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# MUCUSSO RESERVE LARGER MAMMALS ASSESSMENT

OKAVANGO INTEGRATED RIVER BASIN  
MANAGEMENT PROJECT

JANUARY 2008

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## **DISCLAIMER**

The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.



# CONTENTS

<b>1.0 INTRODUCTION</b> .....	<b>1</b>
1.1 The Need for a Mammal Biodiversity Inventory.....	1
1.2 Objectives and Scope of the Inventory.....	1
<b>2.0 STUDY AREA</b> .....	<b>3</b>
<b>3.0 METHODS</b> .....	<b>5</b>
3.1 Overview .....	5
3.2 Limitations and Constraints .....	6
3.3 Direct Counts.....	6
3.3.1 Aerial Survey.....	6
3.4 Indirect Counts .....	7
3.4.1 Research Design and Data Collection.....	7
3.4.2 Track Counts.....	7
3.4.3 Scat Counts.....	7
3.4.4 Auditory Stations.....	7
3.4.5 Opportunistic Observations and Interviews.....	8
<b>4.0 DATA MANAGEMENT</b> .....	<b>9</b>
<b>5.0 RESULTS</b> .....	<b>10</b>
5.1 Species Accounts.....	11
5.1.1 Detected Target Species.....	11
5.1.2 Target Species Spoor Indexes.....	28
5.1.3 Non Detected Target Species.....	30
<b>6.0 IDENTIFIED THREATS TO MAMMALS</b> .....	<b>32</b>
<b>7.0 RECOMMENDATIONS FOR THE IMMEDIATE FUTURE</b> .....	<b>35</b>
<b>BIBLIOGRAPHY</b> .....	<b>37</b>
<b>APPENDIX I. ELEPHANT DUNG PILE COUNT IN THE MUCUSSO GAME RESERVE</b> .....	<b>38</b>
<b>APPENDIX II. AERIAL SURVEY OF THE MUCUSSO GAME RESERVE, PROGRAM</b> .....	<b>42</b>
<b>APPENDIX III. SEMI STRUCTURED QUESTIONNAIRES TARGETING KEY SPECIES (EXAMPLE)</b> .....	<b>48</b>



# 1.0 INTRODUCTION

The aim of this report is to outline data that was collected during the period of May-December 2007, including preliminary analysis of data sets as an indication of trends that can be discerned to date.

## 1.1 THE NEED FOR A MAMMAL BIODIVERSITY INVENTORY

Mammals are an essential component of most terrestrial ecosystems. This group is a key stone in assessing biological resources toward developing management strategies, particularly in the African context. Such strategies are essential for establishing guidelines to protect biological diversity into the future.

Angolan government stakeholders<sup>1</sup> targeted the Mucusso Game Reserve (the Reserve) as a priority area for gathering current information on flora and fauna. The Okavango Integrated River Basin Management Program (IRBM) has been implementing this task under Angola's National Biodiversity Strategy and Action Plan. The Southeast section of Kuando Kubango in which the Mucusso Game Reserve is located has long been renowned by the unique diversity and abundance of mammal species, namely ungulates and larger predators. In fact, these mammalian communities were by far the most abundant in all of Angola until the mid seventies (Cabral & Verissimo, 2005).

Although a proper wildlife survey has never been conducted in the reserve since its establishment in 1959, anecdotal information was collected during the time it functioned as a hunting reserve until 1974. The subsequent long civil unrest that the region experienced, associated with three decades Angolan Civil War, not only prevented any kind of thorough biological assessment during this period, but more importantly contributed to the dilapidation of the once abundant wildlife communities, particularly larger mammals.

Regional conservation developments also stress the importance of assessing mammalian biodiversity and potential for future regeneration in the Mucusso Reserve. An international effort is underway to establish a 5-country transfrontier conservation area that will encompass the Mucusso Reserve (the Kavango-Zambezi Transfrontier Conservation Area). Information on Southeast Angola's biodiversity and potential for future regeneration is important to future decisions regarding the design and management of such an endeavour.

The findings presented in this report are compiled from the survey activities carried out between June and December 2007.

## 1.2 OBJECTIVES AND SCOPE OF THE INVENTORY

The Implementation Plan for Biodiversity in Kuando Kubango, developed by IRBM and MINUA, identified a need for updated information on the abundance and distribution of fauna in the Mucusso Game Reserve. Under this premises the *a priori* primary goals of the mammalian biodiversity inventory of MGR were:

- Identify larger mammal species known to occur in the project area, with comments on their status, distribution and relative abundance where possible; and
- Identify major threats and protection measures required.

Prior to the inventory, the author identified the former mammal species known to occur in the Reserve and nearby sites based on a review of scientific literature and other anecdotal information collected

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<sup>1</sup> The Ministry of Urban Affairs and Environment of Angola (MINUA), Institute of Forestry Development (IDF), and the Provincial Government of Kuando Kubango.

from available sources. This information was used to develop a provisional list of species that were known to occur in the study area in the past. The historical list may not be complete, since in the past there were no actual surveys of mammals conducted in the Reserve.

With the preliminary mammals species list on hand, select target species were identified for the inventory (Table 1). The primary criteria used for selection of these species was size, so the reference larger mammals, such that all species included have an average body mass of more than 5kg, or a minimum height of about 50cm. This criteria covers all the regional species of the orders: *Pholidota* (1 species); *Tubulidentata* (1 species); *Proboscidea* (1 species); *Perissodactyla* (2 species); *Suiformes* (2 species); *Whippomorpha* (1 species); *Ruminantia* (17 species); as well as 14 species of the order *Carnivora*, 1 species of the order *Rodentia* and 2 species of the order *Primates*.

The focus on larger mammals in initial inventories is appropriate for the Mucusso Reserve. Mammals of this category were the primary reason for the establishment of the area as a Game Reserve, and can provide the impetus for enhanced conservation measures in the future. Larger mammals play significant roles in ecological processes across a range of habitats. In the process of studying them in ground surveys, supplemental information on smaller mammals is also recorded.

**TABLE I. SELECTED TARGET SPECIES IN THE MUCUSSO GAME RESERVE INVENTORY**

<b>Species</b>	<b>Scientific Name</b>	<b>Species</b>	<b>Scientific Name</b>
Chacma Baboon	<i>Papio ursinus</i>	Black Rhinoceros	<i>Diceros bicornis</i>
Vervet Monkey	<i>Cercopithecus aethiops</i>	Common Warthog	<i>Phacochoerus africanus</i>
Ground Pangolin	<i>Manis temminckii</i>	Bushpig	<i>Potamochoerus porcus</i>
African Porcupine	<i>Hystrix africaeaustralis</i>	Hippopotamus	<i>Hippopotamus amphibius</i>
Bat-eared Fox	<i>Otocyon megalotis</i>	Giraffe	<i>Giraffa camelopardalis</i>
Side-striped Jackal	<i>Canis adustus</i>	African Buffalo	<i>Syncerus caffer</i>
Wild Dog	<i>Lycaon pictus</i>	Eland	<i>Taurotragus oryx</i>
Cape Clawless Otter	<i>Aonyx capensis</i>	Kudu	<i>Tragelaphus strepsiceros</i>
Honey Badger	<i>Mellivora capensis</i>	Sitatunga	<i>Tragelaphus spekei</i>
African Civet	<i>Civettictis civetta</i>	Bushbuck	<i>Tragelaphus scriptus</i>
Spotted Hyena	<i>Crocuta crocuta</i>	Roan	<i>Hippotragus equinus</i>
Aardwolf	<i>Proteles cristatus</i>	Sable	<i>Hippotragus niger</i>
African Wild Cat	<i>Felis lybica</i>	Waterbuck	<i>Kobus ellepsiprymnus</i>
Serval	<i>Leptailurus serval</i>	Lechwe	<i>Kobus leche</i>
Caracal	<i>Caracal caracal</i>	Reedbuck	<i>Redunca arundinum</i>
Cheetah	<i>Acinonyx jubatus</i>	Wilderbeast	<i>Connochaetes taurinus</i>
Lion	<i>Panthera leo</i>	Tsessebe	<i>Damaliscus lunatus</i>
Leopard	<i>Panthera pardus</i>	Common Impala	<i>Aepyceros melampus</i>
Aardvark	<i>Orycteropus afer</i>	Steenbuck	<i>Raphicerus campestris</i>
African Elephant	<i>Loxodonta africana</i>	Oribi	<i>Ourebia ourebi</i>
Plain Zebra	<i>Equus burchellii</i>	Common Duiker	<i>Sylvicapra grimmia</i>

## 2.0 STUDY AREA

The Mucusso Game Reserve is located in the Southeast of Kuando Kubango province (*Fig. 1*). With an area of roughly 23 000km<sup>2</sup>, its limits are the Lumuna, Luengue and Luiana rivers to the North, the Luiana Partial Reserve to the East, the road between Dirico and Mucusso to the South, and the Cuito river to the West. The Reserve was created in 1959 by the *Portaria* (decree) n°11280 of 15 of July. The original limits were modified to its present boundaries in 1966, by the Legislative Decree n°3677 of 17 of September, that also created a Partial Reserve in the area of Luiana.

FIGURE 1. MUCUSSO GAME RESERVE



The Reserve lies within the administrative boundaries of 3 municipalities: Dirico, Rivungo and Mavinga. The Reserve's land lies within a total of 6 communes, which fall within these three municipalities as follows:

- Dirico municipality; communes – Xamavera, Dirico and Mucusso;
- Rivungo municipality; communes – Jamba/Luiana, Rivungo; and
- Mavinga municipality; commune – Luengue.

Climatically, the area is characterized by a typical dry sub-humid climate, with a dry season between May and August. In the coldest months, June and July, frost occasionally occurs along the valleys and depressions. The hottest months are October and November, coinciding with the beginning of the rainy season which stretches until March-April. The average annual precipitation is around 600mm, but with very irregular inter-annual quantities. On average, January and February have the highest monthly precipitation values.

The Mucusso Reserve lacks major orographic variability. Marked changes in the topography occur only along the major water courses. The altitude gradient is overall a little more than 100m along the central body of the reserve (from 1150m in the Northwest to 1020m in the Southeast.) The major rivers bordering the reserve are the Kubango to the South, and the Cuito to the East. These rivers have perennial regimes and broad river valleys with extensive wetlands and floodplains. The Lumuna, Luengue and Luiana rivers, with seasonal regimes, account for the outflow drainage systems in the northern sector of the Reserve. Most of the central belt is characterized by a constellation of endoreic

depressions that contain water in lagoons during the wet season. Towards the Southeast, fossilized belts of Tertiary Kalahari sand dunes underline long and narrow depressions (“*omurambas*”).

Most of the Reserve’s area is covered by unconsolidated Tertiary and Pleistocene sand deposits, only interrupted along the river valleys and depressions where clay and alluvial deposits are dominant. Along the river alluvial platforms the vegetation is composed primarily by herbaceous communities, dominated by *Loudebia simplex*. Permanent wetlands are covered by *Cyperus papyrus*, *Phragmites mauritianus* and *Tipha capensis*.

On the Tertiary deposits, where the soils are essentially psamitic in nature, the vegetation is dominated by woody species, with a mosaic of open dry forest, thickets and tree-shrub savannahs, interspaced by shrub-grasslands in the clayed depressions. Some of the more common tree species to be found in this area are: *Baikiaea plurijuga*, *Guibourtia coleosperma*, *Burkea africana*, *Pterocarpus angolensis*, *Cryptosepalum pseudotaxus*, *Julbernardia paniculata*, *Acacia spp*, amongst others.

Most of the human population is concentrated in a series of villages along the Kubango river front, all of which lie within the Dirico Municipality. To the North, only small settlements occur, scattered in different locations, with fewer than a hundred people per settlement. Most households practice subsistence agriculture, in a slash and burn practice with a very demanding impact on land availability and vegetation cover. Some of these households also sell natural resources such as reeds and thatch grass. Private logging companies extract *Baikiaea plurijuga*, *Burkea africana*, and *Pterocarpus angolensis* within the reserve, and account to another major extractive use of its natural resources .

# 3.0 METHODS

## 3.1 OVERVIEW

As referenced in Section 1.2, the present inventory is designed to provide preliminary information on the presence of larger mammal species known to occur in the area, and, where possible, determine their status, distribution and relative abundance; as well as to understand and identify major threats and highlight protection needs. These premises are part of a process to provide management guidelines to the reserve, and require an array of methods that support the data collection process and its validity.

*In general*, accurate estimates of population size or density are necessary to predict the long term persistence of animal populations (Sutherland, 1996). However, accurate estimates are difficult to obtain for many species, and require considerable investment of resources and time.

In the Mucusso Game Reserve, the potential spatial and temporal patterns in distribution and abundance of larger mammals are highly variable. To verify these patterns, a variety of survey techniques are necessary, which would ideally sample all habitats in different times of the year to capture seasonal variations.

Two different counting techniques were proposed for the Mucusso Game Reserve Mammal Inventory: Direct Counts and Indirect Counts. It was assumed that the combination would improve the overall output results, considering the specifications of the area and the lack of any prior surveys to serve as guidance.

Under the Direct Counts, a Sample Count from the air (Aerial Survey) was planned. Direct Counts based on terrestrial line transects, however, were deemed not suitable for the Mucusso Game Reserve. Terrestrial line transects are conducted by travelling in a straight line, recording each animal seen from the transect and its distance from the observer. As a baseline requirement, approximately 60 to 70 animal sightings are needed per species to generate robust density estimates with this technique (BUCKLAND *et al*, 2001). Where mammals are in low numbers or elusive, as is the apparent case of many of the species in the Reserve, the number of observations are too low to estimate population size using the terrestrial direct observation line transect technique. For example, the assessment team made no direct observations of mammals in many drives in continuous lines of more than 100km through the reserve. Nonetheless the team recorded all direct observations made. Direct observations along walking line transects accounted for only 6% of the total data gathered. This might relate not only to the scarcity of most large to medium mammal species but also to the high density of the vegetation cover in many of the areas prospected.

The Indirect Count surveys were based on Index Counts and Indicator Counts. Many mammals leave a multitude of signs of their presence, such as droppings and tracks, which are often much easier to quantify, and are more numerous and spatially stationary than the animals themselves. Both of these techniques use indicators of the presence of animals, such as droppings or footprints, providing where possible absolute densities (index counts), or indices of abundance (indicator counts). Mammal signs therefore provide evidence for assessing the species and location of mammals when other methodologies are not feasible (Jachmann, 2001). However, density calculations from indirect counts are less reliable, and require conversion factors that address parameters such as the production and decomposition rates of the signs.

Spoor counts have been used as indices of abundance for species that are difficult to observe directly, but that have tracks that are easily seen and identified. The later developments on the use of these signs (Smallwood & Fitzhugh, 1995; Stander, 1998; Gusset & Burgener, 2005) is in part based in the assumption that track counts are related to population size in a linear monotonic - varying in such a way that it either never decreases or never increases - fashion (Wilson *et al*, 1996). Tyson (1959), in a

study of a species of cervid, concluded that an approximate 1:1 ratio existed between the counts (the index) and population size, although probably not constant over years or areas. Nevertheless, for a large spectrum of species, as it is the case of the present inventory, many variables remain to be accounted for, and although it is assumed that a potential relations exists between counts and populations sizes, the results of the track counts are considered only in a qualitative manner.

Ground surveys were based essentially on the recording of indirect signs of the target species along different sites. Site selection was conducted in an *ad hoc* manner, based on accessibility (refer to 3.2 for limitations and constrains) and the suitability of the locations for reading signs and overall diversity of habitats.

## **3.2 LIMITATIONS AND CONSTRAINTS**

Several factors accounted to the incompleteness of a complete inventory of larger mammals of the reserve. The aerial survey was nullified due to lack of clearance approval from the Angolan aviation authority (Instituto Nacional de Aviação Civil – INAVIC), in spite of a multitude of formal requests and support from counterparts in the Ministry of Environment and Urban Affairs, Ministry of Water, Ministry of Territory and Provincial Government of Kuando Kubango. INAVIC's failure to authorize flight clearance jeopardized the recording of fundamental mammal distribution and abundance data, as well as identification of key concentration areas for ungulate species during the dry period. This was a major drawback in the effort of collecting information for the present inventory.

Since the aerial survey activity has not materialized during the period in reference, ground based surveys provided all the present records on mammal fauna of the reserve. The ground surveys have been affected by limited access to different parts of the reserve, due to concerns on land mines issues and other war related devices and the lack of roads and tracks in the overall area; as well as limitations for financing a survey of the entire reserve taking in consideration of the huge size of the survey area. These factors resulted in biases as outlined below, and the *ad hoc* selection of sites location.

The southern part of the Reserve was more intensely surveyed than other areas resulting in a spatial bias. Sampling areas were limited to passable tracks known to be clear of land mines, and therefore the sample for the whole of the reserve is incomplete. Since the surveys were conducted during the dry season, a temporal bias also exists. The concentration and distribution of observations therefore provides indications of the seasonal movement of the species towards permanent water sources, but does not necessarily reflect a year round average distribution. Other biases relate to varying visibility of signs; for example, signs are clearer in the dry soils of the inner reserve than in areas with late season, tall grass such as permanent wetlands.

## **3.3 DIRECT COUNTS**

### **3.3.1 AERIAL SURVEY**

An aerial multi-species sample count survey was planned and programmed to take place during the month of September 2007 and to cover the Mucusso Game Reserve and surrounding areas, with a focus on large to medium size mammal species. A block count along the Kuito river floodplains to record the presence of hippopotamuses and floodplain ungulates (Waterbuck, Lechwe, Reedbuck and Sitatunga) was also planned (A more detailed presentation of the aerial survey programme and research design can be found in Appendix II). The aerial survey design was stratified according to expected distribution of wildlife in the dry season, and ground information collected to date. However, as referred in 3.2, this primary activity was cancelled by the non cooperation of the Angolan aviation authority (Instituto Nacional de Aviação Civil – INAVIC) in providing a proper flyover clearance permit.

## **3.4 INDIRECT COUNTS**

### **3.4.1 RESEARCH DESIGN AND DATA COLLECTION**

Walking line transects represented the primary method used for conducting ground inventories. About 60% of all transects were conducted during the early to mid morning, as well as the late afternoon, to increase likelihood of direct observation of target species. A field team comprising six local technicians who live within the Mucusso Reserve and received training from the IRBM Biodiversity Programme, conducted the surveys. All local mammal trackers have extensive previous experience and knowledge in mammal identification and tracking skills.

Two-person teams—one observer and one navigator/recorder—conducted transects 2km in length, departing at a perpendicular angle from existing roads and tracks. Transects were set a minimum of 5km from each other to minimize recounting signs of the same individuals. The average rate of walking speed during the surveys was around 1 – 1.5km/h, resulting in a typical survey duration of 1.5 - 2 hours for each transect (not including return time). Transects were conducted as quietly as possible by avoiding loud talking and stepping on sticks or dry leaves.

Each team used a GPS to maintain the initial orientation bearing, and to determine the length and the starting and ending points of the transects. A total of 75 areas were surveyed in different locations and habitats types with a total of approximately 300km walked (not including walking to and from observation sites).

### **3.4.2 TRACK COUNTS**

Identifying, recording and interpreting tracks or spoor left by mammals provided a vital information source about mammal presence in the Reserve, particularly as opportunities to observe mammals directly in the field proved to be extremely limited. In some cases, spoor counts helped to establish qualitative assumptions on mammals' relative densities.

Spoor counts were done throughout the 75 different transect sites. The surface along the transect line was scanned for spoor of large to medium mammals. When encountered “fresh spoor” (in the present study assumed to be not older than 7 days) was assessed for species and group size. In this manner, observations of spoor were weighted by group size; therefore spoor refers not to a group, but to an individual animal. This allows for the calculation of “Spoor Density”, i.e. the number of individual animals spoor per km, and “Spoor Frequency”, or the number of kilometres per spoor.

