

THE PRESENCE, DIET & RELATIVE ABUNDANCE OF OTTERS (CARNIVORA:  
MUSTELIDAE) IN NORTHERN NAMIBIA

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BY

YEHOLENDJESHILI LAINA N. ABIATAR

STUDENT NUMBER

201403705

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MAIN SUPERVISOR: DR. SETH J. EISEB, UNIVERSITY OF NAMIBIA.

CO-SUPERVISOR: MR. KENNETH HEINRICH UISEB, MINISTRY OF ENVIRONMENT,  
FORESTRY AND TOURISM.

## ABSTRACT

Four species of otters (Carnivora: Mustelidae) are known to occur in Africa: Eurasian otter *Lutra lutra*, spotted-necked otter *Hydriectis maculicollis*, African clawless otter *Aonyx capensis* and the Congo clawless otter *Aonyx congicus*. The African clawless and Spotted-necked otters are known to occur in Namibia although very little is known about their biology and distribution. IUCN Red List of Threatened Species indicated the status of African clawless and spotted-necked otters to be near threatened due to a reported decline in their numbers primarily due to habitat loss and destruction, mainly from unsustainable agricultural land expansion, human and otter conflict, invasive species, river pollution as well as widespread continent-wide decrease in river water quality. The collection and use of faecal samples and camera trapping have become an important non-invasive source of information, especially when dealing with elusive animals.

The specific objectives of this study were to determine the presence of otter species that occur in the Kunene and Okavango rivers, their diet as well as their relative abundance. Community sightings of otters were utilized, along with on sight observations (for example, sightings and signs) while collecting data in the field to determine the presence of otter species. Sightings of the African clawless and Spotted-necked otters, as well as signs (footprints) of the two species of otters were recorded as an indication that both species do occur in Namibia. In order to determine the diet of otters, spraints were collected along the banks of the two rivers, air dried, teased apart and prey remains identified by utilizing a stereomicroscope. Prey remnants were sorted into major categories and recorded. Prey items such as crabs, frogs, fish, plant material and insects were found in the otter spraints. Due to the small sample size of spraints collected, it could be possible that not all potential prey items were available for recording.

A total of 40 cameras were deployed along the banks of the Okavango River within the Bwabwata National Park, recording a total of 967 camera days. Due to extremely low detection of the Spotted

and African clawless otters (3 encounters), no density estimates were computed. Instead, a relative abundance index (RAI) of 0.3 of African clawless otter was calculated and compared to RAIs data obtained from six natural areas around Southern Africa. Results suggest that the Relative abundance index (RAI) of 0.3 for the Okavango River was the lowest compared to similar studies done elsewhere in southern Africa. A species accumulation curve for all mammals photo-captured in the study area was plotted which nearly reached an asymptote (with 21 captured species), suggesting that the inventory on species composition in this phase was more complete.

Conservation of the wetlands and restoration of water quality might be the most important steps towards ensuring the future of otters in Namibia. There is also a need for a more expansive study to be conducted on the taxonomy, distribution, diet, and population density of otters that occur in all northern perennial rivers of Namibia.

**Keywords:** African clawless otter, Camera Traps, Diet, Elusive animals, Faecal samples, Population Density, Relative abundance index (RAI), Spotted-necked otter, Species accumulation curve

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## **List of Abbreviations**

**MET:** Ministry of Environment and Tourism (now Ministry of Environment, Forestry and Tourism)

**NCE:** Namibian Chamber of Environment

**RAI:** Relative Abundance Index

**IUCN:** International Union for Conservation of Nature

**mtDNA:** Mitochondrial Deoxyribonucleic Acid

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## **DEDICATION**

I dedicate this work to my dear parents. I am truly grateful and blessed. I thank them for the love, support and words of encouragement they have given me during my studies. My siblings for playing their role right, I will always appreciate what they have done.

## Declaration

I, (Yeholendjeshili Laina Nakapushu Abiatar), hereby declare that the work contained in the thesis entitled “The species composition, diet and population density of otters (Carnivora: Mustelidae) that occurs in the northern rivers of Namibia.” is my own original work and that I have not previously in its entirety or in part submitted it at any university or higher education institution for the award of a degree.

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## CHAPTER ONE

### 1. INTRODUCTION

#### 1.1 Background of the study

Four species of otters are known to occur in Africa: Eurasian otter *Lutra lutra*, spotted-necked otter *Hydricteis maculicollis*, African clawless otter *Aonyx capensis* and the Congo clawless otter *Aonyx congicus* (Jacques et al., 2009). Otters occur in an array of environments and aquatic habitats, from freshwater lakes to the marine shorelines and surprisingly in episodic rivers in arid areas, provided that freshwater sources are fit for consumption and there is an availability of sufficient food. African otters are nocturnal, semi-aquatic predators whose prey consists primarily of aquatic species such as fish, frogs and crabs with some insects and other taxa (Nel & Somers, 2007). Otters prefer to select undisturbed areas with rock cover and dense natural vegetation. Knowledge of the distribution of African otters is attained from museum specimens, sightings (not always reliable where two or more species are sympatric) and on signs, e.g., distinctive tracks and spraints (faeces), or from diaries and expedition reports of earlier travellers (Nel & Somers, 2007). The African clawless and Spotted-necked otters are known to occur in Namibia although very little is known about their biology and distribution. The African clawless and Spotted-neck otters are reported to be declining across their range. The International Union for Conservation of Nature (IUCN) Red List indicates the status of African clawless and Spotted neck otters to be near threatened due to reported decline in their numbers primarily due to habitat loss and destruction, mainly from unsustainable agricultural land expansion, invasive species, pollution (Reed-Smith, Jacques, & Somers, 2015), as well as widespread continent-wide decrease in river water quality (Jacques, Reed-Smith, & Somers, 2015). Human activities along the northern rivers of Namibia (e.g., fishing, cutting of reeds, domestic use of water, possible water pollution), are also a cause for concern.

## **1.2 Statement of the problem**

IUCN has designated otters as a near-threatened species, adding them to the red list (Shin et al., 2020). Since otters are generally shy and elusive animals, in-depth study of these species in Namibia has not been done. There is therefore insufficient knowledge about the population density and distribution of otters in Namibia, which is necessary for conservation purposes.

## **1.3 Research objectives**

The objectives were to:

- a) Determine the presence of otters that occurs in the northern perennial rivers of Namibia.
- b) Determine the diet composition of otters that occurs in the northern perennial rivers of Namibia.
- c) Determine the relative abundance of otters occurring along the Okavango River in Namibia.

## **1.4 Significance of the study**

This study has generated information on the presence, diet and relative abundance of otters that occur in Namibia, for future studies and implementation of novel conservation actions therefore, creating a platform for future studies to be carried out and implementation of novel conservation actions.

## **1.5 Limitation of the study**

River otters are difficult to monitor because of their secretive nature and the fact that they naturally occur at relatively low densities on the landscape (Shin et al., 2020). It is also challenging to acquire sufficient information on the otter diet, as some prey items may not remain in the spraints after the digestive process has taken place. Fresh spraints were not obtained for DNA extraction in order to determine the **taxonomic status of otters** due to the inception of the rainy season, high river levels, as well as limited time to collect data. The presence of tall bushy vegetation and high-water levels

in the study area limited our chance of finding the otter spraints, and other signs of their presence. Due to time limitation, the study was not carried out along the Kwando-Linyanti-Chobe, and Zambezi rivers.

### **1.6 Delimitations of the study**

The study was conducted along the Kunene and Okavango rivers, in northern Namibia.

## CHAPTER TWO

### 2. LITERATURE REVIEW

#### 2.1 The species

Andarge, Wube, and Balakrishnan (2017), stated that otters belong to Order Carnivora, Family Mustelidae, sub-family Lutrinae and are characterized by long streamlined bodies, fine dense hair, and scent glands at the base of their tails.

The African clawless otter is the largest otter in Africa, Europe and Asia and the 3rd largest of all otters after the giant otter (*Pteronura brasiliensis*) and the sea otter (*Enhydra lutris*) (Larivière, 2001). Its body is massive, the tail is stout, and the fur is dense and shiny. The upper lips, sides of face, throat, belly and edge of ears are white. The otter has small, rounded eyes and ears. It has long, white whiskers on both sides of the upper jaws. Its front feet have long fingers with an opposable thumb, lacking in claws, except for digits 2, 3 and 4 of the hind feet, which are partially webbed (Larivière, 2001). Their hind feet are webbed to aid in swimming.

The Spotted-necked otter on the other hand is easy to recognise due to the unique white patches on its upper lips and/or neck. Not all individuals exhibit the same markings, as some show just a few lip markings or spots in their neck and others none at all. Unlike the African clawless and Congo clawless otters, the Spotted-necked otter is slender and has webbed paws. Its whiskers are reduced (Dunlap, 2008). The Spotted neck otter prefers to be in water rather than land compared to the other African otter species.



Figure 1. The African clawless otter. (Critter Science, n.d).



