



LEC Anniversary

2



2000 – 2020

Leopard Ecology & Conservation

Annual Report

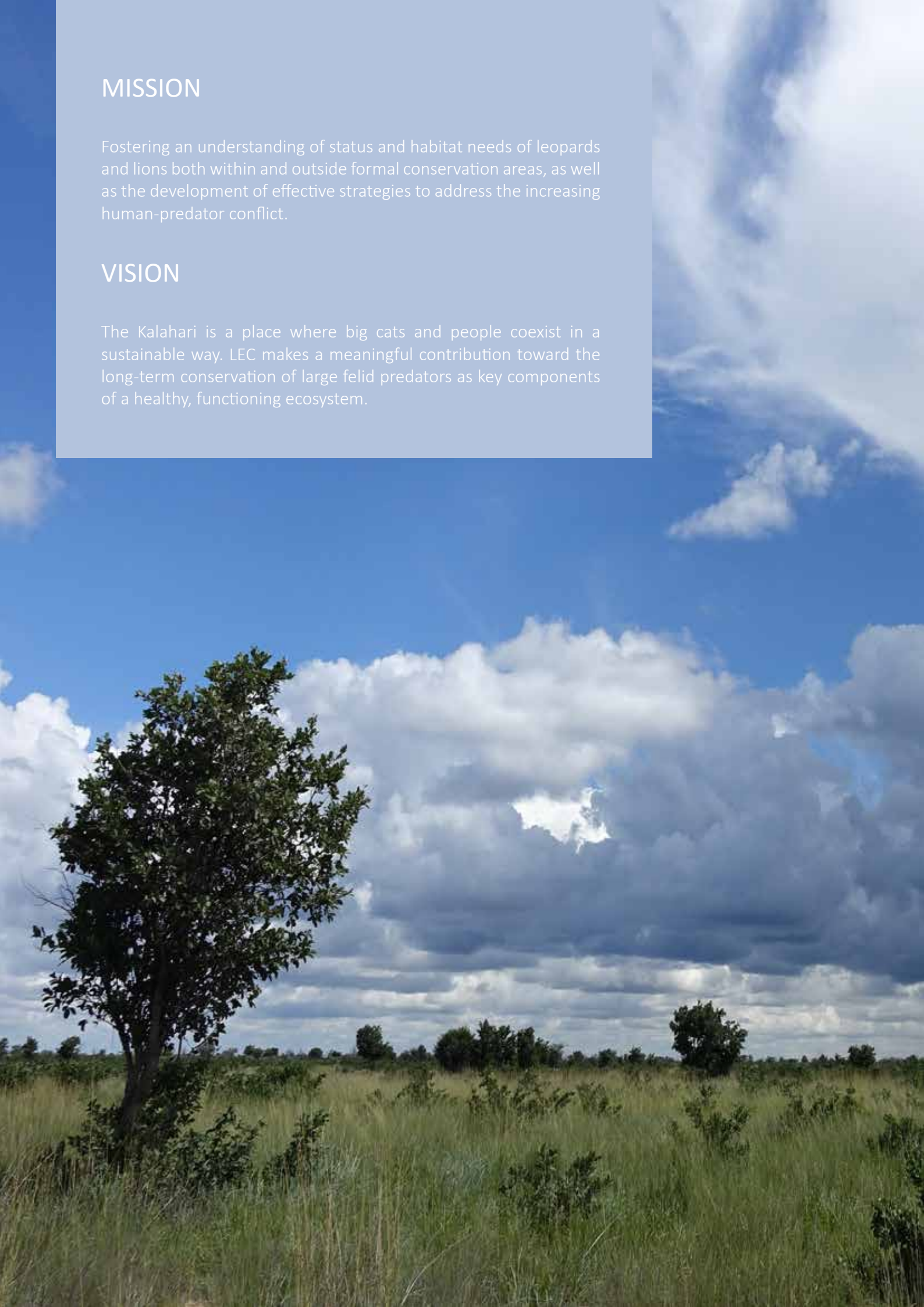
2020

MISSION

Fostering an understanding of status and habitat needs of leopards and lions both within and outside formal conservation areas, as well as the development of effective strategies to address the increasing human-predator conflict.

VISION

The Kalahari is a place where big cats and people coexist in a sustainable way. LEC makes a meaningful contribution toward the long-term conservation of large felid predators as key components of a healthy, functioning ecosystem.





OBJECTIVE

Leopard Ecology & Conservation strives to make a meaningful contribution toward the long-term conservation of large felid predators as key components of a healthy, functioning ecosystem in Botswana. This requires an understanding of status and habitat needs of leopards and lions both within and outside formal conservation areas, as well as the development of appropriate and effective strategies to address the threats they face.



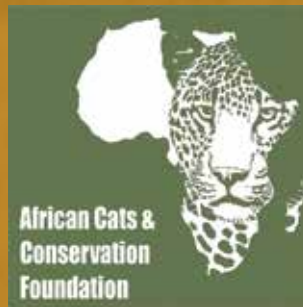
Leopard Ecology & Conservation (LEC)

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Leopard Ecology & Conservation Trust

Botswana



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A map showing most of the places mentioned in the text can be found on page 42.



LETTER FROM LEC FOUNDER: MONIKA SCHIESS-MEIER



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Different cultures can be merged to improve the outcomes. We combine the tracking, a millennia-old tradition of the San, with the high-tech method of using computer programmes to identify individual animals.

MONIKA SCHIESS-MEIER, Founder and Director.

In 1998, I was contacted by the Botswana Government, because they had been told that I was interested in conducting research on leopards. So, our next family holiday destination became Botswana to check out a potential research site. I was a greenhorn in the bush back then and I had my first experience of the Kalahari wilderness: a dry and harsh environment with an atmosphere that immediately drew me in. Little did I realise it on my way to Botswana that first time, but that holiday changed my life forever.

Arriving in Gaborone I was met by the Department of Wildlife & National Parks who kindly lent us a tent. It was my first time in a tent and we didn't know how to put it up properly. The Kalahari is an incredibly windy place, and the tent collapsed every time we left it. We visited Khutse Game Reserve, the place I would ultimately call home for so many years. At the gate, a wildlife officer called Parks, who is still working at Khutse Gate today, suggested that we visit the nearby village of Kaudwane. At the time, there were only a few people living there, and one of them was Mpheletsang. Parks suggested we ask him to accompany us in the reserve to assist with tracking leopards.

Up until this point, I had only ever observed animals directly and was not familiar with the art of interpreting animal behaviour through tracking, so I was happy to have someone to guide us. Mpheletsang turned out to be an excellent tracker and this was the start of a wonderful journey. It was on the basis of this experience that I designed my project.

I arrived back in Khutse in 2000, to start my three-year project, after a total reorganisation of my entire life (and that of my family's). It very quickly became obvious to me that, in order to collect the necessary data in this harsh and sandy environment, tracking was going to be absolutely key. As such, local San Trackers have been an integral part of the project from the very onset.

For the San, tracking is like reading a book. A Tracker may not be able to read and understand the words written in a book, but they do see the difference between each letter. Just like they see and understand every mark and sign in the bush. When I first started, I was completely illiterate at reading the tracks. The Trackers had to be very patient with me while I tried to learn. Likewise, over time they learnt what kinds

of information I was interested in them reading from the tracks, and so we worked together, each learning from the other, towards a common goal.

The problem for my research though, was that there is only so much you can deduce from reading the tracks when you don't know which individual animal you are following. While the Trackers are able to distinguish between female and male tracks, it is not often that they can determine the individual, unless they have a distinctive flaw in the track like a crooked toe. So, over the years we have tried many methods to identify the individuals. In the past this was a big challenge as photographs were not of high enough quality and computer programmes not sophisticated enough, especially for the very soft sands of the Kalahari. We always ended up frustrated and without usable outputs.

Over time, as the research developed and evolved, we started to collar leopards. This then allowed us to follow specific individuals and start to match the behaviour the trackers were interpreting from the spoor with animals of different ages, sex and life stage. These moments when we finally got to see a leopard, after having tracked them for hours, was always a unique experience full of emotions. These beautiful, elusive and smooth cats! In these moments they allowed us some glimpses into their secret lives. These moments were really special and will be cherished forever.

But, here at LEC, we are always driven to keep trying new techniques and we felt sure that collaring an animal isn't the only way you can determine which individual you are following. These days, we are happy to say, technology is much more advanced and is now finally helping us to identify individuals in ways that require no disturbance of these secretive cats.

This is why I was so happy when the Research Team formed a relationship with WildTrack (see Project in Focus). We now have the appropriate tools in hand to do what I was trying to do so many years earlier. The technology being developed by WildTrack maps out a track of a leopard, much like a fingerprint, matching it to a database of leopard tracks that we continuously build as we traverse across the Reserve each day. It will allow us, at last, to identify which leopard we are following simply by taking a photo of the print.

This project is a good example of how different cultures can be merged to improve the outcomes. The tracking, a millennia-old tradition of the San, and the high-tech method of using computer programmes to identify individual animals from just their footprints. But it is important to me to remind everyone that the computers can only provide information on who the individual is, to get the information we need on the behaviour of that animal we will always require the ancient skills of tracking. Only the trackers can provide real insight into the bigger picture of what is happening in the world of the leopards we are studying, in a way that cannot be replicated by technology.

So now the three-year project has become 20. What started out as one simple project has evolved and grown year on year. I would like to thank everyone that has been involved throughout the years from team members to supporters, advisers to volunteers. Each and every one has contributed to what LEC has achieved and will continue to achieve in the coming years. I would also like to take this opportunity to celebrate the fact that even though LEC evolves and we utilise new techniques and technologies, the overall aims and ambitions remain the same, to conserve the leopards and lions of Khutse, and the San Trackers will always be at the centre of the work.



HOW IT ALL BEGAN

LEC Anniversary



2000 – 2020



Leopard Ecology & Conservation (LEC), initiated by Monika Schiess-Meier in 2000, is a non-governmental organisation that aims to preserve Botswana’s leopard and lion populations through focused scientific research, education, and the provision of conservation management advice.



LEC began its journey twenty years ago, as a result of Monika’s passion to study the secret life of leopards in the Kalahari and protect these amazing animals that touched her heart. Research began, working alongside local trackers, to learn about the behaviour of leopards by following and interpreting their tracks. Research on lions started in 2002, as part of a PhD student project. This research was continued and incorporated into LEC’s portfolio in response to observed declines in the lion population in the area.

The Education & Community Programme was started in 2004 with a number of community projects, including the animal husbandry project and the Itsoseng nonprofit shop. This expanded and developed into the “Act Now for Tomorrow” initiative in 2009, which is an education program designed to instruct rural farmers and herders in the concepts and techniques underlying the management of rangeland, livestock, disease and wildlife with an emphasis on the sustainable use of resources.





“

When I first pitched my tent here in Khutse 20 years ago, I never thought I would look back today. Looking back on a work that fulfils me, on a team that makes me proud and on a piece of earth that I consider my home. .

MONIKA SCHIESS-MEIER, Founder and Director.

WHAT WE DO NOW

Today, the LEC Research Programme is made up of six core projects studying the habitat of leopards and lions, their population status, and the human-predator conflict that exists between them and the local community. These core projects have produced long-term datasets on predator ecology and human-wildlife conflict, providing a longstanding perspective on the evolving ecological needs of, and threats to, predators in the Kalahari.

While we maintain continuity in data collection methods, we also adapt and modify our activities to ensure that the research topics and methodologies remain relevant and up to date, allowing us to inform current management strategies appropriately.

The Education & Community Programme employs a team, made up of local residents and individuals with expertise in social science and community-based conservation. They work with farmers and herders to provide education about livestock predation mitigation measures. They also work with residents of the local village, Kaudwane, on a number of community projects, such as an organic vegetable garden, a community conservation club, a solar cooker project and a conservation-based horse race. LEC is particularly proud of the relationship which has developed over the past 20 years with the local community.

THANK YOU Monika for making all this happening!

Anniversary LEC

20
2000 – 2020



NUMBERS IN 2020



Created by ProSymbols
from Noun Project

Organisation - Team

15 people from local community
working at field site in Khutse GR

3 international post graduate students supported:
Genevieve Finerty, Lauren Rudd, Shani Baumgartner

3 new international collaborations: FIT,
Snapshot Safari, CREEM

488 sightings of
lions older than 6 months

166 sightings of
collared lions

Lions

117 sightings of lions cubs

55 sightings of Notch, a
10-year old female lion

14 lion matings

6 lion litters with **20** cubs

104 visits to cattle posts

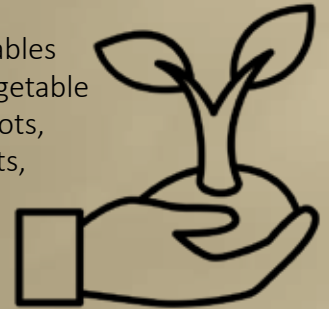
2 hooftrimming workshops: reaching farmers across 7 cattle posts

22 times hiring of hooftrimming equipment

20

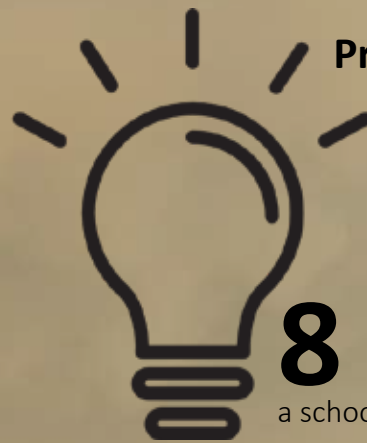
400 m² of garden is net-shaded.

