in their conservancy. When asked when they last lost livestock to lions, 5% (n = 3) stated they had lost livestock to lions within the past half year, 30% (n = 16) stated they had lost livestock to lions in the past year or few years, while 65% (n = 35) stated they have never lost livestock to lions. Among survey respondents, 59% (n = 30) identified spotted hyenas as the most problematic carnivore species. Lions were not considered to be particularly problematic due to their low numbers. 46% (n = 22) of respondents said they have never been compensated for losing livestock to predators.

Doro !Nawas Conservancy

During the population survey no lions were found in Doro !Nawas Conservancy. Based on GPS/satellite collar data and monitoring by the Lion Rangers, no lions are considered Doro !Nawas Conservancy residents. Lions inhabiting the Huab ephemeral riverbed area formerly came into Doro !Nawas farming areas near the village of Bethanie and farming area Rendezvous. These lions were relocated from these areas by MEFT in 2021.

Sorris Sorris Conservancy

During the population survey no lions were found in Sorris Sorris Conservancy. Based on GPS/satellite collar data and monitoring by the Lion Rangers, no lions are considered Sorris Sorris Conservancy residents. Lions inhabiting the Ugab ephemeral riverbed area formerly came into the De Rest farming area. All lions were removed from these areas by MEFT in 2021 and 2022. It is uncertain whether two lionesses, formerly inhabiting the Brandberg and Ugab ephemeral riverbed area, persist in Sorris Sorris. 27 trail cameras to check for lion presence, were deployed by the Technical Team in June 2023 for approximately one month in the Brandberg and Ugab river areas, no lion images were captured by these cameras.

Tsiseb Conservancy

During the population survey no lions were found in Tsiseb Conservancy. Based on GPS/satellite collar data and monitoring by the Lion Rangers, no lions are considered Tsiseb Conservancy residents. Lions inhabiting the Ugab ephemeral riverbed area formerly came into the De Rest farming area. All lions were removed from these areas by MEFT in 2021 and 2022. It is uncertain whether lionesses, formerly inhabiting the Brandberg and Ugab ephemeral riverbed area, persist in Tsiseb, though it is considered highly unlikely by the Technical Team. 27 trail cameras to check for lion presence, were deployed by the Technical Team in June 2023 for approximately one month to check for lion presence in the Brandberg and Ugab river areas, no lion images were captured by these cameras.

Lion Rangers, Doro !Nawas

Chapter 6

Government-managed areas

Approximately 14,782 km² of government-managed areas (tourism concession and national park) were surveyed. These include the Skeleton Coast National Park (SCNP) from the Hoaruseb to Huab ephemeral riverbeds, an area of ~ 8,000 km², Etendeka Tourism Concession (633 km²), Hobatere Tourism Concession (258 km²), and Palmwag Tourism Concession (5,891 km²). These areas have been set-aside for the conservation of wildlife by government and contain no permanent human residents, therefore social surveys were not performed in these areas. SCNP (gazette date: 1971) has famously contained "coastal-roaming" lions in the past and since approximately 2017 when small prides returned to the area to forage on marine wildlife. The tourism concessions were gazetted during the 1990s. The Etendeka Concession, operated by Dennis Liebenburg of Etendeka Mountain Camp, borders Anabeb, ǂKhoadi-||Hôas, Omatendeka, and Torra conservancies. ǂKhoadi-||Hôas and Ehi-rovipuka conservancies border Hobatere and share its concession, operated by Journeys Namibia. The "Big 3" conservancies of Anabeb, Sesfontein, and Torra border Palmwag sharing its concession which is operated by Gondwana at Palmwag Lodge and Wilderness Safaris at Desert Rhino Camp and Hoanib Camp. SCNP is located along the Atlantic coast, both north and south of the VCF which terminates 28 km from the coast within the park. Etendeka, Hobatere, and Palmwag tourism concessions are north of the VFC. These tourism concessions and SCNP are not contiguous and form no Lion Blocks.

Survey Results

25 lions (17 ♀ and 8 ♂) were found within tourism concessions or SCNP; 32 adult lions (23 ♀ and 9 ♂) are residents of tourism concessions or SCNP. In comparison to the 32 lions found within conservancy lands, lions are considered more likely to be present within these government-managed areas, though differences are not statistically significant. Within these areas lion density ranged from 0.025 (SCNP) to 2.33 (Hobatere) lions/100 km². Total density was 0.17 lions/100 km². It is worth noting that of the 11 adult males identified within the survey, 7 inhabit tourism concessions; no male lions are considered to inhabit SCNP. No lions residing in Etosha National Park were counted during the survey, with the sole exception of the Kaross female, seen in Hobatere, but considered to be a vagrant from Etosha. All cubs found during the survey were identified within tourism concessions or SCNP, suggesting the possibility that breeding lions use these areas as refuges for raising cubs, or that cubs struggle to survive on conservancy lands.

Hoanib Floodplain Pride cub, SCNP

Skeleton Coast National Park

Two female lions (XPL-106 and XPL-109) were found in SCNP during the population survey. Based on GPS/satellite collar data and monitoring by the Lion Rangers, a further three are considered park residents. SCNP lion density is 0.06 lions/100 km², the lowest density among non-conservancy lands. All residents of SCNP are females, centered near the mouths of the ephemeral Hoaruseb, Hoanib, Uniab, and Huab riverbeds. All five lions are collared. None are considered active HLC threats. The Floodplain Pride (XPL-106 and XPL-109) are currently raising one cub, the other two died in 2022-2023. Three of the resident lions are considered "coastal-roaming" or "marine-foraging" by DLC (Stander 2019; Stander et al. 2023). Long-term effects of marine diet on lions remains unknown. However, the recent mortality of XPL-97 (September 2022) raises concerns that lions relying primarily on a marine diet may suffer from inflammation of fatty tissue which has been shown to cause mortalities in other feline species (Tidholm et al. 1996). Research into this is being undertaken by DLC.

Etendeka Tourism Concession

Nine lions (6 ♀ and 3 ♂) were found in Etendeka during the population survey. While other individuals may move through the concession, no other lions reside there. Etendeka lion density is 1.42 lions/100 km². Based on GPS/satellite collar data and monitoring by the Lion Rangers, all lions residing within Etendeka frequently move onto neighboring conservancy lands. The Etendeka pride primarily resides within the southern portion of the concession. This pride is currently raising four cubs in this area, likely sired by XPL-107. Four lions residing in Etendeka are currently uncollared. This includes two uncollared adult females of the Etendeka pride, as well as the female OPL-5 and male OPL-7, whose collars have malfunctioned. Lions within Etendeka are primarily monitored by the Ombonde Research Team and NLT. None of the Etendeka lions are considered active HLC threats.