### **3.4.3 SCAT COUNTS**

Like spoor, a scat or dropping represents an important indication of the presence of a certain species if this sign can be properly identified and recorded. Indices based on scat or droppings counts are frequently used to estimate abundances of certain large mammals, such as ungulates. However, the relationship between counts of faecal material and abundances or species numbers is often unpredictable, particularly due to the absence of well established local production and decay rates limiting the utility of scat for examining the density of populations based on dung counts. An exception is the Elephant. Average decay rates for the dung of this species have been established in the region. This decay rates were used to estimate elephant densities in areas of the Mucusso Reserve (see appendix I).

### **3.4.4 AUDITORY STATIONS**

Vocalization response recording has been used to identify the presence of mammals that communicate by loud vocalizations in several regions of Africa and elsewhere, and are traditionally not detected in aerial transect counts. (Kruuk, 1972; Harrington and Mech, 1982) This is one of the most effective method of establishing Lion and Spotted Hyena presence and density estimates. The technique involves broadcasting species-specific calls that cause animals to respond, and recording the number and location of response vocalizations. Vocalization response recording is one of the most cost-effective methods for assessing the presence of elusive predators such as lion and hyena. Several

constraints can influence the call rates, (i.e. the radius within which either the animals or observers respond to or detected calls): weather conditions; topography; vegetation cover; behavioural factors like daily and seasonal social dynamics, animal movement and activity level.

Calling stations were established in several locations inside the Mucusso Reserve, specifically targeting Spotted Hyena (*Crocuta crocuta*) and Lion (*Panthera leo*) as test samples for this method. In each test, vocalizations of the two species were independently broadcast . These vocalizations depicted sounds of long range calls, squabbling over food, struggling with other groups, and contests between lions and hyenas over a kill. The vocalizations were played for 2 hours per calling station, 2 hours after sunset, at intervals of 15 minute of call playing and 15 minutes of silence for response. None of the tentative tests produced response calls.

#### **3.4.5 OPPORTUNISTIC OBSERVATIONS AND INTERVIEWS**

All the observations of mammals made outside of the survey activities were also recorded, with the identification of the species, group size, sex, age, time and date of the contact, and the geographic location, as well as any other relevant information. This recording was regarded as complementary to the information collected along the transect line surveys. These observations were not systematic, being uncontrolled in terms of variables such as time of the day, season and location. Therefore, specific calculations presented in the report do not include this data. However, opportunistic observations provided reliable, geo-referenced species presence data. The scarcity of direct observations also provided an indication of the low density of mammals in accessible areas of the Reserve.

In order to enlarge the scope of information about mammal composition and status in the Reserve, as well as to identify trends and threats, interviews using semi structured questionnaires targeting key villagers living in the Mucusso Game Reserve have been conducted. These interviews provide historical and present anecdotal information on the larger mammal species that originally occurred in the area, with special attention to 3 species: Black Rhinoceros (*Diceros bicornis*), Lion (*Panthera leo*) and Cheetah (*Acinonyx jubatus*) (refer to Appendix III). Each sighting identified in the interviews is associated with a geographic place name. An extensive effort has been underway to acquire geographic coordinates for locations in the reserve that have place names, a fundamental tool in the understanding of the geographic layout perceived by local residents.

# 4.0 DATA MANAGEMENT

A GIS database was developed to assist in entering, editing, storing, analysing and reporting biological and environmental spatial information. No datasets concerning mammal distribution existed for the Mucusso Reserve area prior to the present inventory, other than the book on the historical presence of ungulates of Angola (Cabral and Verissimo, 2005). All field data gathered was entered into the GIS data base. All data layers are readily usable in ArcGis/ArcView format, in WGS84 UTM 34S coordinate system. Each data layer contains a descriptive attribute table that provides information on each data entry point, and can be used to prepare products such as maps, tabular summaries, statistical assessments and reports.

The Mucusso Reserve GIS mammal database includes not only field data from the present survey, but also regional data from past mammal surveys in Namibia and Botswana. GIS datasets were identified for areas bordering Southeast Angola through consultation with regional partners in Namibia and Botswana, namely: the Namibia Ministry of Environment and Tourism of Namibia (MET) and the Botswana Department of Wildlife & National Parks. Datasets were not acquired if they contained only records prior to 1975, or site localities were not accurately geographically specified.

The database was augmented with important geographically referenced information for planning and contextualizing biodiversity inventories and management, including:

- geographically referenced ortho-photographs for the Kavango and Caprivi regions,
- ortho-satellite maps from 2002 and 2006 satellite imagery,
- geographic features for the Mucusso Reserve extracted from topographic maps, and acquired during field work,
- georeferenced topographic maps for the Mucusso Reserve of Angola, and the Kavango and Caprivi regions of Namibia. and
- SRTM Digital Elevation Model with a resolution of 90 meters for the whole of the Kuando Kubango province.

This database will serve as an important reference to the future tasks within the Biodiversity Programme for Kuando Kubango, including:

- updating and improving of the mammal diversity knowledge of the Mucusso Game Reserve;
- identification of areas of high species diversity or abundance;
- refinement and/or creation of fauna distribution models;
- classification of ecosystems;
- zonation of areas within the Reserve; and
- establishment of long term biodiversity monitoring sites or programs as part of implementing directives.

# 5.0 RESULTS

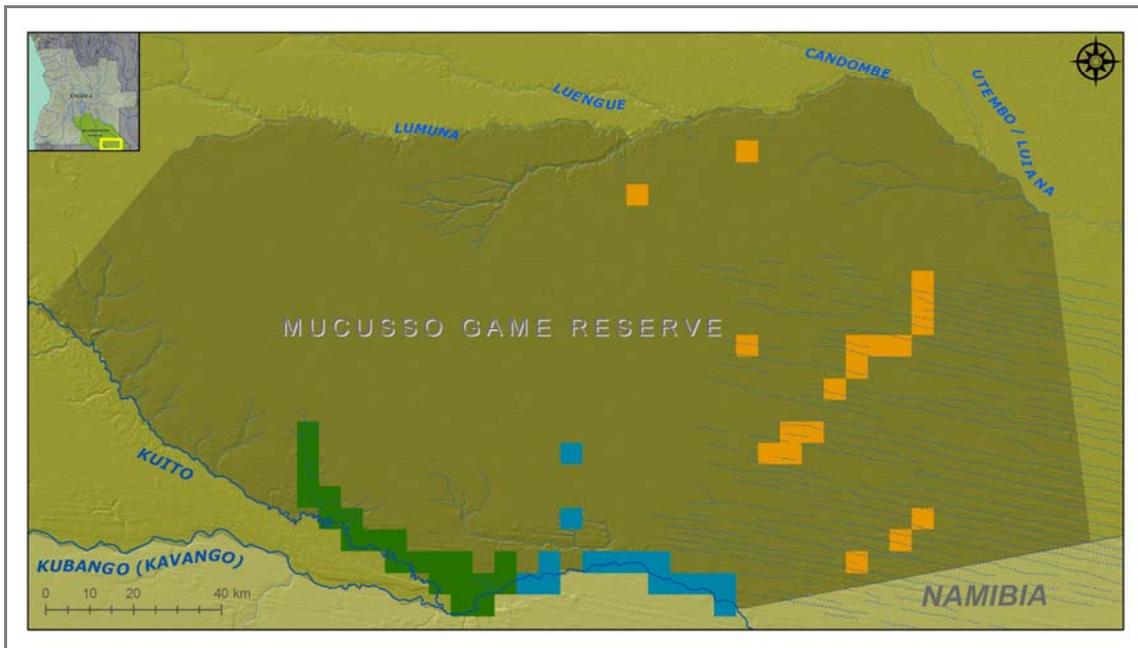
Of a total of 39 different species of mammals reported during the survey in the reserve so far (Table 2), 29 account has focal target species. No direct indication of the presence of the other 13 focal target species has been secured to-date, although collected reports from the inquiries have produced additional information (section 5.1.3).

**TABLE 2. LIST OF SPECIES CONFIRMED TO BE PRESENT IN THE MUCUSSO GAME RESERVE. TARGET SPECIES OF THE INVENTORY (LARGE TO MEDIUM MAMMALS) ARE IN BOLD.**

Species	Scientific name	Kuito Block	Kubango Block	Eastern Block
<b>Vervet monkey</b>	<b><i>Cercopithecus aethiops</i></b>	•		•
Southern Lesser Galago	<i>Galago moholi</i>			•
Scrub Hare	<i>Lepus saxatilis</i>	•	•	•
Tree Squirrel	<i>Paraxerus cepapi</i>	•	•	
Spring Hare	<i>Pedetes capensis</i>			•
<b>Porcupine</b>	<b><i>Hystrix africaeaustralis</i></b>	•	•	•
Greater Cane Rate	<i>Thryonomys swinderianus</i>			•
<b>Bat-eared Fox</b>	<b><i>Otocyon megalotis</i></b>			•
<b>Side-striped Jackal</b>	<b><i>Canis adustus</i></b>			•
<b>Wild Dog</b>	<b><i>Lycaon pictus</i></b>	•	•	•
<b>Cape Clawless Otter</b>	<b><i>Aonyx capensis</i></b>	•		
<b>Honey Badger</b>	<b><i>Mellivora capensis</i></b>	•	•	•
Striped Polecat	<i>Ictonyx striatus</i>	•		
Banded Mongoose	<i>Mungus mungo</i>	•		
Large Grey Mongoose	<i>Herpestes ichneumon</i>	•		
Slender Mongoose	<i>Galerella sanguinea</i>	•		•
Small-spotted Genet	<i>Genetta genetta</i>	•		
<b>African Civet</b>	<b><i>Civettictis civetta</i></b>		•	
<b>Spotted Hyena</b>	<b><i>Crocuta crocuta</i></b>	•	•	•
<b>African Wild Cat</b>	<b><i>Felis lybica</i></b>	•	•	•
<b>Serval</b>	<b><i>Leptailuruss serval</i></b>	•		
<b>Caracal</b>	<b><i>Caracal caracal</i></b>	•	•	•
<b>Leopard</b>	<b><i>Panthera pardus</i></b>	•		•
<b>Aardvark</b>	<b><i>Orycteropus afer</i></b>	•	•	•
<b>African Elephant</b>	<b><i>Loxodonta africana</i></b>	•	•	•
<b>Common Warthog</b>	<b><i>Phacochoerus africanus</i></b>	•	•	•
<b>Bushpig</b>	<b><i>Potamochoerus larvatus</i></b>	•		•
<b>Hippopotamus</b>	<b><i>Hippopotamus amphibius</i></b>	•	•	
<b>Giraffe</b>	<b><i>Giraffa camelopardalis</i></b>			•
<b>African Buffalo</b>	<b><i>Syncerus caffer</i></b>	•	•	•
<b>Greater Kudu</b>	<b><i>Tragelaphus strepsiceros</i></b>	•	•	•
<b>Sitatunga</b>	<b><i>Tragelaphus spekei</i></b>	•		
<b>Bushbuck</b>	<b><i>Tragelaphus scriptus</i></b>	•		
<b>Roan</b>	<b><i>Hippotragus equinus</i></b>	•	•	•
<b>Sable</b>	<b><i>Hippotragus niger</i></b>	•	•	•
<b>Lechwe</b>	<b><i>Kobus leche</i></b>	•		
<b>Common Reedbuck</b>	<b><i>Redunca arundinum</i></b>	•	•	
<b>Steenbok</b>	<b><i>Raphicerus campestris</i></b>	•	•	•
<b>Common Duiker</b>	<b><i>Sylvicapra grimmia</i></b>	•	•	•
<b>Total = 39 species</b>		<b>32</b>	<b>20</b>	<b>26</b>

The arrangement of the survey areas can be grouped in 3 different sectors, based on their environmental conditions and human presence: the Kuito block, the Kubango block and the Eastern block (Figure 2).

**FIGURE 2. MGR LINE TRANSECTS SURVEY SECTORS; KUITO IN GREEN, KUBANGO IN BLUE, EASTERN IN ORANGE.**



## 5.1 SPECIES ACCOUNTS

### 5.1.1 DETECTED TARGET SPECIES

The distribution figures in this section depict the georeferenced information of sightings and indicia collected during the present survey on the target confirmed species. In considering these maps, the bias referred to previously must be kept in mind. The maps do not necessarily represent the limits of species distribution in the Mucusso Game Reserve, and should not be used to extrapolate quantitative values. They are nevertheless, important from a preliminary assessment point of view since MGR was never surveyed for information on mammal distribution.

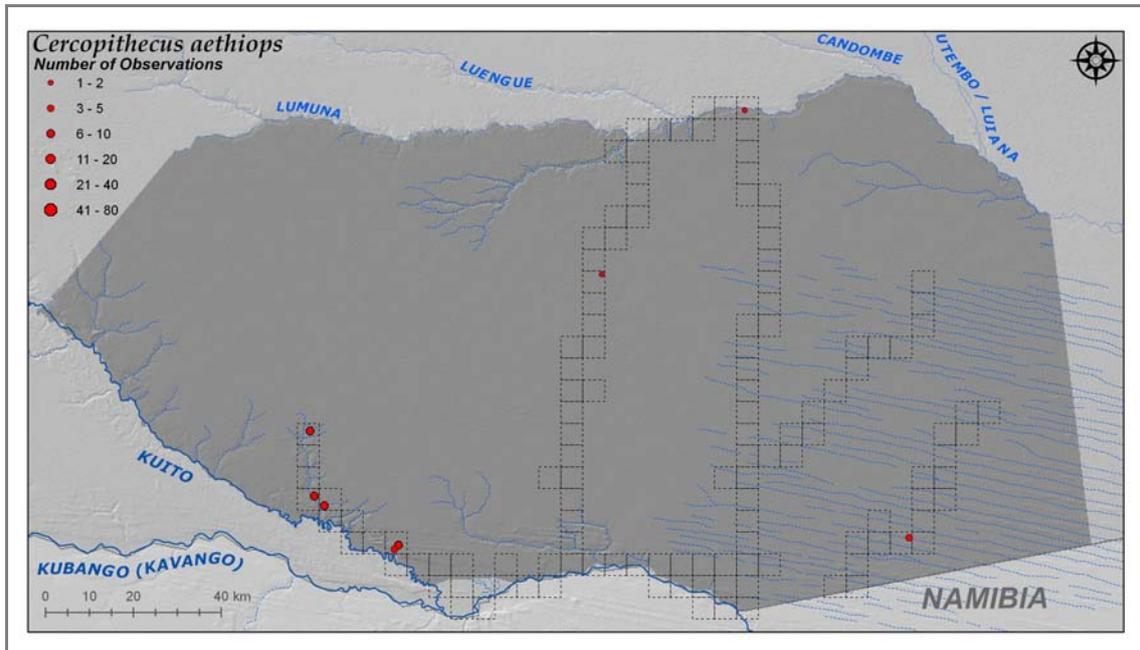
#### 5.1.1.1 ORDER PRIMATES

##### VERVET MONKEY (*CERCOPITHECUS AETHIOPS*)

This species was recorded 42 times during the present survey. 88% of the observations were concentrated along the Kuito river sector, where the habitat of riverine forest and wooded/thicket mosaics is more favourable for the species requirements. The lack of records along the Kubango river might indicate the scarcity or even the local disappearance of the species in this area by influence of human persecution and habitat degradation (almost all the river front has been impacted by human exploitation, with the remaining riverine forest pockets remaining only in the islands).

The identification of 5 individual tracks in the eastern sector of MGR in the early dry season, accounts for the present of the species along the wooded margins of the *omurambas*, at least until the temporary lagoons have water. The groups recorded vary between 5 and 10 individuals. The survival of this species in the reserve his apparently secure, as long has the conditions of habitat and low human presence, namely along the Kuito river, remain, being the only exception the Kubango river front.

**FIGURE 3. RECORDED OBSERVATIONS OF VERVET MONKEY. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**

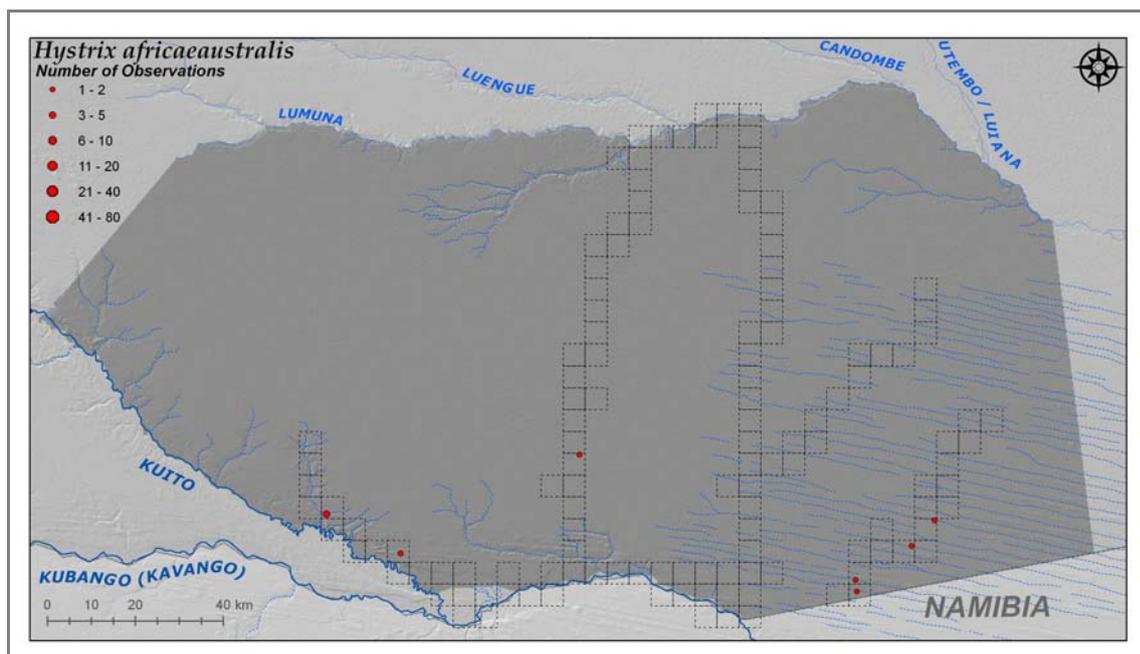


**5.1.1.2 ORDER RODENTIA**

**PORCUPINE (HYSTRIX AFRICAEAUSTRALIS)**

Porcupine evidences were seldom recorded, although it is assumed that this species is common overall in the reserve, since its cryptic and nocturnal habits account for the scarcity of results in the areas surveyed. The lack of signs of the species along the Kubango can also be a result of human disturbance, related to direct persecution for food and crop raid issues.

**FIGURE 4. RECORDED OBSERVATIONS OF PORCUPINE. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



### 5.1.1.3 ORDER CARNIVORA

Data on the distribution of larger carnivores are limited, largely related to low population sizes and extremely secretive habits of this group of species, reducing considerably the opportunities of encounters during surveys. This facts must be considered while analysing the following information.

#### **BAT-EARED FOX (*OTOCYON MEGALOTIS*)**

The presence of this species is presently confirmed in MGR by only one direct observation of two individuals in the center-north of the reserve. Mostly a nocturnal animal, the Bat-eared Fox is presumed to be more frequent in the open areas of the eastern part of MGR. The presence of harvester termites can account also for patterns of distribution of the species in the area.