Figure 2. The Spotted neck otter. (Commons Wikimedia, 2011).

## 2.2 Distribution

There are 13 extant species of otters of which three are limited to Sub-Saharan. Only two species of otters are said to occur in Namibia (Figure 3), the African clawless and the Spotted-necked otters. The African clawless otter *A. capensis* occupies rivers and lakes, and all streams in which there is adequate water to support frogs, crabs, and catfish or mudfish, but is absent from the central rain forest area in the Congo basin, where the Congo clawless otter *A. congica* is present (Nel & Somer,

2007). Spotted-necked otters are found in central Africa's clear, fresh waters (Oregon zoo, n.d).

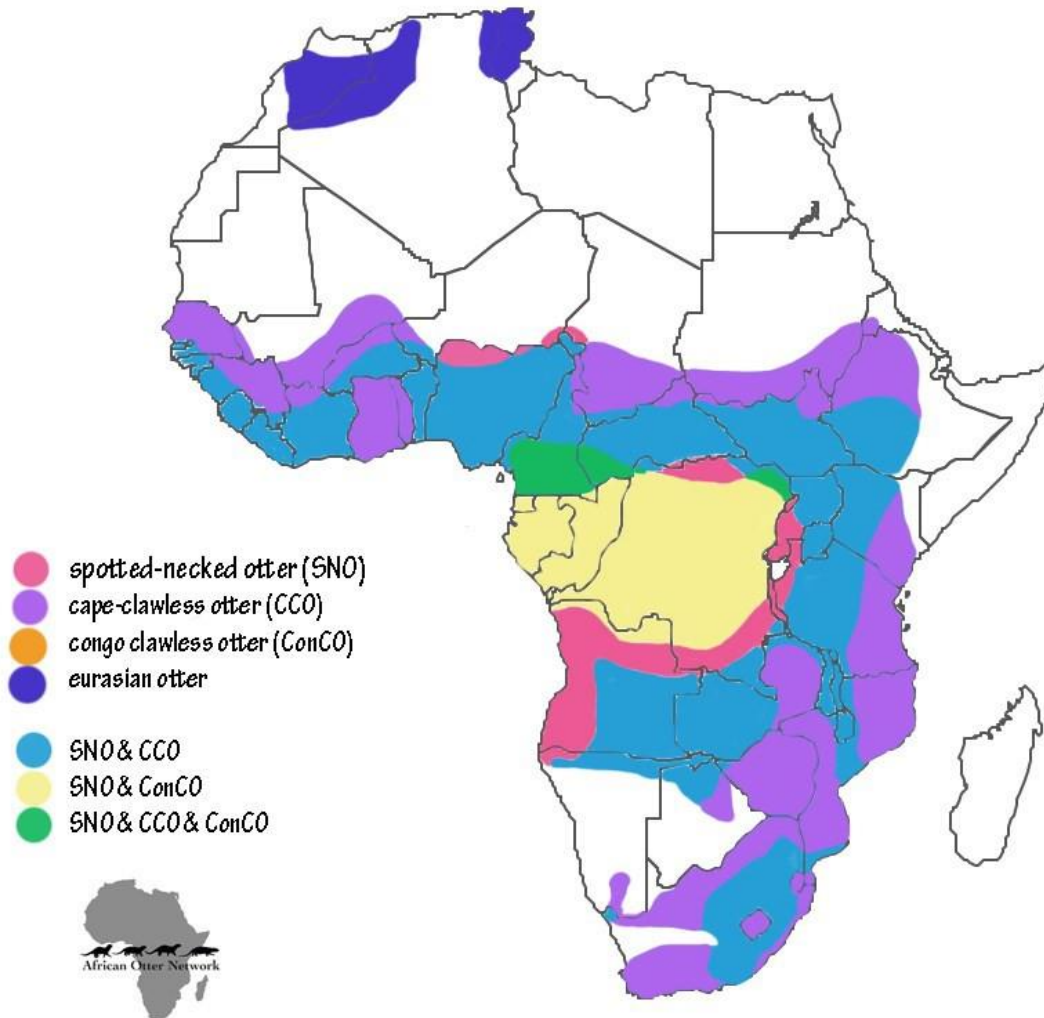


Figure 3. Combined distribution map of all African otter species. Adapted from African otter network (n.d).

### 2.3 Behaviour and Diet

Otters obtain most of their food from water, whereas reproduction and resting takes place on land. Otters deposit spraints, urine, and anal secretions at latrines, providing terrestrial ecosystems with highly concentrated patches of nutrients and increasing diversity of soils and plant communities (Chin & Black, 2020). Otters play a crucial role in controlling the order within the aquatic ecosystem and balance of the aquatic environment food chain (Shin et al, 2020). Rowe-Rowe (1977), states that in confinement, factors such as turbidity, water temperature, depth, substratum, and darkness do not greatly affect the ability of the otters to catch crabs and frogs in freshwater but do for fish.

The African clawless otter *A. capensis* is specialised in feeding on crabs and occasionally on frogs and fish (Larivière, 2001). The African clawless otter finds its food mostly by touch, especially in murky water. The forefeet of the *A. capensis* is dexterous, which is very useful in detecting prey by touch (Larivière, 2001). The African clawless otter is known to usually feed alone but may occur in groups of up to five (Somers & Nel, 2004).

The spotted-necked otter *H. maculicollis* is specialised in feeding on fish, and occasionally on frogs and crabs (Perrin & Carugati, 2000). The spotted-neck otter needs to see their prey when in water. It appears that *H. maculicollis* is more dependent on permanent clear water than is *A. capensis*, which makes it the dominant otter in most of the large lakes as well as in some floodplain systems (Rowe-Rowe, 1986). The Spotted-necked otter will also feed on crabs, molluscs, water insects and frogs but they prefer fish, allowing them to coexist with the African clawless otter that primarily feed on crabs (Somers & Purves, 1996). Spotted necked otters are seen to form large, social, all male or juvenile groups if there is sufficient prey. Otters in general are famous for their strong inclination to play and have been seen playing with each other and while alone (Foster-Turley, Macdonald & Mason, 1990).

## **2.4 Human-otter conflict**

Rowe-Rowe (1986) reports that surveys carried out on otter status and distribution in 23 African countries gave no reports of large-scale killing of otters for the fur trade. According to the findings of these surveys, a portion of otters are killed either for their fur, or because humans deem them as pests, or because they are regarded as competitors for fish. Fisherman on Lake Tana expressed negative attitude towards otters claiming that otters cause conflict by depredating netted fish and damage of fish nets (Ergete et al., 2018). However, the survey revealed that an increase in human population and habitat destruction are the greatest threats to otters. Ergete et al. (2018) stated that an even greater threat is posed to the otters by the poisoning plus pollution of rivers and clearance of river bankside vegetation. Most research done on the Lutrinae subfamily has taken place in the Northern Hemisphere and reflects where species richness is highest, but most threats identified in the literature affect very few species (Wright et al, 2022). Very little attention has been given to other otter species which are mostly found in the tropics especially on the African continent. The diversity of threats reported for other Lutrinae species still remain high even though the literature representing them is less (Wright et al, 2022).

## **2.5 Molecular Analysis**

Spraint surveys have been used all over the world over the last decade to assess the distribution of otters and sometimes to indicate population status, in broad terms, as well as to identify habitat features considered of importance to otters (Mason & Macdonald, 1987).

However, due to similarity in diets, the spraint from different species can most often be observably similar, making it difficult to identify the species occurring in a given area accurately. In addition, spraints eroded through exposure to environmental conditions leads to the physical breakdown of the spraint, changing how it looks making it even more difficult to visually differentiate between the two species of otters based solely on the spraint (Madisha et al, 2015). New, reliable, and effective ways have been developed in order to differentiate between the two otter species, namely the African

clawless otter, *A. capensis* and the Spotted-necked otter, *H. maculicollis*, making it easier to conduct a rough estimation of the occurrence rate of each species in an area, as well as help to better define their preferred habitats. The recent studies have shown that the use of genetic barcoding can be effectively used as a means of identifying species based on mitochondrial DNA (mtDNA) sequences (Madisha et al, 2015). It is often difficult to obtain tissue and blood samples from elusive animals, therefore alternative non-invasive samples can be used by collecting material left behind by the animal including hair, shed skin, eggshells and even spraints. The use of these non-invasive samples has advanced research on a diversity of elusive, rare, and endangered species which previously could not be studied due to several reasons, such as ethics, safety concerns and even unavailability of good samples (Madisha et al, 2015). There are several drawbacks to these non-invasive samples.

Otter spraints samples do contain some of the intestinal mucosa epithelial cells as well. As excreta are pushed through the intestines, the quality of the sample decreases as there is a combination of the animal's DNA and DNA from prey eaten by the animal such as fish, small rodents, crabs and frogs, which may be a problem as general barcoding of faecal samples that are used to identify unknown species tend to amplify the DNA of prey more than the target species (the primers used are usually universal and non-specific, Madisha et al (2015).