Chapter 6

Hobatere Tourism Concession

Six lions (4 ♀ and 2 ♂) were found in Hobatere during the population survey. No other individuals reside in the concession. Lions density in Hobatere is 2.32 lions/100 km² – the highest density of lions within the survey area. Based on GPS/satellite collar data, all lions residing within Hobatere frequently move onto neighboring conservancy lands, though they are often chased back into Hobatere by the Lion Rangers, to limit HLC. The Hobatere pride is currently rearing 8 cubs within the concession. The cubs of XPL-10 are estimated about 1 year old and were likely sired by OPL-7 and/or OPL-8 who departed Hobatere in March 2022 – these two were likely evicted by OPL-19 and OPL-20. The younger cubs of OPL-6 and OPL-9 were likely sired by OPL-19 and OPL-20. One uncollared lioness was seen in Hobatere during the survey, though she is considered a vagrant from the Kaross area of Etosha and has not been seen since. Lions within Hobatere are primarily monitored by MEFT.

Palmwag Tourism Concession

Eight lions (5 ♀ and 3 ♂) were found in Palmwag during the population survey. Based on GPS/satellite collar data and monitoring by the Lion Rangers, a further four reside within the concession. Palmwag lion density is 0.13 lions/100 km². All resident lions frequently move onto neighboring conservancy lands, particularly Anabeb and Torra conservancies. Two females of the Awaxas pride are uncollared, a subadult and adult. However, the uncollared Awaxas adult female was killed in Anabeb Conservancy in April 2023. The Uniab pride, which also reside in Palmwag, is considered an active HLC threat. Lions within Palmwag are primarily monitored by DLC; those residing in Palmwag as well as conservancy lands are monitored by the MEFT/Ombonde Research Team, NLT, and Lion Rangers.

XPL-141, Palmwag Concession

Chapter 7

Discussion of Results

The northwest lion population, estimated at 57-60 adult lions is stable and self-sustaining, i.e., though vagrant lions from Etosha frequently visit the survey area, they do not significantly contribute to the population. These results provide a baseline for long-term monitoring of the population (Large Carnivore Plan, Section 2.4.1; GRN 2016), assuming follow-up surveys are performed and monitoring strengthened. Yet, caution is urged for two reasons. First, this is the first population estimate based-upon a complete survey, previous estimates have been based upon different methods, predicated upon expert opinion (Stander 2010, 2018; GRN 2017). Second, this is both the lowest population and lowest density estimates given for lions in northwest Namibia since the 1990s, when the first scientific records are available (Stander 2000).

Our assessment that the population is stable and self-sustaining is not based solely on numbers, but also on the body condition of individuals, sex ratio of the population, and number of cubs. Possible complicating or constraining factors include: the recent inferred population decline, likely stemming from HLC and linked to a declining prey base; the proportion of lion mortalities due to HLC; the extreme low density of the population and subsequent possibility for stochastic events related to changing climate; the relative youth of the males, concentration of cubs within government-managed areas, and overall discrepancy between lions in conservancy versus government-managed areas.

Population Numbers and Trends

Previous estimates, based upon expert opinion, suggest the population has declined by as much as 60% in the past five years (Table 2). We reiterate the need for caution when comparing population estimates based-upon dissimilar methods. Nevertheless, such a decline is concerning and highlights the need for ongoing monitoring of the population. We recommend follow-up surveys take place every three to five years.

Based upon available records and monitoring by researchers, the Lion Rangers, and MEFT, the proximate cause of the population's decline is HLC. From 2000 to 2010, HLC incidents were responsible for 80% of lion (non-cub) mortalities, this trend continued through the 2010s (GRN 2017), to the present. From 2021 through mid-2023, HLC has been responsible for 27 lions either being killed or permanently removed, by MEFT and its partners, from northwest Namibia (Lion Rangers unpublished data). Since the population survey was completed four lions have been killed as a result of HLC.

The ultimate cause of the population's decline is more difficult to assess. HLC is caused by a diverse set of interacting factors, touching both environmental and human-centered variables.

A declining prey base may be driving much of HLC; this is a source of concern for the long-term viability of the northwest lion population. Examining lion population estimates over the past decade-plus alongside population estimates for indicator prey species reveals dramatic declines for each (Table 2). In the past five years, indicator prey species numbers have fallen by 53-85% (NACSO 2023), while lion numbers have fallen by 46-60%. While a declining prey base is partially explainable given a decline in grass and browse since 2010, visible in the diminished levels of normalized difference vegetation index (NDVI) in eastern conservancies and near absence of vegetation in western areas (see maps 8-11), illegal hunting may also be significantly contributing. A declining prey base will drive lions to prey-upon livestock, leading to HLC incidents and subsequent lion mortalities. Further research is needed to better understand prey based declines, and the effect of prey availability on lion dietary composition and the size of the population.

SPECIES	2010 ESTIMATE	2015 ESTIMATE	2017 ESTIMATE	2022 ESTIMATE
Gemsbok[1]	25,152	12,970 (↓48%)	6,090 (↓53%)	899 (↓85%)
Springbok[1]	104,920	59,940 (↓43%)	70,420 (↑17%)	33,422 (↓53%)
Mountain Zebra[1]	20,460	17,910 (↓12%)	12,380 (↓31%)	5,083 (↓59%)
Lions	*112-139*[2] (0.28-0.35 lions/100 km^2)	180[3] (↑29-61%) (0.48-0.62 lions/100 km^2)	112-139[4] (↓22-37%) (0.31-0.37 lions/100 km^2)	57-60 (↓46-60%) (0.11-0.12 lions/100 km^2)

Table 2: Population estimates for indicator prey species and lions for 2010, 2015, 2017, and 2022. Population estimates for indicator prey species are for the entire Kunene Region. Percentage increase or decrease compare yearly estimate with previous estimate (e.g. 2015 compared to 2010). Italicized values are based on expert opinion. Sources footnoted below.

[1] NACSO 2023
[2] Stander 2010
[3] GRN 2017
[4] Stander 2018

Map 8: NDVI for Kunene Region, 2010

Map 9: NDVI for Kunene Region, 2015

Map 10: NDVI for Kunene Region, 2017

Map 11: NDVI for Kunene Region, 2022

Community Perceptions

Negative attitudes among conservancy residents may be driving HLC mortalities. Recently-completed social surveys across lion-range conservancies reveal overwhelming negative attitudes of farmers towards lions (Heydinger 2022). Of 339 farmers surveyed, 61% (n = 204) classified their attitude towards lions as negative (Figure 1). When asked whether most lions attack livestock, 86% (n = 287) answered affirmatively (Figure 2). When asked when lions come to someone's farm, "if lions cannot find livestock to eat, what do you think they will do?", 66% (n = 225) responded that lions will try to attack people (Figure 3). When asked whether they are benefitting from having lions in their conservancy, 79% (n = 263) of respondents said they are not (Figure 4). When asked whether it is important to continue having lions in their conservancy, 62% (n = 201) responded no, it is not (Figure 5). Oral histories and other social surveys have uncovered that conservancy farmers view lions as fearsome – liable to attack people, destructive – they constrain people's livelihoods by attacking livestock, and increasing in number (Heydinger et al. in press). The northwest lion population's prospects may be improved by programs working to change conservancy residents' attitudes towards living with lions. One such program being piloted is the Wildlife Credits program, through which conservancies receive monetary benefits for lion presence (Conservation Namibia 2023).