6 different vegetables are planted in the vegetable garden: spinach, carrots, chili pepper, beetroots, rapeseed, tomatoes.



Created by Lars Meier toberens from Noun Project

Community and Education



Promoting young talents

7 students from Botswana were invited into the Park

8 school children were awarded in a school prize giving ceremony

Research

96 camera traps

over an area of **480** km²

135 predation events. 127 by lions.
Most common prey species was Gemsbok.



RESEARCH PROGRAMME

Research Overview

Conservation of leopards and lions requires a detailed understanding of population size, spatial distribution, and demographic trends and how these link to changes in the environment and resources. Retaliatory killings, habitat degradation and fragmentation, and environmental change threaten the long-term persistence of predator populations worldwide. Having regular and reliable survey and monitoring data, will allow us to evaluate the sources, intensity, distribution and impacts of these potential threats, from which appropriate management strategies can be derived.

To ensure that the data are collected in a systematic fashion, and to maintain continuity in our long-term datasets, LEC has six long-term research projects looking at the key parameters of leopard and lion persistence within the study area. While LEC focuses on these six long-term projects, we continuously strive to update our research methodologies as well as integrate innovative technological and methodological advances to maximise the value of our research activities. We also contribute to a number of research collaborations and support students in their research beyond these six projects.

Progress in 2020

Just like with the Community & Education Programme, many of the activities planned under the Research Programme for this year were impacted by the Covid-19 pandemic. In particular, we were impacted by the delayed arrival of new equipment and the inability for external collaborators to visit the site. However, our core research was able to continue in most cases, and so in the following sections we provide an overview of the work done in 2020 towards each of these projects.

Project 1:

Landscape and habitat monitoring

- To define the Khutse landscape in terms of the key environmental features and their interactions.
- To monitor changes in landscape conditions that are biologically relevant, and which vary in both space and time.
- To monitor key climatic drivers of landscape change.

Project 2:

Prey Availability

- To monitor the distribution and relative abundance of potential prey species.
- To monitor the demographics (age class and sex ratios) and physical condition of the principal leopard and lion prey species.

Project 3:

Predation

- To describe leopard and lion predation patterns across the study area.
- To identify drivers that best predict leopard and lion predation patterns across the study area.
- To quantify the extent to which domestic and wild prey sources contribute towards the diet of leopards and lions in the study area.
- To quantify predation of livestock in terms of prey species, age class and sex.

Project 4:

Predator Movement and Habitat Selection

- To determine leopard habitat selection patterns inside and outside the protected area.
- To identify key resources across the study area for leopards and lions.

Project 5:

Predator Demographics

- To calculate population size of leopard and lion populations inside the protected area.
- To calculate population size of leopard population outside the protected area.
- To understand sex ratios and age classes of both territorial and dispersing leopards.
- To determine the population structure, pride size and pride structure of the lion population, and how these change over time.

Project 6:

Human-Predator Conflict

- To identify the intensity and trends of human-predator conflict in the study area.
- To determine environmental and social factors affecting the coexistence of human activities and wild carnivores.
- To identify effective mitigation strategies.

Project 1. Landscape and Habitat Monitoring

In 2020, we continued our long-term data collection on the vegetation and climate in our study area. The main goal is to define the landscape in which the leopard and lion population are living and how changes in landscape features may impact the ecology of our study carnivore populations. On a larger scale, we are interested in monitoring the climatic changes in our study area.

Due to the limitations on hosting researchers and students throughout the year, we preferred to focus on the existing data collection protocols at LEC and the reorganization of the existing datasets to simplify their future analysis.

Concerning vegetation in the study area, we continued to collect fixed point landscape photographs on a monthly basis. The existing datasets have been reorganised and stored on our server for future analysis. The vegetation maps created by Mishra et al. 2014 and the MSc thesis from Caroline Buettner (2019) provide sufficient information for the current needs. Finer temporal and spatial scale monitoring of the vegetation structure of the study area will be

investigated in coming years through remote sensing methodologies.

Our weather station at the entrance of Khutse GR and the set of rain gauges deployed across the study area allowed us to monitor temperature, rainfall and windspeed throughout the 2019–2020 austral seasonal year. As showed in Fig.1.1, the rainfall has been notably greater than the last 2 years, reaching values in line with the rainfall mean value for the last 20 years. In Fig.1.2, the chart is presenting the rainfall and temperature values per month. The highest mean temperatures have been reached in November 2019 (28.1°C) while the previous year was December 2018 (30.3°C). The higher rainfall in 2019–2020 may have reduced average temperatures in December 2019 (27.5°C) and January 2020 (25.6°C) comparing to the same months of the previous seasonal year (30.3°C in Dec 2018 and 27.4°C in Jan 2019). In January 2019, the total rainfall was 61.7 mm while in January 2020, it reached 156.4 mm.

The monitoring of artificial waterholes is a key activity as such waterholes are the only surface water source

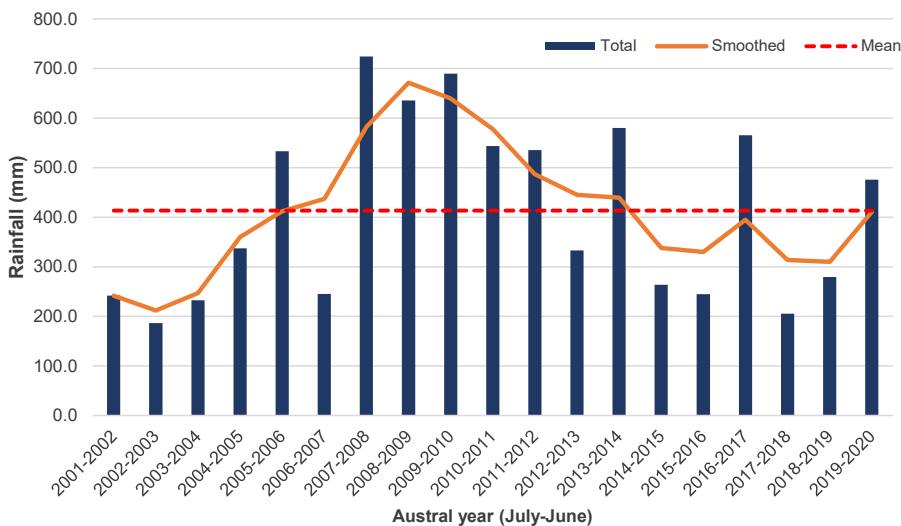


Figure 1.1. Annual rainfall recorded at the LEC research station (histogram). To highlight the trend within variable rainfall data these were smoothed (line) using a three-point weighted interpolation where annual rainfall (R) is the product of the current year’s rainfall (R0) as well as the previous and following year’s values (R-1 and R+1 respectively) ($R = 0.25 \times R-1 + 0.5 \times R0 + 0.25 \times R+1$).

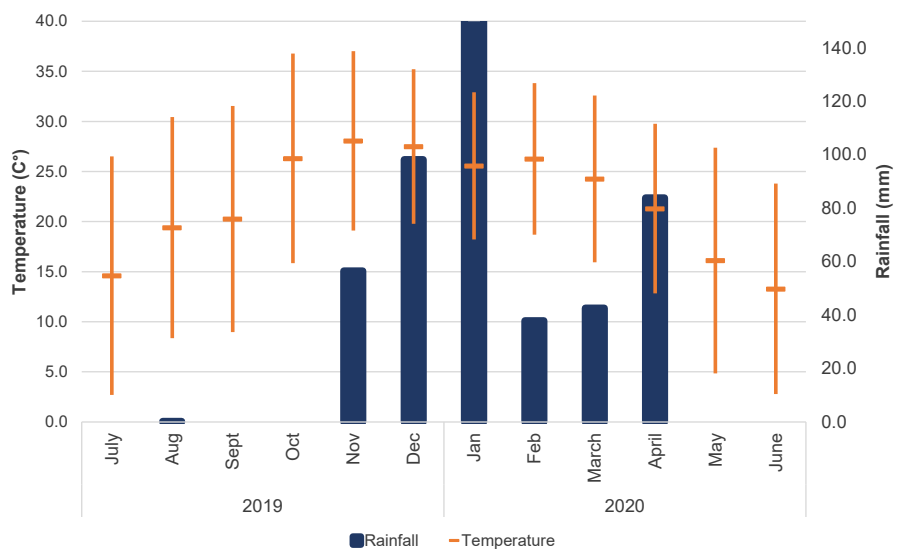
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The Central Kalahari region is a dynamic but poorly understood system, where key resources are limited and widely dispersed. This area provides a particularly interesting opportunity to explore predator population biology at the edge of their density range in a dynamic ecosystem.

during the dry season in Khutse GR. It is crucial to record any changes in the artificial waterholes as they may heavily affect the movement patterns of large carnivores and their potential prey especially in the dry season. Molose waterhole pump was damaged by elephants in November 2019 and was only repaired on the 1st July 2020. Moreswe waterhole was not pumping from May 2020 until the 15th June 2020 and its pit was cleaned on the 27th June 2020. Sekaka waterhole stopped working between July and August 2020. Elephants have a major impact on the natural and artificial waterholes and the vegetation in

the protected area. They are now present throughout the year in Khutse GR. Compared to 2019, the recorded observations are more widely distributed in the study area, most probably because the Molose waterhole, the elephant core area in 2019, was not operational for several months. Only bulls have been observed and they are generally in groups of 4–7 individuals. In May and June 2020, herds of elephants were particularly active around Motailane pan. The greatest herd recorded in 2020 consisted in 26 individuals at Motailane pan on the 3rd May 2020.

Figure 1.2. Monthly temperature and rainfall as recorded at the LEC research camp, Khutse GR, for the 2019-2020 seasonal year. The average median daily temperature is shown as a point, with the average daily minimum and maximums as bars.



Project 2. Prey Availability

Prey populations are probably the most critical factor influencing the status of large carnivore populations. Therefore, LEC aims to continue improving its monitoring of the relative abundance and the demographics of key prey species (i.e. medium to large mammals and key birds) in Khutse GR.

In 2021–2022 austral seasonal year, LEC will implement an extensive prey and spoor count inside and outside Khutse GR. Such a survey has been completed in the study area every 4 years since 2000. In 2020, we reviewed the existing dataset and investigated a new analytical framework, the Formozov-Malyshev-Pereleshin (FMP) formula, to obtain improved population estimates from spoor counts. In the coming extensive survey, due to start

at the end of 2021, we will adapt the data collection protocol to allow different analyses without losing the comparability of the new data with the previous ones.

In late 2020, we also started testing another method to determine prey relative abundances, the large-scale camera trapping. While the primary driver for setting up a large-scale camera trap grid in Khutse is for estimating the leopard population, the benefits of camera traps, and the analysis methodology we are using, are that they are not species-specific and so we will also be able to derive data on prey abundances as well. For further information on this project, see Project in Focus.

Project 3. Predation

This year, we were limited to collecting predation data opportunistically, through lion resightings, visiting ad hoc GPS clusters of collared lions, and by responding to livestock predation reports. Unlike in 2019, there was no team, funded by the National Geographic grant, systematically checking potential kill site clusters and without any leopards collared, only very limited leopard predation data was collected. As such, conclusions on predation patterns cannot be derived, we only summarise the findings here (see Tables 3.1, 3.2).

While it is not possible to make statistically-based conclusions from the data, there are a few patterns that appear to be emerging from the data that warrant further investigation.

- Recorded predation inside the reserve indicates a preference for gemsbok and eland, as was observed in 2019. Although it is noted that the data collection method favours finding large prey species over small prey.
- Recorded predation events by lions outside the reserve peaked during the wet season, with no recorded events during the driest months of the

year (June – October).

- All predation events recorded outside the reserve were by male lions only.

Apart from a period of 13 days in January 2020 when Alice (LF060) was moving outside the reserve on the western, unfenced boundary, none of the collared female lions have been outside the reserve in 2020. Neither Alice, nor any of her GPS locations, were visited during the period she was outside the reserve, but it is likely there was a predation event during this time. However, it is noted that on this unfenced boundary there are wild prey ranging outside the reserve and therefore it cannot be assumed that during this time she preyed any livestock.

In comparison, three of the four male lions collared in 2020 repeatedly left the reserve and were confirmed to be preying on livestock.

In 2021, we plan to reintroduce systematic predation data collection as well as trial new techniques for studying predation behaviour.

Table 3.1. Predations by lions inside the reserve

Species	Adult Male	Adult Female	Subadult	Juvenile	TOTAL
Aardvark (<i>Orycteropus afer</i>)	1	1			2
Blue wildebeest (<i>Connochaetes taurinus</i>)	1	1	2		4
Cattle* (<i>Bos taurus</i>)	1				1
Donkey* (<i>Equus asinus</i>)	2		1		3
Eland (<i>Taurotragus oryx</i>)	8	6	8		22
Gemsbok (<i>Oryx gazella</i>)	9	14	6	1	30
Giraffe (<i>Giraffa camelopardalis</i>)	1	2	1	3	7
Horse (<i>Equus ferus</i>)	3	4	2		9
Kudu (<i>Tragelaphus scriptus</i>)	2	1			3
Ostrich (<i>Struthio camelus</i>)	4				4
Porcupine (<i>Hystrix africaeaustralis</i>)			1		1

* There are some cases of livestock predation inside the reserve, either of animals that are resident from villages inside the reserve, or animals resident outside but that have ranged inside the reserve.