## **2.6 Camera Traps**

Good estimates of animal population density are important in ecology and conservation studies as they are essential to the understanding of population dynamics and factors such as probability of survival, density dependent population growth, probability of local extinction, or sensitivity to stochastic processes. Animal population density estimates can also be linked to habitat quality, trophic level occupied, and even individual body mass (Majelantle et al, 2021). The study of cryptic species with semi-aquatic habits, such as otters is challenged by their behavioural ecology. Estimating their population density is an arduous task due to their elusive behaviour, low population density, nocturnal activity patterns and the type of continental habitat that characterize this group of

species (Gil- Sánchez & Antorán-Pilar, 2020). The use of camera-trapping, particularly when dealing with elusive and rare species (such as otters) represents a powerful tool in wildlife research.

Remote photography is a tool that offers an alternative, rapid and relatively cost-effective way to estimate animal population density, as well as provide additional data such as activity time, in addition to density estimates (Majelantle et al, 2021).

Camera traps have improved in recent decades and have revolutionized biodiversity monitoring. Camera traps have seldom been used to model the abundance of unmarked animal populations despite clear implementation in conservation science (Gilbert, Clare, Stenglein & Zuckerberg, 2021). A couple of challenges are linked to this. It is very difficult to determine whether an image of an unmarked animal recorded in multiple detections represents multiple individuals or a single individual repeatedly entering the camera view shed. Furthermore, a clear definition of the sampling area is obscured by the constant animal movement, as a result, the area to which an abundance estimate corresponds (Gilbert, Clare, Stenglein & Zuckerberg, 2021). These challenges should be considered. When practitioners are seeking for an appropriate method, they should evaluate the life history of the principal taxa, carefully define the area of the sampling frame and consider what types of data collection are possible. Estimating abundance of unmarked animal populations is a challenge that still persists, although multiple methods exist, no one method is flawless for camera-trap data under all circumstances (Gilbert, Clare, Stenglein & Zuckerberg, 2021). Camera traps have been used on other species, such as to estimate tiger abundance in India (Silver et al, 2004). The sampling technique was also used to continue long-term monitoring of jaguar populations at the same sites, to compare with further sites, and to develop population models (Silver et al, 2004). With the increase in abundance estimates of unmarked animals, camera traps will become even more important for informing conservation decision making.

Relative abundance indices (RAIs) for a wide diversity of medium- to large-bodied wildlife species can be provided by photographic capture rates from camera trap surveys. RAIs estimates are easy to use and straightforward. RAIs are commonly used when true abundance is difficult or costly to

measure and less complex than other estimation methods. However, this method is still under discussion as it does not account for potential bias arising from imperfect detection (Palmer, Swanson, Kosmala, Arnold & Packer, 2018).

It is important to evaluate a completeness when conducting any inventory, in order to estimate how many species might be detected by further sampling effort. It is especially important to have an estimate of the completeness of an inventory when comparing species diversity among sites or when looking at changes in species composition over time. In order to deal with this issue, species accumulation curves and diversity estimators are commonly used. The cumulative number of species discovered is plotted against the sampling effort per unit time on species accumulation curves, which in the case of camera traps can be survey days or camera days (the number of survey days multiplied by the number of cameras used). When all of the species from the focal taxa have been recorded, the curve achieves an asymptote (Tobler, Carrillo-Percestequi, Leite Pitman, Mares & Powell, 2008).



### **3.2 Research Design**

Surveys for otter sign, especially observation and sampling of spraints, was conducted at different locations along the Kunene and Okavango riverbanks. The Okavango River was specifically selected for determining the relative abundance of otters due to the high density of people living near the Okavango River (Mendelsohn & el Obeid, 2004).

### **3.3 Procedures**

#### **Collection of spraints for objectives (a) and (b).**

Spraints were collected along the Kunene and Okavango rivers, Namibia between 12 January 2022 and 31 July 2022 (Tables 10 and 11 in appendix).

A 4x4 wheel drive vehicle was utilized to travel next to the rivers. When an accessible path to the river was found, a distance of 400m was covered along the river to collect spraints and observe any signs (The road is sometimes far from the river and there are also many houses and fences along the river). Most areas along the river are inaccessible beyond 400m.

A distance of 2km was covered outside the Kunene River Lodge along the banks of the Kunene River in the Kunene region as a result of the Lodge being fenced off (Table 10 in appendix). A 2km stretch was covered because a large area along the river was accessible.

#### a) The presence of otters

To determine the presence of otters, community sightings of otters were utilized (community members came forward with sightings after requesting for their help), along with on-site observations (for example, sightings and signs) while collecting data in the field.

#### b) Diet composition of otters

Spraints were collected along the banks of the two rivers with inverted plastic zip lock bags. The bags were then each allocated with a unique identification number. The spraints were air dried, teased apart and prey remains were identified using a Zeiss Stemi 508 stereomicroscope (x10 – 100

magnification). Prey remnants were sorted into major categories (e.g., fish and non-fish) and recorded (Somers & Nel, 2003).

c) Relative abundance of otters

A total number of 40 camera traps (20 units of Panthera PoacherCam, 10 units of Proof Cam03 and 10 units of Browning Trail Cameras) were installed along the Okavango River in the Bwabwata National Park (Buffalo and Mahango core areas) from the 16<sup>th</sup> July to the 20<sup>th</sup> August 2022 to collect data.

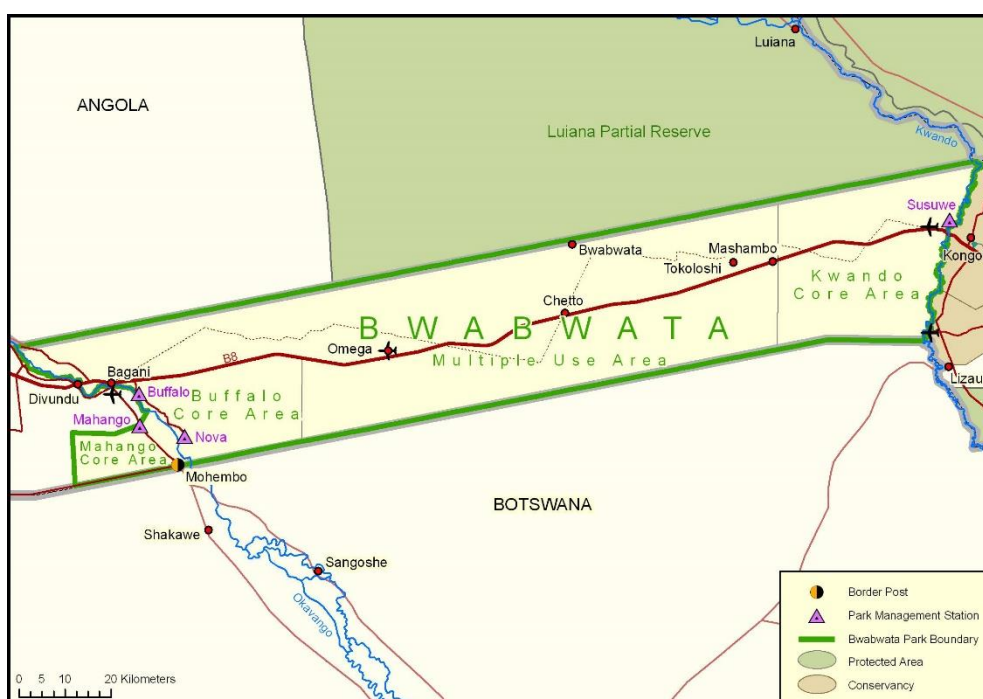


Figure 5. A map of the Bwabwata National Park. (The Namibian Wetlands Route, 2018)

The Bwabwata National Park is a protected area in north-eastern Namibia, it was established in 2007 and covers 6 274 km<sup>2</sup>. Camera traps were sequentially alternated, where both models were used at the sampling point.

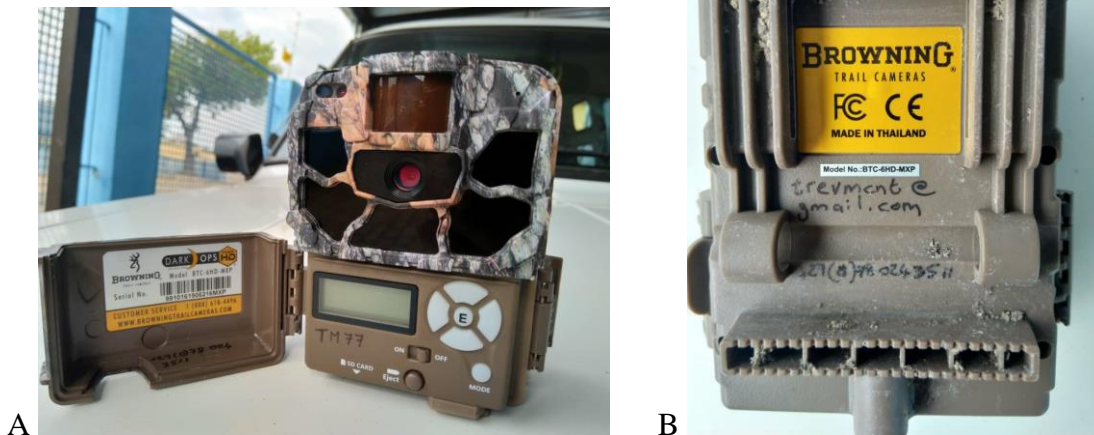


Figure 6. Front (A) and back (B) sides of the Browning Trail Camera. (Eiseb, 2022).