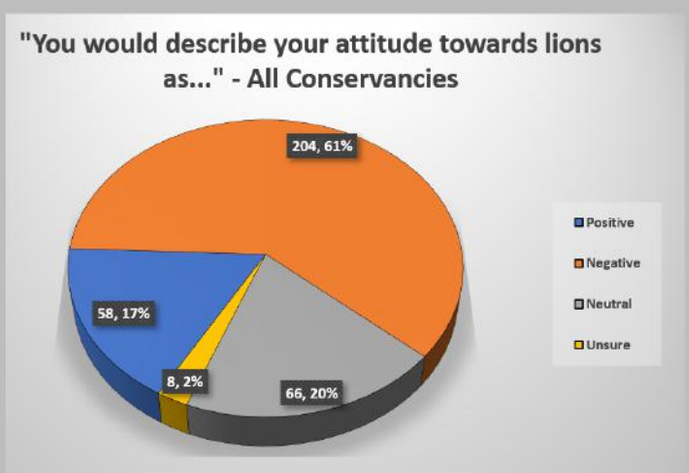


Figure 1: Livestock owner responses (n = 339) when asked their attitude towards lions.

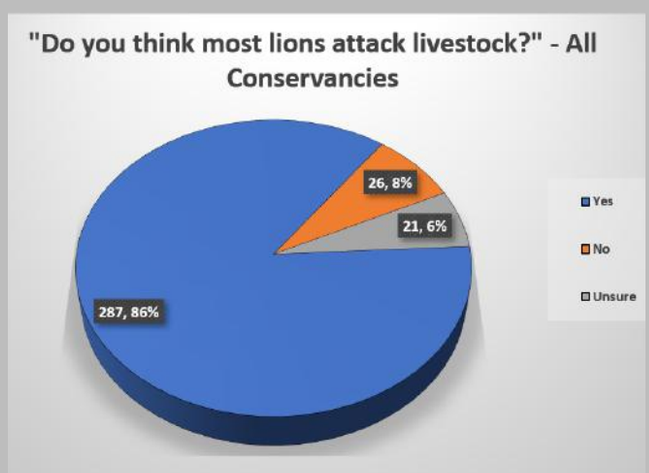


Figure 2: Livestock owner responses (n = 339) when asked whether most lions attack livestock.

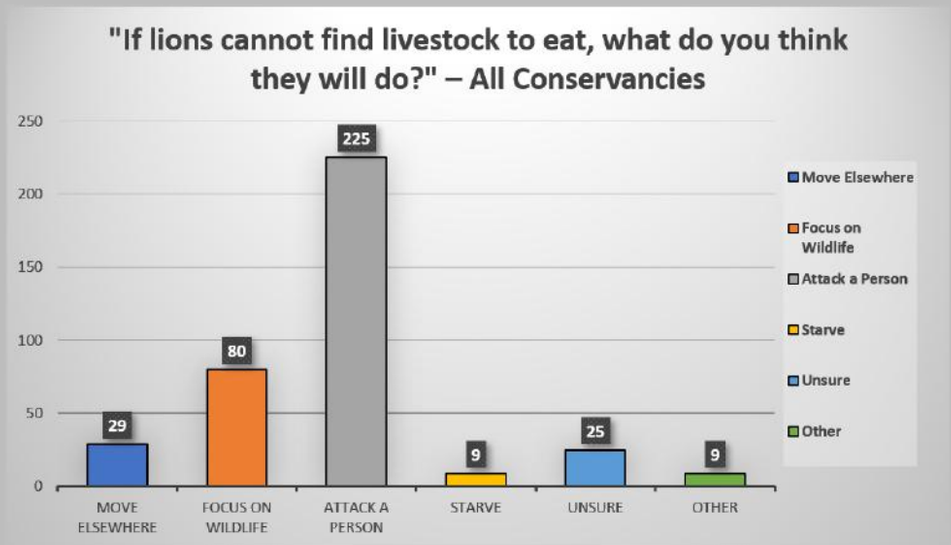


Figure 2: Livestock owner responses (n = 339) when asked what lions will do if they cannot find livestock to eat when invading conservancy farms.

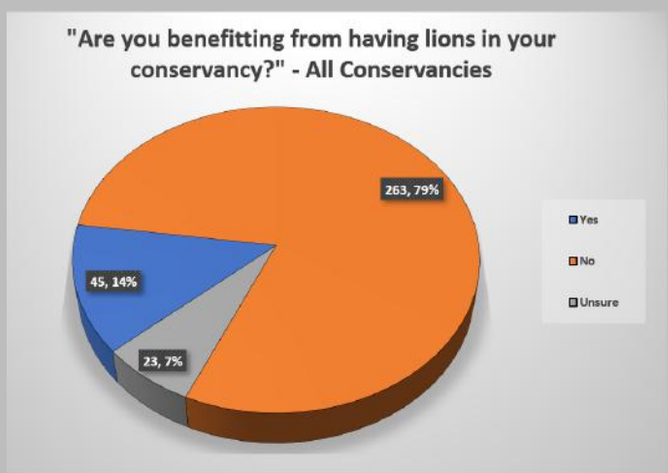


Figure 4: Livestock owner responses (n = 339) when asked whether they are benefitting from having lions in their conservancy.

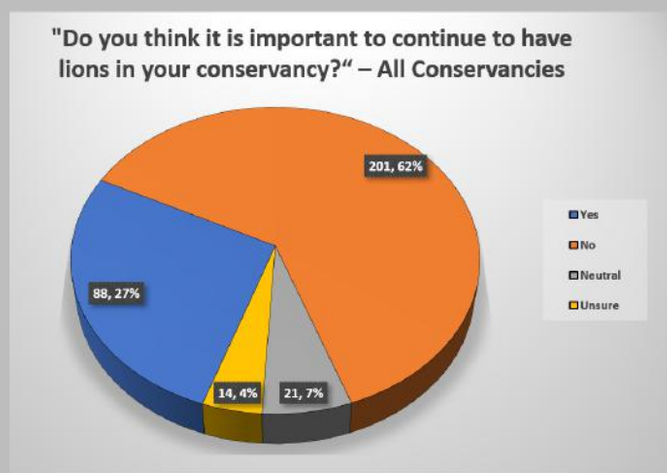


Figure 5: Livestock owner responses (n = 339) when asked whether it is important to continue to have lions in their conservancy.