Table 3.2. Livestock predation by lions outside the reserve.

Species	Adult Male	Adult Female	Adult unknown	Sub-adult	Juvenile	TOTAL
Cattle (<i>Bos taurus</i>)	2	9		15		26
Horse (<i>Equus ferus</i>)	3	3			1	7
Zebra (<i>Equus quagga</i>)**	1					1
Donkey (<i>Equus asinus</i>)	5		1		1	7

** This was a zebra being farmed alongside livestock. There are no wild, free-roaming zebra within the study area.

Project 4. Predator Movement and Habitat Selection

Although predation is one of the principal drivers of predator behaviour, habitat components also play an important role. As such, the primary aim of this project is to investigate the habitat selection patterns of leopards and lions, through the monitoring of movement patterns of collared individuals. This includes both resident animals and those translocated into the study area.

Resident individuals

Lions

In recent years, LEC has made great progress in describing the movements and habitat selection of resident lions in the study area. The existing extensive lion movement dataset, produced over the last 20 years, has recently been analysed by Genevieve Finerty for her PhD thesis “Connecting the dots: Ecology, Movement & Conservation of Lions Across the Kalahari-Okavango Landscape”. The outputs of this study will be shared in 2021. In addition, LEC started a collaboration with MSc Student, Shani Baumgartner, supervised by Genevieve, who will be further analysing the movements and habitat selection of lions in Khutse GR. Combined, these projects will provide great insight into the behaviour of lions in our study area.

Unfortunately, due to repeated collar failures and the loss of some key study individuals, it has been difficult for us to maintain the movement database to the same high standard. Concerted efforts will be made in 2021 to re-establish coverage of all the priority individuals within the study area.

Leopards

For the leopards, the focus for the next few years is to collect a comparable amount of data, which, in the case of leopards, includes both inside and outside the protected areas.

Capturing and collaring a sufficient number of leopards for such a study is challenging in the Khutse environment. Despite concerted efforts in the past few years, further hampered by Covid-19 restrictions in 2020, we have not been able to collar any resident study animals. Collaring efforts will continue in 2021, with the introduction of some new techniques, including making use of call-up stations (calls played through a loud-speaker designed to attract any leopards that are in audio range) and the Remote Darting Device, developed by the Workshop of the Physics Institute at the University of Zurich in collaboration with LEC. It is hoped that these two techniques, used in combination, may improve our success rate in targeting this particularly elusive species. In the meantime, it is hoped that our other survey techniques, in particular the camera trapping project (see the Project in Focus), will provide an alternative method for gathering data on leopards in the study area.

Translocated individuals

Lions

In May 2020, the Department of Wildlife and National Parks translocated four lions, an adult female, two subadult females and a subadult male, from a cattle post around Dutlwe, just south of Khutse, into the reserve. They were released on the upper cutline inside CKGR just west of Gope Road. Unfortunately, there was no veterinarian available and so collaring was not possible and as such we have not been able to monitor their movements. This group of lions were not seen again, however, tracks suggest they may have walked back to the south of Khutse GR, possibly returning to the area they were captured.

Leopards

In 2020, the DWNP also translocated a total of four adult leopards, considered problem animals, into

our study area. Unfortunately, due to the absence of veterinarians in three of these cases, collars were not able to be deployed on those individuals and as such, no movement data could be collected. However, on the 20th November, a 70 kg male leopard (subsequently named Lucky by the LEC tracking team) was translocated from Otse farmland, in the south of Botswana. This time the leopard was collared. We are now monitoring his post-release movements across

the study area (see Figure 4.1).

In 2020, we initiated a collaboration with MSc student, Vera Alessandrello, who will be analysing LEC's movement data of translocated leopards over the past 20 years. We hope this will provide some insight into the behaviour of leopards translocated into the study area.

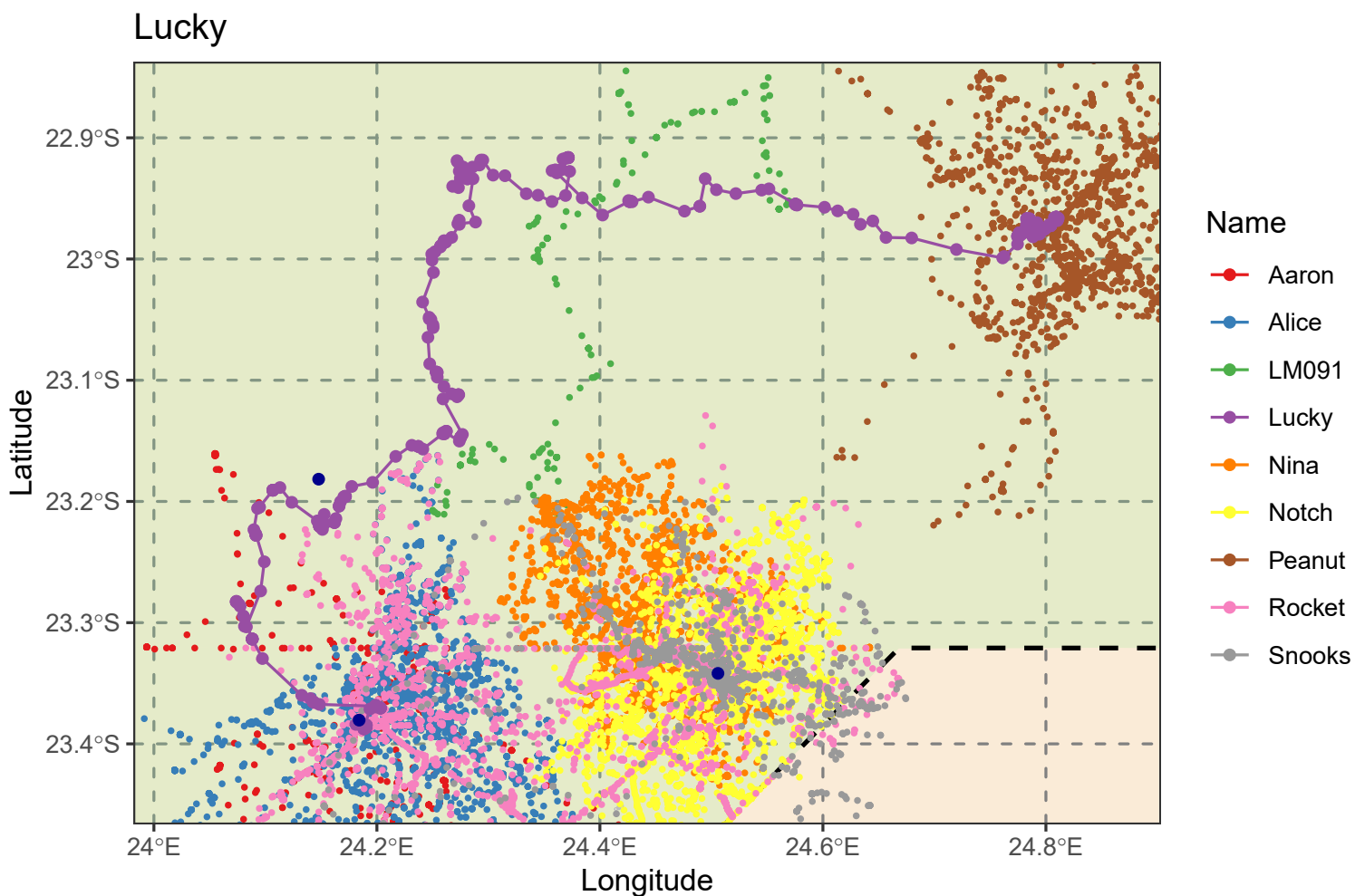
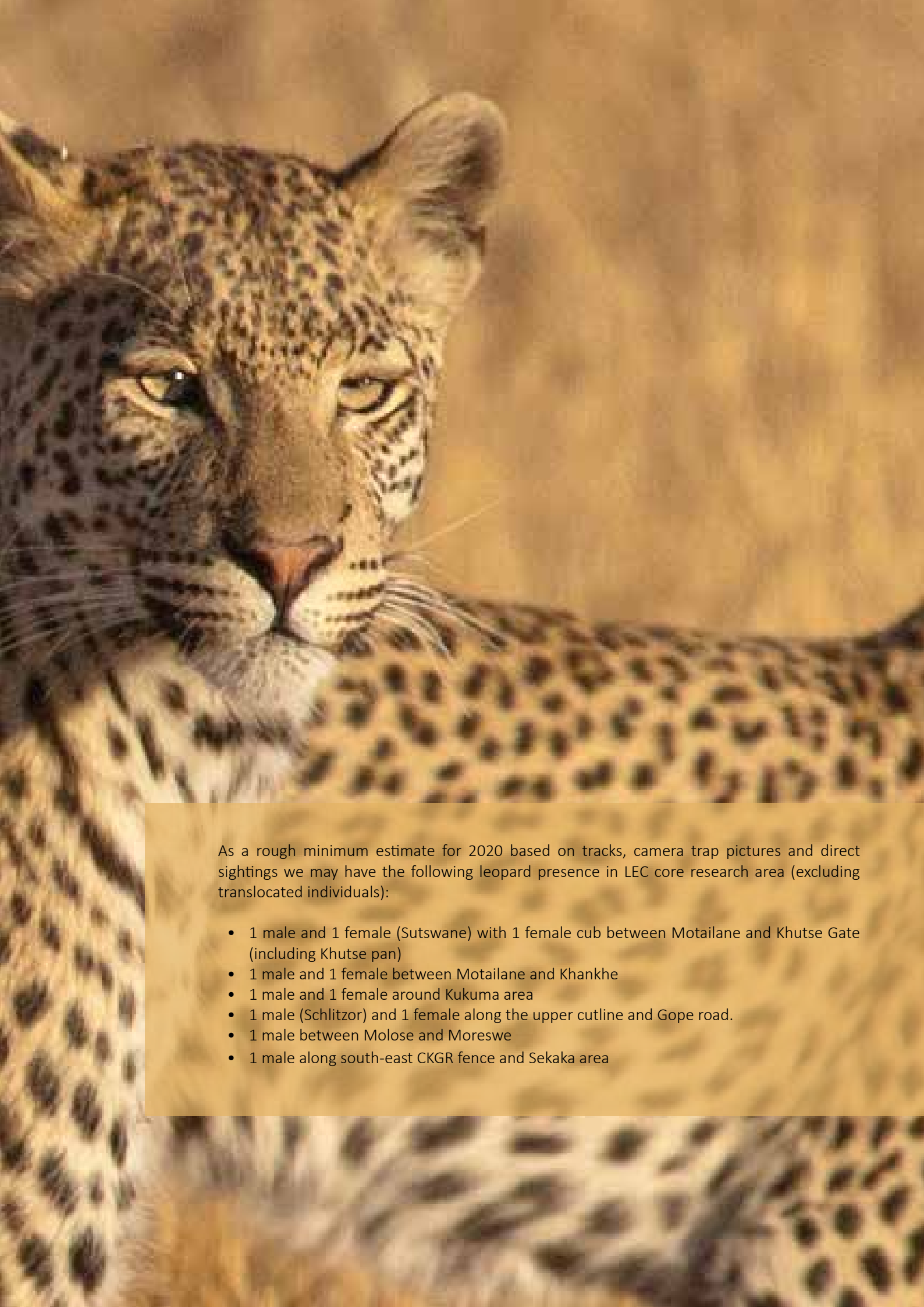


Figure 4.1. Map showing the post-release movements of Lucky (purple).

A close-up photograph of a leopard's fur, showing the characteristic rosette pattern of dark spots on a lighter background. The fur is the central focus, with a blurred background of dry grass and a warm, golden light. A semi-transparent text box is overlaid on the upper left portion of the image.

Project 5. Predator Demographics - Leopards

The cryptic nature of leopards, the low densities in our study area and the lack of any collared resident leopard demanded a new systematic approach to understand where and how the research efforts to study leopards should be focused.



As a rough minimum estimate for 2020 based on tracks, camera trap pictures and direct sightings we may have the following leopard presence in LEC core research area (excluding translocated individuals):

- 1 male and 1 female (Sutswane) with 1 female cub between Motailane and Khutse Gate (including Khutse pan)
- 1 male and 1 female between Motailane and Khankhe
- 1 male and 1 female around Kukuma area
- 1 male (Schlitzor) and 1 female along the upper cutline and Gope road.
- 1 male between Molose and Moreswe
- 1 male along south-east CKGR fence and Sekaka area

At the beginning of 2020, a system of monitoring routes (see Fig. 5.1) was created to detect the presence of leopards across the study area reducing the possible bias due to the preferential use of certain roads during LEC research activities.

Each route was driven at least twice per month to detect any tracks or signs of leopard activity in the area. The system was carried on successfully until the beginning of March when the first lockdown reduced substantially our capacity. Route 8, on the inner side of the fence, was accessible only for 40% of its length and Route 5 was often disturbed by cattle tracks and no leopard tracks were recorded on it. Nevertheless, the system was partially resumed later in 2020 and we managed to obtain a clearer idea of where, along the existing roads, leopards were most active. The data presented in the heatmap shows all opportunistic observations made when traversing the roads of the park. The lighter coloured areas represent where most signs were detected. The road between the entry gate and the Khutse GR–CKGR cutline is certainly the most used during research activities and that might be the reason of the higher presence of signs detected around Khutse pan and Tsilwane pan. Nevertheless, the relatively lower number of observations along the road between the gate and Khutse pan supports the idea that the above mentioned pans are quite important areas for leopard movements. In addition, Gope road, Kukuma waterhole and Khankhe pans seem to be areas of interest for leopards.