Cameras were positioned within 15 m of, and pointed towards, water sources at each site. Only locations where the slope of the riverbank was easily accessible to the field team were considered. Camera traps were placed 100 m apart, with most of the cameras mounted on trees while the rest were mounted on wooden stakes at not more than a height of 100 cm and tilted slightly downwards. The cameras were set to record four (4) photos at a time with a minimum delay between trigger events set to 10 seconds. All camera trap images were processed manually. When an otter was identified in an image, the study site, camera station, date, time, and group size were recorded (Majelantle et al., 2020).

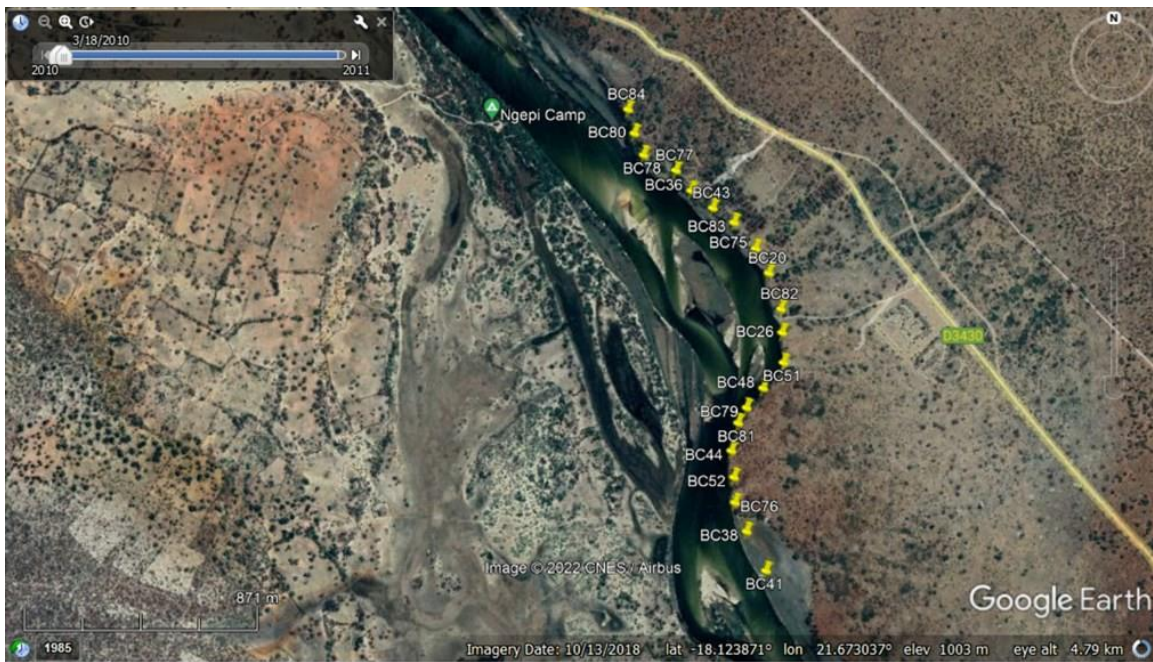


Figure 7. Locations where 20 camera traps were placed from the 16<sup>th</sup> July to the 20<sup>th</sup> August 2022 along the Okavango River in the Bwabwata National Park (Buffalo Core Area). (McIntyre, 2022).

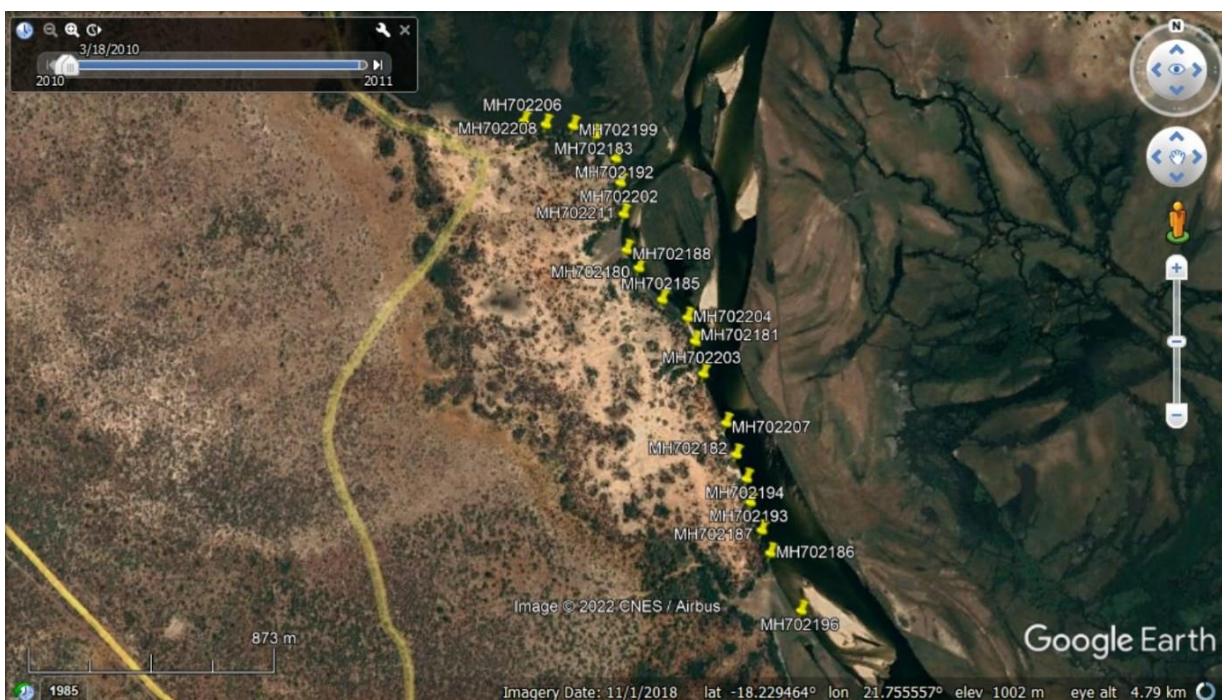


Figure 8. Locations where 20 camera traps were placed from the 16<sup>th</sup> July to the 20<sup>th</sup> August 2022 along the Okavango River in the Bwabwata National Park (Mahango Core Area). (McIntyre, 2022).

### 3.4 Data analysis

#### a) The presence of otters

Data obtained from community sightings and on-site observation were recorded in Microsoft Excel and inserted in tables. Camera images of otter signs (footprints, presence etc) were saved under images on the computer and separated based on their differences. Differences refer Date, time of day they were captured, species etc.

#### b) Diet composition of otters.

Data was evaluated by relative percent occurrence of prey items.

Calculated as: Total number of spraints containing the same prey item/ Total number of spraints x 100

$$\frac{\text{Total number of spraints containing the same prey item}}{\text{Total number of spraints}} \times 100$$

#### c) Relative abundance of otters.

Quantitative data was collected by manually processing camera images from each camera trap survey, recording all otter detections in Microsoft Excel (including date, time, group size, SD card number, camera number and GPS coordinates) (Lewis, 2021).

Relative abundance index (RAI) for African clawless otter was determined using the following equation.

$$\text{RAI}_{\text{spa}} = \text{events} * 100 \text{ camera trap nights} / \text{sampling effort}. \text{RAI}_{\text{spa}} = \left( \frac{\text{events} * 100 \text{ camera trap nights}}{\text{sampling effort}} \right)$$

Where  $\text{RAI}_{\text{spa}}$  = relative abundance index for species 'a'; events = number of independent records per species; 100 camera trap nights = unit of standardization to compare data with other studies; sampling effort = total amount of nights that the camera trap stations were working (Arroyo-Arce, Thomson, Fernández & Salom-Pérez, 2017).

*In situ* camera deployments in Bwabwata National Park and for the six study areas are summarized in the tables below.

Table 1. Synopsis of *in situ* camera deployments in Bwabwata National Park, Okavango Region, with  $n$ =number of camera traps.

Study area	$N$	Cameras used	Duration	Camera days
Bwabwata National Park	40	Primos, Browning & Panthera poacher	16 July -20 August 2022	967

Table 2. Synopsis of *in situ* camera deployments for the six study areas, with  $n$ =number of camera traps (Lewis, 2021).