More broadly, the marginal livelihoods and limited social and economic prospects of conservancy residents increase the negative household effects, both monetary and non-monetary, when lions attack livestock. Across the Kunene Region, approximately 75% of residents have no schooling or only a primary level education (Atlas of Namibia Team 2022). Kunene is Namibia's second poorest region: 38% of residents suffer from acute poverty, meaning they lack access to basic household resources as well as services and assets essential for basic wellbeing. 41% of residents are unemployed. Pastoralism comprises the majority Kunene household incomes, which are typically low and insecure (Mendelsohn et al. 2002). Mean household losses of livestock to HLC of approximately N$ 55,000 (Heydinger et al. 2019) not only constrain pastoralists' livelihoods, they bring into question whether the only source of income available to most residents is secure. Social welfare and economic development programs to diversify livelihoods may limit the scope of negative outcomes experienced when HLC occurs. Because of the effects of HLC on the lion population and residents' livelihoods, greater, more coordinated recording of HLC is needed.

Chapter 7

Cattle killed in conflict incident, Anabeb Conservancy. Photo: A. Wattamaniuk

Two lions killed following conflict incident, Anabeb Conservancy. Photo: C. Tjikundi

Extreme Low Density

The extreme low density of the population (0.11-0.12 lions/100 km^2) speaks to the challenges of lions persisting in northwest Namibia. This density is the lowest recorded for free-ranging, self-sustaining lion populations in Africa. Lion density is not uniform across the landscape. No lions were found within the Blue Block conservancies (Doro !Nawas, Sorris Sorris, and Tsiseb). When these conservancies are removed from analysis density across the area increases to 0.16 lions/100 km^2. Lion density within government-managed areas (0.17 lions/100 km^2) is nearly double that of lion density within communal areas (0.09 lions/100 km^2). However, when the Blue Block conservancies are removed, lion density within communal conservancies (0.15 lions/100 km^2) is similar to density within government-managed areas.

Both the recent inferred population decline and subsequent extreme low density likely ultimately result from the low productivity of northwest Namibia ecosystems. Drought-level conditions, resulting in declining prey species numbers, have affected lion survival. Yet, lions in the region appear well-adapted to persist in these arid and semi-arid environments. Low density may also buttress the population against deleterious processes such as disease, but may make it more susceptible to stochastic events or the effects of climate change.

Lions in Government-managed Areas

Because HLC is the overwhelming driver of lion mortality, lions inhabiting government-managed areas where human settlement is prohibited, are less likely to cause HLC incidents, and therefore may be less likely to be killed in retaliation then lions inhabiting conservancy lands. More research is needed to assess which environmental and human covariates drive lion landscape use.

Government-managed areas may serve as a refuge for lions; they may be more desirable for lions than conservancy lands. Of the 21 males identified, 13 inhabit conservancy land and 8 inhabit concessions (no males were found in SCNP). The estimated mean age of males inhabiting conservancy lands is 5.04 years (n = 13), while the estimated mean age of males inhabiting tourism concessions is seven years (n = 8). This difference is statistically significant (p = 0.018, two-tailed t.test). The average estimated age of all lions (non-cubs) within conservancy lands was 5.75, while the average estimated age of all lions within government-managed lands was 7.18 years (p = 0.002). The higher relative density of lions within government-managed areas indicates improved survival prospects. The presence of cubs within government-managed lands, and their complete absence on conservancy lands, underscores the difference between these land designations. Because the Etendeka, Hobatere, and Palmwag Concessions and SCNP together encompass a range of environments broadly representative of the survey area, ecological factors such as rainfall or landscape features are unlikely to explain discrepancies in lion presence.

Contextualizing Male Numbers

Of 21 males, ten (47%) are yet to disperse from their natal pride. Probability of male lion mortality in northwest Namibia is highest between the ages of three and six (p = 0.2-0.25 per year, Stander 2010). Additionally, since the survey was completed adult two males (OPL-3 and OPL-33) died following HLC incidents. The remaining population of nine adult males, coupled with relatively high probability of sub-adult male mortality, is the primary concern relative to population viability. Though historically the population was augmented by lions dispersing from Etosha National Park (Stander 2004; 2018), Etosha is not considered a source for the northwest population. The discrepancy in location of subadult versus adult males is also noteworthy. Of the ten subadult males, nine inhabit conservancy land, while only one inhabits government-managed areas. This suggests the survival of adult males is correlated with their ability to maintain a home range within government-managed areas. Further research is needed to better understand male ranging patterns and behavior.

Chapter 7

The International Union for the Conservation of Nature (IUCN) Species Survival Cat Specialist Group has created a set of best practices for the trophy hunting of wild African lions (IUCN 2018). These best practices are based upon the expectations that trophy hunting will take place sustainably and legally, with an eye to the overall health and wellbeing of the population. Lions considered suitable for trophy hunting are males, aged seven years or older, whose removal will not clearly compromise the future of the population, i.e. other breeding-age males are present. Due to uncertainty surrounding male lion persistence within communal lands a review of trophy hunting criteria, relevant to lions in northwest Namibia, can be an important part of population management. While the IUCN provides internationally-recognized lion trophy hunting guidelines (IUCN 2018), these may not be suitable for lion management in northwest Namibia. A positive outcome of this survey has been the near-complete picture provided of the population. This creates the possibility that trophy hunting quotas could be replaced by a system whereby individual males could be designated for trophy hunting. Those males who have already contributed to the population and may be past their reproductive prime could potentially be trophy hunted without extensive negative effects on the population.

The sex ratio of individuals (1 ♀: 0.58 ♂) is within expected bounds. Management of the population should consider likelihood of subadult male mortality as a factor when attempting to maintain target sex ratio.

Body Condition of Individuals

Nearly all individuals identified during the survey were in good (4) condition. The exceptions were three individuals in fine (3) and four in excellent (5) condition (see Chapter Five).

All members within each pride displayed a similar body condition, suggesting all lions are being provisioned relatively equal within each pride.

No lions were spotted with extensive injuries and there was no concern about disease within the population.

Looking Forward

Given this population's unique ecological circumstances, cautious management is urged. The region's declining prey base is particularly concerning. Further research is needed to assess how drought-like conditions are driving prey species declines and to what extent recent climatic conditions may be considered a 'new normal.' When assessed collectively, survey results and available environmental and social survey data indicate the importance of maintaining the region's prey base while increasing local tolerance for living with lions. Effort in these arenas will likely have the greatest positive effect in supporting the persistence of free-ranging lions in northwest Namibia.

OPL-5 and OPL-4, Etendeka Concession

Chapter 8

Report on Goal, Objectives, and Recommendations

Survey Goal and Objectives

Goal

The goal, to conduct the first comprehensive survey of free-ranging lions in northwest Namibia on communal and government-managed lands, was achieved. This report provides decision makers with baseline information for management, while setting a repeatable standard for future northwest lion population surveys. It provides limited recommendations for supporting community-centered lion conservation in the region.