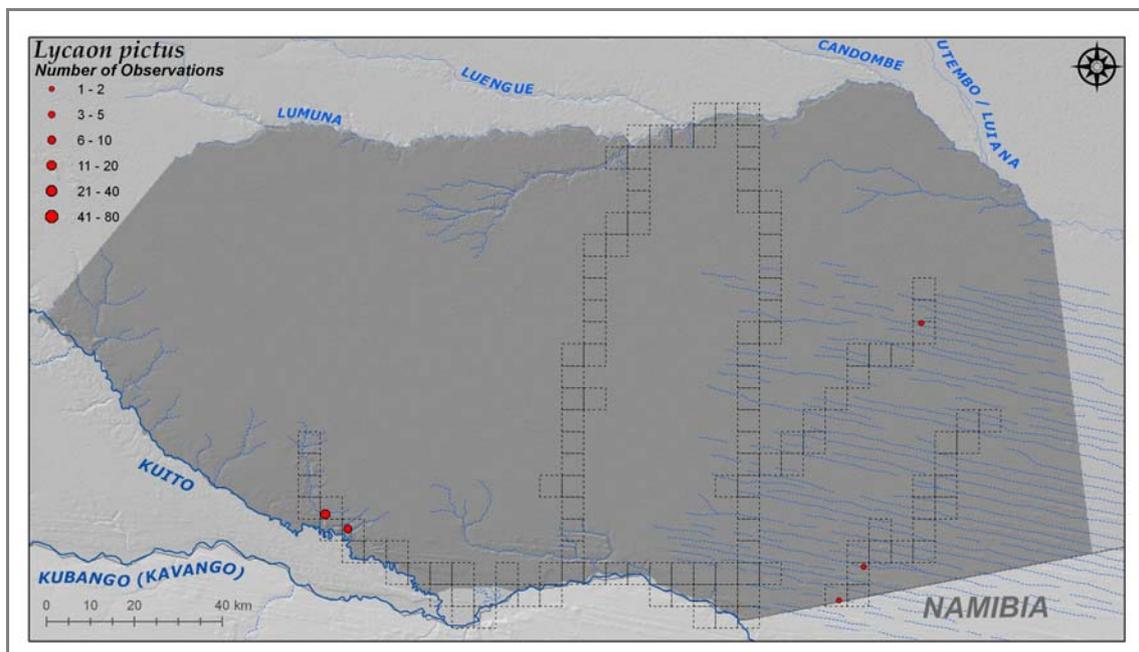
#### **SIDE-STRIPPED JACKAL (*CANIS ADUSTUS*)**

During the survey only one observation accounts for this species, in the far south-eastern side of the reserve near the border between Angola and Namibia. The overall absence of record for the species apparently indicates that in MGR the Side-striped Jackal is uncommon and scarce.

#### **WILD DOG (*LYCAON PICTUS*)**

This is an endangered species and still persecuted through its range in the region. The presence of this animal is confirmed in the reserve by a number of direct and indirect sightings during the survey. From the transect observations, 2 different packs were sighted in the Kuito sector with 12 and 6 individuals respectively. Other evidences in the east of the reserve also attend for the movement of this animal close to the border of Luiana Partial Reserve and Namibia.

**FIGURE 5. RECORDED OBSERVATIONS OF WILD DOG. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



Local interviews and opportunistic records testify for the visual observation in the month of May of two groups of wild dogs, one composed by 6 individuals in the area of Thiruka, and another of 10 elements close to Katunda, both this locations situated in the Kubango block. Considering the long range movements of the species there is no definite certainty that one or more of the groups observed was the same in different spatial and temporal locations, although the low densities of prey species might corroborate the potential large home range of the species in the MGR, namely a transboundary year round movement.

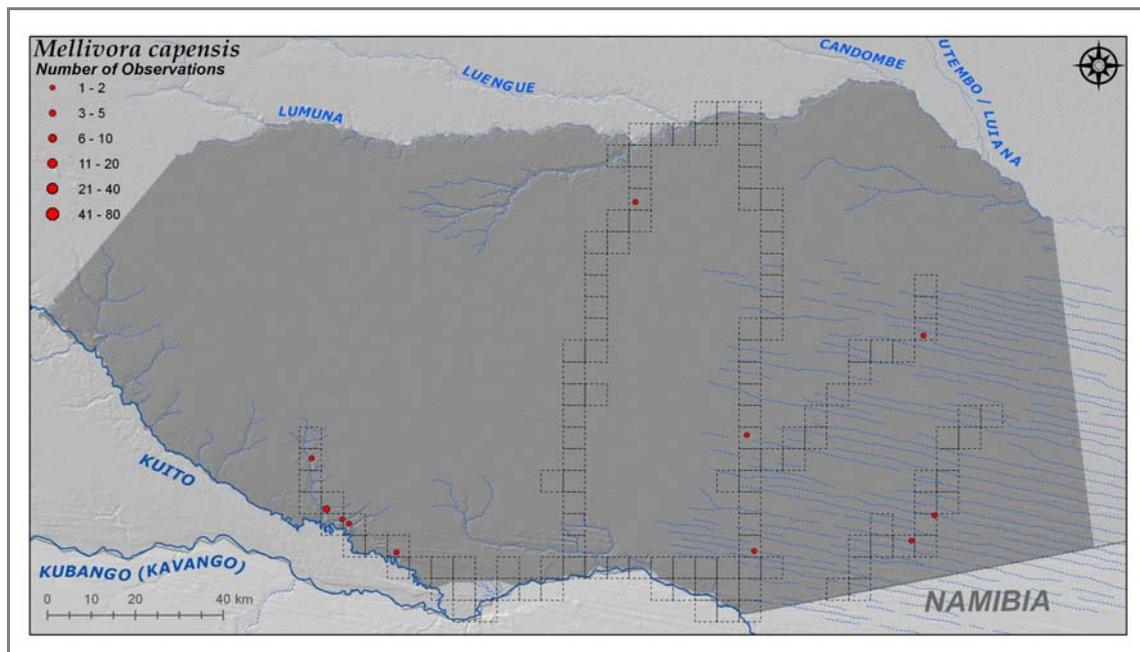
### CAPE CLAWLESS OTTER (*AONYS CAPENSIS*)

The presence of the species has been secured in the Kumbilo area, a wetlands and floodplains system in the confluence of the Kuito and Kubango rivers. No dedicated surveys efforts have been attempted so far for the collection of evidences for this species or the Spotted Neck Otter (*Lutra maculicolis*), although information obtained from local inquires suggest that both are present along the Kubango and Kuito rivers, bordering the reserve.

### HONEY BADGER (*MELLIVORA CAPENSIS*)

The presence of this species was recorded in several locations, widespread over the reserve. The Honey Badger is a common predator in the area, and its survival is naturally secured.

**FIGURE 6. RECORDED OBSERVATIONS OF HONEY BADGER. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



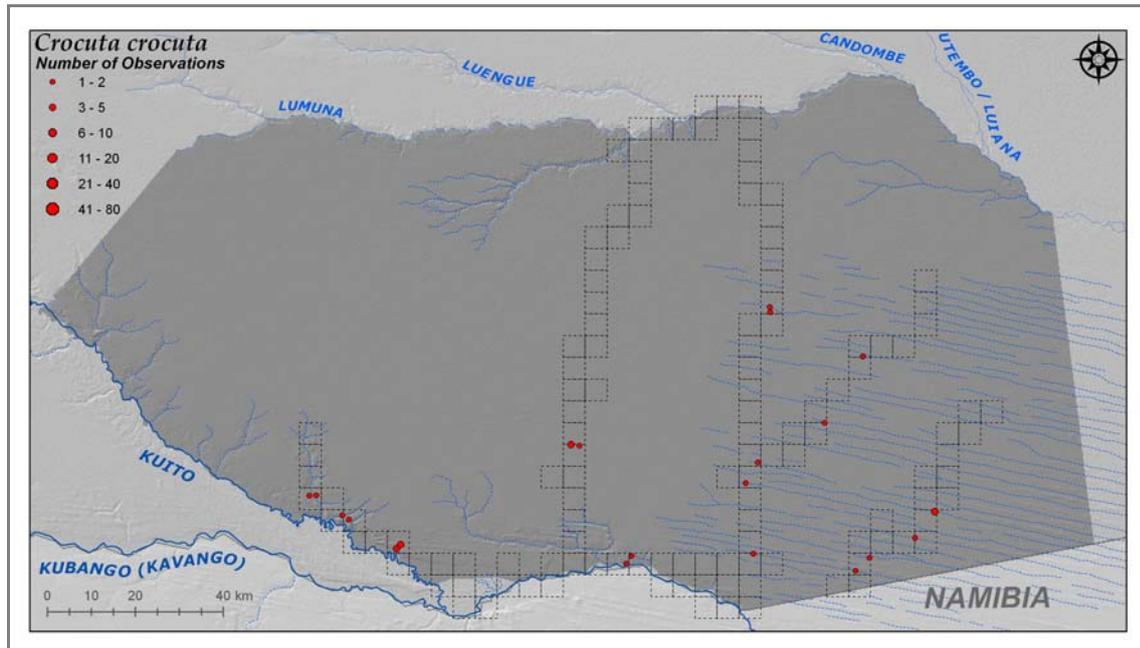
### AFRICAN CIVET (*CIVETTICTIS CIVETTA*)

Only two records were secured thus far for this species in the reserve; one near the Kubango river, in the South, and the other in the woodlands bordering the Luengue river, in the North. Considering the habitat preferences of the species, and the nocturnal and crepuscular animal activity, the present distribution of the Civet in MGR should be concentrated along wooded sectors bordering the rivers Kuito, Kubango, Luengue and Luiana.

### SPOTTED HYENA (*CROCUTA CROCUTA*)

Occurrence of Spotted Hyena was recorded in all of the 3 sector blocks, with a total of 27 observations. In terms of proportion, the Kuito accounted for 44%, the Eastern 33% and Kubango 19%, of the observations, respectively. This large predator, was nevertheless never sighted in groups. Most of the records account for isolated individuals or pairs, which might reflect the lack of abundant prey to support the establishment and development of clans. Furthermore, some predation on domestic livestock has been referred to this species, particularly along the Kubango river, with a potential attack reported in the month of October in the area of Temwangue, where apparently an undetermined number of goats was target by a pair of Spotted Hyenas. This events may also contributed to direct persecution.

**FIGURE 7. RECORDED OBSERVATIONS OF SPOTTED HYENA. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



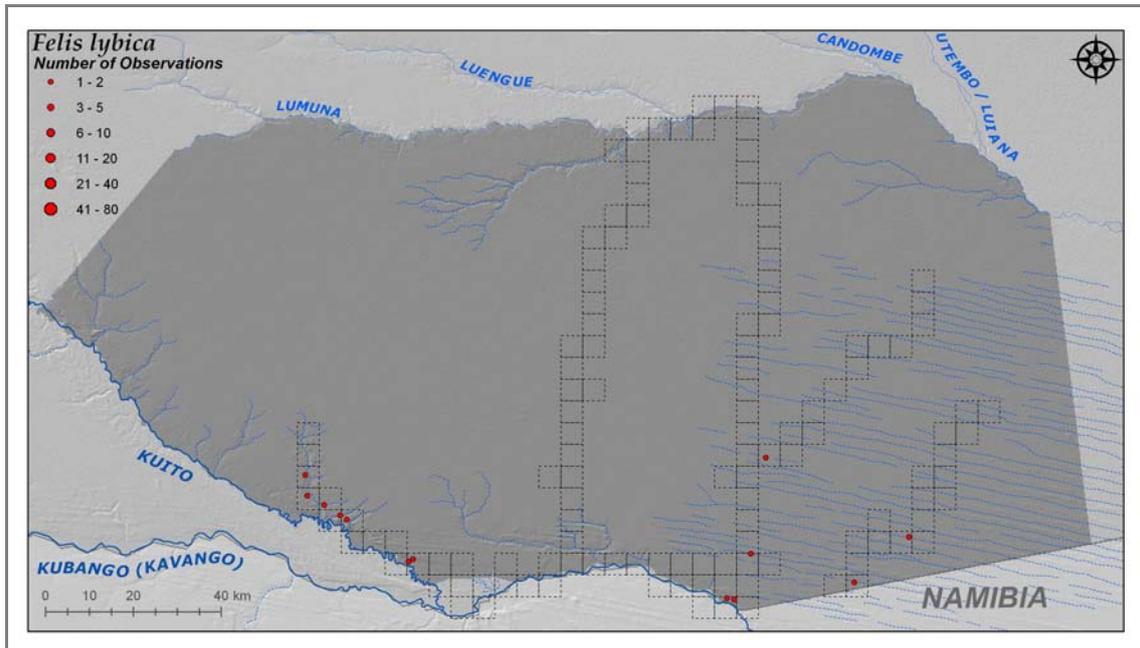
As for other species of large predators, the preliminary indications are that Spotted Hyena occurs in low densities in the MGR, with an overall uncommon presence in most of the reserve.

#### **AFRICAN WILD CAT (*FELIS LYBICA*)**

Evidences for this species were collected in all the 3 sectors, with the bulk (66%) of the records in the Kuito block. The Wild Cat is assumed to be generally widespread in the reserve, although in naturally low densities. The availability of small prey species for this predator is presumed overall to be in healthy numbers and the cryptic habits of the animal prevent him to be a target and persecuted.

The immediate threat to the wild population is potentially the inbreeding with domestic cats, although the later seams to be absent from most of the human settlements inside or bordering the reserve.

**FIGURE 8. RECORDED OBSERVATIONS OF WILD CAT. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**

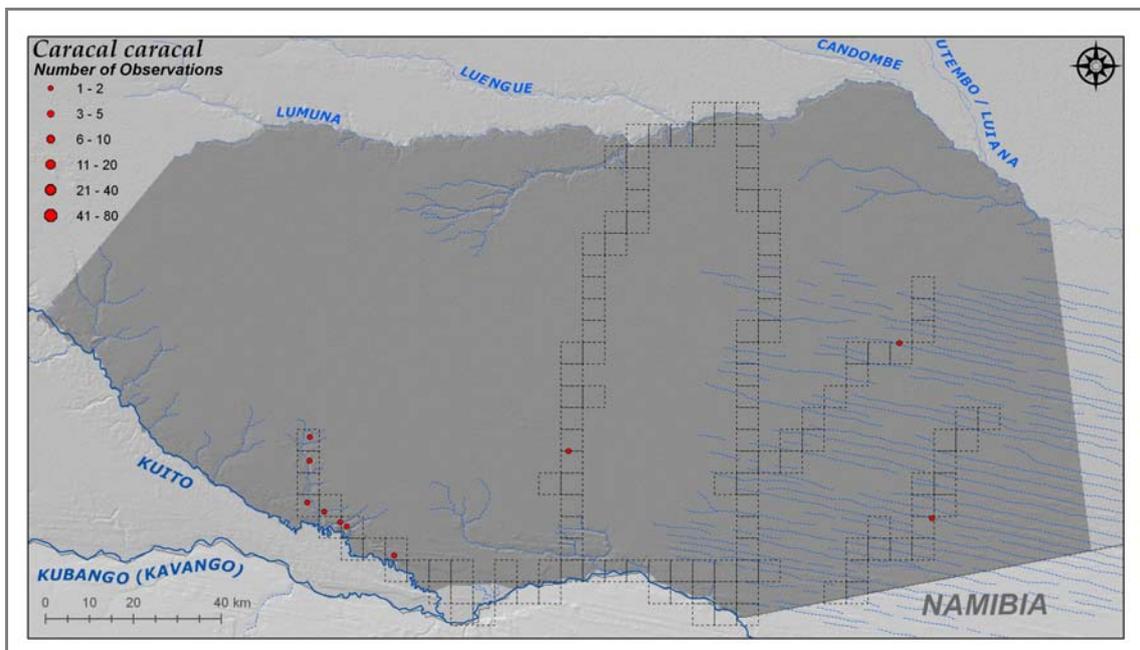


**SERVAL (LEPTAILURUS SERVAL)**

Only one record confirmed the presence of the species, along the open woodland belt near the Kuito river. The absence of further records might reflect the scarcity of typical habitat for the species in the areas surveyed thus far, or a regional low density of the species.

**CARACAL (CARACAL CARACAL)**

**FIGURE 9. RECORDED OBSERVATIONS OF CARACAL. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



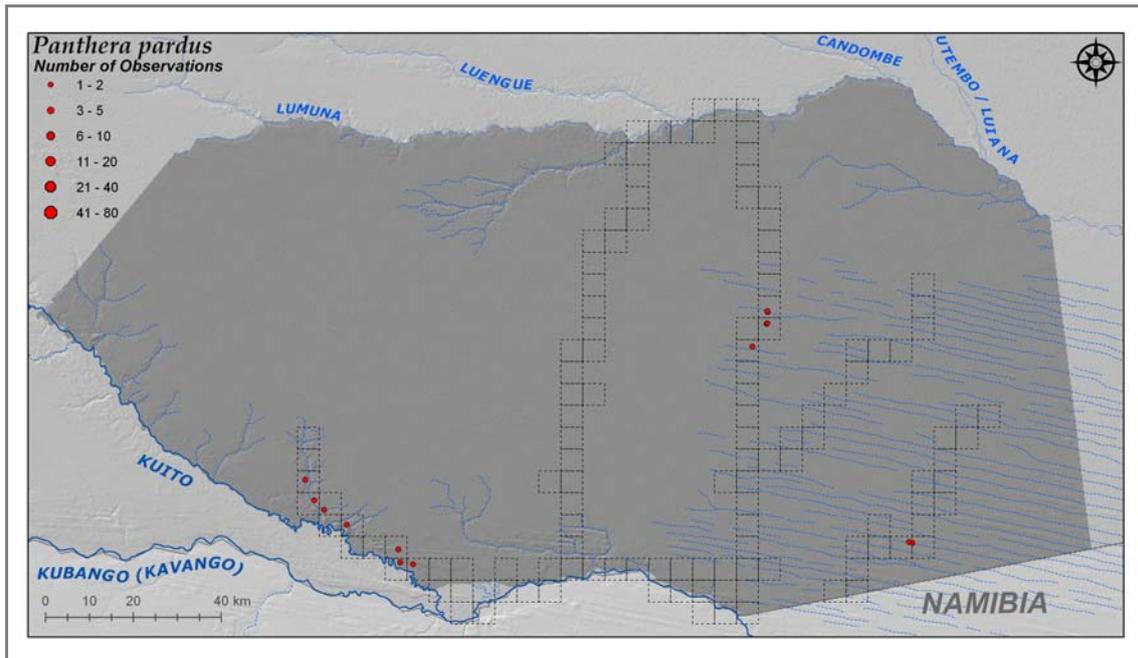
The presence of Caracal was confirmed by 7 observations in the Kuito block, 2 in the east and 1 in the south central portion of the reserve. The species, might be considered widespread in the area with a

potential stable nuclei in the west. Nevertheless, the scarcity of information for other areas prevent a more synoptic assessment.

### LEOPARD (*PANTHERA PARDUS*)

The leopard observations were recorded with a preponderance of indicia along the Kuito, representing 85% of all the data collected on the species in MGR. This fact points to the perception that the concentration of leopard records is related to the better conditions of the ecosystem in what concerns habitat and prey species availability.

**FIGURE 10. RECORDED OBSERVATIONS OF LEOPARD. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



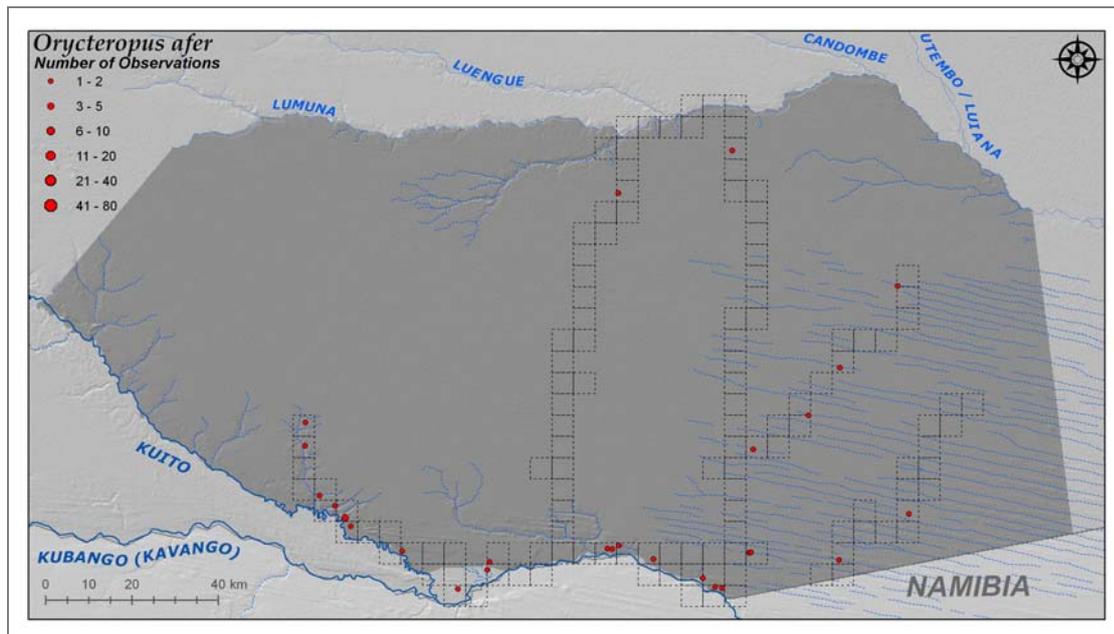
No information was secured along the Kubango sector, which might account for the scarcity of the species in the more densely populated area of the reserve. Other records were collected in the “omurambas” system in the eastern section where the presence of prey species is also verified. The overall condition of the species in the MGR is here suggested as secured, on the bases that habitat and prey conditions improve. Although uncommon, the species is perceived, from information collected from interviews, to be present in most of the area.