As mentioned in Project 4 above, in 2020 DWNP translocated four adult leopards to Khutse GR:

- 1 young adult female from Kanye farmland was released without collar on the KGR–CKGR cutline (10 km West from Tsilwane pan).
- 1 adult female from Tuli block (Dovedale Game Ranch) was released without a collar on the KGR–CKGR cutline between Gope road and the fence (5 km from the fence).
- 1 adult male from Mangadieie cattle post (inside LEC study area) was released without a collar at Molose waterhole. Information gathered from herders at Mangadieie suggests that he came back to the area where he was trapped.
- 1 adult male, PM032 Lucky, from Otse farmland was released with a collar at Molose waterhole. Lucky is a large male (70 kg) who was predated cattle in Otse. Since his release into Khutse GR, he has been moving extensively across the protected area entering CKGR and moving East towards Sekaka waterhole. During direct observations, he was very shy but in good condition. He has been observed feeding on porcupines on at least 3 occasions.

The camera trap pilot study should provide further insight on leopard activity patterns, especially away from roads (see Project in Focus). If the pilot is successful, the camera grid will be extended to a larger portion of the study area, including sections with limited road cover, and could provide a better understanding of the population demographics through precise identification of the individuals.

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Once widely distributed across Asia and Africa, the leopard, *Panthera pardus*, is now confined to only 25 – 37% of its historic range, with populations becoming increasingly isolated

JACOBSON et al., 2016

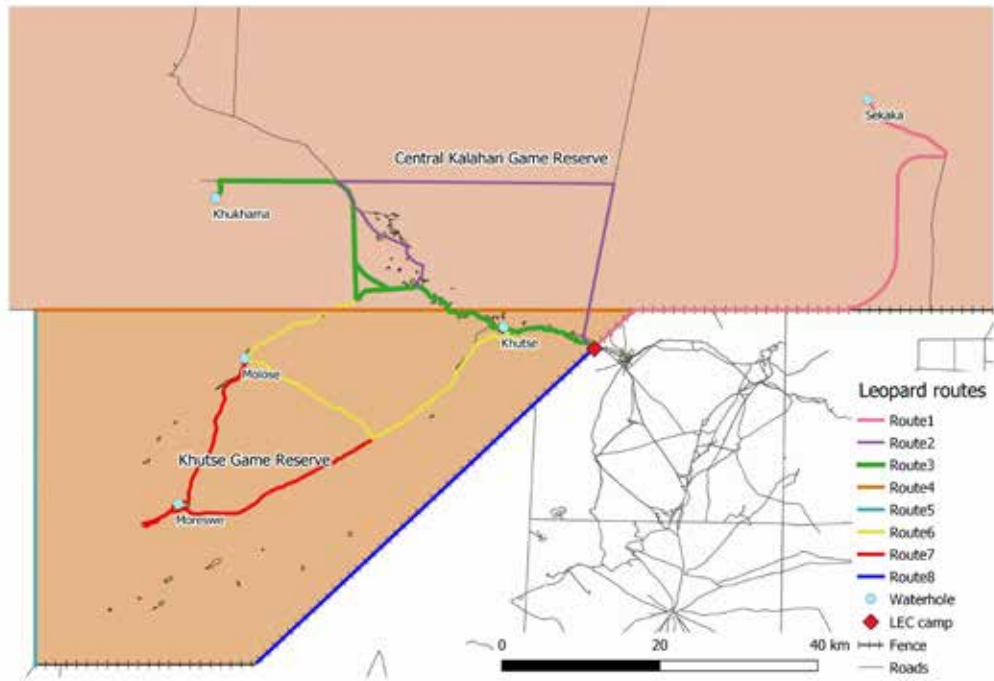


Figure 5.1. Map of Monitoring Routes used to plan sampling effort along the existing roads in the study area.

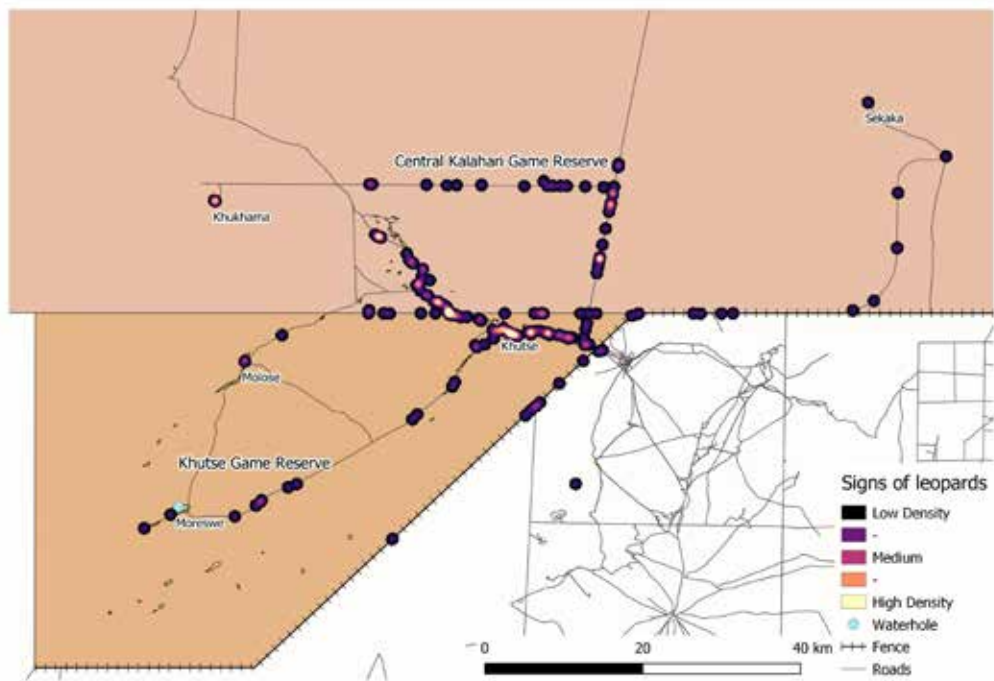


Figure 5.2. Heatmap of all signs of presence of leopards along roads detected in 2020. The signs considered in the map include tracks, direct sightings, scats and predations. The data from Lucky, the translocated collared male leopard are not included.

Project 5. Predator Demographics - Lions

This year for the lions, we focused on ensuring that our resighting protocols were enabling us to collect the right data needed to determine the population structure, pride size and structure, and demographic rates of the population. Being able to accurately track these parameters, this allows us to understand how the population is functioning and can provide an early warning system for changes in the status. In order to do this, we need to be able to see a wide range of individuals from the population repeatedly over the course of the year. One way that we do this is by collaring key individuals from the population.



Lion collaring 2020

To achieve a good coverage of lions from the Khutse population, we aim to collar at least one female in each pride group, one male from each coalition, and one individual from each dispersing group. As lions are social animals, by visiting collared individuals we are also able to see the members of the group they associate with. Collaring individuals from different life stages allows us to observe different aspects of lion biology. The females allow us to track the permanent residents in the park, the males tell us who has tenure with the females, and for how long, while the dispersing groups provide information on where and what routes our individuals take when they leave their natal prides. Unfortunately, due to repeated collar failures and Covid-19 restrictions limiting our activities we have not yet achieved full coverage of all groups, but we hope to achieve this in early 2021.

As not all individuals in a group are together all the time, we need to visit collared individuals regularly to gather information about the group as a whole. To do this effectively, in 2020 we redesigned our resighting protocols to ensure we are attempting to resight each group a minimum of twice per month, and that during the resighting we collect as much relevant data as possible on the group demographics. For example, any evidence of reproduction



is recorded, as well as injuries and illnesses that may then explain the disappearance of an individual from the group. In addition, we aim to get high-quality photos for all lions sighted so that they can be identified and recorded in the data accordingly. We also worked to make the data collection process as simple and user friendly as possible.

As well as improving the usability of new data coming in, we have been processing the historic data and identifying individuals from the photos going back through the years. Photo tagging software is being utilized to build a database of all the lion photos and the corresponding resighting data is being updated with the confirmed lion identities. While an enormous task, this is critical for us to build up an understanding of the group dynamics, trace movements of individuals within and between groups, and understand male tenures and litter survival rates.

Once complete, we plan to produce a document describing the histories of all lion groups observed in our study area since the start of the research. This will be of great value to anyone trying to interpret the lion data we have collected in Khutse.

Meet the class of 2020

East Khutse Pride

The East Khutse Pride is made up of five related females, four of which are sisters from the same litter, and their cubs. They have been the resident pride in the eastern part of Khutse since around 2012, although they were born into the Molose Pride in ~2007 (Verity) and 2010 (Notch, Nina, Peggy & Sarah), and dispersed east when they were subadults and left their natal pride. Two of the females had collars in 2020, Nina and Notch.

While considered one group, the five lionesses often separate and different combinations of individuals are seen together. In 2020, Nina was the most disparate out of the group, spending more of her time in the northern part of their range than the others. Behaviour probably driven by the presence of her three male cubs that require increasingly large quantities of food and will likely be viewed as competition for resources by the rest of the pride. The coalition of Snooks and Rocket were in tenure over the East Khutse Pride for the whole of 2020 and it is assumed they are the fathers of all the cubs in this group.



Aaron and Moses

Aaron and Moses are a coalition of young males, around 4 years in age, that to date we have not determined the origins of. However, we suspect they are brothers, and it is possible that they were born within the Khutse GR. As up until April 2020 they were being well tolerated by the East Khutse Pride and the coalition of Snooks and Rocket, suggesting it was possible that they were known lions. Aaron was collared in 2019, and while they ranged widely, they were mostly resident in the southern section of the Reserve around Moreswe. They were also frequently noted to be outside the Reserve and were suspected of a number of livestock predation events.

One morning in April 2020 the pair left their normal range and made a beeline for the East Khutse Pride. There were no witnesses to the events that followed, but GPS movement data, and subsequent sightings of Aaron, tell us that there were at least two encounters between Aaron and Snooks. The first encounter left Aaron seriously wounded and unable to move far, however after a few days he appeared to be recovering, only for the second encounter to leave him mortally wounded. He died the following day. Moses has not been seen since. While there was some evidence of him moving in the area of the injured Aaron in the days following the first encounter with Snooks, there have been no signs of him since and his fate is unknown. He may also have been killed, or it is possible that, weakened by the loss of his coalition partner, he left the area to find a safer range.

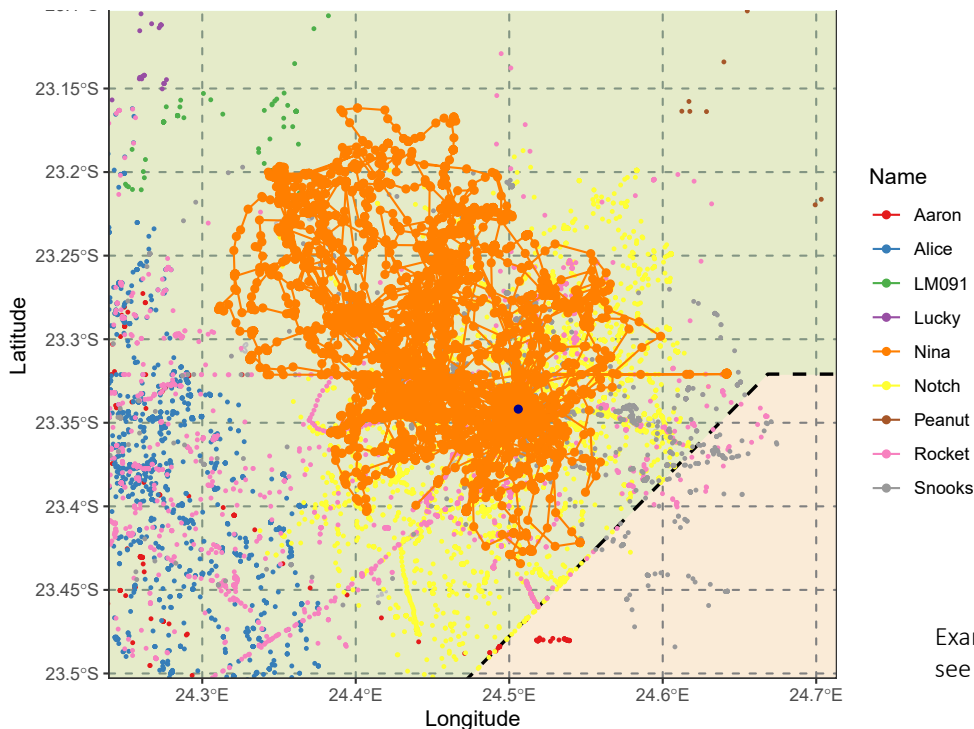


Molose Pride

Once the largest group in Khutse GR, the group was studied intensively until 2016. Around this time, a number of younger cohorts dispersed (including previously collared individuals Inca and Inuit) and the pride male at the time (Mexico) left. In early 2017, the primary collared lion Maipelo was found dead. Maipelo formed part of the core group that had continuously occupied this neighbourhood since Sandra Ramsauer collared lions in 2003. With the loss of her collar, we lost track of many of the older individuals that formed the original Molose Pride.