Study area	$N$	Cameras used	Duration	Camera days
Spekboom	23	Primos	15 June – 28 August 2019	578.2
Verloren Vallei	22	Primos	28 June – 19 August 2018	928.3
Telperion	35	Primos	4 May – 5 June 2017	930.5
Cobham	24	Primos	9 October - 27 November 2018	710.9
Vaalhoek	20	Primos & Spypoint	22 September – 29 October 2020	389.9
Sandfontein	22	Primos & Spypoint	16 -29 September 2021	192.3

The RAI calculated in this study was then compared to RAIs data obtained in 2021 as a B. Science. Hons report by Lewis, B, C., from six natural areas, Telperion Nature Reserve, Verloren Vallei Nature Reserve, Rietvlei Farm (“Spekboom”), Cobham Nature Reserve, and Vaalhoek Nature Reserve, South Africa, and Sandfontein Nature Reserve, Namibia.

A Species Accumulation Curve to determine the success of the completeness of the species inventory was plotted, which saturate when all species of interest in the study area are detected (Tobler et al. 2008). With expanding trapping effort, the species accumulation curve should approach an asymptote, which permits a judgment of sampling adequacy of the camera-trap based inventory and level off, when the sampling effort (camera trap days) is sufficiently large, showing the inventorying of targeted mammalian taxa is sufficient (Ugland & Ellingsen, 2003).

### **3.5 Research ethics**

Ethical clearance (Reference number: SOS-0041) for this study was obtained from the Decentralized Ethics Committee (DEC) and the Research Permit (RCIV00022018) from the National Commission on Research, Science and Technology (NCRST).

## CHAPTER FOUR

### 4. RESULTS

#### 4.1 The presence of otters

The water levels of the Okavango River at Rundu showed increasing water levels from the previous year October 2021 till the current year April 2022

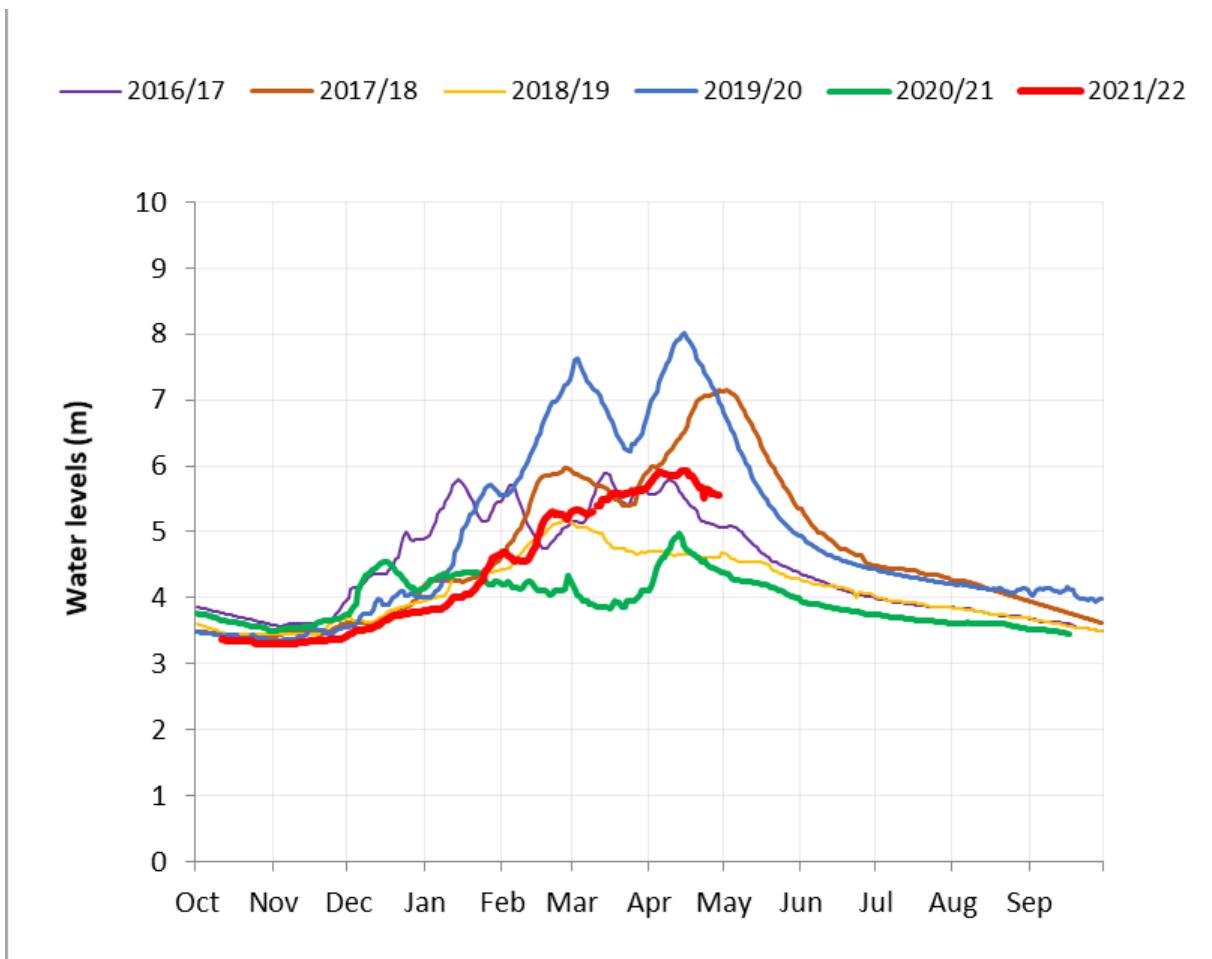


Figure 9. Water levels of the Okavango River at Rundu (Hydrological Services Namibia-Daily flood bulletin, 2022).

Two otter species, namely the African clawless and Spotted-necked otters have been spotted along the Okavango and Zambezi rivers by community members (Table 3).

Table 3. Sightings of otters by community members

Date	Area	GPS coordinates	Sightings	Observer
26/04/2022	Shamvura lodge, Okavango river	17.54181° S 18.53519° E	Two adult Spotted neck otters foraging.	Mark Paxton
14/05/2022	Shamvura lodge, Okavango river	17.54181° S 18.53519° E	One adult male Spotted neck otter.	Mark Paxton
23/05/2022	Near Makena, Okavango river	18.03557° S 20.84659° E	Two Spotted neck otters foraging near Makena.	Mark Paxton
24/05/2022	Near Makena, Okavango river	18.03557° S 20.84659° E	One Spotted necked otter crossing river near Makena.	Mark Paxton
24/05/2022	Near Matondoti, Okavango river	18.00052° S 20.84659° E	One adult male Clawless otter rolling on the banks near Matondoti.	Mark Paxton
24/05/2022	Near Putus rocks, Okavango river	17.9931° S 20.90831° E	Two Spotted neck otters crossing main river near Putus rocks.	Mark Paxton
24/04/2022	Caprivi Mutoya lodge, Zambezi river	17.55666° S 24.47402° E	Two clawless otters residing in front of the lodge.	Zina Dale
24/04/2022	Mavunje Camp, Banks of Kwando river.	17.91922° S 23.31825° E	Two spotted neck otters residing in my lagoon.	Dan Stevens
18/05/2022	Mobola Island lodge, Okavango East region	17.99076° S 21.3286° E	One clawless otter.	Prof Peter Benda and team.
01/06/2022	Shamvura lodge, Okavango river	18.03222° S 20.85574° E	Male Spotted neck otter foraging along the banks.	Mark Paxton
01/07/2022	Shamvura lodge, Okavango river	18.032199° S 20.860416° E	Adult male Clawless otter foraging at the canal entrance	Mark Paxton
01/07/2022	Shamvura lodge, Okavango river	18.021581° S 20.861030° E	Adult spotted neck otter with two pups crossing the main river	Mark Paxton
01/07/2022	Shamvura lodge, Okavango river	18.003980° S 20.868415° E	Adult male spotted neck otter foraging	Mark Paxton

Images displaying two different otter footprints that were seen along the Okavango River (Figures 10 and 11).



Figure 10. Spotted-necked otter footprints along the banks of the Okavango River (Mark Paxton, 2022).



Figure 11. African clawless otter footprints along the banks of the Okavango River (Mark Paxton, 2022).

#### 4.2 Diet composition of otters.

From 12 to 14 January 2022, seven spraints were collected along the Kunene River, and from 20 to 24 March 2022, six spraints were collected along the Okavango River. Crab was found in all spraints along the Kunene River while fish was found in all spraints along the Okavango River. The items recorded in the spraints are summarised in Tables 4 and 5.

Table 4. Summary of prey items recorded in 7 otter spraints from Kunene River.

<b>Item</b>	<b>Observed</b>	<b>Relative % occurrence</b>
Crabs	7	100
Fish	1	14.3
Frog	0	0
Insect	1	14.3
Leaves	6	85.7
Mammal	0	0
Bird	0	0

Table 5. Summary of prey items recorded in 6 otter spraints from Okavango River.