#### 5.1.1.4 ORDER TUBULIDENTATA

##### AARDVARK (*ORYCTEROPUS AFER*)

This species is widespread in the area, being recorded in all three sectors. Although nocturnal and secluded, the number of indirect signs attest for the wanderings of this animal in the majority of habitats surveyed. The Aardvark is assumed to be relatively common, nevertheless rarely observed directly. The patterns of distribution will be in fact directly related with the availability of its primarily food sources: ants and specially termites. The more frequented habitats of the species in the reserve are the open woodland, sparse scrub and grasslands.

**FIGURE 11. RECORDED OBSERVATIONS OF AARDVARK. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**

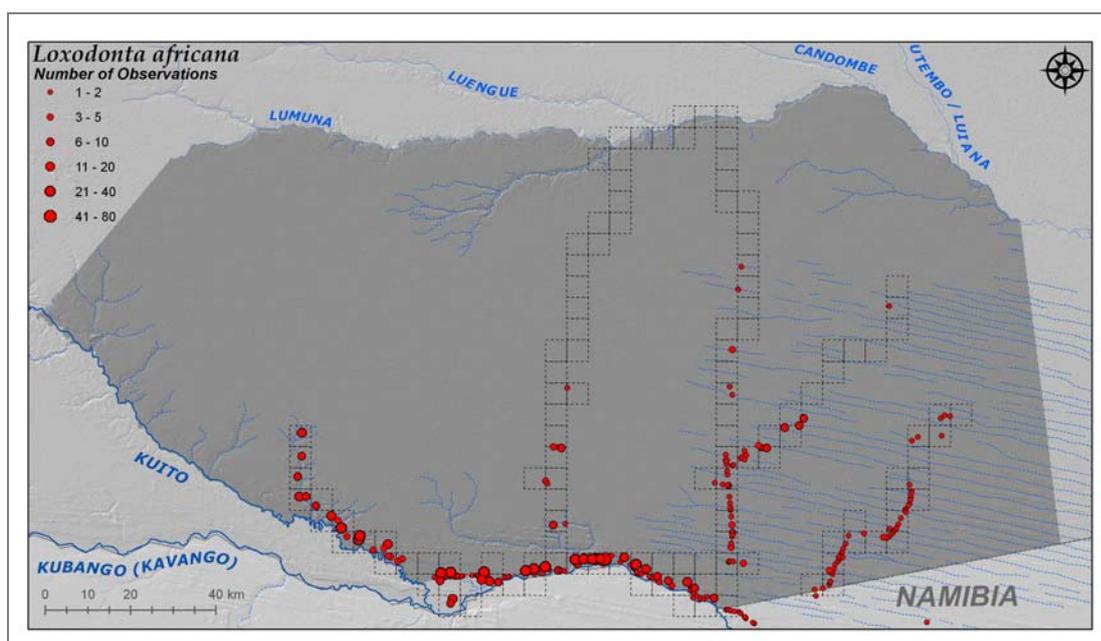


**5.1.1.5 ORDER PROBOSCIDEA**

**AFRICAN ELEPHANT (*LOXODONTA AFRICANA*)**

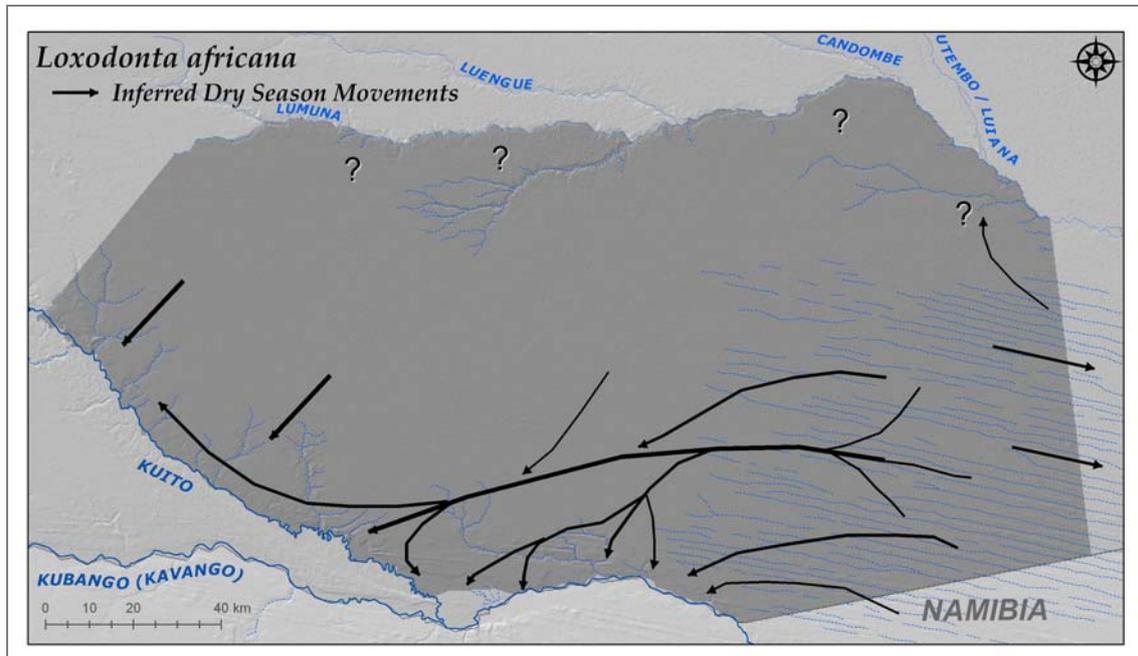
The presence of elephants was confirmed (considering the period – dry season) predominantly along the Kuito and Kubango rivers, where the availability of water resources determines these concentrations in the dry season. In the Eastern sector, well established elephant paths exist along the *omurambas*, serving as communication routes that link Western Caprivi, and Luiana P.R. to MGR. Has assumed from satellite tracking elephants data (KAZA/Caprivi Elephant Tracking Programme), long distant movements take place in this region, with individuals travelling from Caprivi, westwards to the Kuito river.

**FIGURE 12. RECORDED OBSERVATIONS OF ELEPHANT. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



The movements of the elephants inside, and to and from the reserve, are being accessed, but a preliminary inferred draft is here presented (Fig. 13). The species presence was regularly confirmed in the Eastern sector until late June, when the temporary lagoons and mud holes started to dry up. From this date onwards the reduced elephant activity in the area is assumed to be related with the movement of the herds, either south-eastwards in the direction of the Kwando river, or westwards in the direction of Kubango and Kuito. There is also the possibility of movement towards the North, intercepting the Nota and Luengue-Luiana (Utembo) drainage, although not yet verified in the field.

**FIGURE 13. INFERRED ELEPHANT DRY SEASON MOVEMENT IN SOUTHERN MGR**



During the months of July and August, the presence of elephant herds was increasingly frequent along the Kubango river front, as testified by numerous encounters by the local residents and team members. Also during this time, particularly in July, the raids on crops by elephants was confirmed in several locations between Mucusso village and Chamutue along a 50km river front. The period in reference (2007 dry season) was particularly dry, accounting for the depletion of inland seasonal water resources that usually remain available until late in the season, by being exhausted earlier this year. Further surveys along the Kuito river in the second half of the dry season testified a high concentration of elephant presence in this sector, the highest in all the surveyed areas so far visited.

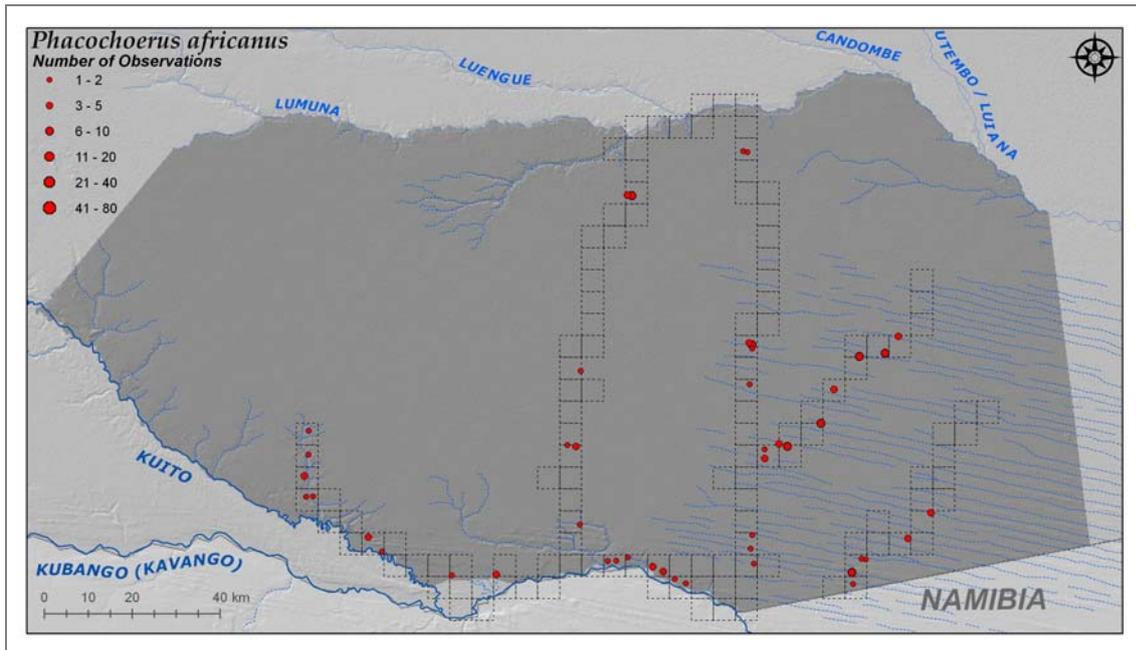
No substantial information has been compiled thus far for the northern sector of the reserve, related to elephant movement and distribution. A tentatively population assessment for the specie in the 2007 dry season was conducted in the Lower Kuito and Kubango blocks, based on indirect indicia (please refer to Appendix I), from which an estimate of  $1117 \pm 142$  and  $234 \pm 2$  individuals, respectively, was obtained.

#### 5.1.1.6 ORDER SUIFORMES

##### COMMON WARTHOG (*PHACOCHOERUS AFRICANUS*)

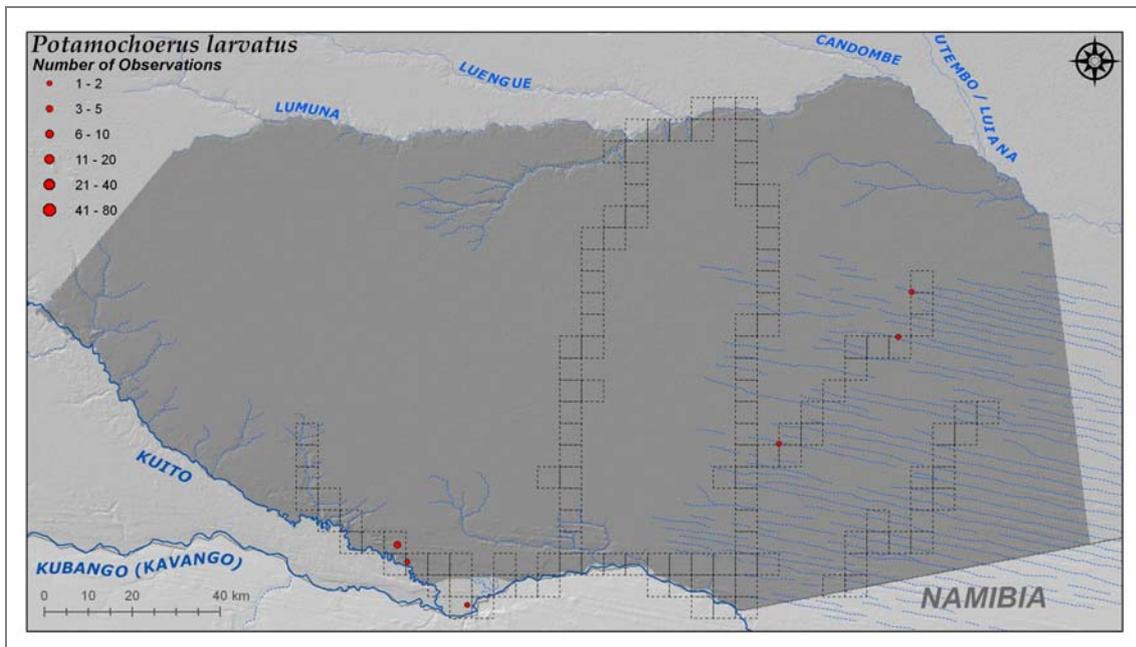
Most of the records secured for the species came from the Eastern sector, representing 66% of all observations. In this area, the habitat of interspaced fossil dunes with open wooded savannah and grass/shrubbed savannah in the interdune *omurambas* provides optimum habitat for the species. Elsewhere the Warthog is nevertheless widespread and accounts as an overall common species in the MGR.

**FIGURE 14. RECORDED OBSERVATIONS OF WARTHOG. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



**BUSHPIG (POTAMOCHOERUS LARVATUS)**

**FIGURE 15. RECORDED OBSERVATIONS OF BUSHPIG. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



The presence of this species was only confirmed in a few locations, with most of the observations (73%) along the Lower Kuito. Since the requirements of the Bushpig, in terms of habitat and availability of water, confine the species mainly along the wooded margins of the permanent water courses, it's presumed that the major bulk of the population is concentrated along the Kuito river. Although no direct survey information was obtained for the Kubango sector, anecdotal information suggests the presence of a few scattered individuals in this area, though heavily persecuted both for meat and as a crop problematic species.

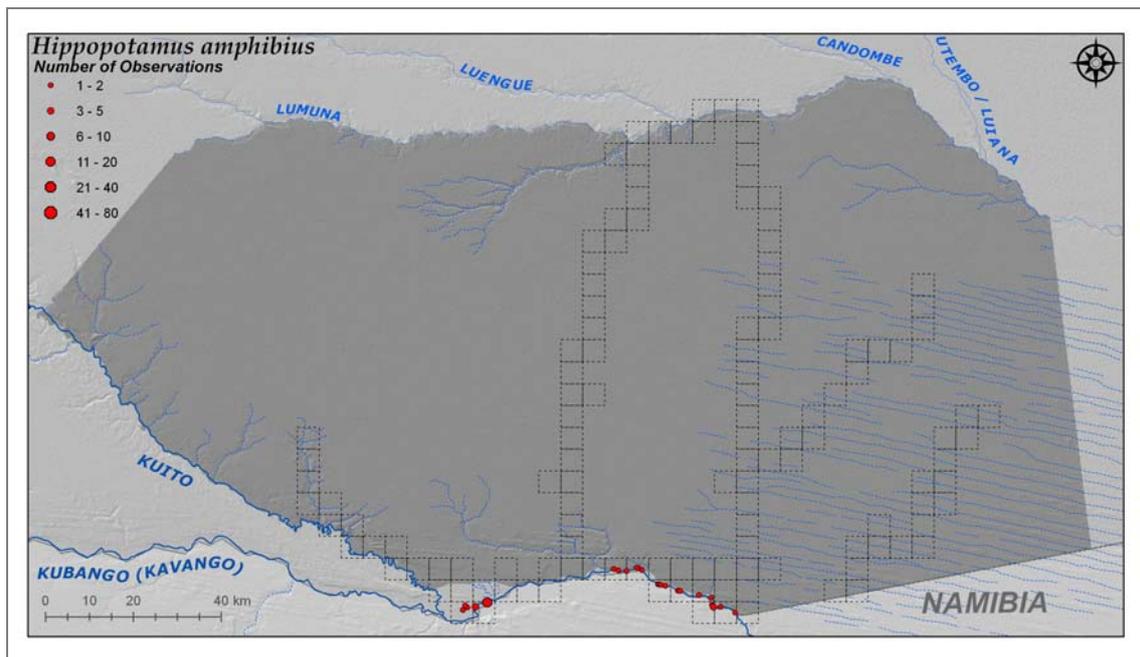
In the early wet season, a set of tracks was identified as this specie in the Eastern part of the reserve. This information is presented, but with some reservations, considering the fact that this area has only limited water resources by the end of the dry season.

**5.1.1.7 ORDER WHIPPOMORPHA**

**HIPPOPOTAMUS (HIPPOPOTAMUS AMPHIBIUS)**

Findings from the hippopotamus surveys indicate that hippos are sparse in most of the Kubango river front. The main population of hippos is concentrated in the vicinity of the Kumbilo wetlands system (floodplain and wetlands system in the Kuito river mouth). In other areas, hippos occur as vagrant individuals, or in very small groups (2-3 individuals).

**FIGURE 16. RECORDED OBSERVATIONS OF HIPPOPOTAMUS. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



The Kumbilo wetlands have the highest concentration of hippopotamus along the entire international Kubango river. Interviews with local residents indicate that approximately 31 hippopotamus live in the Kumbilo system. Based on the findings of the Team’s hippopotamus research along the Kubango River, the Kumbilo hippo community may comprise more than 80% of all hippopotamus on the section of the Kubango (Kavango) river between the Kuito confluence and where the Kubango River departs from Angola. Their protection is therefore essential to the long-term survival of the local hippopotamus population. No evidence of the species has been secured further upstream along the Kuito river which might indicate either a very low density or even the local extinction of the species in this section of the river. Furthermore, information collected in the north of the reserve, along the Luengue river, suggest also that the former presence of the species in this section of the Kwando drainage is no longer a reality, due to direct human persecution.

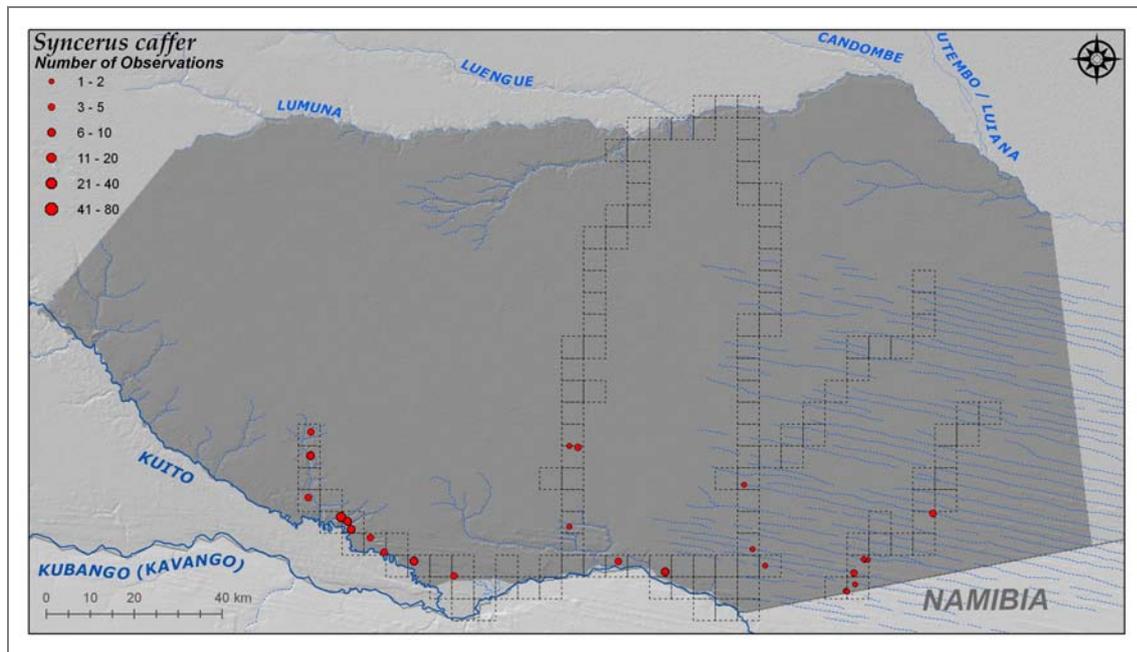
**5.1.1.8 ORDER RUMINANTIA**

**GIRAFFE (GIRAFFA CAMELOPARDALIS)**

Only one definitive record accounts for the presence of the species in MGR thus far. On March, a herd of 11 individuals was observed in the east of the reserve, along the fossil dune belt, less than 20km from the Caprivi border. Further anecdotal information collected, attest the presence of Giraffe not only in the east of the reserve but also in the central belt between the Kubango/Kuito watershed and the Northern Luengue and Lumuna rivers, although their presence is apparently more frequent in the East. The species is assumed to be uncommon in reserve.

