

Murchison Falls National Park Lion Monitoring Project Report

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Contents

Acknowledgements.....	1
INTRODUCTION	2
MATERIALS AND METHODS.....	2
Study site.....	2
Data collection	4
RESULTS	5
Demography.....	5
Sex ratios.....	6
Mortality	7
Home range.....	8
Population	8
Diet.....	10
Vultures and other scavengers	12
DISCUSSION.....	12
References.....	14
Appendix 1.....	16

INTRODUCTION

A Wildlife Conservation Society (WCS) carnivore research team, in partnership with Uganda Wildlife Authority (UWA) has been monitoring lions on the northern bank of Murchison Falls National Park (MFNP) since 2010. This followed a national census of lions and hyenas in Uganda in the three largest carnivore habitats; Queen Elizabeth National Park (QENP), Kidepo Valley National Park (KVNP) and Murchison Falls National Park between November 2008 and November 2009 (Mudumba, Okot et al. 2009).

The results of the survey showed that the population of lions in Uganda had declined by at least 30% in less than 10 years with the largest decrease of 40% (from 324 in 2002 to 132 individuals in 2009) registered in MFNP. At the same time, after the discovery of commercially viable quantities of inside the park; oil exploration in preparation for extraction was starting. Therefore, this study is to generate baseline data about the lions of MFNP and why the population has declined and also use lions as flagship species and monitor how oil exploration and extraction will impact the local fauna. This study is equally important because it is the first time that an investigation is being done of lion ecology under oil mining activities.

This report is for a period of over 35 months starting Oct 2010 to Nov 2013. We have collared 7 individuals (3 males & 4 females from 4 prides) and also used individual recognition using whisker spots, scars and natural ear tears from sightings and photographs to collected data on; demography, movement and distribution. We also recorded the position and cause of death of all carcasses found in the study. See appendix 1 for detailed data sheet.

As more data are being collected from the radio-collared animals, this report serves in many ways as a preliminary analysis that will help guide the study in the future, as well as help advice in an adaptive way the management of MFNP of potential impacts of oil exploration activities within the park. It will inevitably guide decision makers on how best to extract oil bearing in mind the likely effect on wildlife

MATERIALS AND METHODS

Study site

Murchison Falls National Park is located in the north western part of Uganda (02°15'N 31°48'E), and as with all other protected areas in the country, is managed by the Uganda Wildlife Authority (UWA) figure 1. Established in 1952, the 3,840 km² park was a popular tourist destination in the 1960s, having

the highest number of visitors per year in Eastern and Central Africa (Rwetsiba and Nuwamanya 2010). The Nile River runs from east to west, and forms a 7 m wide, 43 m high falls that are the namesake of the park (Figure 1). Two wildlife reserves are contiguous to MFNP: Karuma Wildlife Reserve to the southeast and Bugungu Wildlife Reserve to the southwest. Together, the three protected areas extend over 5,308 km² and are collectively referred to as the Murchison Falls Conservation Area (MFCA). The 7 lions collared for this study were located on the north-western part of the park, an area covering about 1,200 km².