However, one pair of females from this group that we have been able to track since they were cubs are Alice and Alexa. These are two sisters from a litter of four born to Maipelo in 2014. There were no confirmed sightings of them in 2017, following the death of their mother. However, in 2018 they were seen on a few occasions, twice with collared lion Inca and her cohort of LF041 and LF047, and twice with the male coalition of Snooks and Rocket. Alice was then collared in July 2019 and has been followed ever since. Alice and Alexa have a tight bond and are rarely seen apart. They continue to regularly associate with the male coalition of Rocket and Snooks, but have not been seen with any other females since the time of first collaring. Alice's collar data shows us that she spends most of her time in the area around Molose Pan, the same territory that her mother held before her.

In 2020, between the two sisters we recorded three litters of cubs. The litter born in March was lost, but we suspect, from information provided by the trackers, that the litters from September (Alexa's; 3 cubs) and October (Alice's; 4 cubs) are still alive. Sadly, these females have become shy and so prolonged sightings are challenging, and it is not always possible to track the status of their cubs or even determine whose cubs are whose. Rocket, and occasionally Snooks, have been seen regularly with the Molose Pride, and mating events were witnessed, leading us to believe that this coalition of males are also the fathers of the cubs in this group.



Example for a home range map; see annex for maps of individuals.

Kukuma Dispersal Group

Periodically we have been observing tracks and signs (incl camera trap images) of a group of lions in the area of Kukuma (Gugamma). Finally, at the end of 2020, we got a visual of lions in this area and were able to dart and collar one young male, LM091. The group that was present at the darting was made of two young males and a young female, all believed to be around 3–4 years in age and most likely related. Their group composition and age indicate that this is a group of subadults dispersing from their natal pride. Within the next year the female will likely separate from her male relatives to seek out her own territory and a chance to breed with unrelated males. While we still have only limited movement data from the new collar, their behaviour since collaring is also indicative of a dispersing group; ranging long distances, often in loops returning to a central location. It could be interpreted that this behaviour allows them to scout potential new territories, whilst returning to a familiar place in between.

Collaring this group will provide important information on the dispersal behaviour of subadults within our study area. It also provides an exciting opportunity for us to observe the process of home range formation and settlement. Ideally, we would like to also collar the female to observe if and when the trio split and then how their movements differ. As yet we have not been able to verify the origins of these subadults. From reviewing historic photos, we have eliminated the East Khutse Pride as being their natal pride. However, at around the time these lions would have been born we had lost track of the different sub-groups from the Molose Pride, and so it is possible they originated from one of these. Kukuma is right on the fringe of the range of the Molose Pride, so this is possible. It is also possible they came from a group not part of our current study area. For example past study animal Jane occupied a range in a similar area and left behind several older subadult lions when she died.



Snooks and Rocket

Snooks and Rocket are the prime males for Khutse GR. Although we do not know the origins of the pair, it is believed they are brothers born around 2013. They were first seen in 2018 around the Molose area, associating with the females Alice and Alexa. But since then, they have also been seen with Princess Fiona, Inca's Group (Inca, LF041 and LF047), and since 2019 with the East Khutse Group (Nina, Notch, Peggy, Sarah and Verity). They have become the dominant males for all the known groups of females within the Khutse GR. Snooks has been collared since 2018 however, his most recent collar stopped working prematurely in April of 2020. It was planned to recollar him, however, an opportunity arose to collar Rocket instead in May 2020, and as such Snooks' collar was not replaced.

The unexpected opportunity to collar Rocket has ended up proving extremely fruitful. Prior to the collaring of Rocket, we were not aware of how much time he spent away from Snooks and away from the East Khutse Pride. It seems that, compared to Snooks who now spends the majority of his time in the east, Rocket roams far more widely and splits his time more equally between the East Khutse and Molose Groups. We also knew Snooks regularly left the Reserve and preyed on livestock in the areas just outside the fence. Since collaring Rocket, we have found he also displays this behaviour. In April 2020, a pair of younger males, Aaron and Moses, ventured deep into the territory of the East Khutse Pride. While this pair had previously been tolerated by both the females and Snooks and Rocket, on this occasion they were not. We did not witness the encounter; however, we can interpret from the GPS collar data of Aaron and Snooks at the time, and subsequent sightings of Aaron, that there were at least two altercations that ultimately resulted in the death of Aaron. As far as we are aware, the dominance of Snooks and Rocket has not been challenged by any other males during the course of this year.



Peanut

Peanut was first collared in 2018 as an incoming dispersing male of unknown origin. The aim of his collaring was to observe whether he passed through the area, or whether he was able to establish a territory somewhere within the study area. By 2020 it was apparent that Peanut had established a territory in the north east of the study area between Sekaka waterhole and Gope Road. Sightings of him have been fairly infrequent because of limited accessibility to his range. However, he was observed on several occasions with a group of females which he is presumed to hold tenure over.

Unfortunately, Peanut's collar stopped working in May 2020 and he has not been seen since. The decision was made not to recollar Peanut as the purpose of his collaring was to observe his dispersal behaviour and he has now settled in a territory with a pride of females. Furthermore, this group appears to have very limited interaction with our core study groups and so are not a high priority for movement data from collars or demographic data from resightings. As such, we are focusing our resources on the groups and individuals within our core study area.



Other Lion Sightings in 2020

LF041 and LF047

In 2020 we had two sightings of females LF041 and LF047. These sisters are related to Alice and Alexa, also born into the original Molose Pride approximately 6 months earlier than Alice and Alexa, towards the end of 2013. All four of these lions were regularly seen together as cubs when the Molose Pride was still intact. LF041 and LF047 dispersed from the main Molose Pride around 2016, together with another female, Inca, who was also born into the Molose Pride in the same year (2013). Inca was collared in late 2017 and so this group was then closely followed. The group was seen with Alice and Alexa twice in 2018, as well as being seen regularly with the male coalition of Snooks and Rocket. Sadly, Inca was found dead in January 2019 and we lost track of the group. So, we are really excited to have 'rediscovered' LF041 and LF047. Their current range seems to overlap with Alice and Alexa's but so far, we have not established if they have any contact. However, on both occasions that these females have been seen this year they were mating with Rocket. Snooks was also present on the second occasion, so this association has continued. We hope to locate these females in 2021 and collar one of them so that we can understand how they currently fit in the landscape and continue observations of females that were being tracked since birth.

LM093

At the time of collaring LM091, from the Kukama Dispersal Group, there was another young male seen in the area. We do not know who he is, and he has not been seen with the group of three since.

Princess Fiona

Sadly, there were no confirmed sightings of former long-term study animal, Princess Fiona, in 2020. This was after her collared failed again at the end of 2019.

Unknown lions

There were only a handful of sightings of unknown lions in 2020, these were mostly centred around Moreswe and along the road between Moreswe and Khutse 1 Pan. It is possible some of these sightings were of Princess Fiona and her 2018 cubs. It is also possible that these groups are from the Molose group. We have lost contact with it. We plan to focus on collaring lions in this area in order to better understand the population dynamics in this part of the Reserve. In May 2020, the DWNP translocated four lions, an adult female, two subadult females and a subadult male, from a cattle post around Dutlwe into the Reserve. They were released on the upper cutline inside CKGR just west of Gope Road. Unfortunately, there was no vet available and so collaring was not possible, making proper ID photos unattainable. As such, it is not certain if these are known lions to our study group or not. This group of lions were not seen again, however, tracks suggest they may have walked back to the south of Khutse GR, possibly returning to the area they were captured.

Project 6. Human-Predator Conflict

The restrictions that Covid-19 imposed on us this year meant that our opportunities to monitor the human-predator conflict were limited.

However, in the final quarter of 2020 the Community & Education and Research teams worked together with Leejiah Dorward, a Postdoctoral Researcher at the University of Bangor, on designing a questionnaire to survey cattle posts located along the southern boundary of Khutse and CKGR. The survey will be used to develop an up-to-date baseline on the perceived extent, impact and trends in livestock predation in our study area. We will also be asking

about what livestock management techniques are used to reduce livestock predation and questions to determine attitudes towards different predators.

As we will be surveying cattle posts that we have worked intensively with for many years on livestock predation mitigation measures as well as cattle posts where we have had no direct interventions, we hope to evaluate the impact our mitigation projects have had. The survey will also help us prioritise our Education activities.

The survey is planned for the first quarter of 2021.

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Within much of their remaining range the long-term sustainability of wild carnivore populations are threatened by human activities. Expanding human populations, coupled with habitat fragmentation, has led to an increase in conflict between predators and humans, due to shared resource requirements and the consumption of livestock. Even when protected areas exist, due to their extensive home ranges, large carnivores will naturally move into surrounding areas, which can result in conflict with livestock farmers, and ultimately retaliatory killings.

VARIOUS SCIENTISTS

Woodroffe & Frank, 2005; Schiess-Meier et al., 2007; Bauer, De longh & Sogbohossou, 2010

Collaborations and Students

Although opportunities to host visitors in camp have been inherently reduced this year, we still managed to maintain a healthy collaborative relationship with a number of external students and partners during 2020.

This year has seen a renewed drive from the conservation focussed Botswana Carnivore Forum (BCF), and LEC is proud to have contributed to country-wide efforts to model leopard distribution across the country. Preliminary analyses have already been completed and will continue to be refined and expanded to other species over the coming months. A mammoth effort to collate varied data sources from across the country, gathered at the first BCF meeting in 2016, has also been completed by BCF this year. Led by Leanne Van der Weyde, the paper, featuring two LEC co-authors, presents an approach to collaborative conservation to model species occupancy using sparse data. The paper is currently under review in the journal *Diversity and Distributions*.

As part of our ongoing relationship, we hosted Walter Zucchini in camp at the start of the year, where he provided statistical expertise to support a number of local projects, including stationary tests of collar accuracy and Keitumetse Ngaka's report on the visitation of GPS clusters. As ever, we are grateful for the time Walter dedicates to the project and the opportunity to benefit from his considerable experience.

2020 also saw the completion of the fieldwork element of LEC's collaboration with Lion Research

Center, University of Minnesota, USA, into the hunting behaviour of lions in Khutse. We are excited to see what outputs come from the analysis of this data over the coming year. Successful collaboration breeds further collaboration, and this relationship has produced sparks that have grown into two more long-term collaborative projects: a collaborative research grant between LEC's Genevieve Finerty and Dr Natalia Borrego, and the Snapshot Serengeti project. Elements of these exciting projects have been featured in our Project in Focus.

In related news, Genevieve completed her PhD thesis "Connecting the dots: Ecology, Movement & Conservation of Lions Across the Kalahari-Kavango Landscape" this year, and is preparing for her viva in early 2021. We look forward to seeing, and sharing with you, the publications resulting from the thesis as they come out over the coming year. From June 2021, Genevieve's academic home will be moving to the Department of the Ecology of Animal Societies, University of Konstanz / Max Planck Institute of Animal Behaviour, although she will be maintaining strong links with her current institution, the Wildlife & Conservation Research Unit, University of Oxford.

Shani Baumgartner continues to progress successfully with her Masters project at the University of Zurich, co-supervised by Professor Arpat Ozgul and Genevieve Finerty. Shani has completed the coursework element of her studies and is now focussed on developing her Masters thesis. We are all impressed by the focus and motivation Shani has demonstrated over this challenging year and are confident she will produce a top-level thesis.

PROJECT IN FOCUS: COMBINING TRADITION WITH INNOVATION



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We have been learning new skills with the cameras, with setting up the cameras, taking the directions, setting everything, we have been getting familiar with doing this. We understand the reason for putting so many cameras out in one area, because it's like we are spotting that area to see what is using that area.

POGISO “AFRICA” ITHUTENG, Field Assistant and Lead Tracker

“

I'm excited to see great quality footprint images coming from the excellent LEC field research team. Initial analyses suggest that we're going to get some great results for both sex and individual ID.

SKY ALIBHAI, Founder of WildTrack.



Embracing and promoting traditional skills and knowledge has always been at the heart of LEC's research work. Carnivore populations exist at extremely low populations in our study area and, with a limited road network, many standard survey methodologies are unable to provide accurate results. Without the expertise of the San trackers, we would be seriously limited in what we could achieve in terms of data collection. However, that does not mean we ignore technological advances or new scientific methodologies. In fact, we find they often work in conjunction with our traditional methods, being complementary rather than contradictory.

In 2020, we started two new collaborations testing state of the art technology that can be used alongside our traditional tracking methods to help provide the data necessary to achieve one of our key research objectives: to establish population estimates for leopards and lions across our study area.

Camera Trapping

While the use of camera traps is not new to LEC, we have never used them to try to estimate leopard population numbers before. This has now been made possible through a collaboration with Snapshot Safari, a project of the University of Minnesota Lion Center (www.lioncenter.umn.edu/snapshot-safari/).

Camera trapping survey design and analytical approaches have become more advanced in recent years, with large-scale camera grids now becoming a mainstream tool for monitoring wildlife populations. The Snapshot Safari project has refined this methodology at sites across Southern and Eastern Africa and have internationally recognised expertise in the process.

A characteristic of camera trapping is that it is a non-species specific, data intensive methodology. As such, it requires many hours spent pouring through image after image to pull out the species you are looking for. However, Safari Snapshot has developed a tool to speed up this process. They use a citizen science platform, called Zooniverse (www.zooniverse.org), that engages members of the public to identify and tag the species for you, in combination with sophisticated algorithms that are able to classify certain types of images. The amount of time this approach saves to researchers in the field is immeasurable. The added benefit of this process is that we will, in fact, get data on a much wider range of species, not just leopards, for no additional effort on our part.

The first step has been designing and carrying out a pilot study aimed to test the feasibility of camera trap surveys in the LEC study area. The results of this pilot should then allow us to adapt the survey design to best suit the constraints of the study area, and to

precisely budget for the running costs of the related fieldwork going forward.