## AFRICAN BUFFALO (*SYNCERUS CAFFER*)

FIGURE 17. RECORDED OBSERVATIONS OF BUFFALO. SHADED GRID REPRESENTS VISITED 5X5KM UNITS



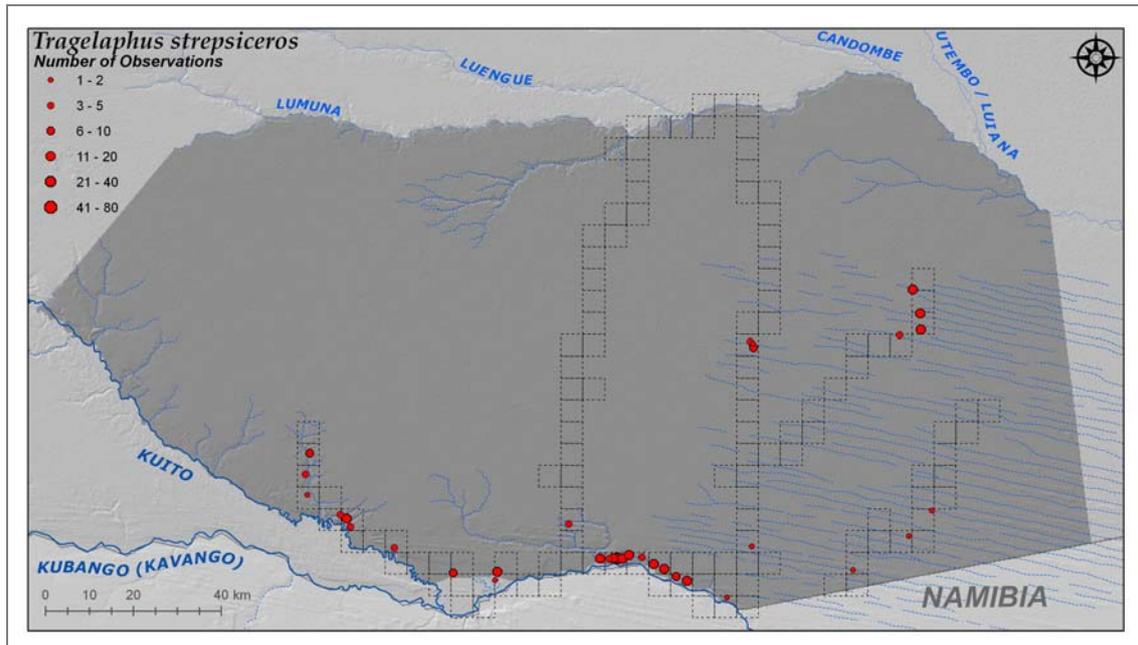
Evidences of Buffalo were confined to the south of the survey area, namely along the Kuito and parts of the Kubango. This fact can be addressed considering the dry season period when the species moves towards the permanent water resources. 65% of the observations concentrated in the lower Kuito, and 20% in the Kubango. This species mirrors in part the pattern in distribution observed in the Elephant. In fact, along the eastern and south central surveyed areas, both Buffalo and Elephant use the same paths, align in a general South-east – North-west direction.

The herds detected, range from 6 to 12 individuals attesting a low population of the species even in the areas where the presence is potentially more dense (Lower Kuito) inside the reserve. The movement of buffalo is not confined inside the MGR, the species moves to and from the reserve, towards Luiana P.R. and Western Caprivi, potentially following well established seasonal movements.

## GREATER KUDU (*TRAGELAPHUS STREPSICEROS*)

Kudu is probably the most numerous of the larger antelopes of the MGR, although because of their cryptic habits they are not easily seen. They are widely distributed in the reserve and, surprisingly, according to the preliminary results they are more frequently detected in the Kubango sector (53% of all observations). The Kudu might be considered relatively common in areas surveyed in the reserve.

**FIGURE 18. RECORDED OBSERVATIONS OF KUDU. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**

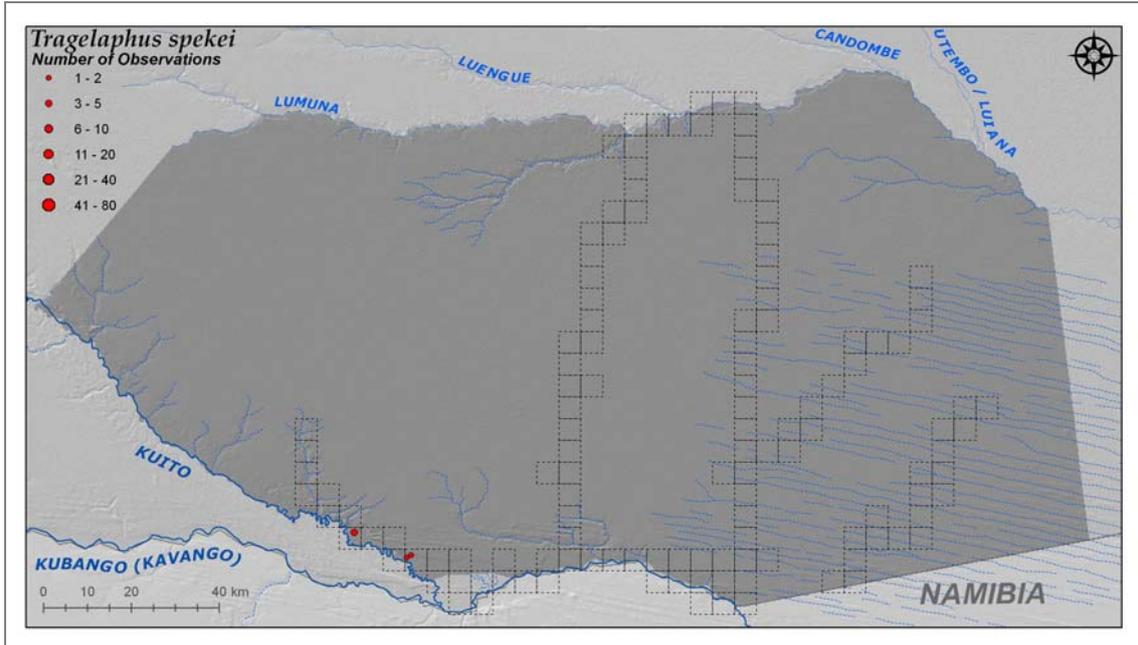


#### **SITATUNGA (TRAGELAPHUS SPEKEI)**

The presence of Sitatunga has been confirmed in MGR only in the Kuito system. So far, along the survey transects 7 different sets of Sitatunga tracks were identified in three separate locations. The species habits and habitat; a very shy antelope and normally solitary (although connected to a loosely knit herd), confined to the reedbeds in permanent swampy areas during the day, only venturing in the floodplains and surrounding riparian forest only during the night makes the observation (direct and indirect) of the species rather uncommon.

Anecdotal reports were collected stating the presence of the Sitatunga in the Kumbilo wetland system, in the mouth of the Kuito river. No evidence was secured of the presence of this antelope along the Kubango river section, which highlights the human impact in the habitat and mammal communities along the river bank. Nevertheless, it was stated by several residents that the antelope inhabits some of the river islands of the Kubango, along the Angola/Namibia border.

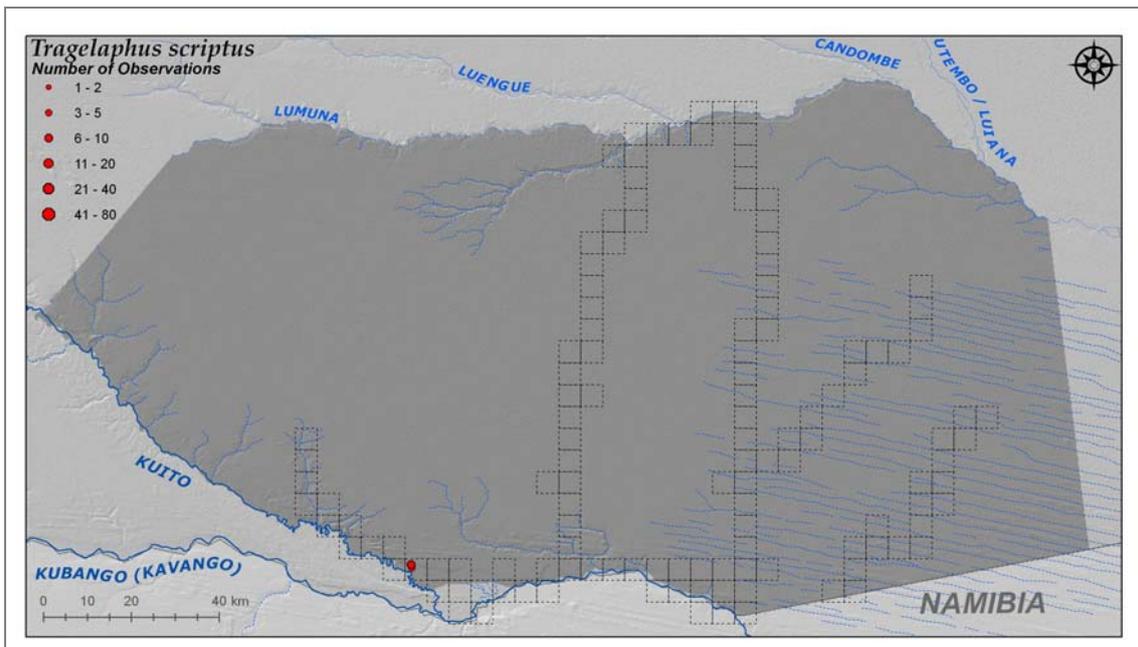
**FIGURE 19. RECORDED OBSERVATIONS OF SITATUNGA. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



**BUSHBUCK (TRAGELAPHUS SCRIPTUS)**

The species has only been detected in the lower Kuito, with a total of 6 observations. This seems to indicate, at least preliminary, that the Bushbuck is rather uncommon in the MGR, apparently absent of the Kubango sector, and associated only with the riparian system of the Kuito. The species is of taxonomic interest since it represents the subspecies *Tragelaphus scriptus chobiensis* endemic to the region and only found in Angola in the Southeast of Kuando Kubango.

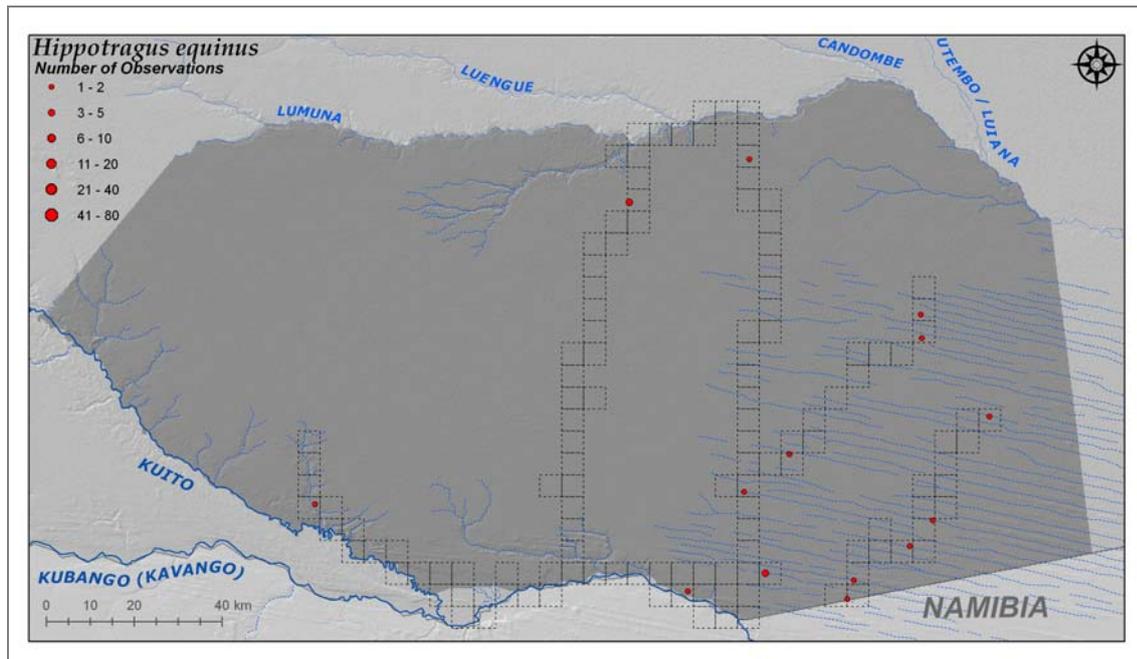
**FIGURE 20. RECORDED OBSERVATIONS OF BUSHBUCK. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



## ROAN (*HIPPOTRAGUS EQUINUS*)

This antelope has a record of observations that apparently depict a predominance of the species presence in the east of the reserve. In fact, 78% of all sightings were produced in the Eastern block, and only 14% along the Lower Kuito. The Roan was nevertheless recorded always in very low numbers, with the majority of the observations accounting for the presence of 1-2 individuals per location. This points to the fact that the species is present in MGR in low densities, and probably with a population that reflects the effects of a long term decline due to human influence.

**FIGURE 21. RECORDED OBSERVATIONS OF ROAN. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



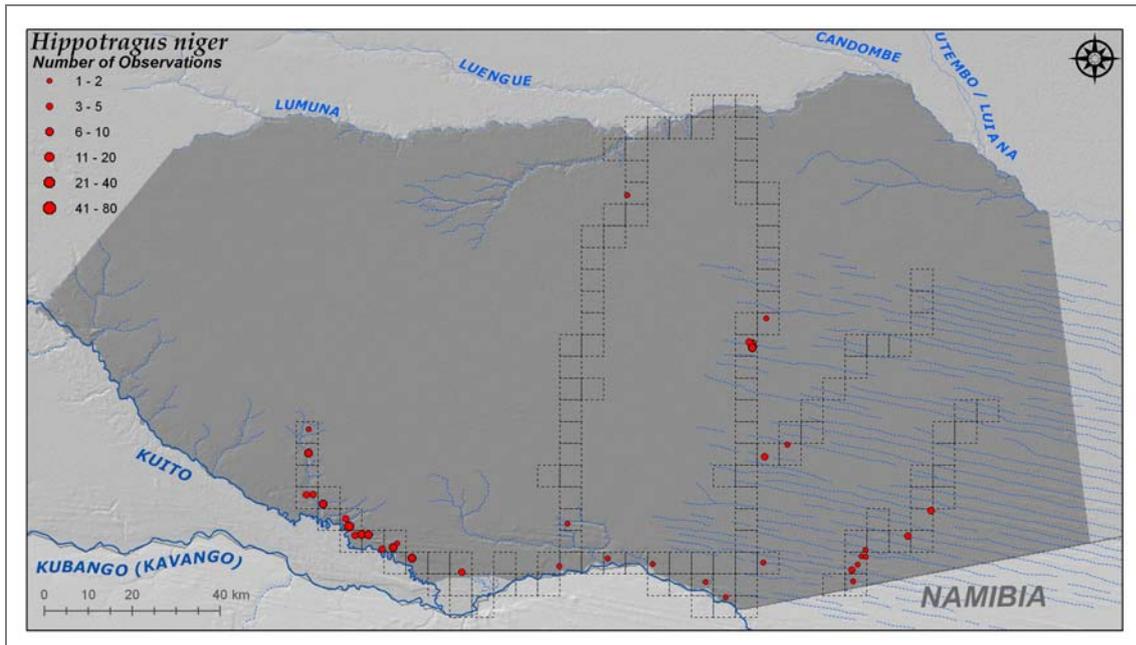
The status of this animal in the region is of concern. An estimate population of 25 individuals was presented for the all Western Caprivi strip in 2003 (MET, 2003). This fact, associated with the veterinary fence in the Botswana border, blocking the natural movements of wildlife, highlights the perspective that Mucusso Game Reserve and Luiana P.R. play a vital role in the future of the species in the region, serving as potential disseminating core areas. Further information is nevertheless needed to evaluate the population status in the MGR.

## COMMON SABLE (*HIPPOTRAGUS NIGER*)

The Sable Antelope was recorded in all the sector blocks surveyed, with a larger proportion of observations along the Lower Kuito, representing 62% of the sightings. The habitat requirements of the species attest the difference between the distribution of the two Hippotraginae species, with the Sable more associated with the mosaic of open woodland and insular grassland pockets near reliable water sources.

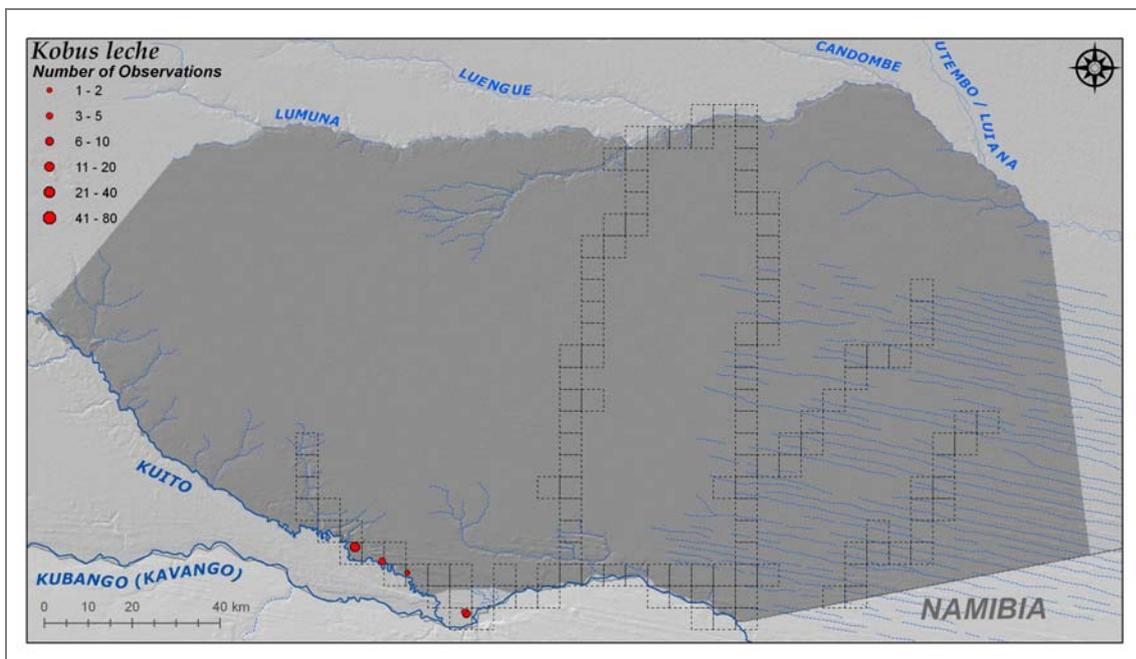
In conjunction with the Kudu this specie is fairly recorded along the Kubango river in several locations, a fact that may in part be the result of the symbolic appreciation of the species in Angola, determined by the subspecies *Hippotragus niger variani*, confined to the Malanje region. In fact, several accounts collected in the area, attest for the strict prohibition of shooting Sables in the region during the 80's and 90's, with heavy penalties to the trespassers. The "respect" of the local population towards this antelope, is a key factor in the survival of the species in the MGR, and accounts for its occurrence in otherwise settled areas.