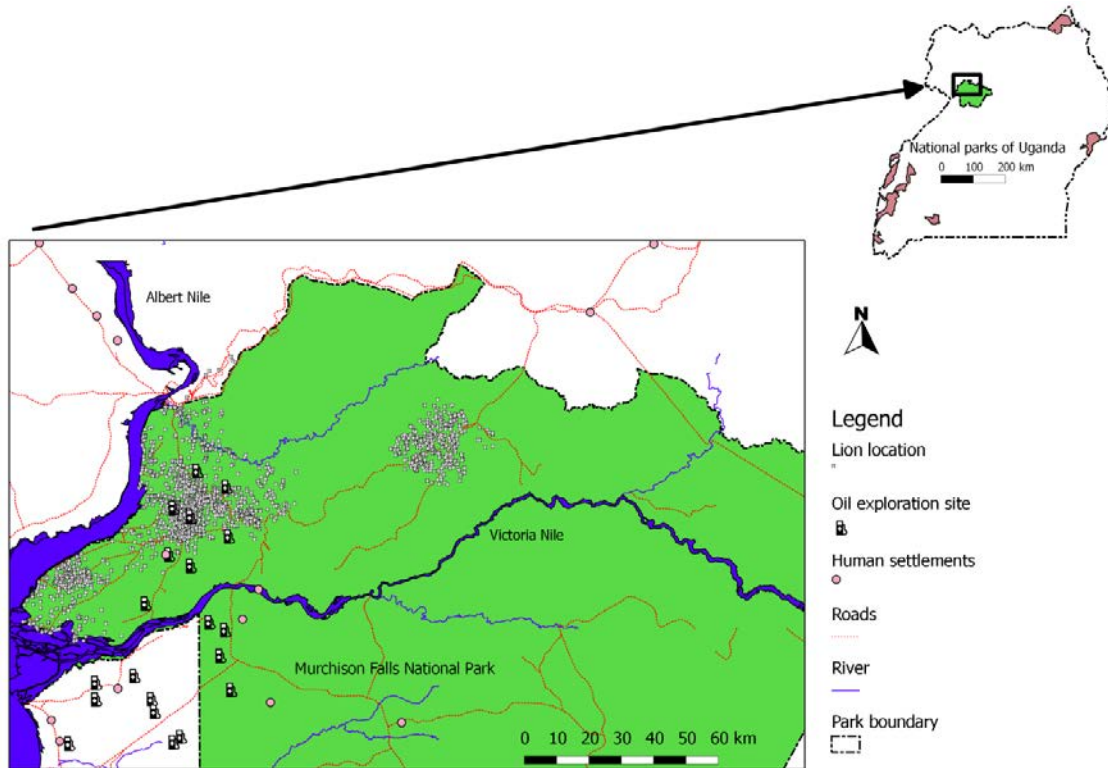


Figure 1: Part of Murchison Falls National Park with lion locations, oil exploration sites and human settlements

There were eight active oil exploration sites in a section of approximately 200 km² located centrally in the study area and 3D seismic survey started in March 2013 to date. Historically, MFNP had a rich large carnivore community consisting of lions *Panthera leo*, leopards *Panthera pardus*, spotted hyenas *Crocuta crocuta*, and wild dogs *Lycaon pictus*, but there have been no confirmed sighting of the latter in the last three decades (Driciru 2005; Mudumba, Okot et al. 2009).

The main carnivore prey available in the area includes the Uganda kob *Kobus kob thomasi*, warthog *Phacochoerus africanus*, hartebeest *Alcelaphus buselaphus lelwel*, Cape buffalo *Syncerus caffer caffer*, waterbuck *Kobus ellipsiprymnus*, giraffe *Giraffa camelopardalis*, oribi *Ourebia ourebi*, and

reedbuck *Redunca redunca*. Recent aerial surveys of large mammals showed an increase in the population of ungulate species (Rwetsiba and Nuwamanya 2010).

There are two rain seasons in the region; the main rain season from April to June and a minor one from September to October. Mean annual precipitation is 1,000-1,250 mm. The dry season runs from mid-December to mid-February with temperatures reaching up to 40 °C. The Victoria and Albert Nile border the entire southern and western sides of the study area. The Park's topography is mostly level grassland fields interspersed with whistling acacia *Acacia drepanolobium* and borassus palm *Borassus aethiopum* on the northern bank, and closed-canopy moist forest dominated by *Cynometra alexandri* in the south. The mean elevation of MFNP is 800 m. Nangendo et al (2005) provides a detailed description of the vegetation of MFNP.

Data collection

In total, seven lions have been fitted with a VECTRONICS Aerospace GmbH[®] collar fitted with 3D GPS PLUS 2010 VHF/GPS, of these 4 with Satellite/VHF, 1VHF and 1 VHF/GSM enabled transmitter. The total weight of each collar was less than 3% of the body weight of the animal it was fitted on. The satellite/VHF and VHF/GSM collars were programmed to record six positions per 24 hours and to transmit their coordinates via a satellite or GSM station to a data base each time that four positions had been registered. Starting in October 2010 to Nov 2013, except for short breaks, there has been radio tracking of the collared individuals. More than 55,000 kilometres have been driven to track collared individuals and also to find carcasses by the monitoring team, more distance than the equatorial circumference of the earth. The tracking of lions has at times relied on UWA ranger guides and patrol teams who alert the monitoring team of sightings. Whenever possible, first time sightings were photographed using a NIKON D40 camera to show whisker spots for identification and a movie clip recorded using a NIKON CoolPix P100. Appendix 1 has got details of data sheets used to collect data once the lions and/or carcasses were found late during daily tracking.

One lioness: DFO_003 was trampled by buffaloes as she gave birth in October 2011 and her collar was transferred to another lioness (DFO_002) of the same pride. One male: DMO_001 has been missing since March 2011 and the collar ceased transmitting locations in April 2011 at about the same time a VHF collar was deployed on a male (OMS_007) that replaced him as pride head but this male got killed in a wire snare trap on 29th December, 2012.