For this pilot, we used a total of 96 camera traps covering an area of 480 km² between Khutse GR and Central Kalahari GR. The whole research team has been trained and involved in the setup and controls of the camera traps. Camera trap placement was determined by combining the two components; the scientifically determined grid design, and the expertise of the trackers on animal behaviour. A randomly-generated virtual grid was superimposed on a map of the pilot study area. Each cell covers 5 km² and, for data analysis purposes, the camera must be placed within a 250 m radius of the centre of each cell. Once each 250 m radius target area was identified on the ground, the Trackers then used their skills to select the precise spot with the highest chance of capturing images of predators.

A preliminary screening of the images that we have captured so far has shown that large carnivores are more readily detected along roads. Cryptic species, such as aardwolf and armadillo, are also being regularly captured by the camera traps. From a technical point of view the camera trap model chosen has been reliable and can withstand the harsh Kalahari conditions. Furthermore, the quality of the pictures is good enough to identify individual leopards from their spot patterns. This is an important component to being able to interrogate the population structure, which has not previously been possible when only using tracking surveys.

We now wait for the results of the analysis to determine to which extent this methodology is suitable for estimating population size in our study area and which solutions can be envisaged to optimize our results.

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The trackers like the WildTrack, yesterday when we were discussing it, they indicate the point that in the future this will help a lot as we will know an individual by its track. They understand that it is a tool, it does not replace the Trackers as they are needed to use the tool, the tool doesn't work on its own, we tell it what to do.

POGISO “AFRICA” ITHUTENG, Field Assistant and Lead Tracker

WildTrack Footprint Identification Technology

The second important collaboration that developed during 2020, is an innovative new project involving WildTrack, LEC, and the Max Planck Institute of Animal Behavior, Konstanz. The project aims to apply WildTrack's award-winning and patented Footprint Identification Technology (FIT) to the study of leopards and lions in our study area. This project has great potential to expand the capability of individual-level animal research and wildlife management tools both in our home at Khutse and other field sites across Africa.

WildTrack (www.wildtrack.org) was founded by Zoë Jewell and Sky Alibhai. Their FIT uses simple digital images of footprints, captured on smart phones, and state of the art statistical techniques to identify species, individual, sex and age-class of the animals that made them. Inspired by a close working relationship and awe for the ancient art and science of expert indigenous trackers in Africa, the development of FIT was motivated by the desire to find a cost-effective and non-invasive approach to wildlife monitoring. To date, WildTrack have developed FIT algorithms for 15 endangered species ranging from rhino to dormouse. We will enjoy to be working with them on the development of FIT algorithms for African leopards and lions and survey methods for low density areas.

The first stage in the project has been to build a reference library of footprints from known animals in Khutse. The field team has been working hard on this over 2020, learning where to find the best prints for photographs, and how to best capture them on camera. Good quality footprints are a critical element

in the successful development of the FIT, something our experienced tracking team have excelled in.

While our team in Khutse have been busy collecting the prints we need to establish the feasibility of FIT in our study area, LEC member Genevieve Finerty and collaborator Dr Natalia Borrego secured a collaborative research grant from the Max Planck Institute of Animal Behavior, Germany, to support the development of custom analytics. This has allowed WildTrack to start extracting geometric profiles of the photos from the field, and begin to test out their clustering technique, which will allow known individuals to be identified from their tracks.

The next steps in the project will be to forge ahead with the creation of a library of known prints for the leopards and lions resident in LEC's study area, and validation of the preliminary FIT algorithms for the species. We will be working on this over 2021 by matching prints to animals via observation, GPS collar data and images from our new camera trapping project. Once we have this, it will open up possibilities to combine the FIT with our long-term spoor and prey counts, as well as investigating individual behaviour from the interpretation of tracks, coming full circle to the core of LEC at its start, but with a new spin on the approach. So far, the results are promising, and we are looking forward to see what comes from the next stage of the project.

Conclusion

It is often the case in science that one method alone will not give you all the answers you need. We are excited that we are finding ways to combine multiple methodologies, using both traditional skills and new techniques to answer important research questions, and doing so in the most resource-efficient and minimally invasive way possible.

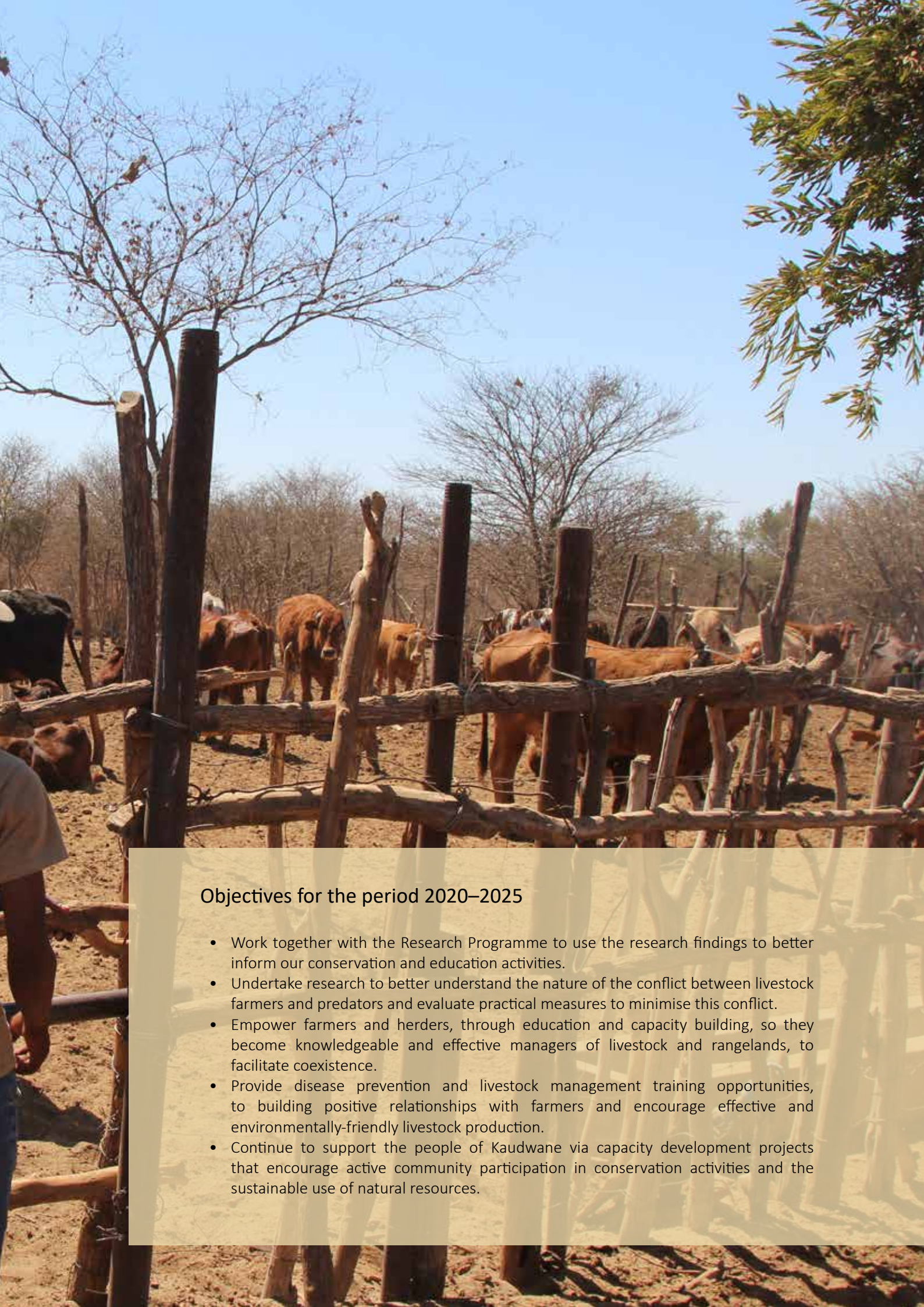


COMMUNITY & EDUCATION PROGRAMME

With the Community & Education Programme (C&E), LEC endeavours to support the community in developing a system that allows them to coexist with wildlife and live sustainably. Central to this are two key areas of work: fostering an interest and passion for wildlife and conservation and minimising the conflict between farmers and predators. One aspect of our work that LEC highly appreciates of is the level of trust and collaboration we have cultivated between LEC and the local farmers in what is a challenging environment.

As we have learned over the past 20 years, by integrating research and education we are better able to effectively reduce or mitigate human-wildlife conflict in our study area. And by working hand-in-hand with the community, we are able to facilitate an effective and open interaction with the people living alongside the predators we are trying to conserve.





Objectives for the period 2020–2025

- Work together with the Research Programme to use the research findings to better inform our conservation and education activities.
- Undertake research to better understand the nature of the conflict between livestock farmers and predators and evaluate practical measures to minimise this conflict.
- Empower farmers and herders, through education and capacity building, so they become knowledgeable and effective managers of livestock and rangelands, to facilitate coexistence.
- Provide disease prevention and livestock management training opportunities, to building positive relationships with farmers and encourage effective and environmentally-friendly livestock production.
- Continue to support the people of Kaudwane via capacity development projects that encourage active community participation in conservation activities and the sustainable use of natural resources.

The Community & Education Programme work is organised in three areas

A - Research

The collection of data on livestock predation and human-carnivore conflict as well as on livestock management and conflict mitigation practices being utilised by farmers in our study area.

Aim: To understand the level and impact (real or perceived) of human-carnivore conflict in the study area. To evaluate the effectiveness of conflict mitigation strategies.

B - Education & Capacity Building

The provision of training and development opportunities to the community, especially with farmers and herders. These largely focus around livestock and rangeland management, but also animal welfare and disease prevention beyond livestock. Some activities are focused on reaching a small select audience, for example livestock owners, other reach huge audiences for example our annual Conservation Horse Race.

Aim: To empower the local community to be guardians of their land and livestock in a way that supports effective and sustainable natural resource management. To increase the awareness of effective livestock and rangeland management practices as well as to raise interest and awareness of conservation issues.

C - Community Support & Development

The support of community-led projects that are conservation-focused and provide sustainable development opportunities in the community.

Aim: To inspire conservation action and the sustainable use of natural resources, while at the same time providing opportunities to individuals to develop skills and/or knowledge.



Progress in 2020

The pandemic situation had a major impact on the ability to progress work towards these aims in 2020. A lot of the work requires the gathering of groups of people, or the reliance on external trainers or advisors to visit camp. These sorts of activities were just not possible in 2020 and so either had to be cancelled, delayed or modified.

A - Research

Apart from a few weeks of strict lockdown, the team was able to continue visiting the seven cattle posts we work with in the study area. This involves weekly visits where we collect livestock predation and disease data, monitor implemented projects and consult with farmers on non-lethal predator management strategies. This year the team visiting the cattle posts also played a really important role in disseminating up-to-date information and guidelines about the Covid-19 pandemic and making sure that remote herders were being seen by the community social service team as required.

Over the course of the year the team conducted 104 cattle post visits and collected data on 57 predation reports. Camera traps were set up outside the park in all the 7 cattle posts as trial. They are left for a week at a time in each of the cattle post. You can find

some more insights in Project 6. Apart from using this information to increase our understanding of the extent and impact of human-predator conflict, we also played a role in sharing this information with the DWNP Problem Animal Control Unit, which assesses livestock predation events in order to allocate compensation to impacted farmers.

In addition to our weekly data collection at the seven cattle posts, this year we wanted to undertake a wider survey of livestock owners and herders extending along the boundary of the park. The aim of this is to get a baseline understanding of the scale and extent of human-wildlife conflict across a wider area and how that compares to the cattle posts that we have been working intensively with for many years.

You can read more about this survey under Project 3.

B - Education & Capacity Building

LEC has a number of long-running education projects, some that involve targeted workshops and training sessions with farmers and some that focus more on raising awareness with larger audiences in the community and with the school. Many of these activities could not go ahead this year, however a couple were adapted to allow us to keep some connection with our audiences.

Towards the end of the year, we were able to run two farmers workshops on hoof-trimming. This activity trains farmers in proper hoof care of their livestock, a simple but effective strategy for reducing the risk of predation, as animals with overgrown hooves are less able to evade capture by predators. Normally workshops are held in a central location with a large number of participants, but to reduce the risk of spreading Covid-19 the team adapted and ran two

smaller workshops at the cattle posts, inviting only one or two farmers from each cattle post, so that the groups could be managed in accordance with the Government guidelines. In total 20 farmers were trained. The feedback was extremely positive with many farmers requesting further training opportunities. Plans are being developed for different training workshops to be delivered in 2021.

Following the hoof-trimming training, LEC distributed three sets of hoof-trimming tools into the community, such that farmers have ready access to the tools they require to put what they have learnt into practice. The set that has been made available centrally in the village of Kaudwane, which we keep records for, was hired 22 times between September and December. Farmers have given feedback that they are really grateful for the access to the tools.

Normally, each year LEC takes a group of school children from the local village school on a trip to the capital Gaborone for one week. The aim of the educational tour is to expose the children to experiences outside of their day-to-day frame of reference and expand their minds about the different opportunities there can be in the field of conservation and wildlife management. This year a trip to Gaborone was not possible, so instead the selected children were invited to go on a day trip into the Khutse GR with LEC’s Head Tracker and Field Assistant Africa Ithuteng and Education Liaison Officer Keolebetse Otukile. The children were introduced to the DWNP

and taken on a tour around the park, being taught about the history of the park and teaching them tracks of different animals, different habitats and the traditional uses of plants in the park.