Objectives

1. All known lions (non-cubs) inhabiting communal and government-managed lands west of Etosha National Park were identified. A further 14 cubs were identified. High-quality vibrissae (whisker spot) photos were captured of 54 of 57 individuals. The population is estimated at 57-60 individuals - the additional three individuals not identified represent the possibility of lions persisting near the Brandberg/Ugab riverbed area and the possibility of as-yet unrecorded Etosha vagrants consistently inhabiting communal areas adjacent to the park.
2. Drawing on the expertise of lion researchers, the Lion Rangers, and MEFT staff, practical, repeatable, and efficient methods set a baseline for future northwest lion population surveys. Combining LEK with highly-technical remote sensing in the form of GPS-satellite collars and camera traps, diverse and complimentary methods enabled survey teams to efficiently and effectively cover the northwest core lion range. All lions tracked or seen during the survey were identified and all spoor were attributed to specific individuals.
3. From the planning to implementation to follow-up stages, the work of the Lion Rangers and MEFT staff took center stage. Methods were inclusive, drawing-upon local expertise. Both day-to-day and overall workplans were developed in consultation with Lion Rangers and other local stakeholders. The survey itself served as capacity development and further training for the Lion Rangers and MEFT staff. It is recognized that greater capacity development in the form of technical knowledge is needed to continue empowering the Lion Rangers as custodians of lions and lion conservation within communal lands.
4. This survey is an important step towards addressing certain research and monitoring needs for lions in the northwest as laid-out in the Large Carnivore Plan (GRN 2016). Evidence-based recommendations, below, speak to Strategies (Section 2.4) highlighted in that document to ensure the continued survival of a viable northwest lion population.
5. This report provides methods, data, and analysis which can contribute to the development of a national lion management plan for Namibia.

Recommendations

Based upon survey findings, the following recommendations are made to MEFT, pursuant to guidelines laid-out in the Large Carnivore Plan (GRN 2016).

Repeating the northwest lion population survey every three to five years

While this survey provides an important baseline, the northwest lion population requires consistent monitoring which should include periodic surveys and body condition assessments. Full population surveys should take place every three to five years, with body condition assessments taking place at least once between surveys (Large Carnivore Plan, Section 2.4.1). It is recommended that the Game Products Trust Fund (GPTF) prioritize ongoing support for future surveys.

Upscaling lion research, monitoring, and stakeholder coordination relevant to communal lands

The northwest lion population inhabits a landscape which is unique across the range of African lions. Yet, few peer-reviewed publications examining lion behavior, ecology, and the effects of HLC within the region exist. A lack of available longitudinal knowledge about individuals, prides, and their behaviors hampers population management. Further research, particularly within communal areas is needed. Greater monitoring of lions and other wildlife by local conservationists, such as the Lion Rangers, is needed to ensure the security of the population (Large Carnivore Plan, Section 2.4.1). Greater

Rain in Puros Conservancy. Photo: A Wattamaniuk

standardization and coordination among stakeholders are needed (Section 2.4.2.). The Northwest Lion Working Group, disbanded in 2019, could be re-instituted among permitted researchers and partnering stakeholders as a dedicated platform for upscaling and implementing coordinated activities (Section 2.4.5).

Maintaining lion ID database and disseminating information to conservancies and field staff

This survey has created ID cards for every known adult lion in northwest Namibia. These cards and related information should be disseminated to lion range conservancies and relevant field staff to improve lion monitoring and promote programs and activities for reducing HLC (Large Carnivore Plan, Section 2.4.4). Researchers and field staff should be responsible for maintaining and updating lion ID cards as a resource for population management.

Exercising cautious, proactive conservation and management of an ecologically-unique population

The ongoing effects of drought-like conditions, and forthcoming effects of global climate change within northwest Namibia are unknown. Though the northwest lion population currently appears stable and self-sustaining following recent declines, it inhabits an area that is ecologically-unique across African lion range. The limited available information about these lions, combined with an uncertain ecological future indicates cautious management is needed to increase the likelihood that free-ranging lions will persist in northwest Namibia. The NW Lion Plan (GRN 2017) requires updating, as part of landscape-wide conservation and management of the northwest lion population and for its contribution to a national lion management plan (Large Carnivore Plan, Section 2.4.2).

Limiting HLC as part of supporting rural development and community outreach to improve tolerance for living with lions

HLC is the premier proximate factor affecting the survival of lions in northwest Namibia. The significant difference between the average age and density of lions on conservancy lands compared to government-managed lands may be cause for concern. Drivers of HLC remain little understood. Greater coordination around HLC record-keeping (Large Carnivore Plan, Section 2.4.4) and standard operational procedures (SOPs) related to addressing HLC (Section 2.4.6) are needed. The effects of HLC are exacerbated by limited livelihood prospects for the region's residents. Rural development and livelihood support programs compatible with lion conservation (Section 2.4.7) for people inhabiting core lion range can help limit the effects of HLC and subsequent retaliatory (or preventative) killing of lions. Supporting human social welfare may also support the survival of lions in their wild and native environments (Section 2.3.2).

Looking for lions, Anabeb Conservancy. Photo: A. Wattamaniuk.

Rain in Puros Conservancy. Photo: A Wattamaniuk

Okavariona pride captured on trail camera, Omatendeka Conservancy

References

Atlas of Namibia Team (2022). *Atlas of Namibia: its land, water, and life* (Windhoek: Namibia Nature Foundation).

Bauer, H., et al. (2015). Lion (Panthera leo) populations are declining rapidly across Africa, except in intensively managed areas. *Proc. Natl. Acad. Sci. USA* 112, 14894–9.

Belant, J. L., et al. (2019). Track surveys do not provide accurate or precise lion density estimates in serengeti. *Glob. Ecol. Conserv.* 19, e00651.

Bollig, M. (2020). *Shaping the African Savannah: From Capitalist Frontier to Arid Eden in Namibia* (Cambridge: Cambridge University Press).

Charnley, S., et al. (2007). Integrating traditional and local ecological knowledge into forest biodiversity conservation in the Pacific Northwest. *For. Ecol. Manage.* 246, 14–28.

Coleman, J. (2004). *Vicious: Wolves and Men in America* (New Haven: Yale University Press).

Conservation Namibia (2023). Wildlife Credits: innovation in conservation by and for Namibians. URL: https://communityconservationnamibia.com/support-to-conservation/livelihoods/specialist-articles/diversifying-income-with-wildlife-credits

Dickman, A. J. (2010). Complexities of conflict: the importance of considering social factors for effectively resolving human-wildlife conflict. *Anim. Conserv.* 13, 458-466.

Dolrenry, S., et al. (2016). Conservation and monitoring of a persecuted African lion population by Maasai warriors. *Conserv. Biol.* 30, 467–475.

Dupont, P., et al. (2019). Population closure and the bias-precision trade-off in spatial capture–recapture. *Methods Ecol. Evol.* 10, 661–672.

Dröge, E., et al. (2020). Assessing the performance of index calibration survey methods to monitor populations of wide-ranging low-density carnivores. *Ecol. Evol.* 1–17.

Elliot, N. B., Gopalaswamy, A. M. (2017). Toward accurate and precise estimates of lion density. *Conserv. Biol.* 31, 934–943.

Elliot, N. B., et al. (2020). The importance of reliable monitoring methods for the management of small, isolated populations. *Conserv. Sci. Pract.* 2, 1–11.