RESULTS

Demography

Ninety six lions have been identified in an area of about 1200 km² from 4 prides (Figure 1), most of these females (57.3%).

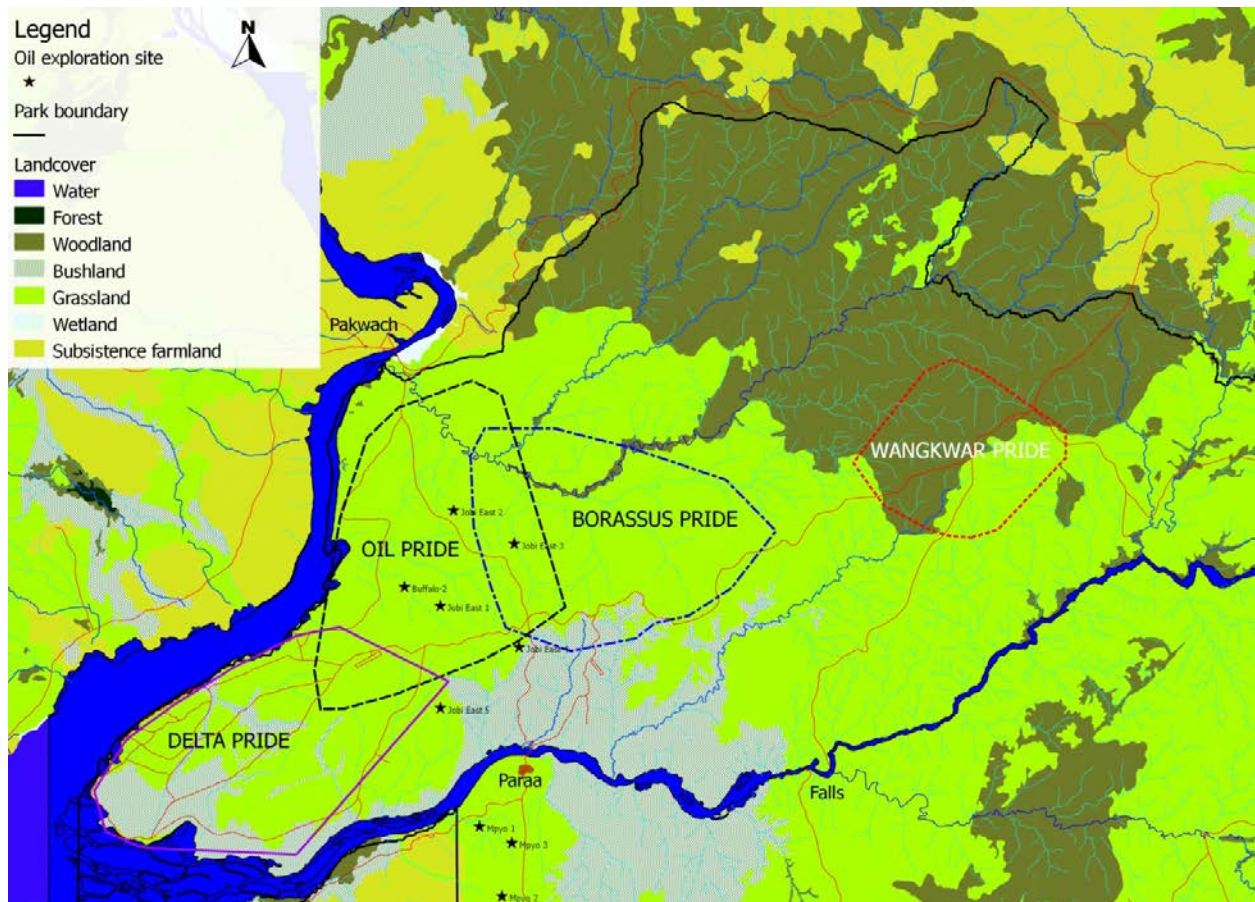


Figure 2: Pride names and locations during the study period

The total number of individuals that have been recognized in each pride were 17 for the Oil region pride 22 for Borassus, 24 for Delta and 11 for Wangkwar prides. The mean pride size considering all encountered lions for the study area was 18.5 ± 2.5 . Twenty two lions died during the study and about 11% have not been seen in the last 12 months despite continued monitoring. The Delta pride had the largest (24) number of individuals and Wangkwar pride has 11 identified lions (Table 1).