**FIGURE 22. RECORDED OBSERVATIONS OF SABLE. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



**LECHWE (KOBUS LECHE)**

**FIGURE 23. RECORDED OBSERVATIONS OF SABLE. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



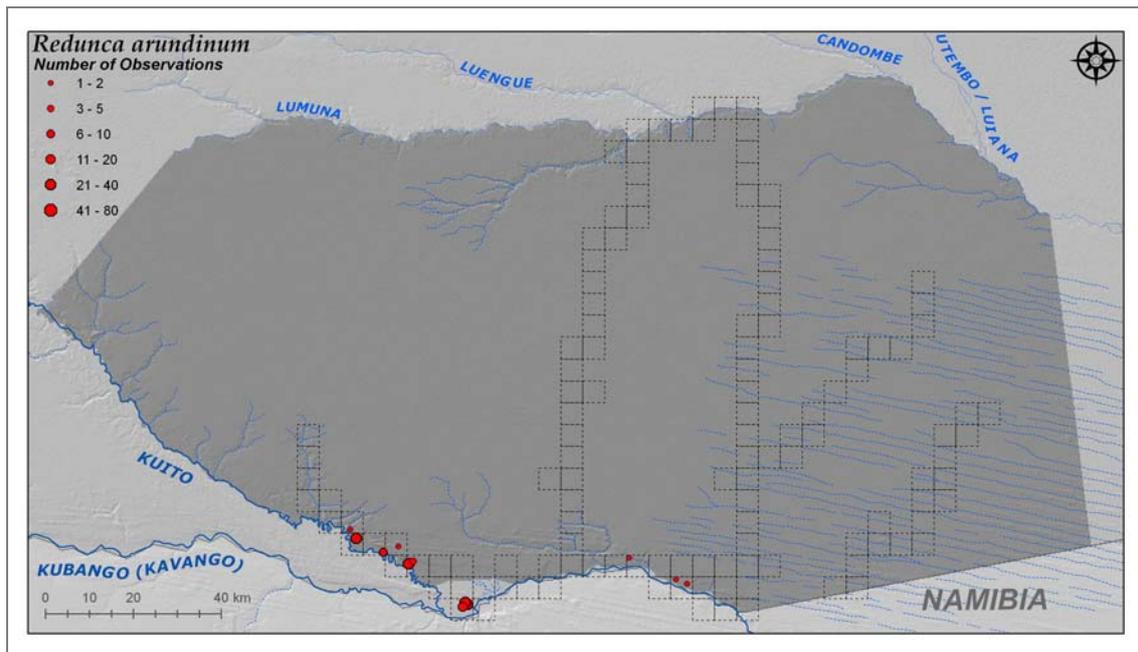
A characteristic wetland antelope, the Lechwe presence as been so far recorded only along the floodplains of the Kuito. This species, once present also along the Kubango river, has apparently been whip out not only from this stretch, but also from the floodplains of the Lumuna-Luengue river junction. In the MGR, the Kuito floodplains present the best area for the recovery of this unique antelope. The habitat requirements and low populations in the reserve, make the Lechwe a particular vulnerable and localised species.

### COMMON REEDBUCK (*REDUNCA ARUNDINUM*)

In resemblance with the Lechewe, this wetland grazer is presently mostly confined to the Kuito wetland and floodplain system. 91% of all records for the species were detected in the Lower Kuito, with spoor densities of 3 tracks/km on average. The same remarks apply to this antelope in what concerns its habitat constrains and localized populations in relation to antropic disturbances.

A few records from the Kubango river front, attest the decimation of the species in a more densely human settled area bordering the reserve; an area that once (60's and 70's) observed relatively fair numbers of reedbuck.

**FIGURE 24. RECORDED OBSERVATIONS OF REEDBUCK. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**

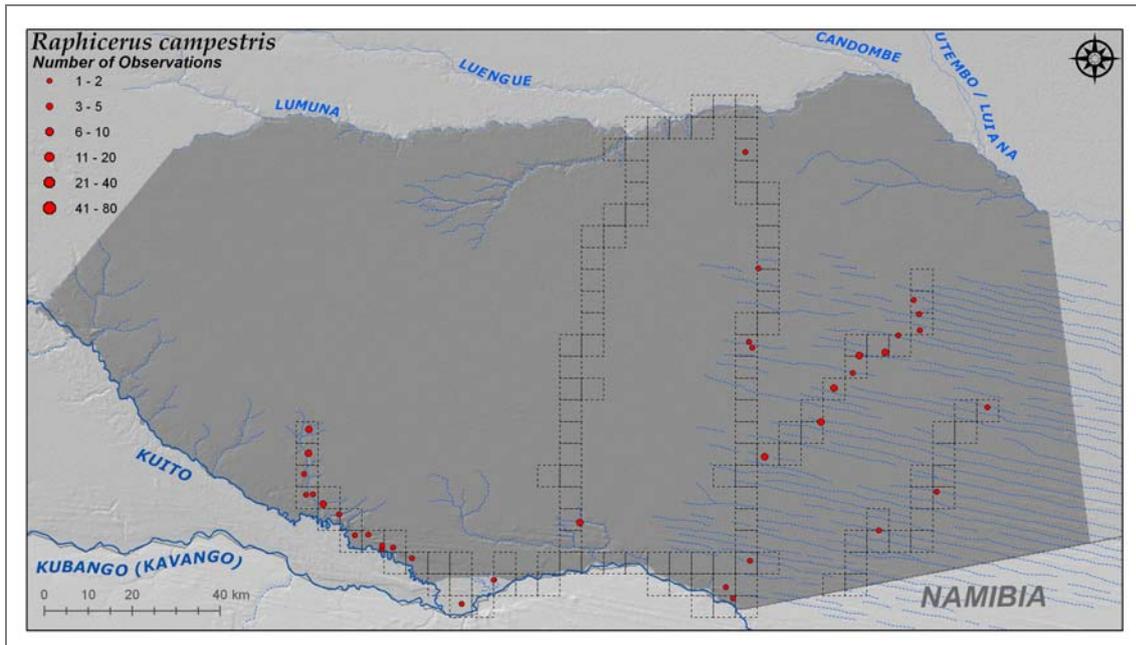


### STEENBOK (*RAPHICERUS CAMPESTRIS*)

This small antelope is widespread and common in all areas surveyed, although relatively less frequent in the Kubango sector. The present status in the reserve is assumed to be secured, nevertheless being a target in the local bush meat.

No indications on the potential presence of the Shaarpe's Steenbock (*Raphicerus sharpei*) in the area surveyed, account for the natural absence of the species in Angola.

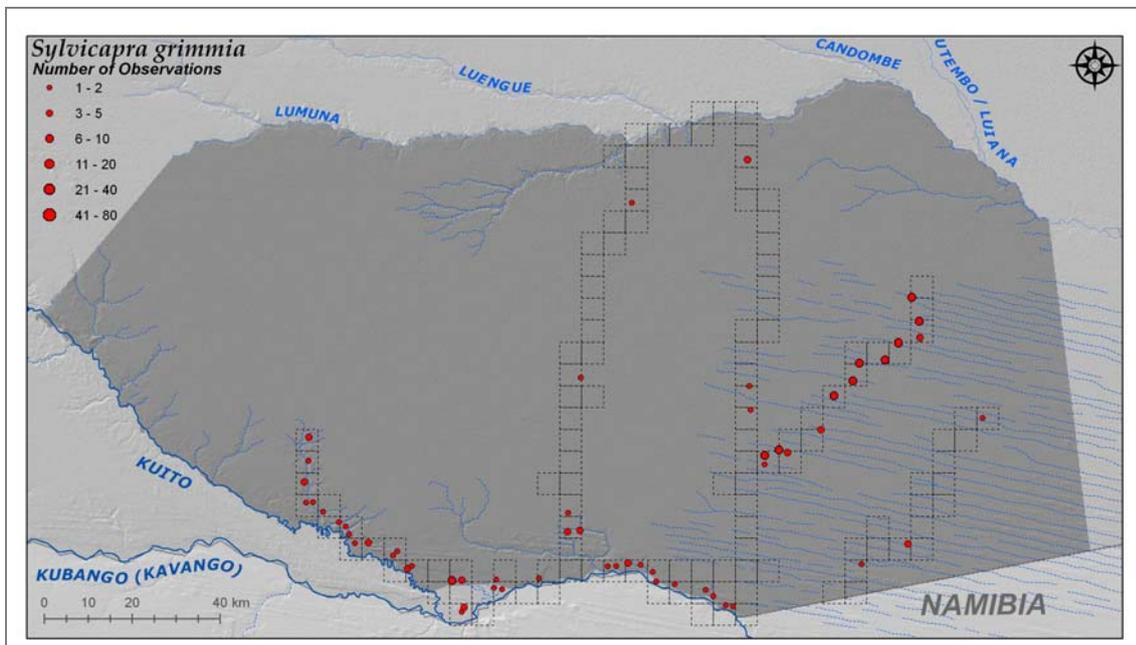
**FIGURE 25. RECORDED OBSERVATIONS OF STEENBOK. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



**COMMON DUIKER (SYLVICAPRA GRIMMIA)**

The Common Duiker is present in most of the locations visited, with a predominance of sightings in the eastern part of MGR (52%). The natural dynamic of the species and its generalistic habitat tolerance, granted this antelope a secure condition in the reserve, being a common species in the area.

**FIGURE 26. RECORDED OBSERVATIONS OF COMMON DUIKER. SHADED GRID REPRESENTS VISITED 5X5KM UNITS**



**5.1.2 TARGET SPECIES SPOOR INDEXES**

The frequency indexes presented in this section, are based on the recorded observed proportion of sampling units within the 3 different sectors surveyed (Kuito, Kubango and East, Fig. 2) that

contained spoor trails of the target species. This method is here used in view of the difficulty in enumerating the species populations, as discussed previously.

**TABLE 3. TARGET SPECIES: SPOOR DENSITY ( $P_D$ ) AND SPOOR FREQUENCY ( $P_F$ )**

SPECIES	KUITO		KUBANGO		EAST	
	$P_D$	$P_F$	$P_D$	$P_F$	$P_D$	$P_F$
<i>CERCOPITHECUS AETHIOPS</i>	0.79	1.27	0.0	-	0.13	7.64
<i>HYSTRIX</i>	0.11	9.39	0.02	48.32	0.13	7.64
<i>AFRICAEAUSTRALIS</i>						
<i>LYCAON PICTUS</i>	0.38	2.61	0.0	-	0.05	19.10
<i>MELLIVORA CAPENSIS</i>	0.19	5.21	0.0	-	0.10	9.55
<i>CROCUTA CROCUTA</i>	0.26	3.91	0.10	9.66	0.26	3.82
<i>FELIS LYBICA</i>	0.17	5.87	0.04	24.16	0.05	19.10
<i>FELIS CARACAL</i>	0.15	6.70	0.02	48.32	0.05	19.10
<i>PANTHERA PARDUS</i>	0.13	7.82	0.0	-	0.03	38.20
<i>ORYCTEROPUS AFER</i>	0.32	3.13	0.17	6.04	0.24	4.24
<i>LOXODONTA AFRICANA</i>	8.89	0.11	8.03	0.12	1.13	0.89
<i>POTAMOCHOERUS</i>	0.17	5.87	0.0	-	0.08	12.73
<i>LARVATUS</i>						
<i>PHACOCHOERUS</i>	0.45	2.23	0.56	1.79	2.46	0.41
<i>AFRICANUS</i>						
<i>SYNCERUS CAFFER</i>	1.24	0.81	0.41	2.42	0.29	3.47
<i>TRAGELAPHUS</i>	1.28	0.78	3.0	0.33	1.83	0.55
<i>STREPSICEROS</i>						
<i>SYLVICAPRA GRIMMIA</i>	1.17	0.85	0.52	1.93	2.36	0.42
<i>RAHICERUS CAMPESTRIS</i>	0.53	1.88	0.08	12.08	0.79	1.27
<i>REDUNCA ARUNDINUM</i>	2.98	0.34	0.27	3.72	0.0	-
<i>KOBUS LECHE</i>	0.55	1.81	0.0	-	0.0	-
<i>HIPPOTRAGUS EQUINUS</i>	0.04	23.47	0.02	48.32	0.29	3.47
<i>HIPPOTRAGUS NIGER</i>	1.64	0.61	0.23	4.39	0.94	1.06

Table 3 presents the indicator values for the same target species detected in the present inventory, in what concerns Spoor Density Index ( $P_d$ ), i.e., the number of individual spoor trails *per* 1 kilometre, and Spoor Frequency Index ( $P_f$ ), i.e. the number of kilometres *per* individual spoor trail. Although a quantitative relationship between true density (animals km<sup>2</sup>) and spoor and/or frequency densities is not where accessed, by absence of calibrated sample data, it's nevertheless perceived that a strong correlation exists between them, providing important qualitative information to the understanding of species presence in the areas surveyed.

The overall results point to the higher values of spoor density ( $P_d$ ) per species in the Lower Kuito sector. Concerning the carnivores species, all have a maximum index value in this sector, except in the case of the Spotted Hyena that shows a similar density index in the Eastern sector (0.26). In the case of the Leopard and Wild Dog, the Lower Kuito has a remarkable  $P_d$  values of 0.13, and 0.38, respectively, accounting for a spoor frequency of 7.8 and 2.6 km/spoor. Spoor density for the African Elephant, appears both in the Kuito and Kubango sectors with values surpassing 8, the maximum value recorded by any of the species concerned, attesting the dry season concentration of this species along the two perennial rivers. In fact, the low value in the East sector (1.13) is a direct result of the lack of water resources in the area during the dry season. This Kuito is also highlighted by the densities of Buffalo spoor in the present dry season, 1.24, compared with low values of 0.41 and 0.29, for the Kubango and East sectors, respectively.

Among the two wetland antelope species referenced, the Kuito is the main stronghold, with a relatively high spoor density for Reedbuck (2.98) and a substantial low value for the Lechwe (0.55). The spoor density of 0.79 for the Vervet Monkey in this sector, underlines the fact that this species has suitable habitat along the riverine wooded banks of the Kuito river, while is apparently absent from most of the Kubango river front and scarce elsewhere in the reserve.

The Kubango sector presents the lowest values in spoor density for the bulk of the species, with the exception of the Elephant and Kudu. This last species attains the highest values in this sector, 3.0, if compared with 1.83 in the East and 1.28 in the Kuito. The overall low spoor density values of the target species in this sector are correlated with the denser human presence and related disturbance factors.

The East sector has a significant higher spoor density for non water depended species, accounting for the pattern of wildlife distribution during the dry season, the period in which the present survey was conducted. Of particular notice are the cases of Warthog (2.46), Common Duiker (2.36) and Steenbok (0.79). The Roan antelope also presents the highest spoor density values in this sector (0.29), if compared to the densities obtained in the Kuito (0.04) and Kubango (0.02). In the opposite spatial distribution of the Roan is the Sable, where the Kuito accounts for a spoor density of 1.64, contrasting sharply with the values of 0.94 and 0.23 for the East and Kubango sectors, respectively.

### 5.1.3 NON DETECTED TARGET SPECIES

Considering the initial 42 target species, 13 were not accounted during the ground surveys. Taking in consideration the extent of the Reserve and the smaller proportion of the areas visited, the absence of observation of some of this species may not imply their absence. Furthermore, anecdotal and inquiring information (an ongoing process), provided indications that suggest the presence of some of this species in the area, though subjected to confirmation in the field in future surveys. Next, it is presented a synoptic comment for the species in reference.

**CHAKMA BABOON (*Papio ursinus*)**. This species is known to occur in the Luiana P.R. along the Kwando river margins and its tributary Luiana. The species is referred to be present in the Northeast of MGR, near the Luiana-Nota confluence. This fact is in accordance with a presumed natural extent of the species along the semi permanent Luiana river, which borders the reserve in the NE.

**GROUND PANGOLIN (*Manis Temminckii*)**. Although no records were obtained, this species, with very cryptic and shy behaviour, is known from the local residents. According to the testimonies, the Pangolin is to be encounter in the area, and the lack of data is assumed to be related to the secretive presence of the species.

**AARDWOLF (*Proteles cristatus*)**. No information could be obtained for this nocturnal species, and most of the people interviewed could not identify the animal or refer the local name. The presence of the Aardwolf is also sketchy in the West Caprivi, with scarcity of ocular observations.

**CHEETAH (*Acinonyx jubatus*)**. References to the specie are concentrated in the eastern part of the reserve, along the fossil Kalahari sand dune belt. The record data dates from 2007, 2005 and 1998.

**LION (*Panthera leo*)**. In the past a well established predator in the reserve, during the present survey no observations were secured for the species, although several anecdotal reports point to the presence of this carnivore in the area. In 2007 two sightings were documented: in May a reported attack of 5 lions to a herd of cattle during the night in the North of the reserve in the Tondo area; in December a male was observed in the eastern section of the reserve near Havo. In 2006 a pair of Lions was prevented from catching an ox in the centre of the reserve near Oceano. Older encounters report to the years of 2000, 1999 and 1998. The scarcity of the findings apparently indicates a very low number of individuals in the reserve, that might be residents or vagrants from other locations. This situation is no doubt result of direct persecution and decline of the populations of prey species.

**PLAINS ZEBRA (*Equus burchellii*)**. This species, once abundant in the reserve, is apparently exterminated in most of the South belt. Only scattered information has been collected for the species occurrence in the East, along the *omurambas* during the wet season, presumably moving from the Caprivi Kwando area. A record from 2003 indicates a group of 3 individuals in the Lumuna area, in the North of the Reserve.

**BLACK RHINOCEROS (*Diceros bicornis*).** A well established species until the 70's, the Black Rhino experienced a drastic decline during the 80's, with the bulk of the population being exterminated by the end of the decade by poaching. Non confirmed observations have been reported in the Mucusso Reserve area, for the possible presence of the species. This locations are omitted here until further clarification is presented for the status and potential presence of this critically endangered species, in future surveys inside MGR.

**ELAND (*Taurotragus oryx*).** The populations of this large antelope have been drastically impacted by poaching, with only a few scattered records of its occurrence inside MGR. Mainly concentrated in the East and North of the reserve, this records never document herds composed by more than 6 individuals.

**WATERBUCK (*Kobus ellepsiprymnus*).** In the recent past (70's) present along the Kubango and Kuito river margins, today the species is definitely exterminated along the Kubango, and with only unconfirmed rumours of its presence in the Kuito. No information has been attended for the North of the reserve, namely for the Luengue and Lumuna areas, addressing the eventual presence of the Waterbuck there.

**TSESSEBE (*Damaliscus lunatus*).** This species was reported by several sources to be present in the North of the reserve, in the areas of Lumuna, Luengue and Luiana. The water dependency of this antelope implies his congregation along the permanent water resources, making it a particularly vulnerable species to poaching. Its absence from the Southern sectors of the reserve are most likely related to human persecution.

**WILDERBEEST (*Connochaetes taurinus*).** Recent evidences for this species inside the reserve have been presented by the observation of a herd of 8 individuals in 2006 in the East, near Kashi; another herd of 5 sighted in 2005 in Bembe and a herd of 8 in the North of the reserve along the Lumuna river in 2003. The feeble numbers and paucity of the reported groups observed, confirm a drastic decline of this antelope if compared with the abundance of the species until the 70's in the area.

**COMMON IMPALA (*Aepycerus melampus*).** Historically present along the Kubango and Kuito rivers, as well as in the Luengue-Luiana system, the common impala is definitely exterminated in the Kubango sector. No records where obtained for its presence in the Kuito or in the North of the reserve thus far, in the inquiries submitted.

**ORIBI (*Ourebia ourebi*).** No anecdotal information has been secured for the presence of this species in the MGR thus far, although present in the recent past along the Kubango.