After the trip they were invited back to the LEC camp where they enjoyed a cooked meal followed by some movies. The movie the children liked the most was a documentary about lions. The children had a wonderful day and it was a chance for our local staff to teach the children what their jobs are with LEC. The activity was so successful we now plan to incorporate it into our normal workplan from 2021.

C - Community Support & Development

A collaboration project for vaccinating and sterilizing dogs in the community with the organization Maun Animal Welfare Society could not go ahead this year due to the Covid-19 regulations. However, LEC instead supported the local Government Veterinary Department to complete their national Rabies vaccination scheme, by providing transportation around the local area to ensure all dogs were reached.

The Kaudwane Community Conservation Club (CCC), that LEC formed and supports, was restricted by what they could plan this year. Normally they host big events to commemorate important dates in the calendar, however these could not go ahead. Together

we test models for a solar cooker that works in our area. The CCC have been instrumental in us getting our Community Organic Garden off the ground. This is a horticulture project aimed at providing the space, resources and training to the community for growing vegetables in a sustainable way. Very few people in the local area grow vegetables and with the nearest shops selling fresh produce being more than 100 km away, LEC identified there to be a real need to improve the accessibility of fresh vegetables to support community welfare. Next year training opportunities will be provided to the CCC members, who then in turn will pass on this knowledge to the local community. The garden will eventually operate by having one section for ongoing training and development, while the remainder will be available for individuals to utilize, much like an allotment system. By having an allotment system, individuals benefit from ready access to communal water, compost and shade, as well as on-hand expertise to help problem solve and advise on growing timings and techniques.

In 2020 the focus has been on developing the plot. LEC staff and the CCC members put in more than 80 hours of volunteer work preparing the soil, constructing the shade netting and building the water tower. Just before Christmas the first seeds were planted; spinach, carrots, beetroot, chili pepper, rapeseed and tomatoes. We are now eagerly waiting to see the fruits of these labours in early 2021.





INTERVIEW: ALFRED MOSWEU

WELCOME TO THE TEAM

One highlight of 2020 was welcoming Alfred Mosweu to the team. After months of Covid-induced delays in the recruitment process, we were finally able to make the appointment and Alfred arrived in Khutse in September. We asked Alfred about his experiences with LEC so far and what he is looking forward to in 2021.



Name: Alfred Mosweu

Job Title: Community & Education Programme Officer

Started with LEC: September 2020

Tell us a little bit about yourself and what drew you to joining the LEC team?

I am a qualified teacher, I also acquired training in Human Resource Management and experience in project management. I have 8 years of teaching experience both in the government and private schools – abroad and locally, and 5 years experience in project management. I am a dynamic individual with passion for working with and for the community. What the job entails and the milestones reached by LEC is what motivated me to apply.

What was your first impression when you arrived at the Khutse Field Camp?

When I first arrived in the camp, the place looked deserted and dusty, I asked myself if I have really made a good decision by wanting to relocating here, mind you I have never lived in a tented accommodation, let alone in the bush! Speedy-Dusty, the dog, met me with her normal hyperactive mood, jumping on me and licking my elbows as if to welcome me. Fast forward to present day, I'm content with camp life and, apart from a few episodes of missing my family, I have adapted and am surviving thanks to the whole team.

What are your main roles and responsibilities as the Community & Education Programme Officer and what would a typical day look like?

My main role is to organize and implement C&E projects. This entails scheduling events and activities and day to day liaison with relevant stakeholders and partners. My days are normally different; a typical day would include a combination of activities such as report writing, stakeholder meetings in the village, cattle post visits or doing some work at the community garden.

What do you think are the most important objectives of the Community & Education Programme and how best can we achieve them?

Promoting conservation and sustainability of natural resources and improving the lives of the community through empowerment.



What do you think are the main challenges for the Community & Education Programme?

The main challenge is a lack of commitment and discouraging attitude displayed by some of the people we work with in the community and stakeholders. This has a potential to cause delays and worse, failure of our projects. Other challenges include limited access to resources such as mobile telecommunications, internet in the community and presently, the distraction caused by COVID-19.

In what ways do you feel you have contributed most since joining the team?

I feel I motivated the team members and empowered them in order to tap into their potential. I also introduced tools that we collectively designed that could make our work easier and make the flow of information easier. For example, we designed a SWOT analysis for the community garden, scheduling our work using an action plan updated online in google sheets as well a C&E team calendar for important dates and activities. Everyone has been willing to learn and contribute.

What new things have you learnt since starting at LEC?

There are a number of things I have learnt since starting with LEC, for example the collection of data on human-

behavior, feeding and hunting patterns and seasons, prey preferences can all be used by the C&E team to come up with interventions that can help farmers learn about mitigation strategies to reduce predation.

In 2020, LEC started systematically using camera traps for conducting research inside the park. Camera traps are also used by the Community & Education Programme aren't they? Can you explain a little bit about how and why they are used?

The C&E team has been piloting the use of camera traps in some cattle posts where farmers/herders have reported signs of predators near their homesteads and kraals. Before setting the cameras up, we normally hold a small discussion with the farmers/herders on the use and purpose of setting one up. To my understanding, camera traps are fixed to a solid structure/object and made to face the direction of where animals are anticipated to pass. When an animal passes in front of the camera within a certain range, it triggers the camera to snap some shots. The camera traps can be used to capture still images 24/7 without interruptions as long as the batteries are charged up. We use this information to then get a better understanding of what predators are at the cattle post, and enable the Problem Animal Control team at the government make informed decisions about any action



Collaborating with stakeholders, assisting the communities through empowering programs and seeing people's lives change for the better. Working with and impacting the communities is close to my heart in many ways.

ALFRED MOSWEU, Community & Education Programme Officer

wildlife conflict and mitigation strategies and the writing of funding proposals. I have also been helping to preparing a social science survey to investigate the extent and impact of livestock predation in the area surrounding the park. I am also starting to learn more about research on predators and conservation. All these things were quite new to me when I started but I am enjoying gaining new knowledge and skills.

LEC aims to use quality scientific research to inform our work, in what ways does research contribute to the Community & Education Programme?

I think the information collected by the research team can be helpful in C&E's aims to mitigate human wildlife conflict. Information on things such as predator

taken. So far, the cameras have been well received by the farmers, they can see there is great value in using them. So, this is an initiative we may be able to expand in 2021.

If there is one thing you hope to achieve by the end of 2021 what would it be?

In my first year on this position, I would be grateful if we can ensure timely completion of the C&E projects. This would be self-fulfilling to me! I would also love to have an opportunity to acquire more knowledge about the work that the research team does and once in a while take part in some of their tasks/activities, e.g; collaring, tracking, spoor identification as this will be valuable in my ability to make informed decisions about how to progress the C&E projects.

APPENDIX I

Table Leopard Telemetry. Animals monitored by LEC during 2020

ID	name	first collared	date removed	notes
PM032	Lucky	26 February 2018	on animal	

Table Lion Telemetry. Animals monitored by LEC during 2020.

ID	name	first collared	date removed	notes
LF018	Notch	6 June 2013	on animal	sat communication not working from 23/12/2020
LF027	Nina	18 April 2019	on animal	sat communication not working from 11/01/2021
LF028	Peggy	12 February 2021	on animal	
LF060	Alice	24 July 2019	on animal	sat communication working randomly
LM073	Snooks	8 February 2018	12 August 2020	sat communication not working from 11/01/2021
LM074	Peanut	8 February 2018	on animal	sat communication not working from 11/01/2021
LM084	Aaron	5 November 2019	20 March 2020	died after fight with Snooks
LM085	Rocket	20 May 2020	on animal	
LM091		10 December 2020	on animal	

Acknowledgements

The Government of Botswana, through the Ministry of Environment, Natural Resources Conservation and Tourism and the Department of Wildlife and National Parks, has for 20 years granted permission to Leopard Ecology & Conservation to undertake research and conservation projects. We appreciate the ongoing support received from all levels of these departments.

We also sincerely thank our sponsors for their commitment to the conservation of leopards and lions in the Kalahari. We wish to express our appreciation to the members of the African Cats & Conservation Foundation, the Leopard Ecology &

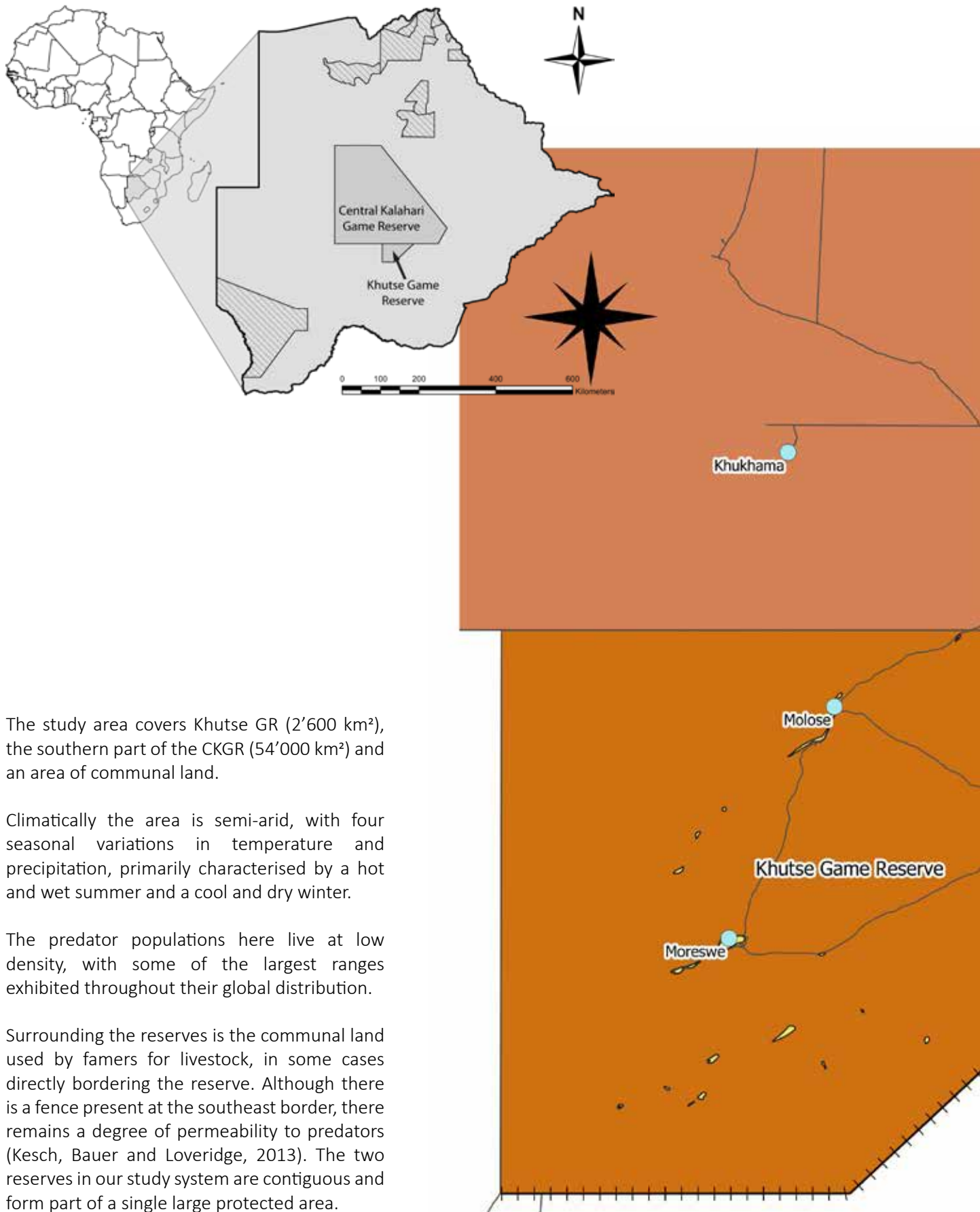
Conservation Trust, the Khutse Leopard Trust and the Act Now for Tomorrow Steering Committee for their ongoing support and guidance. We also value the support provided by the Institute of Evolutionary Biology and Environmental Studies of the University of Zurich.

Finally, our success is a direct result of the dedication shown by all members of the Leopard Ecology & Conservation team, both in Botswana and Switzerland, as well as the numerous individuals associated with this project.

A person wearing a light-colored hoodie is seen from the back, looking through a telescope. The background is a clear blue sky with some light clouds. The telescope is mounted on a tripod-like structure.