Table 1: Pride structures of the northern bank study area

Sex	Age	Pride				Total
		Borassus	Delta	Oil	Wangkwar	
Female	Adult	7	5	6	2	20
	Juvenile			5		5
	Cub	8	7	4	4	23
Male	Adult	2	3	1	5	11
	Juvenile	1	4			5
	Cub	4	5	1		10
	Total	22	24	17	11	74

Sex ratios

There was no significant difference between the proportions of mature lions (adults) and the young (juveniles and cubs) between prides (X-squared = 2.8711, df = 3, p-value = 0.41). The maximum number of adults in a pride was 11 (Table 2).

Table 2: Summary statistics of the demographics

Age	Sum	Max	Min	SE	mean	SD	cv
Adult	35	11	7	0.74	8.75	1.71	0.20
Cub	50	9	4	2.17	12.50	5.00	0.40
Juvenile	11	4	0	0.96	1.75	2.22	0.81

Most (44.6%) of the surviving lions are cubs. Wangkwar pride has no juvenile lions while the Oil region pride has the largest (29.4%) number of juveniles (Table3).

Table 3: Percentage age composition of the study prides

Age	Pride (%)				Total%
	Borassus	Delta	Oil	Wangkwar	
Adult	40.9	33.3	41.2	63.6	41.9
Cub	54.5	50.0	29.4	36.4	44.6
Juvenile	4.5	16.7	29.4	0.0	13.5

Sixty five percent (n= 15) of all the adult lionesses encountered during the study had cubs. A total of 25 litters (56 cubs) have been known during the study; seven lionesses had 1 litter, 4 had 2 litters and 4 had 3 litters. Most (61.5%) of the litters seen consisted of 2 cubs, 19.2% had 3 cubs, 15.4%

had only 1 cub and 3.8% were of 4 cubs. Most of the litters were first seen before the age of 1 month (n= 14) and 11 ranging from over a month to 10 months. The sex ratio for litters older than a month was litters 1:1. The sex ratio is slightly skewed at birth (1 female: 1.3 male) and more females in adults at 1 male for every 1.7 females.

Mortality

Twenty five lions died during the study period, the majority being males (52%). Among the sex classes, 64% (n= 16) were cubs, 4% (n= 1) juveniles and 15% (n= 3) adults. Forty percent of all the dead could not be ascertained while 30% (n= 6) died of natural causes and 36% (n= 9) died from human related incidences. The human related incidences were: strangling by illegal wire snare trap for a juvenile and a pride male (Bernie, OMS_007), and suspected poisoning for Bridget (OFS_021) who died pregnant with 3 cubs at an oil well site (Buffalo East 1). Among those that died under natural causes was pride male Bright (DMO_012) that was killed by Butcherman (DMO_011) and Bernie (OMS_007) in a pride take-over fight in the delta region. The others were a female Fatuma (DFO_003) trampled by 2 buffalos while giving birth and killed with 3 cubs, and a cub Leticia (DFB_049) gored by a warthog during a fatal hunt. Three cubs were killed by uncontrolled fire started by rangers in the Borassus region. The oil region pride registered the most number of dead lions (Table 4).

Table 4: Dead lions by pride, sex and age class

Pride	Adult		Juvenile	Cub		Total
	Female	Male	Male	Female	Male	
Borassus				1	1	2
Delta		2	1		2	4
Oil		1			2	6
Wangkwar					1	1
Grand Total		2	1	1	5	11

Nine lions have not been seen for at least a year (Table 5). Opido (DMO_001) was injured when he was caught in a wire snare and when a coalition of 2 males challenged him for the delta pride he lost and has not been seen since March 2011 although his last location from the satellite collar was in April 2011. All the other missing lions were not collared.

Table 5: List of known missing lions

Name	Unique code	Sex	Age Group	Date last seen	Comment
Opido	DMO_001	Male	Adult	Mar-11	Last seen by WCS lion team near Tangi gate
Freda	DFB_024	Female	Adult	May-11	Last seen by WCS lion team in delta area
Peace	BFR_045	Female	Adult	Jun-11	Last seen by WCS lion team in Wangkwar area
Mathew	WMR_026	Male	Adult	Jul-11	Last seen by UWA chief warden along wangkwar road
Male 2	BMR_037	Male	Adult	Jul-11	Last seen by UWA ranger at Tangi gate
Male 1	WMR_038	Male	Adult	Jul-11	Last seen by UWA Vet. Problem animal in Purongo
Mpagi	WMR_039	Male	Adult	Aug-11	Last seen by UWA guide on wangkwar road to top of falls
Akum	BFR_041	Female	Juvenile	Sep-11	Last seen by UWA ranger at Tangi gate
Acayo	BFR_042	Female	Juvenile	Sep-11	Last seen by UWA ranger at Tangi gate

Home range

The largest home ranges from kernel density estimates is 68.5 km² for the delta pride and smallest is 30.64 km² for the oil region pride (Table 7).