Elliot, N. B., et al. (2021). Report on the application of novel estimating methodologies to monitor lion abundance within source populations and large carnivore occupancy at a national scale. Wildlife Research and Training Institute and Kenya Wildlife Service.

Funston, P. J. (2011). Population characteristics of lions (Panthera leo) in the Kgalagadi Transfrontier Park. *South African J. Wildl. Res.* 41, 1–10.

Goelst, C., et al. (2018). Etosha National Park Carnivore Monitoring Project Update, Unofficial Report re: Lion GPS-satellite Monitoring, Lion Population Call-Up Survey (Okaukuejo: Etosha Ecological Institute).

Gopalaswamy, A. M., et al. (2015). An examination of index-calibration experiments: Counting tigers at macroecological scales. *Methods Ecol. Evol.* 6, 1055–1066.

(GRN) Government of the Republic of Namibia Ministry of Environment and Tourism, (2008). A draft of lion conservation management plan (Windhoek: MET).

GRN, 2016. *National Policy on Conservation and Management of Large Carnivores in Namibia* (Windhoek: MET).

GRN, 2017. *Human-Lion Conflict Management Plan for North West Namibia* (Windhoek: MET).

Hazzah, L. N., et al. (2014). Efficacy of two lion conservation programs in Maasailand, Kenya. *Conserv. Biol.* 28, 851–860.

Hearn, M. (2003). Assessment of Biological and Human Factors Limiting the West Kunene Rhino Population. Report for the SADC Regional Programme for Rhino Conservation.

Heydinger, J. (2021). Human-Lion conflict and the reproduction of white supremacy in northwest Namibia. *Afr. Stud. Rev.* 64, 909–937.

Heydinger, J. (2022). Human-Lion Conflict Farmer Surveys: Mitigation and Impacts. Lion Rangers Program. Windhoek, Namibia. URL: http://lionrangers.org/wp-content/uploads/2023/10/Human-Lion-Conflict-Survey-Report.pdf

Heydinger, J. (2023). Lion Ranger Training and Operations Manual. Windhoek, Namibia. URL: http://lionrangers.org/wp-content/uploads/2023/10/Upadted-Print-VersionLion-Ranger-Manual.pdf

Heydinger, J., et al. (2019). Desert-adapted lions on communal land: surveying the costs incurred by, and perspectives of, communal-area livestock owners in northwest Namibia. *Biol. Conserv.* 236, 496–504.

References (cont.)

Heydinger, J., et al. (2022). Differentiated payments for ecosystem services based on estimated prey consumption by lions within communal conservancies in northwest Namibia. *Ecosyst. Serv.* 53, 101403.

Heydinger et al. (in press) Community-based natural resource management and the desert-adapted lions of Kunene, Namibia, in: Anderson, D., Bollig, M. (eds) *Conservation in East and Southern Africa: People, Policy, and Practice* (Cambridge: Cambridge University Press).

IUCN SSC Cat Specialist Group, 2018. Guidelines for the Conservation of Lions in Africa, Version 1.0 - December 2018. Muri/Bern, Switzerland.

Jacobsohn, M., (2019). *Life is Like a Kudu Horn: A Conservation Memoir* (Cape Town: Jacana).

Jacobsohn, M., Owen-Smith, G. (2003). Integrating conservation and development: a Namibian case study. Nomad. People. 7, 92-109.

Jacobson, A., Riggio, J., (2018). Big Cats in Africa: Status update on the African lion, cheetah and leopard, with recommendations for effective big cat conservation funding. Report prepared for National Geographic Society.

Jędrzejewski, W., et al. (2017). Human-jaguar conflicts and the relative importance of retaliatory killing and hunting for jaguar (Panthera onca) populations in Venezuela. *Biol. Conserv.* 209, 524–532.

Jones, B., Murphree, M. W., 2001. The Evolution of Policy on Community Conservation in Namibia and Zimbabwe, in: Hulme, D., Murphree, M. W. (eds), African Wildlife & Livelihoods: The Promise and Performance of Community Conservation, pp. 38–58 (Oxford: James Currey).

Kilian, W., Moeller, C. H. (2015). Etosha National Park Lion (Panthera leo) Survey Report. Prepared for Namibia Ministry of Environment and Tourism.

Lendelvo, S., et al. (2020). A perfect storm? COVID-19 and community-based conservation in Namibia. *Namibia J. Environ.* 4, 1-15.

Liebenberg, L. (1990). *The Art of Tracking: The Origin of Science* (Cape Town: David Philip).

Mendelsohn, J., et al. (2002). *Atlas of Namibia: a portrait of the land and its people* (Cape Town: David Philip).

Moqanaki, E. M., et al. (2018). Counting bears in the Iranian Caucasus: Remarkable mismatch between scientifically-sound population estimates and perceptions. *Biol. Conserv.* 220, 182–191.

Muntifering, J. R., et al. (2015). Harnessing values to save the rhinoceros: insights from Namibia. *Oryx* 1–8.

(NACSO) Namibia Association of CBNRM Support Organizations (2023). Game Counts in North-West Namibia. URL: https://www.nacso.org.na/sites/default/files/North%20West%20Game%20Count-Regional%202022%20final.pdf

Nijhuis, M. (2019). The most political animal. *Atl.* 1–18. URL: https://www.theatlantic.com/science/archive/2019/04/norway-divided-over-countrys-wolves/587302/

(NNPC) Namibia National Planning Commission (2012). Namibia Poverty Mapping (Namibia National Planning Commission, Windhoek).

Owen-Smith, G. (1971). *The Kaokoveld: An Ecological Base for Future Development Planning* (Pretoria).

Packer, C. (2023). *The Lion: behavior, ecology, and conservation of an iconic species* (Princeton: Princeton University Press).

Packer, C., et al. (2013). Conserving large carnivores: dollars and fence. *Ecol. Lett.* 16, 635–641.

Pennycuick, C. J., Rudnai, J. (1970). A method of identifying individual lion with an analysis of the reliability of identification. *J. Zool.* 160, 497–508.

Redpath, S. M., et al. (2013). Understanding and managing conservation conflicts. *Trends Ecol. Evol.* 28, 100–109.

Roffler, G. H., et al. (2019). Estimating abundance of a cryptic social carnivore using spatially explicit capture–recapture. *Wildl. Soc. Bull.* 43, 31–41.

Schaller, G. B., (1972). *The Serengeti Lion: a study in predator-prey relations* (Chicago: University of Chicago Press).

Stander, P. E. (1999). Conservation of lions and other large carnivores in Etosha National Park and Khorixas District, Namibia (Prepared for Namibia Ministry of Environment and Tourism).

Stander, P. E. (2000). Conservation of lions and other large carnivores in the Kunene Region, Namibia: Population ecology and long term monitoring of free-ranging populations in a marginal and arid environment. Report of the National Carnivore Monitoring Project, Namibia.