<b>Item</b>	<b>Observed</b>	<b>Relative % occurrence</b>
Crabs	4	66.7
Fish	6	100
Frog	0	0
Insect	0	0
Leaves	4	66.7
Mammal	0	0
Bird	0	0

### 4.3 Relative abundance of otters

Out of 42 256 images from all 40 camera traps deployed in the Bwabwata National Park, only 3 African clawless otter encounters were recorded (Table 6).

The results of calculated RAIs are detailed in Tables 6 and 7. The Bwabwata National Park had the lowest RAI of 0.310 compared to the RAIs from the six study sites.

Table 6. Relative Abundance Index (RAI) of African clawless otters in the Bwabwata National Park, Okavango Region.

<b>Study area</b>	<b>Encounters</b>	<b>RAI</b>
Bwabwata National Park	3	0.310

Table 7. Relative Abundance Indices (RAI) of African clawless otters from 6 study sites (Lewis, 2021).

<b>Study area</b>	<b>Encounters</b>	<b>RAI</b>
Spekboom	30	5.188
Verloren Vallei	18	1.939
Telperion	13	1.397
Cobham	9	1.266
Vaalhoek	14	3.591
Sandfontein	6	3.12

A total number of 21 mammal species were photo-captured and identified to species level in the Bwabwata National Park (Table 8).

Sampling effort in the study area is summarised in Table 9.

Table 8. Name of all mammals photo-captured in the Bwabwata National Park

<b>Species</b>	<b>Common name</b>
<i>Lepus microtis</i>	African savanna hare
<i>Civettictis civetta</i>	African civet
<i>Aonyx capensis</i>	African clawless otter
<i>Panthera leo</i>	Lion
<i>Panthera pardus</i>	Leopard
<i>Crocuta crocuta</i>	Spotted Hyena
<i>Atilax paludinosus</i>	Water Mongoose
<i>Felis lybica</i>	African wild cat
<i>Genetta genetta</i>	Genet
<i>Tragelaphus sylvaticus</i>	Bushbuck
<i>Tragelaphus strepsiceros</i>	Kudu
<i>Aepyceros melampus</i>	Impala
<i>Tragelaphus spekii</i>	Sitatunga
<i>Syncerus caffer</i>	Buffalo
<i>Loxodonta africana</i>	Elephant
<i>Phacochoerus africanus</i>	Warthog
<i>Chlorocebus pygerythrus</i>	Vervet Monkey
<i>Papio ursinus</i>	Baboons
<i>Hippopotamus amphibious</i>	Hippopotamus
<i>Funisciurus congicus</i>	Tree Squirrel
<i>Hystrix africaeaustralis</i>	Porcupine

Table 9. Sampling effort (No. stations, No. camera trap days, average number of days of effective camera use, total number of photos) and number of mammals captured by the camera traps in the study area.

No. stations	40
Total effort (camera trap days)	1440
Average number of days of effective camera use	36
Total No. photos (Independent events)	169 023 (42 256)
No. mammals photo-captured	21

The species accumulation curve for the mammals photo-captured in the Bwabwata National Park did not level off and the success of the species inventory is more complete (Figure 10). The species accumulation curve is closer to reach an amplitude at approx. 25 species.

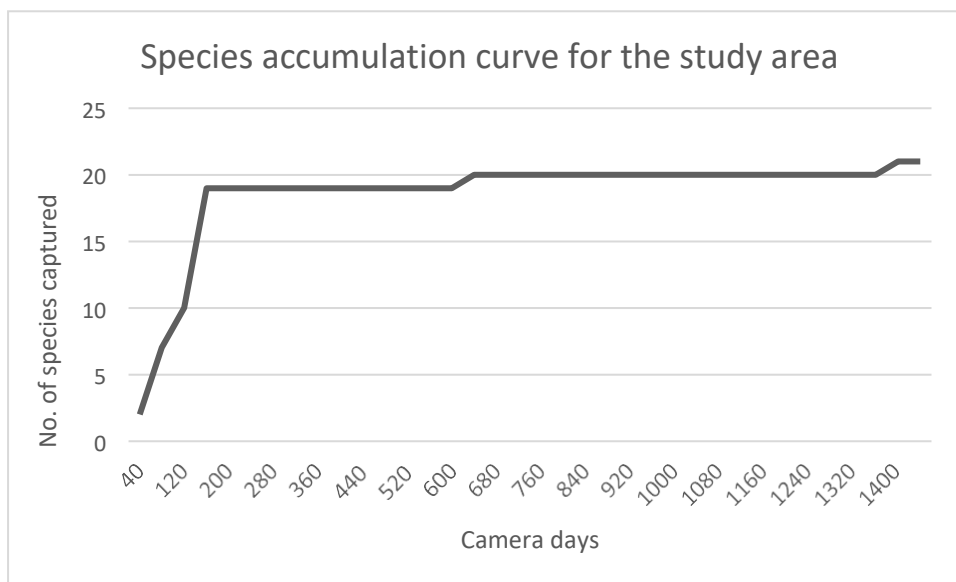


Figure 12. Species accumulation curve

## CHAPTER FIVE

### 5. DISCUSSION

#### **The presence of otters**

DNA sequencing aspects of the study could not be carried out due to failure in acquiring fresh spraint samples. As stated by Madisha et al (2015), it is ideal to collect fresh spraints with anal jelly (gelatinous secretion of anal scent glands) as the targeted DNA is yielded in greater quantity and quality. Weather conditions can lead to degradation of genetic material contained in the spraints.

No otters were recorded to have been seen during the phase of data collection along the Kunene River, in the Kunene region, Namibia (Table 8, appendix). According to a tour guide at Epupa River Lodge, Kunene Region (Kamburu, pers.comm, 2022), otters were last spotted over two years ago in that area. Other locals claim to have seen an otter more than 10 years ago. There are too many human activities taking place along and near the Kunene River, whereby people clear areas to make space for gardening, burning down of palm trees to keep monkeys and baboons away as well as cutting down vegetation which are good for hiding to otters. Adequate vegetation in floodplains and lacustrine habitats in the form of long grass, reeds, dense bushes, overhanging trees and large boulder piles is essential to provide cover during periods of resting and for denning (Reed-Smith, Jacques & Somers, 2015). Otters require undisturbed areas to mark as their territories, therefore they tend to avoid areas where there are too many human and animal movements. The Kunene River level was very low, with murky water, open areas along the river and most banks were steep. The presence of otters in an area of water generally indicates a healthy, unpolluted habitat. They are thought to be indicator species (Rowe Rowe, 1997). The Spotted-necked Otter occupies freshwater habitats where water is not filled up with silt, unpolluted and rich in small to medium sized fishes (Reed-Smith, Jacques & Somers, 2015). Although the African clawless and Spotted-necked otters have a large distribution, they are confined to areas of permanent fresh water, where good shoreline cover and an abundant prey base is available. Therefore, the spatial size of their inhabited home is much smaller

and unknown, particularly due to the reports for much of the African continent of the widespread habitat destruction and pollution problems (Reed-Smith, Jacques & Somers, 2015).

The Okavango River level was recorded to be increasing during the rainy season from the previous year October 2021 till the current year April 2022 (Fig. 9). The increasing river levels also made it impossible to collect any fresh spraints of otters in order to determine the type of otter species found along the Okavango River. According to the owner of Shamvura camp in the Okavango region, it is difficult to collect otter spraints, see any signs or spot any otters during the rainy seasons because most areas where otters normally occur, including their latrines were under water due to increased water levels (Mark Paxton, pers. comm). Otters normally move from their area of residence to high lands during the rainy seasons. Probably minor tributaries were flowing at that time after being dry during the rest of the year and the otters moved up to them (Rowe Rowe, 1977). Otters were mostly spotted being active during the months of November and December, when the river levels were low (Frans Livingi, pers. comm, 2022). The increasing river levels could have impacted the RAI side of the study too.

Two otter species, namely the African clawless and Spotted-necked otter species have been spotted by the community (Table 3), and the footprints observed during the time of data collection were of the two otter species (Fig. 10 and 11). It can be challenging to accurately identify species based on visual cues due to morphological similarities and the mysterious nature of certain species. That is why a more convincing method of identification is required, namely DNA barcoding (Madisha et al., 2015).

### **Diet composition of otters**

A number of prey items found in the otter spraints (Table 4 and 5) constitute the otter's diet. Crab was found in all spraints along the Kunene River while fish was found in all spraints along the Okavango. The African clawless otter is primarily a crab eater while the Spotted-necked otter is a

fish eater, however neither species eats only one kind of food. Alternative prey occasionally takes up greater importance than the primary food, replacing it when its availability decreases (Perrin & Carugati, 2000). No birds or mammal prey were recorded in the otter spraints. The African otters, namely the Spotted-necked and African clawless otters do most of their hunting in water. A possible reason that no birds or mammal prey species were recorded is because otters are not overly fast moving on land to regularly catch prey and predation on reptiles. Birds and mammals likely reflect opportunism rather than focused hunting (Perrin & Carugati, 2000). During data collection, observations showed that the Okavango River water was clearer compared to the Kunene River water.