Table 6: Summary of pride home range size

Pride	Home range (km ²)		
	95%	50%	hRef
Wangkwar	42.92	14.16	644.8
Borassus	49.46	12.11	829.5
Oil	30.64	9.63	372.4
Delta	68.50	14.01	1119.3

There is 3% and 7% overlap of 95% home ranges between delta – oil pride and oil – borassus pride respectively. For a detailed analysis of home ranges and habitat preference, see (Mudumba and Jingo 2011)

Population

The largest cumulative number of individuals in a pride so far is 24 for the Delta pride. From the cumulative curves of the prides (Figure 3), 2 prides: Delta and Oil pride waiver mostly between 14 – 15 and 13 – 14 respectively over the past 12 months. This is despite continued monitoring of the areas for new individuals. It is therefore likely that we have recorded all the pride members of these 2 prides.

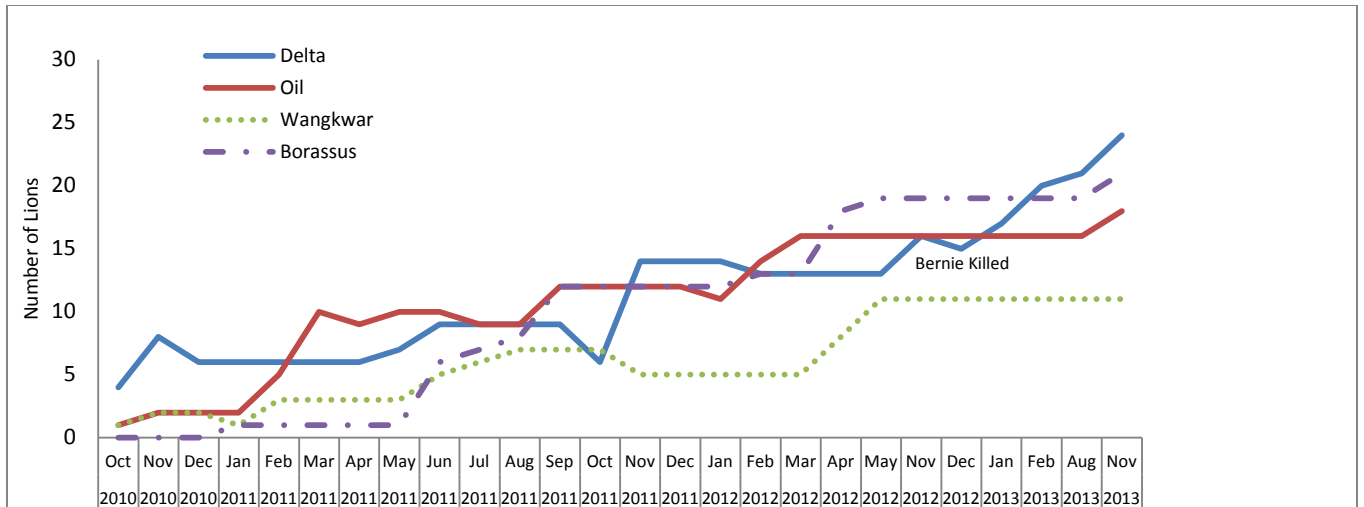


Figure 3: Cumulative Number of Lions from 4 Prides on Northern Bank of MFNP; Oct 2010 to Nov 2013

The sum of the average number of lions in the delta and oil prides is 27 living in an area of 225.96 km² giving a density of 0.12 lions/km². Locations of prey animals from UWA 2012 aerial survey of mammals in MFCA were used to identify suitable lion habitat (figure 4).