Stander, P. E. (2007). Behaviour-ecology and Conservation of Desert-adapted Lions; 2007 Progress Report of the Kunene Lion Project, Namibia (Prepared for Namibia Ministry of Environment and Tourism).

Stander, P. E. (2010). The impact of male-biased mortality on the population structure of desert-adapted lions in Namibia (Prepared for Namibia Ministry of Environment and Tourism).

References (cont.)

Stander, P. E. (2018). *Vanishing Kings: Lions of the Namib Desert* (Johannesburg: HPH Publishing).

Stander, P. E. (2019). Lions (Panthera leo) specialising on a marine diet in the Skeleton Coast National Park, Namibia. *Namibian J. Environ.* 3, 1–10.

Stander, P. E. et al. (1997). Tracking and the interpretation of spoor: a scientifically sound method in ecology. *J. Zool.* 242, 329–341.

Stander, P. E., et al. (2023). An evaluation of the simultaneous utilisation of the Northern Namib coastline by desert-adapted lions (Panthera leo) and recreational shore anglers, during the 2022/2023 Torra Bay campsite season, in the Skeleton Coast National Park. *Namibian J. Environ.* 7, 1–8.

Stuart-Hill, G., et al. (2005). The event book system: A community-based natural resource monitoring system from Namibia. *Biodivers. Conserv.* 14, 2611–2631.

Tidholm, A., et al. (1996). Feline Pansteatitis: A Report of Five Cases. *Acta Vet. Scand.* 37, 213–217.

UNICEF, 2013. Regional Education Analysis for Namibia. URL: http://www.unicef.org/namibia/MoE-UNICEF_2013_Regional_education_analysis_Namibia_combined1.pdf

Viljoen, P. J. (1980). Veldtipes, Verspreiding van die Groter Soogdiere, en Enkele Aspekte van die Ekologie van Kaokoland. University of Pretoria.

Appendix 1

Lion ID Cards (example)

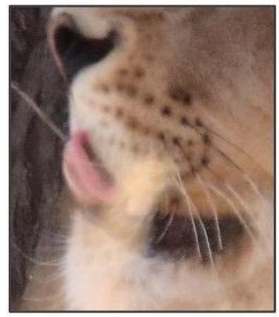
Comprehensive identification cards were created for each adult lion. These are maintained by researchers and shared with MEFT Regionals Services staff, area Lion Rangers, and relevant conservancy personnel.

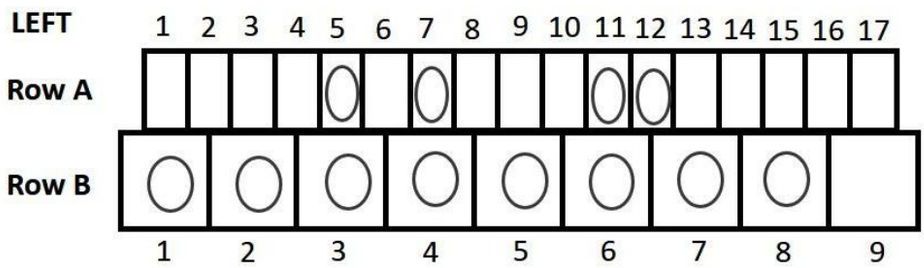




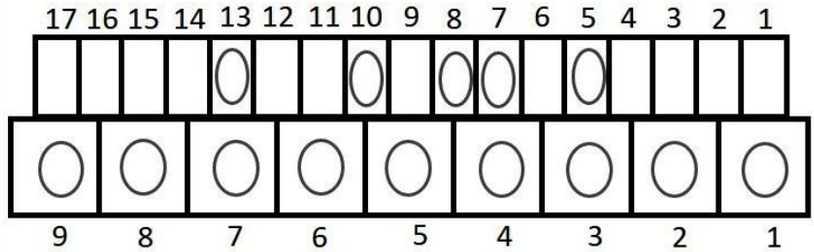
Lion ID: OPL-18
Sex: F
Age Class: 5-6
Pride (size): Okaruikongava (1)
Resident PAs: Omatendeka/ Ehi-rovipuka
Collar: WHXX 6/2022
HLC Problem: No
Brand: N/A
Diag. Marks: N/A
Condition: 4
Photo dates: 26 Dec. 22
Photo GPS: S 19.6874 E 14.1151
Notes: Sometimes with Okavariona pride (OPL-4 (F), OPL-5 (F), OPL-7 (M), & OPL-8 (M)

Left Photo





Right Photo



ID Card: 030/2023

Appendix 2

SMART Reports on Survey Effort

NW LION POPULATION SURVEY

From 2022-11-06 to 2023-01-06

Core Lion Range Conservancies, Kunene Region, Namibia

RANGER TOTAL PATROL EFFORT[1]

RANGER	PATROLS	AVG DISTANCE PATROL (km)	TOTAL DISTANCE (km)	AVG ACTIVE HRS PATROL	TOTAL ACTIVE HRS
Uakendisa Muzuma	93	59.8	5979.3	5.5	547.9
Zelda Dandu	79	52.9	4922.3	5.2	487.9
John Heydinger	89	45.6	4744.8	4.8	494.4
Kavekaetua Tjauira	75	58.1	4704.4	4.9	398.7
Tjango Tjiseua	86	49.3	4291.5	5.2	452.1
Esau Matundu	96	42.3	4064.6	5.7	545
Undari Hoveka	52	74.6	3881.7	5.6	289.5
Uezekandavii Nguezeeta	94	39.5	3713.5	4.8	450.2
Rodney Tjavara	84	41.7	3711	5.3	470.7
Ndjitjiuee Olga Karizemi	77	39.5	3633.9	4.2	386.4
Mbaendeka Kangombe	56	64.6	3616.9	6.4	357.7
Rinoveni Tjauira	73	49.3	3602.1	4.9	355.8
Kapi Kaipaterue	65	46.4	3480.1	4	299.6
Katukuruka Karutjaiva	65	47.8	3395.2	4.8	339.4
Daniel Tjivahe	68	49.9	3392.1	5.1	344.1
Lazarus Hoxobeb	38	84	3193.9	7.1	269.4
Jackson Kavetu	75	40.6	3124.8	4.4	340
Pienaar Kasupi	66	40.4	3112.6	4.1	317.8
Alex Amutenya	42	63.8	3061.5	4.7	226.5
Unity Katjirumbu	82	35.3	2967.1	3.5	291.8
Kaveisire Rutavi	94	30.9	2963.3	3.7	354.6
Benson Hiriua	63	41.1	2837.1	4.5	310.8
Tammy Hoth	32	84.7	2708.9	7.6	243.7
Kauhepere Musaso	44	48.2	2506.4	4.4	230.5
Steven Kasaona	48	45.6	2414.2	3.9	209
Allu Uararavi	34	49.5	2377.6	2.9	140.4
Mackensie //Gaseb	29	81.6	2366.5	7.4	214.4
Linus Mbomboro	59	38.5	2311.8	3.7	221.2
Jendery Tsaneb	58	33.9	2270.8	4.3	290.6
Uaroua Kaidue	77	28.4	2185.9	4.5	345.4
Muvari Tjiseua	41	52.2	2141.7	5.7	235
Jackson Uazunga	65	28.2	1886.7	3.3	218.3

[1] Ranger Total Patrol Effort includes both foot- and vehicle-based patrols for the indicated time period, recorded in the SMART mobile app.