African clawless otters normally locate their prey by touch. The palms and fingers have rough skin that enables the African clawless otters to grasp slippery fish and frogs securely (Larivière, 2001). Somers and Nel (2013) state that when the African clawless otter walks in shallow stoney bottomed water, it submerges the head occasionally, feeling with the forefeet under and between stones for prey, while in deeper water the otter dives to the bottom and hunt for prey on the substrate, once again using the forefeet. When prey is detected, the otter catches it with its forefeet. Most prey are captured by the otter using the forefeet (sometimes with the mouth), then bitten. The large molars, powerful jaws, and lack of cutting teeth of the otter are well adapted for crushing crustacean shells and the skull bones of large fish (Larivière, 2001). When it comes to larger prey, such as large fish and frogs, the killing bite is directed at the head (Somers & Nel, 2013). It was determined during experiments that the individuals of slow swimming fish species are easily captured than individuals of fast swimming species by the African clawless otters, as was the case with small fish versus larger fish of the same species. Smaller prey, fish and crabs are usually carried in the forefeet or mouth and may be consumed by the otter while treading water but are typically taken to the shallow areas and eaten there (Rowe Rowe, 1977). The African clawless otter consumes crabs of all sizes entirely and eat their fish and frog prey from the head first.

The Spotted-necked otter normally locates its prey by sight. Unlike the African clawless otters, spotted-necked otters feed on more mobile prey that are hunted by sight and caught with the mouth (Somers & Nel, 2013). The Spotted-necked otter feed on fish larger in size than those taken by the African clawless otter. Catching, holding onto, and eating fish prey is made easier for the spotted-necked otter due to its claws, webbed feet and teeth (Somers & Purves, 1996). The spotted-necked otter eats their fish prey from the tail first.

Due to the small sample size collected, it is possible that not all potential prey items were sampled.

### **Relative abundance of otters**

The RAI of the African clawless otter in the Bwabwata National Park (Table 6) is low compared to the relative abundance indices of the six study sites, namely Spekboom, Verloren Vallei, Telperion, Cobham, Vaalhoek and Sandfontein (Table 7) and could be a result of direct anthropogenic disturbance and predators in the Bwabwata National Park. Five of the study sites are nature reserves and one is a farm, with little direct anthropogenic disturbance and virtually no predators (Lewis, 2021). The fact that the Okavango River have a high abundance of crocodiles, which are one of the predators that prey on the otters could be one reason for a low relative abundance (Lejeune and Frank, 1990; Aust, Boyle, Fergusson & Coulson, 2009). Predators such as crocodiles, pythons, large carnivores, dogs and fish eagles' prey on the African clawless and Spotted-necked otters (Reed-Smith, Jacques & Somers, 2015). The landscapes of fear can effectively alter the space use patterns of otters in their area, making the results obtained less comparable with the six study sites that do not have these predators (Gaynor et al, 2019). The availability of food can also contribute to the presence or absence of African clawless otters in the area. A low abundance of crabs can be one of the factors contributing to the low abundance index of African clawless otters in the Bwabwata National Park. Clawless otter densities in freshwater are possibly related to the density of their staple food, crabs (Butler & Du Toit, 1994). The seasonal patterns (high water level) could also be a contributing factor to the low RAI in the Bwabwata National Park.

The Spotted-necked otter species image was not captured by any of the camera traps deployed in the study, but one was spotted swimming near the Shametu Lodge, Okavango River, next to the reeds on the 21/07/2022 (Table 9. Appendix). This could be due to their movements actually being highly localised and restricted to areas around the lodges and not venturing to areas that are a bit more open because of fear of predators (there are reeds around the lodges). This could also be due to the fact that the Spotted-necked otter prefer water more than land. Generally, the *A. capensis* is more terrestrial than *L. maculicollis* (Perrin & Carugati, 2000).

Fisherman-otter conflict could also be a contributing factor to the low abundance of otters. Many African countries where fishing and small-scale fisheries (using natural fish stocks) are common, communities depend on fish as a source of protein and/or financial income. Local communities are in permanent conflict with fish predators such as the Nile crocodile and otters, namely the African clawless otter, *A. capensis* and the spotted-necked otter, *H. maculicollis* (both of which are widespread in Africa) due to their dependency on fish (Akpona et al, 2016). Since the spotted-necked otter is regarded as an opportunistic feeder and is not territorial, the minimum area needed to support a viable population is likely to depend on the availability of food resources. The availability of prey is vital because it affects factors such as population density, length, and success of the breeding period, carrying capacity, time spent feeding in different patches and mortality (Akpona et al., 2016). However, local communities too depend on food resource accessibility within the waterways for their subsistence, and typically the principal cause of conflict between fisherman and otters (Akpona et al., 2016). With the increase in local population and natural habitat degradation, the capacity of fisherman to obtain a reasonable harvest have been reduced. It becomes difficult under such circumstances for local communities to tolerate otter damage to their nets, as well as predation on their fish, thus hunting and killing otters. The greatest cost of otter predation owing to equipment damage rather than fish loss per se because, in a single feeding bout, one otter will take fish from (and this way harm) a few lines and nets (Akpona et al, 2016).

Humans persecute, trap, poach and hunt otters, clear massive areas for Agriculture (habitat loss), overfish and also introduce invasive fish species that drive away easy to catch native fish species, making it very difficult for otters to hunt (Reed-Smith, Jacques & Somers, 2015). The combination of humans and high density of crocodiles also have a trophic-level competitive effect on otters, effectively outcompeting them for resources. The most important causes of decline in the otter population are a lack of vegetation cover on riverbanks, human disturbance, water pollution and a lack of food resources (Perrin & Carugati, 2000).

Due to a fall in food production below population growth in Africa about 15 years ago, the need to cope with the food demand has led to extreme rates of soil erosion caused by an increased and often unsound agricultural practices together with overgrazing by livestock. These practices are responsible for the increased soil loss, increased water turbidity and silting, which results in greatly reduced numbers or the extermination of aquatic insects, crabs, frogs, and fish. Otters are directly affected by the loss of these aquatic organisms, as they are at the end of the food chain (Rowe Rowe, 1986). Water draining off fertilised lands can cause detrimental chemical changes in streams, or could pollute them with pesticide residues, once again affecting aquatic life. The relatively low otter abundance in the Okavango River tells a lot about the water quality. Furthermore, otter species being dominant predators in the aquatic ecosystems, are world-wide useful indicators of the health of the wetlands that they inhabit (Butler, 1994). Otters are declining in numbers at an alarming rate. Due to the pollution of their riverine habitat and loss of habitat, otters around the world have declined.

Temporal, environmental impacts on top predators are usually the first indication of habitat deterioration (Kubheka, Rowe-Rowe, Alletson & Perrin, 2013). Global climate change impact throughout Africa also has the potential of decreasing suitable habitats for otters and increasing human/otter conflict, especially for increasingly scarce resources such as water, land and fish (Jacques, Reed-Smith & Somers, 2015). The recent report of the National Geographic Okavango

Wilderness Project (NGOWP) (2021) indicated that the team observed only five (5) Spotted-necked otters when they travelled the length of 487 km over 17 days of the Okavango River from Angola to Botswana. No other otter species was recorded in that report (NGOWP, 2021).

The species accumulation curve with a curve nearly reaching an asymptote (with 21 captured species) shows that the inventory on species composition in this phase was more complete. Additionally, the 36 days deployment of camera traps in the field, indicated by the trend of the curve, shows a good sampling effort. To allow the capture of rare and secretive species, 30 days are recommended (Tobler et al. 2008). The additional camera trapping effort (number of camera trap days) might have added to an increased capture of different species in the Bwabwata National Park. Therefore, camera traps placement in the study area for a longer period allows an increased capture of diverse mammalian taxa including potentially rare and/or secretive species and will record any seasonal changes.

Since the Sandfontein RAI is the first estimate of African clawless otter population abundance in Namibia and within the Desert / Nama Karoo Biomes (Lewis, 2021), the Bwabwata National Park RAI is the second estimate of the African clawless otter population abundance in Namibia. There could be an underestimation of seasonal factors and on the African clawless and Spotted-necked otter abundance in the Bwabwata National Park due to the limited deployment time of camera traps, the number of camera traps used, the type of camera traps used and the disruption of camera traps by large herbivores, such as Elephants. The use of three different camera traps could also have resulted in missed encounters and thus underestimated population abundance. In addition, camera sensitivity differs between models and environmental factors such as temperature, speed, camera height, and distance.

Inaccurate likelihood of detection ought to in this way be evaluated and incorporated into density modelling to improve the accuracy of population estimates (McIntyre 2020).

## **CHAPTER SIX**

### **6.1 CONCLUSION**

The data obtained suggest that there are two species of otters occurring in Namibia, namely the African clawless otter and the Spotted-necked otter. These nocturnal, semi-aquatic predators prey consist primarily of aquatic species such as fish, frogs and crabs with some insects and other taxa. The low relative abundance index of the African clawless otter and low sighting of the spotted-necked otter suggest that these species occur at relatively low densities in Namibia. The IUCN Red List indicated that the status of African clawless and Spotted-neck otters as near threatened due to reported decline in their numbers primarily due to habitat loss and destruction, mainly from unsustainable agricultural land expansion, invasive species, and pollution (Shin et al, 2020).