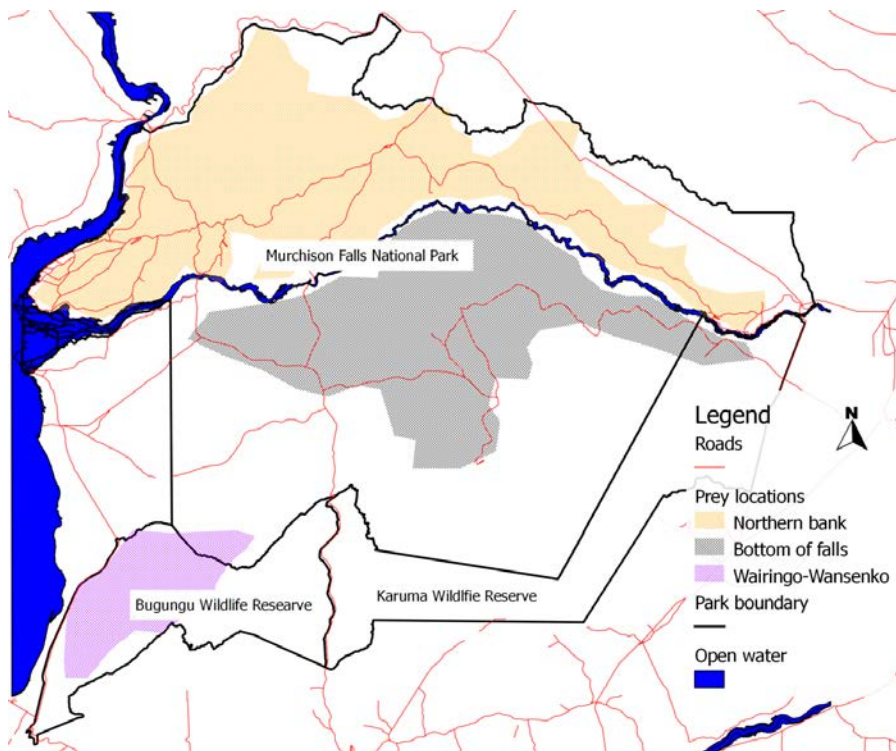


Figure 4: Suitable lion habitats from aerial prey sightings

The northern bank of MFNP has the highest estimated (114) number of lions in MFCA. About 22 are estimated for Wairingo-Wansenko area (Table 7). The estimated population of lions in MFCA from partial total counts is 215. This is up from the 2009 estimate from the Lure count method.

Table 7: Population estimates from extrapolating known density

Location	Area (km ²)	Estimated Population
Bottom of Falls	729.1	87
Wairingo-Wansenko	183.62	22
Northern bank	947.33	114
Southern bank	845.59	101
Total area used	1792.92	215

Diet

Most of the prey carcasses (105) found were killed by predators and a buffalo was killed when it got stuck in a mud-pit (Table 8). There was no significant difference between the proportions of large (buffalo & hartebeest), medium (kob & waterbuck) and small (oribi & warthog) prey eaten by lions in the wet and dry seasons (X-squared = 5.4119, df = 2, p-value = 0.07). Although overall there is no apparent selection for either sex from all the carcasses found, lions ate more female warthogs (89%, n= 14) than males and more male buffalos than females.

Table 8: Count of carcasses for each cause of death

Species	Cause of Death					Study period
	Natural	Poached	Predators	Road kill	Unknown	
Buffalo	1	3	3		3	10
Hartebeest			12			12
kob		3	64	2	14	83
Oribi		1	10	1	1	13
Warthog		1	14			15
waterbuck			2			2
Total number of carcasses	1	8	105	3	18	135

Carcasses found during daily telemetry show that lions catch mainly kob for food (61%, n=135). Waterbuck are consumed least (2% of diet) and only in the wet season (Table 9).

Table 9: Count of carcasses by season

Species	Dry (%) n=60	Wet (%) n=75	Study period (%) n=135
kob	70	55	61
Warthog	5	16	11
Oribi	7	12	10
Hartebeest	15	4	9
Buffalo	3	11	7
waterbuck	0	3	2