Appendix 3

NW LION POPULATION SURVEY

From 2022-11-06 to 2023-01-06

Core Lion Range Conservancies, Kunene Region, Namibia

RANGER TOTAL PATROL EFFORT

RANGER	PATROLS	AVG DISTANCE PATROL (km)	TOTAL DISTANCE (km)	AVG ACTIVE HRS PATROL	TOTAL ACTIVE HRS
Erik Gewers	26	61.9	1672.6	5.9	158.4
Uatiromuinjo Kooti Karutjaiva	47	32.1	1541.5	3.6	173
Edward Rhyn	37	39.6	1464.2	5.9	219.6
Uatuvisa Kennedy Uaroua	34	39.5	1342.1	5	169.8
Lesley Xamseb	52	22.4	1211.9	2.4	130.3
Tjino Musaso	51	21.1	1097.4	4.6	238.4
Isaack Geiriseb	22	47.6	1046.3	5.1	111.8
John Hoaeb	36	21.3	768.6	3.7	134.1
Colin Kasupi	10	37.5	674.5	3.3	58.9
Ahmed Natangwe	10	59.9	599.2	5	50.4
Fiona Goses	19	28.5	540.9	4.7	89.6
Danislaus Gawaseb	13	35.8	466	5.5	71.2
Michael Ivanga Kapuike	23	16.9	389.8	3.6	82.3
Esau Tjeundo	32	9.8	324.5	2.9	94.5
Bertus I Tjipombo	19	15.1	302.2	2.2	44.2
Matarakuani Kavetu	30	9.9	297.2	2.8	85.2
Timotheus Zaongara	33	9	296.8	3	97.6
Richard Katira Zaako	16	12.2	195.4	2.2	35.4
Cliff Tjikundi	2	51	102.1	6.8	13.6
Long-John Uatokuja	6	14	83.9	1.6	9.7
Sonnet Haoses	9	8	72.3	3.3	29.6
Simion Vejorerako	7	9.2	64.4	2.9	20
Titus Turitjo	1	26.4	26.4	4.1	4.1
Benjamin Kordom	2	0.7	4.7	0.6	4.2
TOTALS	2636	39.6	120149	4.4	12805

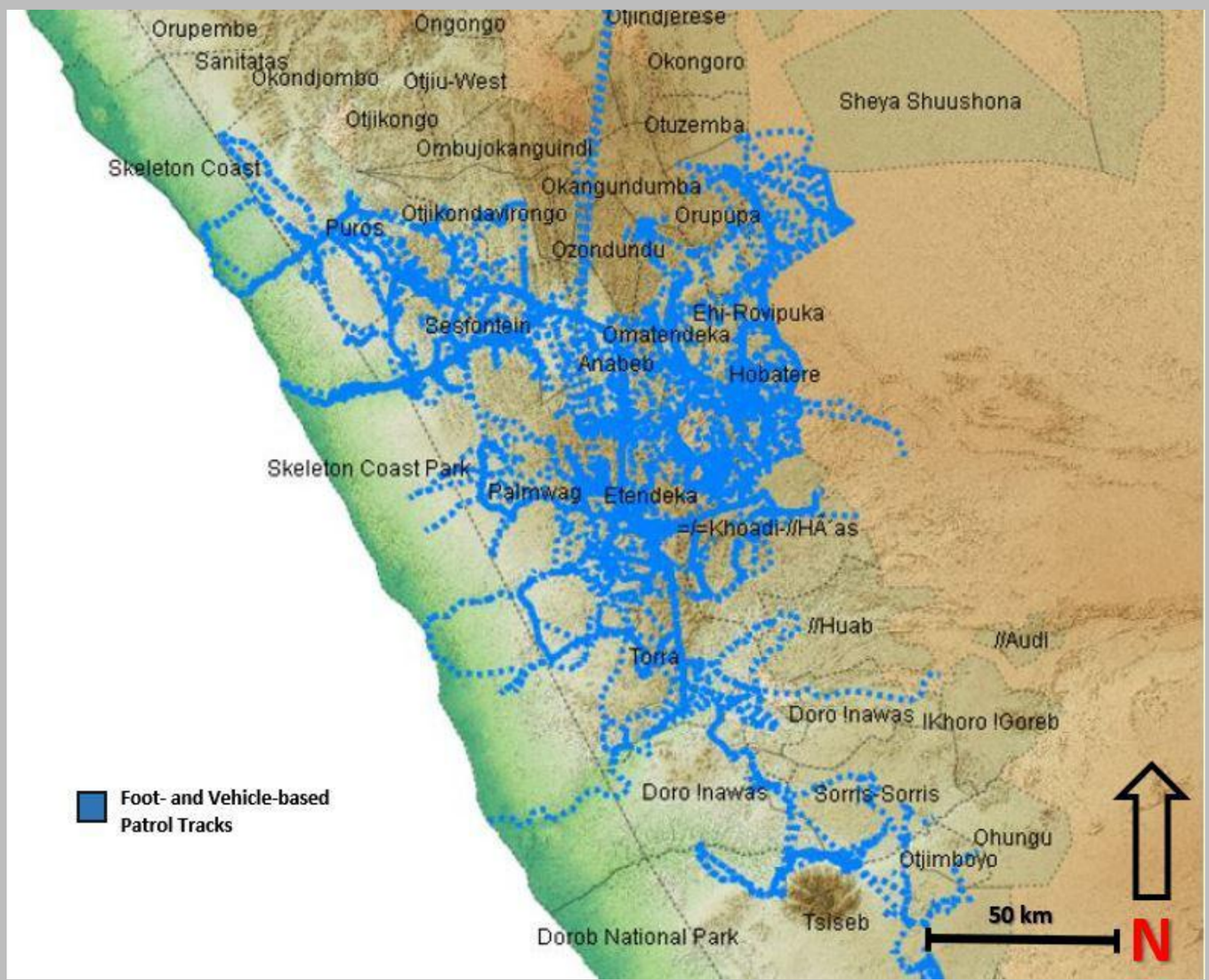
Appendix 3

NW LION POPULATION SURVEY

From 2022-11-06 to 2023-01-06

Core Lion Range Conservancies, Kunene Region, Namibia

RANGER TOTAL PATROL EFFORT



Map of all Lion Ranger and MEFT staff foot- and vehicle-based patrols which took place from 6 November 2022 to 6 January 2023 as part of the Northwest Lion Population Survey and associated lion monitoring.

THANKS TO OUR TEAM AND SUPPORTERS!

CCFN

KFW

german cooperation
DEUTSCHE ZUSAMMENARBEIT