# 6.0 IDENTIFIED THREATS TO MAMMALS

”Threat” is here defined as any factor that has the capacity to impair, degrade or destroy the mammal communities of the Mucusso Game Reserve. The main threats identified through field work, research and community interviews through the course of this consultancy are highlighted below.

**HUNTING** – Poaching accounted for the extreme depletion of wild mammal communities in the reserve throughout the 3 decades of Angolan civil war. During this period, well organized hunting parties systematically poached for meat consumption, and for the revenue from highly lucrative illegal trade in Elephant and Hippo ivory and Rhinoceros horns. Also, the availability of guns and ammunition, and lack of regulation facilitated hunting by anyone living in the area at that time.

Following the war, the intensity of poaching declined. By that time, many species were extremely scarce, and some were possibly locally extinct. Nonetheless poaching still takes place inside the Reserve, not only by local hunters but also by outsiders of the area, both from Angola and other countries. Factors that contribute to the poaching include poverty, lack of law enforcement, lack of conservation awareness, and permeability of the international border. The target species poached are primarily medium to large antelopes and Buffalo.

The practice of hunting by local communities for consumption is part of the rural subsistence economy in the Reserve. Residents use old weapons, spears, bows and arrows dogs and traps as hunting tools. The use of snares is a less common, particularly destructive and indiscriminate method. Local hunters commonly use fire as a hunting tool, either to drive animals out of an area or to catalyse the growth of new green grass, which attracts animals that are targeted for hunting. Fire started by hunters often spreads to create vast burned areas, though generating meagre hunting profits. In general, traditional hunting should not pose a threat to the mammal populations so long as the human density is low and the target species occur in a healthy population. However the Reserve harbours extremely low numbers of most species of larger mammals. Furthermore, many experienced traditional hunters of the Reserve are hunting both for subsistence as well as for sale. Their clients include people from within the Reserve as well as people who live along the border in Namibia.

Hunting continues to represent the greatest single threat to many mammal species in the Reserve, namely the larger ungulates species that have low population levels. If not addressed, the unregulated and illegal hunting activities can contribute to the local extinction of more species, reducing the diversity and ecological significance of the Mucusso Reserve for the future.

**HUMAN POPULATION GROWTH AND DISPERSAL, AND SUBSISTENCE AGRICULTURE** – Unplanned human population growth can become one of the biggest challenges to mammals conservation and natural resource management in the Reserve. Increases in the immigration and resettlement to the area since 2003 have led to a rapid expansion of area under agricultural cultivation along the Kubango River. For example, between 2002 and 2006, the percentage of land under agricultural cultivation increased by almost 400%. This expansion leads to a reduction in mammal access to the permanent water sources, and an increase in human-wildlife conflict.

Human-wildlife problems have become a priority concern of local communities, particularly with respect to Elephant intrusion into crop land (and in a few cases, Hippo intrusion as well). Predation of livestock by hyena has also become a concern of local residents. Crop damage and losses of livestock will continue to increase in the immediate future if cultivation and management of local livestock are not controlled. These losses in turn lead to a human resentment of the mammal population, and a strong drive to take revenge and prevent further occurrences through killing the problem animals.

In order to mitigate the threat to animals and the problems of communities, wildlife corridors must be established, where no human development will occur into the future. Predators may require more abundant wild prey in order to improve their populations and reduce the rate of livestock killings.

Proposed infrastructure development in the Mucusso Reserve area will vastly increase human population spread. Infrastructure development must be closely coordinated with conservation planning in this reserve.

**FIRE** – Fire is a major agent of change in Mucusso Game Reserve, and has the potential to significantly modify the habitats and available forage, thereby impacting wildlife populations. Seasonal fires are started for hunting practices, honey collection and preparation of new crop fields, amongst others. Fires commence in April-May and last until October-November, with the most expansive fires occurring in the late dry season (August). In 2007, fires burned in more than 60% the reserve. This significantly reduces the carrying capacity for grazing species, and represents a direct physical threat to the fauna. Furthermore the frequency and intensity of late season fires can impact the structure and flora composition of the reserve, reducing its natural carrying capacity and overall biodiversity.

**LOGGING ACTIVITIES** – Depletion of tree diversity and wooded cover affects mammal species, particularly those that are more related to forested areas like primates and certain species of ungulates. Logging activities also produce a intricate pattern of new roads and tracks that facilitate the penetration of humans into wilderness areas, and thereby promote activities such as hunting and fire setting. In the Mucusso Reserve, several logging concessions apparently have titles to operate inside the reserve but no regulatory body or personnel are stationed within or near the reserve. The uncontrolled harvest of hardwood species inside the reserve poses a serious hazardous to the integrity of the ecosystem and affects the dynamics of the mammals that are part of it.

**LONG DROUGHT SPELLS** – The natural occurrence of cyclical drought spells has direct implications in mammals populations, increasing mortality rates among adults and juveniles. Human disturbances exacerbate the threat to mammals due to long drought spells. Such disturbances, discussed above, include limiting mammals access to perennial water sources and poaching animals during this period of particular vulnerability. The competition for grazing areas between wildlife and livestock also intensifies the rate of mortality in grazer species. In the Reserve, the southern belt along the Kubango can act as a “sink hole” for several species, particularly antelopes, in these adverse conditions.

**POTENTIAL INCREASE OF CATTLE GRAZING GROUNDS** – In the Reserve, the competition between cattle and wild grazers for water and forage is increasing. The belt along the Kubango floodplains is most heavily impacted. In these locations, the annual increase of cattle grazing in the late dry season comes not only from Angola but also from Namibia. This intrusion of “Namibian cattle” is of particular significance since it significantly enlarges the number of domestic animals present, further dilapidating the grazing resources, and increasing the risk of spreading of diseases from livestock to wildlife and vice-versa. At present herd management is not well established. The future expansion of cattle grazing towards the floodplains of the Kuito river is also a potential risk if this problem is not controlled.

**POPULATION DENSITY IN ADJACENT AREA** - Dense human and cattle populations occur on the Namibian side of the Kubango River, i.e. just outside of the southern border of the Reserve. Areas under cultivation and cattle grazing are extensive in this area, with consequent habitat conversion and degradation. Deforestation along the riverine forests is most noticeable in the Kavango floodplains along the Namibian side of the river, where only small patches of forest remain in the islands, with consequent lost of biological diversity. As fewer and fewer resources are available in the Kavango region of Namibia, many local residents rely upon the natural resources of Angola, such as thatch grass, reeds, grazing areas for cattle, and bush meat. Namibians acquire these Angolan commodities either by purchasing them from Angolans or by directly harvesting them (or in the case of grazing, directly using them) in Angola.

The disruption of regional mammal corridors by veterinary fences and dense human development along waterways in Namibia and Botswana pose serious threats to regional mammal dispersal into Southeast Angola. Of particular concern is the corridor along the Kubango river between the buffalo core area in Namibia to the Mucusso area of Angola, which may be disrupted by dense human settlement in Namibia under a proposed disproclamation of a western, riverine section on the recently established Bwabwata National Park.

**LACK OF AWARENESS AND IMPLEMENTATION OF LOCAL OR NATIONAL LAWS AND POLICIES CONCERNING WILDLIFE AND NATURAL RESOURCES** – The lack of mammal protection in the Mucusso Game Reserve is directly linked to an absence of national and local incentives towards “on the ground” conservation, a lack knowledge and enforcement of environmental laws, and a lack of local empowerment over natural resources governance by governmental and local institutions.. No people from the Institute of Forestry Development or the Ministry of Environment and Urban Affairs are currently allocated to environmental regulation enforcement in the Reserve. Different governmental institutions also have different perceptions and priorities regarding what should or should not take place inside the area, which compromises the premises and goals established at the time of creation of the Reserve.

# 7.0 RECOMMENDATIONS FOR THE IMMEDIATE FUTURE

**MAMMAL POPULATION ASSESSMENT** – The need to acquire updated and complete information on the mammal species distribution and abundance of the Mucusso Game Reserve requires the use of direct counting methods from aerial surveys, in coordination with ongoing targeted ground surveys. The importance of an aerial survey contribution is well expressed in this report, considering that the reserve covers more than 23,000km<sup>2</sup>, much of which is inaccessible by land. The aerial surveys, if possible, should be conducted in two periods of the year: once in the wet season, and once in the dry season. Also, a dedicated wetlands aerial survey should be conducted annually along the Kuito river. This will increase the understanding of species seasonal movements, abundances and key concentration areas in the dry season, and species' dispersal patterns in the wet season.

Target surveys on large predators (Lion and Spotted Hyena) should be further conducted, using auditory stations dispersed in additional areas of the Reserve, to assert the presence and potential relative abundances of these species. Lion and spotted hyena serve as indicator species of the ecosystem status in different areas of Reserve because they reside at the top of the food chain, require large home ranges and flourish under near pristine conditions.

Ground surveys of mammals and assessment of vegetation should be conducted in potential core wilderness areas, granted the safety of access can be confirmed. These include the North and West of the reserve, namely in the Kuito-Uambafuca sector along the Lumuna and Luengue rivers and in Luiana-Nota sector. These surveys will seek to verify key species presence and overall habitat conditions.

The Kumbilo area should serve as a pilot area for the recovery and future expansion of key wetland mammal species in this section of the region. The long term conservation of this area requires nevertheless a collaborative effort between communities and local authorities on both sides of the Kubango (Kavango) River.

**WILDLIFE CORRIDORS AND DISPERSAL AREAS** – There is a critical need to establish and protect corridors for wildlife both in the Reserve and in the region, assuring wildlife the access to water and nutritional resources. These corridors should be established using participatory processes involving governmental and traditional authorities and local residents, to prevent future corridor disruption by cultivation or settlements. The Kubango river front and adjacent belt of 20km from the river are priority areas for establishing corridors within the Reserve.

**HUMAN-WILDLIFE CONFLICT** – The increase in the number of incidences of crop raiding and livestock loss due to wild mammal species (Elephant, Hippo, large predators), justifies the immediate development of a mitigation program in the Reserve. The Kubango river front is again the highest priority area for such an intervention, between the Kuito River and the village of Mucusso. Considering the scale of reported damage, the target species should be Elephant. Methods should involve deterrence as well as improved efficiency and organization of cropped areas.

**DEVELOPMENT OF AN ENVIRONMENTAL AWARENESS AND ANTI-POACHING PROGRAM** - With the support and involvement of the local communities, launch an awareness campaign regarding locally endangered species, their importance and role in the ecosystem. Promote conservation education sessions in villages and schools. Support a potential anti-poaching/surveillance patrol intervention

with the participation of administrative authorities (Police - IDF) and qualified local technical personnel.

**HUNTING AND POACHING PRACTICES ASSESSMENT**- Establish a systematic inquiry on hunting practices and poaching incidents inside the Mucusso Game Reserve. Include local and institutional authorities as well as local hunters as interviewees.

**FIRE LIMITATION CONTROL** – Involve local stakeholders in open sessions regarding the cost/benefit of uncontrolled fires, to catalyse collective dialogue about the negative influence of this phenomena in the ecosystem of the Reserve and its mammal communities. A 25% reduction of annual burnt area by focusing on elimination of late season fires would be a reasonable goal, and considerable step forward toward habitat conservation.

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# APPENDIX I. ELEPHANT DUNG PILE COUNT IN THE MUCUSSO GAME RESERVE

## INTRODUCTION

In estimating large African Mammals numbers, two indirect counting techniques are commonly used: dropping counts and track counts. In woodland savannah, dropping counts of elephants on roads (or tracks) provide a quick and cheap alternative to conventional dropping counts (Jachmann, 2001). Two dropping counts were conducted in the southern sector of the Mucusso Game Reserve (Fig. I-1). On the 14<sup>th</sup> of November 2007, an elephant dung pile count was conducted in the Lower Cuito river to assess the potential number of elephants using the area during the 2007 dry season. The area is the most intense used elephant sector of the Mucusso Reserve surveyed to date, and represents a priority future corridor for elephants and other wildlife along the southern belt of the reserve. Similarly another elephant dung pile count had been conducted on the 9<sup>th</sup> of August 2007 along the Kavango river front, an area where the reports on human-elephant conflict episodes have been the most frequent in the reserve.

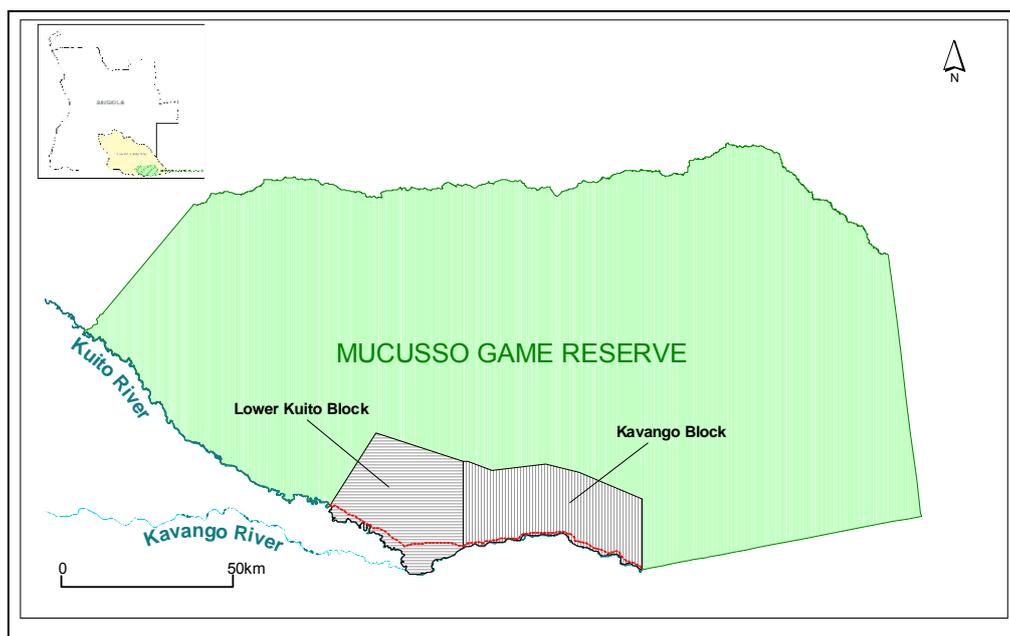
## OVERVIEW AND METHODOLOGY

Estimating distribution and numbers based upon the counting of faecal deposits has been developing in Africa in the last 30 years mostly concerning elephant populations. The main reasons are the fact that elephant droppings remain visible for long periods of time, and the availability of data on variables such as defecation rates and decay rates, both difficult to measure in short recon assessments.

In the present note, tentatively numbers are extrapolated for two areas of Mucusso Game Reserve from the method presented by Jachmann (2001) for *Dropping Counts on Roads*, where a full explanation is provided.

The method relies on the assumption that in the course of time, the accumulation of droppings reduces the sampling error triggered by locally sudden increase in numbers of events. Thus, this technique needs a minimum of 30 days of accumulation in a particular location to produce acceptable results.

**FIGURE I-I. LOCATION OF THE SURVEY BLOCKS WITHIN THE MUCUSSO GAME RESERVE**



In the case of the areas concerned, the counts were conducted after a long period of accumulation (since the beginning of the 2007 dry season, 136 days for the Kuito block, and 70 days for the Kavango river front), which implicates the analysis with the steady-state assumption.

The tracks used are set in along the Kuito and Kavango river valleys, which can lead to overestimates in numbers. Nevertheless is the only network available, and provides the best transect base for the estimate technique at the moment and serves as an experiment to further comparison from aerial surveys results.

It was accepted a dry season decay rate of 0.00866, has proposed by Jachmann (1991) for woodland savannahs habitats. A defecation rate of 15 dung piles produced per elephant per day was assumed. The average width of the tracks was 2.4m. The error margin for the length of the tracks was assumed as 2%, and the error in the number of droppings counted at 2%.

Table I-1 provides length of the track sampled, size of sample area, size of survey block and number of droppings counted in each target area.

**TABLE I-I. LENGTH OF TRACK, AREA, SURVEY BLOCK AND NUMBER OF DROPPINGS**

Target Area	Length of Track (km)	Sample Area (km <sup>2</sup> )	Survey Block (km <sup>2</sup> )	Droppings
LOWER KUITO	43	0.1032	1013	197
KAVANGO	57	0.1367	1063	52

The analysis of population estimates uses the equation for steady-state assumption:

$$E = \frac{Y \times R}{D}$$

Where:

$E$  is the elephant number in the target area;

$Y$  is the number of droppings in the all target area expressed as  $(S/A)xp$ , where  $S$  is the size of the survey block,  $A$  is the size of the sample area (length of the track x width of the track in km) and  $p$  the number of droppings counted;

$R$  is the rate of decay expressed as  $\ln 2/t_{1/2}$  or  $0.693/t_{1/2}$ , where  $t_{1/2}$  is the time (in days) at which half of the original droppings are unrecognisable, using a year-round decay rate ( $t_{1/2}$  of  $80\pm 5$  days in the dry season;  $t_{1/2}$  of  $49.6\pm 3$  days in the wet season);

$D$  is the defecation rate (dung piles produced per elephant per day).

## RESULTS AND DISCUSSION

**TABLE I-2. ELEPHANT POPULATION ESTIMATES AND 95% CL FOR THE TARGET AREAS**

Target Area	Dropping Count	95% Confidence Limits		
	Population Estimate (SE)	Lower	Estimate	Upper
Lower Kuito	1117±142	839	1117	1394
Kavango	234 ± 2	230	234	237

The results depicted in Table 2, attest for the sharp differences in the elephants numbers along the southern Mucusso Reserve during the 2007 dry season. Although the Kavango river front block was surveyed approximately 2 months prior to the Lower Cuito block, the estimate results should represent the overall elephant presence in this sector, since later reconnaissance's along the same track, did not show any substantial modification in the overall number of dung piles accounted in the referred date.

The Lower Kuito block presents the highest number of elephants with an estimate of  $1117\pm 142$  individuals using the area during the 2007 dry season, with an estimate density of 1.1 elephants/km<sup>2</sup>. The area is connected to the Kumbilo Wetlands, in the Kuito river mouth, and a broad floodplain that spreads northwards from there, granting perennial availability of water during the dry season. This area is also very sparsely inhabited by humans, with only a few villages located in the southern extremity of the block, with the majority of the river front free of crops or human settlements, thus allowing the elephants, as well as other wildlife, to access the river without any constrain. The area is apparently an important part of the dry season concentration areas of the species in the Mucusso Game Reserve.

The Kavango block is much less used by the species in comparison to the previous one, although it is in this sector that most of the human-elephant conflict situations have been reported in the present year. An estimate population of  $234\pm 2$  elephants frequent this area in the 2007 dry season up to early August, with an overall estimate density of 0.2 elephants/km<sup>2</sup>. The area has a much more denser human settlement pattern, with a fragmented belt of croplands and villages aligning between the Kavango river and the hinterland, creating the conditions for human-elephant interference, especially during the dry months.

As discussed by Jachmann (2001), dropping counts are subjected to various sources of error, namely assuming a steady-state in an unstable system. Nevertheless, in woodland savannah habitat faecal counts will give accurate results even during halfway through the dry season. Other sources of bias that should be addressed are: use of defecation rates and decay rates from other types of habitats, not calibrated to the conditions observed on location; multiple-counting errors; double counting and undercounting of calves. In the present counting the defecation and decay rates used are based on similar habitat conditions as the ones observed in Mucusso Reserve. Multiple-counting errors were

reduced by assuming a single dung pile as a unit of 5-6 separate boli while undercounting bias where assessed by the increasing droppings counted by 5%. Double-counting was assumed as irrelevant since the count was based on a line base transect approach.

**References:**

- Jachmann, H. (1991) – “Evaluation of four survey methods for estimating elephant densities.” *African Journal of Ecology*. **29**, 188-195.
- Jachmann, H. (2001) – *Estimating Abundance of African Wildlife: an aid to adaptive management*. Kluwer Academic Publishers, Boston, 285p.