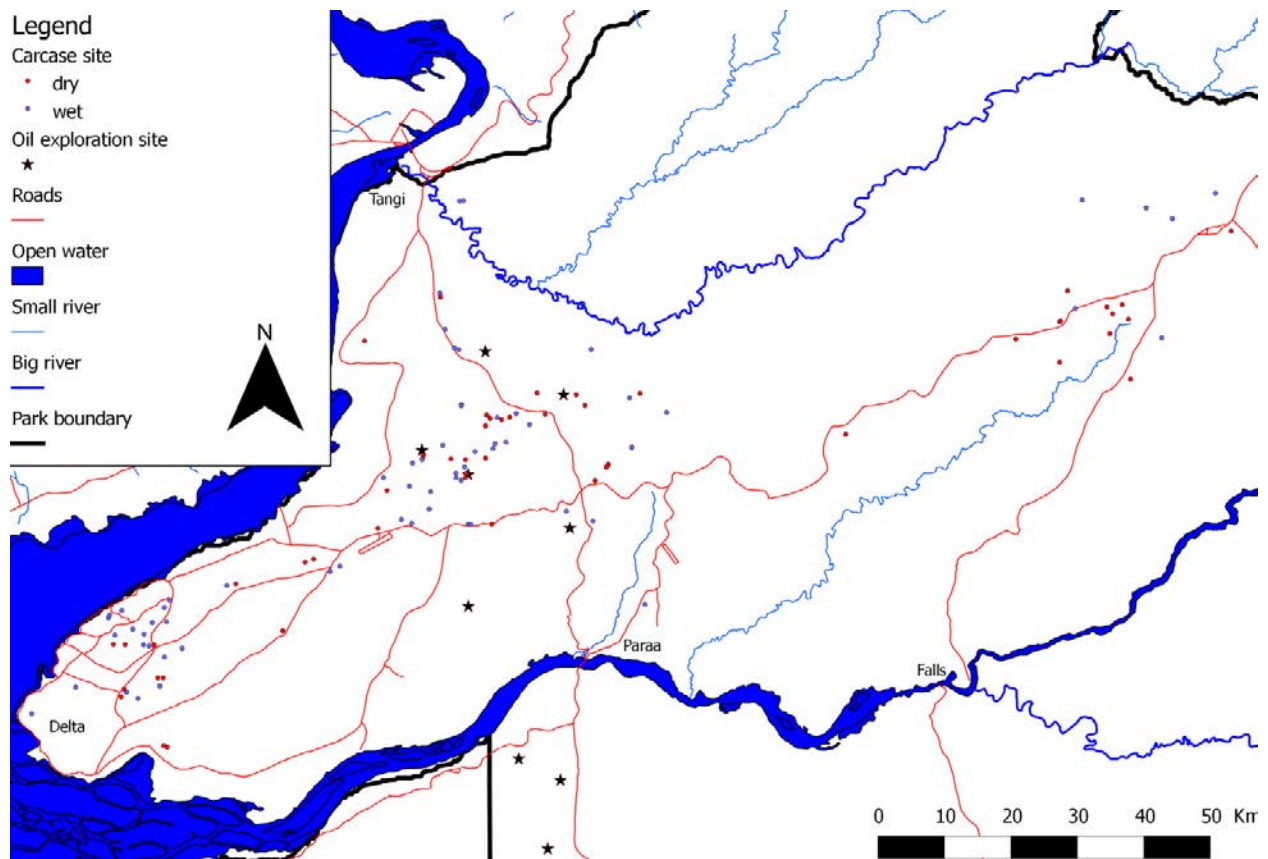


Figure 5: Distribution of carcasses by season

The Wangkwar pride consumes mostly kob (70%, n= 17) and no oribi or waterbuck carcasses were found in their range like was the case for the oil region pride range (Table 10).

Table 10: Distribution of carcasses by pride

Species	Pride (%)			
	Borassus n=43	Delta n=61	Oil n=14	Wangkwar n=17
Buffalo	4.7	8.2	7.1	11.8
Hartebeest	7	9.8	14.3	5.9
kob	48.8	67.2	64.3	70.6
Oribi	16.3	9.8	0	0
Warthog	20.9	3.3	14.3	11.8
waterbuck	2.3	1.6	0	0

Carcasses with signs that they had been poached were found mostly (62%, n=16) in the wet season with hippopotamus as the most commonly poached species (31.2% of poached carcasses found). Other species poached were; buffalo, elephant, kob, oribi and warthog.

Vultures and other scavengers

All vultures and storks found on carcasses were identified and counted. A total of 783 birds were counted a majority (85%) of which were White-backed vultures. Others were Marabou storks (n= 96), hooded vultures (n= 9), Palm nut vultures (n= 2) and Ruppell's griffon vulture (n= 7). Ruppell's griffon vultures were only seen in the dry season while the Palm nut vultures were seen in the wet season.

DISCUSSION

The population of lions throughout their remaining ranges in the world has been declining (Bauer and Van Der Merwe, 2004). The latest estimate for Uganda is typical of this trend (Okot et al, 2013) and MFNP represents the worse decline in lion population. The estimated lion population density 12 individuals for every 100 km² is strikingly similar to that of an earlier study (Driciru, 2005) although this study has covered more ground and also used lion collars. This estimate lies out of the established 35 to 45 individuals per 100 km² for the prey rich and large East Africa savannahs but way above 1.5 to 2.0 lions in the drier regions in southern Africa like Kalahari (Sunquist and Sunquist, 2002).