Conservation of wetlands and restoration of water quality might be the most important steps towards ensuring the future of otters in Namibia. There is insufficient knowledge about otter population density and taxonomic status in Namibia, which is necessary for conservation purposes. In future, studies like this one will generate sufficient information on the presence and distribution of otters in Namibia, therefore creating a platform for more studies to be carried out and necessary action for conservation of these species to be taken.

### **6.2 RECOMMENDATIONS**

Faecal samples, known as spraints, are the easiest way of confirming the presence of cryptic animals in an area, and the ability to accurately identify species using partial DNA will be beneficial in understanding numerous aspects of the behaviour and ecological importance of animals in their environment.

Due to the small sample size of spraints collected and the limited time in collecting data, it was difficult to determine what other species were hunted by otters. In order to improve the accuracy of results, a larger sample size of spraints should be collected, at different times of the year.

Referring to the RAI of the African clawless otter in the Bwabwata National Park, the use of additional cameras or a longer deployment period is recommended at the study area.

Therefore, there is a need for an expansive study to be conducted on the taxonomy, distribution, diet and population density of otters that occur in all northern perennial rivers in Namibia.

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## APPENDICES

Table 10. GPS readings, observations, number of faecal samples collected and time of collection of otter spraints from different areas along the Kunene River.

Date	GPS readings	Signs	Samples collected	Time
12/01/2022	Elevation: 737 m	Otter footprints, monitors (large lizards), Tree squirrels	KRL 1	09:00
	17.35458° S		Note: Locals say they have not seen otters for over 10 years	
	13.88194° E			
13/01/2022	Elevation: 765 m	Birds, Tree Squirrels, monitors	None	11:11
	17.43306° S			
	13.95356° E			
	Elevation: 733 m	Monitors, no footprints (many rocks)	KRL 2,	11:44
	17.34428° S			
	13.85828° E			
	Elevation: 720 m	Birds, goats, Cattle	None	12:01
	17.2805° S			
	13.75156° E			
	Elevation: 698 m	Birds	KRL 3	13:58
	17.24806° S			
	13.68489° E			
	Elevation: 692 m	Birds	None	14:30
	17.10022° S			
	13.51994° E			
	Elevation: 663 m	Goats	None	15:15
	17.00794° S			
	13.43606° E			
14/01/2022	Elevation: 629 m	Vervet monkeys, donkeys, pigs, goats, birds	None	07:07
	16.99814° S			
	13.25483° E			
	Elevation: 622 m	Water monitors, pigs, goats, baboons, monkeys, Humans	KRL 4, KRL 5, KRL 6	11:19
	16.9965° S			
	13.25458° E			
	Elevation: 633 m	Mountaneous (river lower, underwater rocks exposed)	KRL 7.	18:36
	16.99492° S		Walked 2km along river (East).	
	13.25561° E			

Table 11. GPS readings, observations, number of faecal samples collected and time of collection of otter spraints from different areas along the Okavango River.

Date	GPS readings	Observations	Samples collected	Time
20/03/2022	Elevation: 1102m	No sign	Inside lodge (lodge is fenced off). No spraints found.	07:00
	17.54181° S			
	18.53519° E			
	Elevation: 1096m	Boat	None.	10:20
	17.53933° S			
	18.53392° E			
	Elevation: 1097m	Kraal, goats, cattle. Walked more than 200m.	None.	12:22
	17.39092° S			
	18.42064° E			
21/03/2022	Elevation: 1069m	Floodplains, humans, mahangu field, cattle	None	09:15
	17.79958° S			
	18.85522° E			
	Elevation: 1076m	People bathing, cattle, traps set up to catch fish, animal kraal	None	11:15
	17.85614° S			
	19.32247° E			
	Elevation: 1080m	Otter spotted, unsure of the species.	KRL 8	15:40
	17.87358° S		KRL 9	
	19.83261° E		Otter footprints spotted, latrine	
24/03/2022	Elevation: 1057m	Spotted neck otter footprints.	None	08:00
	18.03414° S			
	20.86078° E			
21/07/2022	Elevation: 996m	Lodges and people utilising the river	KRL 10	17:00
	18.11630 S			
	21.58706 E			
21/07/2022	Elevation: 997m	People catching fish along the lodge	KRL 11	17:30
	18.03414° S	Hippopotamus and crocodiles resting on opposite banks and		
	20.86078° E	on small islands		
21/07/2022	Elevation: 994m	Spotted-necked otter swimming near Shametu lodge	KRL 12	17:50
	18.03414° S			
	20.86078° E			

Table 12. A summary of species recorded by the camera traps apart from the otters in the Bwabwata National Park, Okavango Region.

Buffalo Core Area	Mahango Core Area
Lion	Crocodile
Leopard	Water Mongoose
Hyena	Bushbuck
Water Mongoose	Kudu
Bushbuck	Elephant

Kudu	Genet
Elephant	Warthog
Genet	Vervet Monkey
Warthog	Hippopotamus
Vervet Monkey	Birds
Hippopotamus	Lizard
Birds	Water monitor
Water monitor	Tree Squirrel
Tree Squirrel	Baboon
Baboon	Impala
Impala	Sitatunga
Sitatunga	Buffalo
Buffalo	Wild cat
Wild cat	Porcupine
Porcupine	
African savanna hare	
African civet	



## AUTHORIZATION OF RESEARCH PROJECTS

Authorization is hereby granted in terms of Section 21 of the RST Act No. 23 of 2004, to:

**Name:** Yeholendjeshili Laina Nakapushu Abiatar

**Address:** University of Namibia  
Private Bag 13301, Windhoek, Namibia

**Coworkers:** Seth J. Eiseb, Kenneth /Uiseb & Trevor McIntyre.

**Certificate Number (if applicable):** RCIV00022018      **Authorization No:** AN202203002

**Type of Research:**

Non-Commercial research and use of resources be limited to what is in the proposal.

**Title of Research Authorized:**

The taxonomic status, diet and population density of otters (Carnivora: Mustelidae) occurring in the northern rivers of Namibia.

**Locality:**

Kunene River; Okavango River; Kwando River; Linyanti River; Chobe River; Zambezi River  
Mahango & Buffalo Core Areas of the Bwabwata National Park.

**Duration:** 15 February 2022 - 28 February 2023

**Research / Sample Collection Conditions:**

Spraints (faeces) of otters will be sampled from the river banks and areas close to the rivers.

Yours sincerely,

Ms. Albertina Ngurare  
Acting Chief Executive Officer



### Head Office:

101, Loosjans Street, 18 Century, Windhoek, Namibia      +264 61 431 2000      www.ncrst.na  
Olympos Windhoek      +264 61 291 518      info@ncrst.na  
Private Bag 13253, Windhoek  
NCRST      #NCRST      Namibia      @ncrst.na

### Innovation Hub:

101, Loosjans Street, 18 Century, Windhoek, Namibia      +264 61 431 2000  
Private Bag 13253, Windhoek      +264 61 291 518



## ETHICAL CLEARANCE CERTIFICATE

Ethical Clearance Reference Number: SOS-0041 Date: 04 March 2022

This Ethical Clearance Certificate is issued by the University of Namibia Ethics Committee (REC) in accordance with the University of Namibia's Research Ethics Policy and Guidelines. Ethical approval is given in respect of undertakings contained in the Research Project outlined below. This Certificate is issued on the recommendations of the ethical evaluation done by the ethics committee.

**Title of Project:** THE TAXONOMIC STATUS, DIET AND POPULATION DENSITY OF OTTERS (CARNIVORA: MUSTELIDAE) OCCURRING IN THE NORTHERN RIVERS OF NAMIBIA

**Student:** YEHOLENDJESHILI LAINA NAKAPUSHU ABIATAR

**Student Number:** 201403705

**Supervisor(s):** DR. SETH J. EISEB; MR. KENNETH USEB

### Centre for Research Services

Take note of the following:

1. Any significant changes in the conditions or undertakings outlined in the approved Proposal must be communicated to the ethics committee. An application to make amendments may be necessary.
2. Any breaches of ethical undertakings or practices that have an impact on ethical conduct of the research must be reported to the ethics committee
3. The Principal Researcher must report issues of ethical compliance to the ethics committee (through the Chairperson) at the end of the Project or as may be requested by the ethics committee
4. The ethics committee retains the right to:
  - i) Withdraw or amend this Ethical Clearance if any unethical practices (as outlined in the Research Ethics Policy) have been detected or suspected,
  - ii) Request for an ethical compliance report at any point during the course of the research.

The ethics committee wishes you the best in your research.

Dr. Zivayi Chiguvare (Chairperson Ethics Committee)

Prof. Davis Mumbengegwi (Head, Multidisciplinary Research)