ACACF	African Cats & Conservation Foundation
ANFT	Act Now for Tomorrow
BCF	Botswana Carnivore Forum
CCC	Kaudwane Community Conservation Club
C&E	Community & Education
CKGR	Central Kalahari Game Reserve
CREEM	Centre for Research into Ecological and Environmental Modelling
DWNP	Department of Wildlife and National Parks, Botswana
FIT	Footprint Identification Technology
GR	Game Reserve (as in Khutse GR)
LEC	Leopard Ecology & Conservation
NP	National Park
SWOT	Strengths-Weaknesses-Opportunities-Threats
UZH	University of Zurich

STUDY AREA

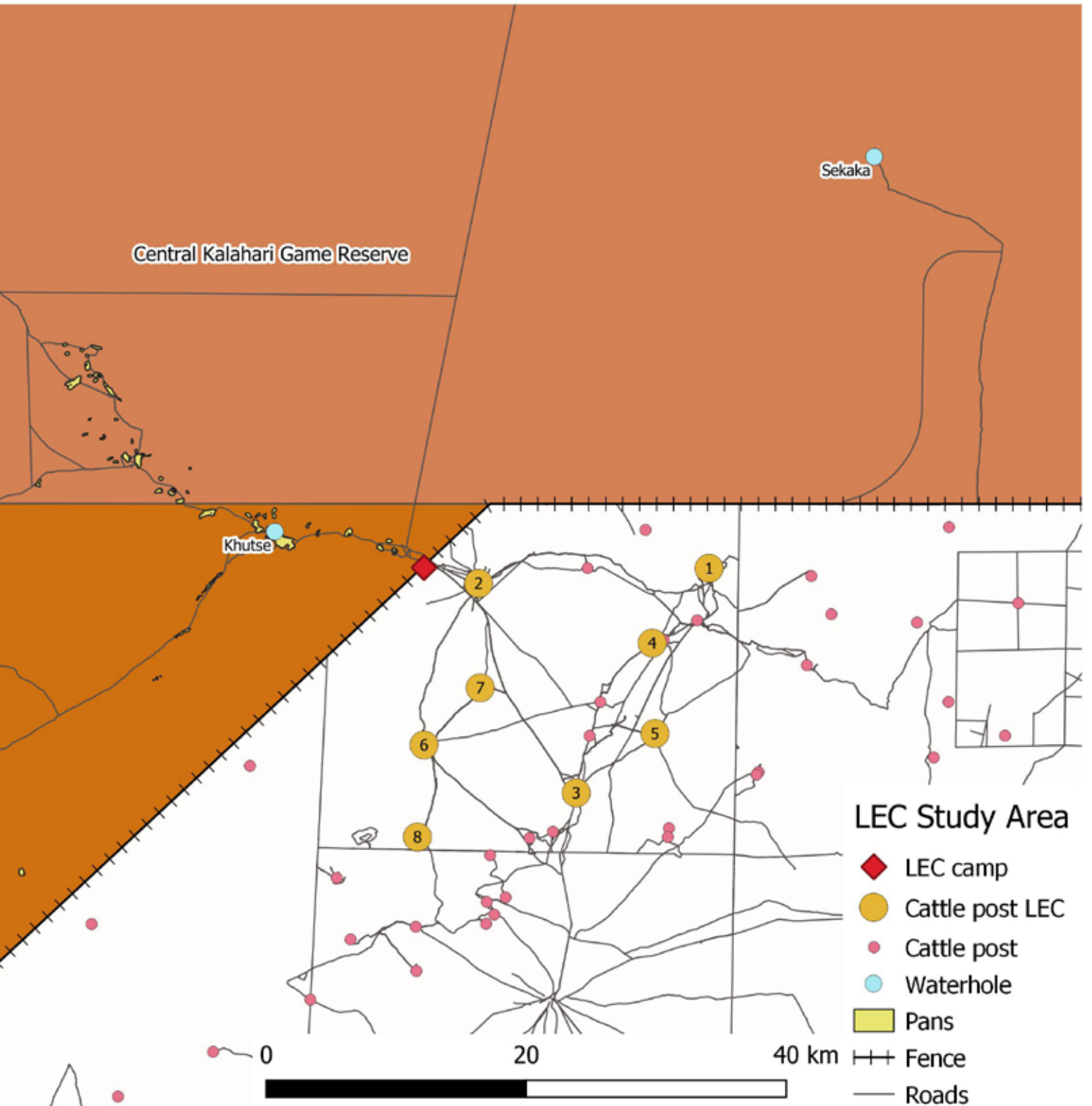


The study area covers Khutse GR (2'600 km²), the southern part of the CKGR (54'000 km²) and an area of communal land.

Climatically the area is semi-arid, with four seasonal variations in temperature and precipitation, primarily characterised by a hot and wet summer and a cool and dry winter.

The predator populations here live at low density, with some of the largest ranges exhibited throughout their global distribution.

Surrounding the reserves is the communal land used by famers for livestock, in some cases directly bordering the reserve. Although there is a fence present at the southeast border, there remains a degree of permeability to predators (Kesch, Bauer and Loveridge, 2013). The two reserves in our study system are contiguous and form part of a single large protected area.



APPENDIX II

The Leopard Ecology & Conservation Team

- Schiess-Meier Monika, MSc Zoology, founder and managing director, University of Zurich, Switzerland
- Araldi Alessandro, MSc Biology, field coordinator, Italy
- Finerty Genevieve, MSc Biology, head of research, UK
- Gabaatlholwe Laone, external office administration assistant, Botswana
- Gabaikanye Tebelelo, camp administration and field research assistant, Botswana
- Gabanapelo Tefo, external community & education advisor, Botswana
- Gabotshwanelwe Sebakeng, camp staff, Botswana
- Gagosimologe Tshoganetso Ernest, community conservation projects officer, Botswana
- Gaseitsiwe Babereki, external mechanic
- Dr Gusset Nicole, PhD, project management, UZH, Switzerland
- Haas Fabian, MSc, education programme and data management, fundraising, Switzerland
- Ithuteng Goitseone, housekeeping supervisor and administrator, Botswana
- Ithuteng Masente, camp maintenance and vehicles assistant, Botswana
- Ithuteng Pogiso, field research assistant, tracking team leader, Botswana
- Kegakilwe Ditshupo, housekeeping, Botswana
- Kegakilwe Phana Segametsi, BAcc, administration and accounts manager, Botswana
- Köpfler Marianne, administration, University of Zurich, Switzerland
- Majafe Kobe, camp maintenance supervisor, Botswana
- Mamou Mosepele, tacker, Botswana
- Miles Rosie, BSc, field coordinator, UK
- Dr Mills David, PhD, research consultant, South Africa
- Mokgwathi Kefilwe, BBA, education & community programme assistant, Botswana
- Monnaanoka Supula, tracker, Botswana
- Motsididi Komano, camp administrator and education & community assistant, Botswana
- Mosikare Neo, cook and housekeeper, Botswana
- Mosweu Kebaabetswe Alfred, BBA, education & community programme officer, Botswana
- Mpofu Ronald, garden maintenance Gaborone, Botswana
- Ngaka Keitumetse "KT", Research Assistant, Botswana
- Nkadima Phalatsa, senior tracker, Botswana
- Otukile Keolebetse, education & community liaison officer, Botswana

- Puridaroma Sokwa, tracker, Botswana
- Schiess Philipp, IT specialist, Zurich, Switzerland
- Senz Sylvia, lic. phil.I, public relations, Switzerland
- Speedy-Dusty, project dog, Botswana
- Tsito Tshepho, community & education programme officer, Botswana

The following people / institutions are involved

Research support and collaboration (leopard and lion behaviour, population genetics and health)

- Dr Borrego Natalia, Lion Research Center, University of Minnesota, USA
- Dr Leejiah Dorward, University of Bangor, UK
- Prof. Hofmann-Lehmann Regina, Clinical Laboratory, Vetsuisse Faculty, UZH, Switzerland
- Garbeli Jary, molecular genetic analysis, Institute of Evolutionary Biology and Environmental Studies, UZH, Switzerland
- Prof. König Barbara, Department of Evolutionary Biology and Environmental Studies, UZH, Switzerland
- Prof. Manser Marta, Department of Evolutionary Biology and Environmental Studies, UZH, Switzerland
- Dr Morris Gerrald, project veterinarian, Botswana
- Dr Neo-Mahapeleng Gosiamo, Wildlife Ecology lecturer, Botswana University of Agriculture and Natural Resources, Botswana
- Prof. Packer Craig, Lion Research Center, University of Minnesota, USA
- Prof. Weibel Robert, GIS, UZH, Switzerland
- WildCRU, University of Oxford, United Kingdom
- Prof. Zucchini Walter, Department of Economic Sciences, Georg August University Göttingen, Germany

Support in Botswana (permits, information and logistics)

- Minister of Environment, Natural Resources Conservation and Tourism
- Dr Kabelo Jacob Senyatso, Director, DWNP
- Dr Cyril Taolo, Deputy Director, DWNP
- Dr Michael Flyman, MENT
- Mrs Malebogo Somolekae, Head of Research, DWNP
- Mrs Oganeditse Dintwa, Park Manager, Khutse GR
- Dr Mmadi Reuben, Principal Veterinary officer, DWNP
- Dr Mmolotsi Dikolobe, Veterinary Officer, DWNP

- Special Support Group (SSG), Khutse Base Camp, Botswana
- Mrs Mercy Munyadzwe, Regional Wildlife Officer Molepolole, Botswana
- Department of Veterinary Services, Letlhakeng

Professional, logistical and material support

- Aebersold Digitaldruck, Jona, Switzerland
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- Fly Away Reiseerlebnisse GmbH, Germany
- Glättli Thomas, Switzerland
- Gilchrist Ruth, Switzerland
- Hilti, Switzerland
- Holzinger Rosmarie, MD, Zurich, Switzerland
- LC Lenz Caemmerer, Basel, Switzerland
- Maier Reto, Universität Zürich, Switzerland
- Nakano Michel, technical support, University of Zurich, Switzerland
- Schiess Fritz, Zürich, Switzerland
- Schmid Peter & Susanne, Oberwil, Switzerland
- Solar International and Solar West, Botswana
- Toyota Motor Centre, Gaborone, Botswana
- Vernier, Lydie Luxembourg
- Wagner Elicar, Kockelscheuer, Luxembourg
- Wehrli-Oehler Hannelore & Bernhard, Feldbach, Switzerland
- Vectronics Aerospace GmbH, Berlin, Germany
- WildTrack

Leopard Ecology & Conservation Trust

- Monika Schiess-Meier (Chair), Switzerland
- Fritz Schiess, Switzerland
- Dieter Gutmann, Germany
- Phana Segametsi Kegakilwe, Botswana

Khutse Leopard Trust

- Monika Schiess-Meier (Chair), Switzerland
- Doreen Khama, Botswana
- Tefo Gabanapelo, Botswana

People and Wildlife Trust (in process of registering)

- Tefo Gabanapelo, Botswana (chair)
- Dr Michael Flyman, Botswana
- Monika Schiess-Meier, Switzerland
- Fabian Haas, Switzerland

African Cats & Conservation Foundation Switzerland

- Eveline Bissegger (chair), Switzerland
- Catherine Oeri, Switzerland
- Philippe Jan, Switzerland
- Willi Schrepfer, Switzerland
- Dieter Gutmann, Germany
- Monika Schiess-Meier, Switzerland

Educational Project (ANFT) Steering Board

- Chief Scientific Officer (ruminants), Department of Animal Production, Botswana
- Chief Wildlife Officer, Community and Extension Services, Department of Wildlife and National Parks, Botswana
- Deputy Director, Department of Veterinary Services (disease control), Botswana
- Chief Forest Resources Officer, Department of Forestry and Range Resources, Botswana
- Kweneng Land Board Secretary, Botswana
- LEC, Education Programme Officer, Botswana
- Khutse Leopard Trust
- Farmer representatives (Pako Keokilwe and Boometswe Mokgothu), Botswana
- Edwin Dintle, former Land Registration Officer of Rolong Land Board (now with Botswana Housing Corporation), Botswana

Scientific Publications, Workshops & Media

- The status of the leopard in Botswana, BCF report 2020
- LEC hoof trimming training; cattle posts in LEC study area, Botswana, several days in July 2020
- “ANFT” Steering Committee meetings

Collaborating Institutions from Botswana in 2020

- Department of Wildlife and National Parks
- Community of Kaudwane
- Kaudwane Primary School
- University of Agriculture and Natural Resources (BUAN)
- University of Botswana, Botany Department
- Cheetah Conservation Botswana
- Kalahari Research and Conservation
- Botswana Carnivore Forum
- BirdLife Botswana
- Village Extension Team and Village Development Committee (Kaudwane)

- Kuanghoo Community Trust
- Letlhakeng Sub-District Council
- JICA, Botswana and Forestry Department

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- BGS-Architekten, Switzerland
- Familie Brühlhart, Switzerland
- BWT Bau AG, Winterthur, Switzerland
- Camera Store, Zurich, Switzerland
- Cécile Mode, Switzerland
- DeZeew Elisabeth, Switzerland
- Devilliers Lindy, Botswana
- Dynoptic AG, Switzerland
- Egger Sandra, Switzerland
- Eiselin Frances, Zürich, Switzerland
- Department of Evolutionary Biology and Environmental Studies, University of Zurich, Switzerland
- Fliedner Monika, Köniz, Switzerland
- Fraser Jill, Botswana
- Getika Foundation, Switzerland
- Hofmann-Lehmann Regina and Michael, Rapperswil, Switzerland
- Humbel Juliette und Tonio, Switzerland
- Interbit AG, Basel, Switzerland
- Jackson Lalage, Botswana
- Kupferschmied Basil, Basel, Switzerland
- Le Castella GMBH, Schuhe und Accessoires, Switzerland
- Libert Françoise, France
- Familie Lüthi, Switzerland
- Neder Thomas, Schweiz
- Soroptimist International Club Rapperswil, Switzerland
- Staudenmann Martin, Zürich, Switzerland
- Toygar Andrea, Switzerland
- Vernier Lydie, Luxembourg
- Vontobel Foundation, Switzerland
- Wagner Elicar, Luxembourg
- Wehrli-Oehler Hannelore und Bernhard, Feldbach, Switzerland
- Wicki Fredy, Cham, Switzerland
- Numerous private and anonymous sponsors

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LEC Anniversary

20
2000 – 2020



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Find more information on our project
www.leopard.ch