The mean group sizes for the study area is above Driciru's 2005 estimate at 18.5 ± 2.5 and where Driciru (2005) had the largest group (21) in the Pakwach there are 22 individuals. The largest group size

(24) this time is further west in the Delta. From Sunquist and Sunquist (2002) similar numbers have been recorded in woodlands with the more open savannah parks like Serengeti having the largest lion assemblies at 35 individuals. Recent large mammal census in MFNP showed all the lion prey to be increasing from previous estimates (Rwetsiba and Nuwamanya 2010) and so prey availability may not play a big role in determining the viability of lions in MFNP.

The percentage of cubs of this study and Driciru's (2005) is comparable at 44.6% and 43.8% respectively. This is not the same for the percentage of adult lions which is 41.9 from this study and Driciru (2005) found only 15.6% of the lion population adults. Driciru (2005) however found a larger number of Juveniles (25%) than we did from this study (13.5%). Juveniles were not seen in Wangkwar pride and most of the lions in the Oil region were juveniles. The absence of juveniles may signify that most of cubs from the past 2 years have been killed in the area which is further strengthened by stagnation of population growth. For the oil region, a high juvenile group could be a result of high cub survival rates in the recent past.

Among the cubs, sex bias towards males is indicative of high male turn over (Smuts, 1976) although at 1.3:1 for the MFNP scenario is not that skewed even with 2 pride take-overs in just over 2 years. It is worth noting that the sex ratio in cubs is unchanged since Driciru (2005). Schaller (1972) found lower litter sizes in Serengeti (1.7 to 1.9) than we found in MFNP (2.2). Driciru (2005) recorded higher litter size (2.4) at the same site but had smaller sample size as compared to this study. Our recent finding falls within the range Van Orsdol (1985) give of between 2.3 and 3.3 for savannah. It was observed that most of the adult females (65%) were breeding with most producing a litter of 2 cubs with a few (3.4%) bearing 4 cubs.

The lions of MFNP were found to live in small ranges and at the very smallest in a home range of just 30.6 km² and the widest just over 68 km², this is about half of the recorded home ranges elsewhere in East Africa (Sunquist and Sunquist, 2002) but typical of Uganda's lions as observed in QENP (Van Orsdol, 19282 and Ziwa and Plumptre 2009). In MFNP, lion prey is mainly encountered in the open savannah (Rwetsiba & Nuwamanya, 2010), and therefore it is reasonable to assume that prey presence influences habitat choice and size. These small ranges pose few threats to the lions with only 36% dying of natural causes. However, the region has the highest number of human activities going on. Oil mining, tourism and transport routes cross through the region and these activities plus illegal access and poaching are responsible for most lion deaths.

Most mortality (71%, n=7) in adult lions is a result of human related incidences mainly snares and other traps. In 2 years, 5 lions were killed in illegal traps (3 in wire snares & 2 in wheel traps), 6 lions have been seriously injured (2 by wheel traps & 4 by wire snares) to require veterinary intervention (3 lost their limbs). To date, three critically injured lions are being observed periodically as they recover from snare injuries but will remain maimed for life. Continued monitoring of the lion population is vital to understand the severity of these threats and their impact on the population.

Efforts are ongoing to reduce illegal traps in the park. Using GIS and UWA ranger patrol data, snare prone areas on the northern bank have been identified and zoned according to type of traps. This has been followed by removal exercises in part of the 550 km² wire snare prone area. So far over 2500 wires, 34 spears, 2 elephant traps have been collected and 6 animals rescued from wire snares. Together with UWA community conservation department, WCS facilitates willing ex-poachers to retrieve wheel-traps at homes and in park. WCS has also sponsored the cutting into pieces of all wire snares that were being kept in MFNP stores to avoid reuse in case they are stolen. The snare removal exercises need to continue as more than 80% of the 'snare zone' is yet to be checked for snares. Therefore, there is need for more resources to pay for basic supplies for the removal team for frequent snare removal exercises that sweep the entire wire snare zone.

Commercially viable quantities of oil have been discovered under Murchison, and the process of further exploration and production will ramp up significantly over the next five years. This has enormous potential to cause further disturbance to the lion population and its prey basis. Ongoing monitoring of the population will be critical to understand the impacts of oil development, and to provide recommendations to UWA and to the oil companies on strategies to minimize impacts.

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