# APPENDIX II. AERIAL SURVEY OF THE MUCUSSO GAME RESERVE, PROGRAM

September – October 2007

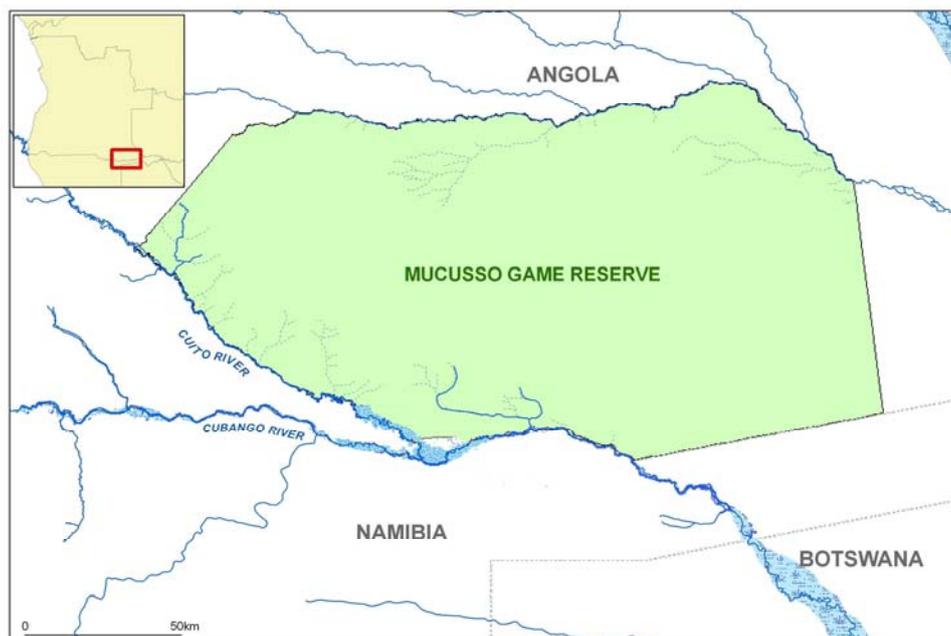
## INFORMATION

IRBM is supporting the implementation of Angola's National Biodiversity Strategy and Action Plan in Kuando Kubango Province. The agreed-upon action plan for biodiversity in Kuando Kubango includes an inventory of large to medium mammal species. An aerial survey is an important aspect of this inventory for the Mucusuo Reserve, because of the reserve's large size and because many areas within the reserve are not accessible by land. The aerial survey will help the IRBM team to provide estimate data for mammal species and other wildlife for the Government of Angola, to obtain density estimates of key mammal species, and to get a better understanding of the conditions of the Reserve's wildlife, as well as habitat and threats to wildlife.

**OBJECTIVE:** Conduct an aerial multispecies sample count survey in the Mucusso Game Reserve and surrounding areas, focus in large to medium size mammal species. Also conduct, upon time and logistics constrains, a block count along the Cuito river floodplains to record the presence of hippos and floodplain ungulates (Waterbuck, Lechwe, Reedbuck and Sitatunga).

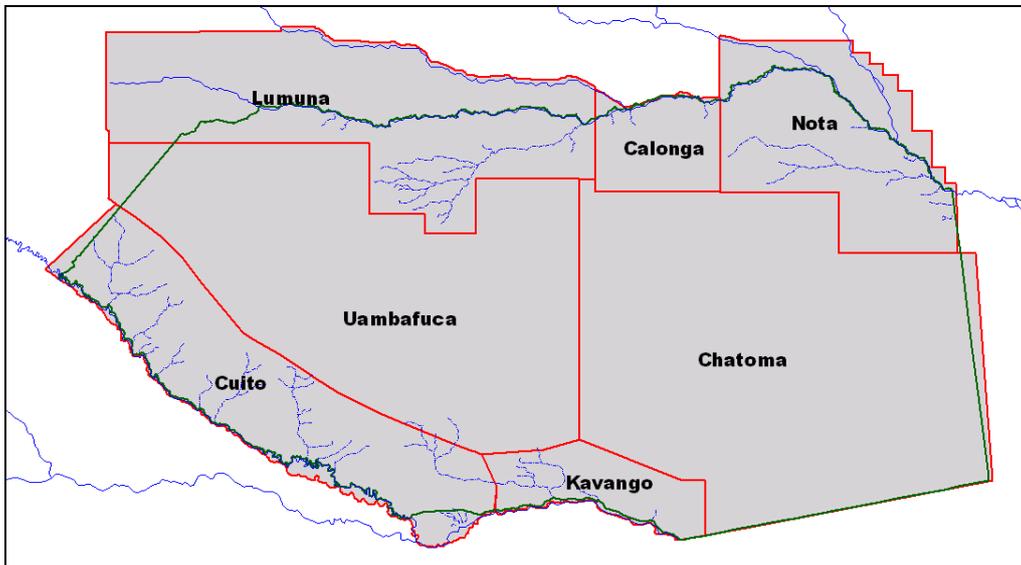
**SURVEY AREA:** The area to be surveyed covers the all of the Mucusso Game Reserve as well as neighbouring sections. The total area is approximately 25,083km<sup>2</sup>.

FIGURE II-I. MUCUSSO GAME RESERVE



**SURVEY DESIGN:** The survey design was stratified according to expected distribution of wildlife in the dry season, and ground information collected to date. Seven strata will be surveyed as follows:

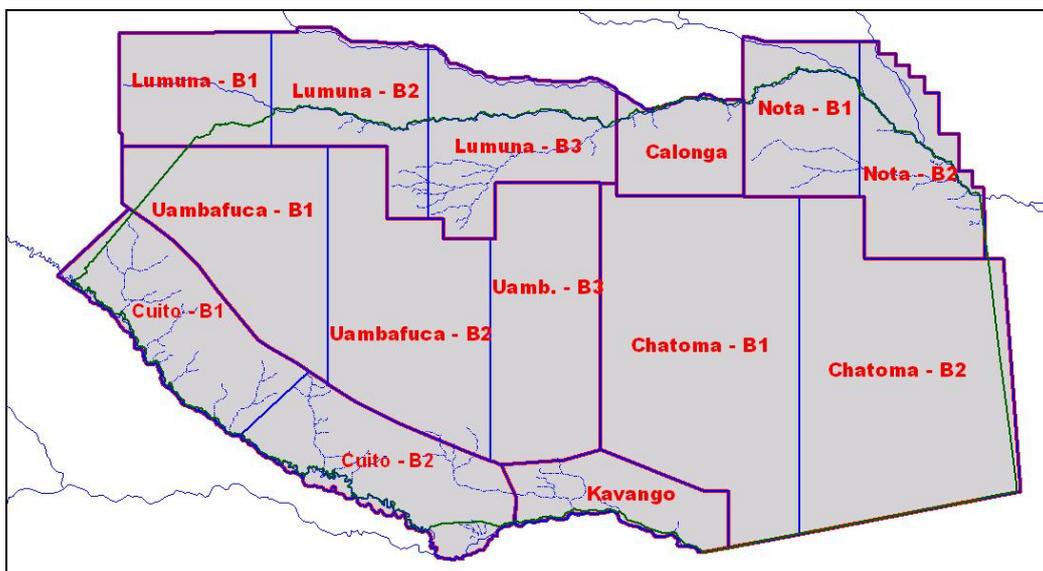
**FIGURE II-2. MUCUSSO AERIAL SURVEY STRATUM**



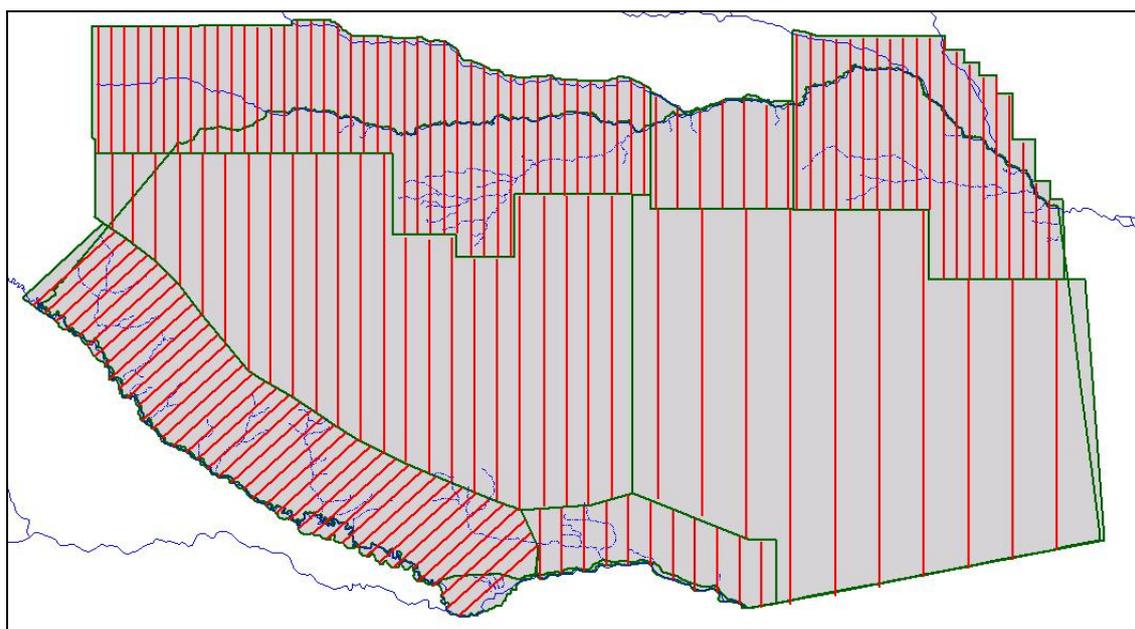
Stratum	Spacing Between Transects	Area (km <sup>2</sup> )
Cuito	3km	3,228
Lumuna	3km	3,684
Nota	3km	2,485
Uambafuca	5km	6,324
Kavango	5km	850
Calonga	5km	784
Chatoma	10km	7,637

Each stratum, except Calonga and Kavango, has been subdivided into blocks of approximately 3-4 hours total flying effort (including ferry).

**FIGURE II-3. STRATA SUBDIVISION**



**FIGURE II-4. TRANSECT TRACKS**



**DATES OF SURVEY:** 20 September – 1 October

**PROGRAMME:**

<b>Date</b>	<b>Period</b>	<b>Strata/Block</b>	<b>Flying Hrs (transect + ferry)</b>	<b>ETD</b>	<b>ETA</b>
20-Sep	<i>Morning</i>	Briefing / Calibrations	1.5	9.30	10.30
	<i>Afternoon</i>	Kavango	2.0	15.00	17.00
21-Sep	<i>Morning</i>	Cuito B1	3.8	7.00	10.48
	<i>Afternoon</i>	Uambafuca B1	3.2	15.00	18.12
22-Sep	<i>Morning</i>	Cuito B2	3.5	7.00	10.30
	<i>Afternoon</i>	Uambafuca B2	3.3	15.00	18.18
23-Sep	<i>Morning</i>	Lumuna B1	3.6	7.00	10.36
	<i>Afternoon</i>	Rest	Nil	Nil	Nil
24-Sep	<i>Morning</i>	Lumuna B2	3.9	7.00	10.54
	<i>Afternoon</i>	Uambafuca B3	2.9	15.00	17.54
25-Sep	<i>Morning</i>	Rest	Nil	Nil	Nil
	<i>Afternoon</i>	Rest	Nil	Nil	Nil
26-Sep	<i>Morning</i>	Lumuna B3	4.3	7.00	11.18
	<i>Afternoon</i>	Calonga	2.6	15.00	17.36
27-Sep	<i>Morning</i>	Nota B1	4.0	7.00	11.00
	<i>Afternoon</i>	Chatoma B1	3.6	15.00	18.36
28-Sep	<i>Morning</i>	Nota B2	4.3	7.00	11.18
	<i>Afternoon</i>	Chatoma B2	3.9	15.00	18.54
29-Sep	<i>Morning</i>	Rest	Nil	Nil	Nil
	<i>Afternoon</i>	Rest	Nil	Nil	Nil
30-Sep	<i>Morning</i>	Cuito Wetlands 1	2.5	7.00	9.30
	<i>Afternoon</i>	Rest	Nil	Nil	Nil
1-Oct	<i>Morning</i>	Cuito Wetlands 2	2.1	7.00	9.06
		Ending Meeting	Nil		

**OPERATION BASE** – Shitemo air strip and Shankara Farm.

**AERIAL SURVEY TEAM:**

**Pilot:** Patrick Ford

**Navigator/Recorder:** Luis Verissimo

**Observers:** Gabriel Shatumu  
Mark Paxton  
Victor Katanga

**CALIBRATIONS**

Prior to the survey all observers, as well as the actual transect width, need to be calibrated. For the Mucusso Survey a Strip Width of 250m on either side of the aircraft will be used.

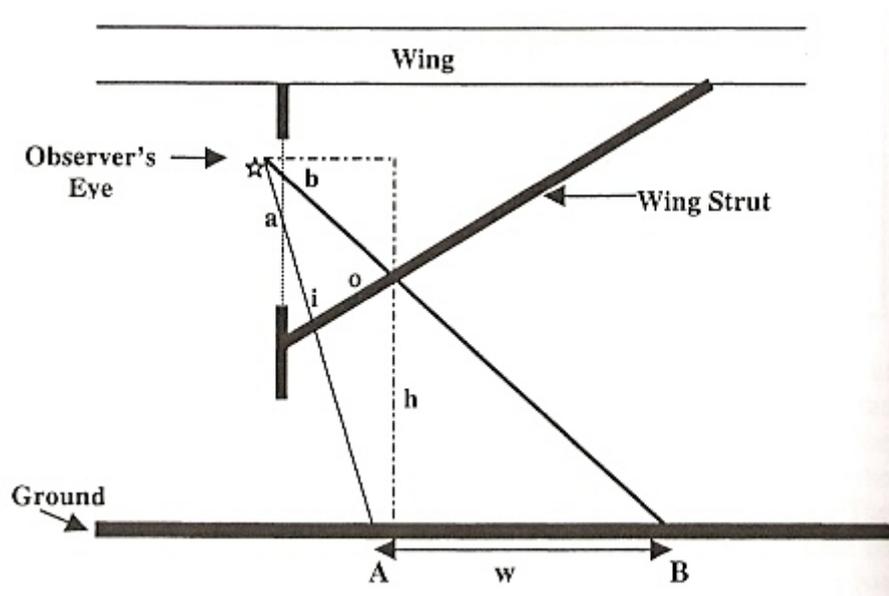
Markers will be placed on the aircraft struts to indicate a 250m strip on the ground as the plane flies at 300 feet above ground.

**PROCEDURES**

**I. POSITION OF THE STREAMERS**

For the Cessna 182, the aircraft should simulate its flying alignment. The streamers are positioned as follows (Fig. II-5):

**FIGURE II-5. POSITION OF THE STREAMERS IN RELATION TO STRIP WIDTH ON THE GROUND WHEN THE AIRCRAFT IS PARKED (JACHMANN, 2001)**



**Note:** The observers should be sitting in the parked plane in a comfortable and relaxed position.

- a) Measure the perpendicular height of the observer's eye ( $h$ ) above ground;
- b) Fix the position of the inner streamer ( $i$ ) as low as possible in the wing strut, ensuring that the line of sight is clear of any aircraft parts. Place a marker on the ground on this line of sight ( $A$ ), while the observer uses a small piece of tape to mark the window ( $a$ ), creating a line of sight that passes from  $a$  to  $i$  to  $A$ .
- c) Place a second marker on the ground ( $B$ ) so that  $w = W \times h/H$ , whereby:

$w$  is transect width on the ground in meters,

$W$  is transect width required during survey in meters

$h$  is the height from the observers eye to the ground in meters, and,

$H$  is the flying height during the survey in meters.

- d) Position the second streamer on the wing strut ( $o$ ) in the line of sight to point  $B$ .
- e) Use a piece of tape to make the second mark on the window.

## 2. CALIBRATION OF THE TRANSECT WIDTH

To prevent errors in this measurements, it is essential to calibrate the transect width. Therefore the following is suggested:

**Note:** During flights it is important that the observers keep the window tape and streamer lined up.

- a) A line of markers will have to be laid out on the air stripe (ex. a set of numbers painted, or white-washed), placed at 10m apart. The line of markers should be at least 50% longer than the required transect width.
- b) The pilot, while using a pressure altimeter to determine height above ground level, should make a low pass over the markers to set the altimeter at zero.
- c) Then, using the radar altimeter, the pilot should make at least 10 passes over the markers, crossing the airstrip at right angles along the flight path, at the required flying height (300ft).
- d) During each pass, the observers reads the two numbers on the ground, closest to the inner and outer markers on the struts. The navigation recorder records this two readings for each observer and the actual height of the aircraft, measured on the radar altimeter.

If it appears that the streamers are not positioned correctly and the difference between the required and the actual transect width is too great, the pilot should land to reposition the streamers. There should be a level of variation between the different actual strip width readings of <20%.

If the error margins are acceptable, the actual transect width can be calculated with the above formula, whereby:

$h$  is the average height of the aircraft during  $x$  passes, in meters

$w$  is the average strip width during  $x$  passes, in meters

$H$  is the required flying height for the survey, in meters

$W$  is the actual strip width at that height, in meters

The calibration is specific to each seat of the aircraft. An observer calibrated for the left rear seat cannot count from the right rear seat. This observer will have to be calibrated for those seats separately.

Calibration data for each observer is crucial during the analyses of the survey data.

## DATA TO BE COLLECTED

All mammal species identified during the aerial survey are to be recorded, as well as Ground hornbill (*Bucorvus leadbeateri*), Ostrich (*Struthio camelus*), Wattled Crane (*Grus carunculatus*) and Crocodile (*Crocodylus niloticus*). This includes identification of the species, number of individuals and geographical position of each sighting. Elephant observations should be classified as follows:

- *Family groups* – herds in which females and young are present. Any bulls in the group are counted as part of the group;

- *Bull groups* – single bulls or herds which contain no females or juveniles
- *Elephant Carcass*:
  - Carcass I – Fresh (<1 month): skin covered, with flesh present giving the body a rounded appearance, ground still moist by body fluids;
  - Carcass II – Recent (<1 year): rot patch still visible; hide still attached to carcass, bones not scattered;
  - Carcass III – Old (>1 year): skin absent, bones bleached and scattered, vegetation regrown in rot patch.

Observations related to human presence and activity are to be recorded, including:

- location of villages/settlements
- location of fields
- number of huts observed and their geographic location
- location of poachers camps (presence of meat racks with or without meat),
- roads/tracks, with GPS location and direction of alignment, classified according to
  - a) in use (ox cart or vehicle tracks visible), and
  - b) not used (vegetation regrowth evident, no ox cart or vehicle tracks visible)

Number of domestic livestock (Cattle, Donkey, Horse, Sheep and Goats).

## **SURVEY CREW RESOURCE MANAGEMENT**

The survey crew in the aircraft will work as a team, with a clear structured and organised management of tasks and activities.

### **PILOT**

In charge of the aircraft and all flight related operations, including navigation of the transects and operation of the GPS, calibration of the radar altimeter, maintenance of the height and speed of the aircraft as defined for the survey. His decisions and judgments concerning the safety of the plane must be respected by the rest of the crew.

### **NAVIGATOR RECORDER**

In charge of the counting operations during the flight (including the observers), recording the sightings, noting the species, number and position from a second GPS fitted in the aircraft (as waypoints), recording the side of the plane on which the observation was referred, and noting the height above ground level as indicated by the radar altimeter every 30 seconds. The navigator/recorder will also record the time at which the flight along each transect is started and ended.

### **OBSERVERS**

Will be focused primarily on searching for and counting animals within the designated counting strip. Upon spotting animals, the observers will inform the navigator/recorder of information in the following order:

- 1 – Species\*
- 2 – Number\* (calves)
- 3 – Seat position
- 4- In or outside strip

*\*additional elephant data, as well as observations related to human presence and activity, should be recorded in accordance with the classification indicated in the “data to be collected” text.*

The observers should call observations when the sightings are as nearly perpendicular to the plane as possible.

# APPENDIX III. SEMI STRUCTURED QUESTIONNAIRES TARGETING KEY SPECIES (EXAMPLE)



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