

Technical Report
Aerial surveys of Kidepo Valley National Park
and Karenga Community Wildlife Area



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Executive Summary

This report summarizes the findings of an aerial survey of large mammals in the Kidepo Valley National Park (KVNP) and the adjacent Karenga Community Wildlife Area (KCWA) in June 2014. These two protected areas occur in north eastern Uganda on the border with Southern Sudan and contain a population of elephants that has fluctuated over the years in response to poaching pressures.

The key results of the survey show that the elephant population in KVNP is relatively stable at around 550 (standard error: 262) individuals estimated from the Systematic Reconnaissance Flight (SRF) surveys or 407 from a total count survey. The SRF estimate is the second largest estimate for elephants in the park indicating that the population is healthy and has recovered to the numbers that were observed in the 1960s before extensive poaching took place. There is indication that elephants are also expanding their range into the KCWA with much larger numbers (214) observed here in the Total Count than previously. Buffalo numbers are also relatively large at 6,935 from the total count individuals, the largest count ever for the park. Other large mammals however are still very few in number with zebras at around 153 individuals and giraffe and eland at between 20-30 individuals from the total count. These latter two species were not observed on the SRF surveys indicating the value of making total counts as well as SRF surveys.

We make several recommendations to improve the protection of elephants in particular but also to conserve the other large mammal species. There is the potential to upgrade the status of KCWA to either a Wildlife Reserve or a National Park. If this went ahead it would afford much greater protection to the wildlife area and in particular protect the elephants that are using this region. Improving transboundary collaboration with Southern Sudan and strengthening the protection of species in the adjacent Kidepo Game Reserve would also provide land where elephants could migrate to safely. The fact that elephant numbers are at the level they were in the 1960s within KVNP indicates that the park is probably reaching carrying capacity for this species and this may explain why elephants are moving into KCWA. Enabling movements to the north also would allow the population to expand further without leading to habitat destruction.

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Introduction

The Kidepo Valley National Park (KVNP) and adjacent Karenga Community Wildlife Area (KCWA) are located in the north east of Uganda and conserve habitat and wildlife not found elsewhere in Uganda's protected area estate. Large mammal species such as greater and lesser Kudu, cheetahs and African wild dogs were found here and other parts of Karamoja in eastern Uganda but now are almost exclusively confined to this region. A species of crocodile, *Crocodylus suchus*, that used to be mummified and placed in the tombs of the pharaohs in Egypt was recently discovered here and is the only population of this species east of the Nile (Hekkala *et al.* 2011). Some species such as Bright's gazelle and oryx have become extinct here during the period of civil conflict in the late 1970s up to the early 1990s.

KVNP was established in 1962 following its initial gazettment as the Kidepo Valley Game Reserve in 1958 and consists of two large valleys surrounded by mountains; the Narus and Kidepo Valleys. It's initial size was 1,259 km² which was expanded to 1,442 km² in 1967 to incorporate important dry season grazing habitat in the upper Narus Valley (Olupot *et al.* 2010). Despite its creation as a national park this did not stop all hunting of wildlife and traditional hunts of several hundred people were recorded in the 1960s. However because they were using traditional weapons their impacts on the wildlife were limited. Following the defeat of Idi Amin in the late 1970s and the civil wars in Uganda during the 1980s, together with the activities of the Lords Resistance Army in northern Uganda in the 1990s and early 2000s arms proliferated in the region and poaching of wildlife is often carried out with AK47 machine guns. This makes it much more difficult for the Uganda Wildlife Authority (UWA) to protect the large mammal species found here. Regular cattle rustling occurs between Southern Sudan and northern Uganda with rustlers moving through KVNP with their cattle and this also leads to poaching as well as a risk of disease being brought in by the cattle.

Due to its remote location KVNP has not been surveyed as often as other savanna parks in Uganda. Aerial surveys were made in the late 1960s and 1970s and then again in 1996-98 (Lamprey *et al.* 2003) and the 2000s. Elephant numbers fluctuated between 277 in 1967 up to 820 in 1972 and averaged 480 in the park between 1967 and 1978 (WCS Unpublished data compiled from the literature). The elephant population is known to leave the park in the wet season but becomes concentrated in the park in the dry season (Eltringham, 1991; UWA 2000) and a similar pattern is seen for many of the other ungulates with up to a three-fold increase in numbers during the dry season (Ross, Field & Harrington 1976). The timing of aerial surveys is therefore important if comparisons are to be made between years.

KCWA, together with the Bokora Corridor Wildlife Reserve, were established in 2003 from what remained of the North Karamoja Controlled Hunting Area when the Wildlife Protected Area System Plan was developed (Lamprey *et al.* 2003). KCWA totals 956 km² and was surveyed in 2012 for the first time by UWA using a total count method for elephants and buffalo.

This report summarises the results of aerial surveys of both the KVNP and the KCWA. This was the first time that both an SRF survey and a total count of elephants was made for both protected areas. The surveys were made as part of the Pan-African Aerial Survey of Elephants (PAASE), a series of surveys of all of Africa's savanna elephants, in response to the increasing poaching of elephants for ivory across the continent. These surveys were financed by the Paul Allen Foundation.

Methods

PAASE developed a strict protocol of methods for the aerial surveys that would ensure they were standardized across the continent. These methods are detailed in the PAASE Aerial Survey Standards and Guidelines (PAASE 2014) and summarized here.

Sampling methods

In order to ensure comparability between surveys in previous years the same design was flown where possible. In the case of KVNP and KCWA, prior surveys had focused on making total counts rather than systematic reconnaissance flights (SRF). In this survey we made both a total count for elephant and buffalo as well as designing a new SRF survey with transect lines at 2.5km intervals (as used in other savanna parks in Uganda). Adaptive sampling was not used in any of the surveys in Uganda because of the need to survey all large mammal species and the fact that stratifying the protected areas could not be achieved for all species simultaneously. The surrounding mountains of KVNP tend to dictate the direction of the transects which ran east-west in the Narus valley and north south in the Kidepo valley. Transects were run north south in the KCWA.

Equipment

Two aircraft were used in these surveys a Cessna 182 (N22044) and a Cessna 206 (N242TC). Both were fitted with a Laser and Radar Altimeters (although one radar altimeter developed a fault for part of the survey) and readings were collected from both altimeters to allow comparison and checking.

Canon EOS 7D cameras with 20 mm wide-angle lenses were mounted on suction mounts to the rear windows of each plane one for each Rear seat observer mounted behind their heads with a cable release. The cameras were oriented to capture the view of the observer as closely as possible. Cameras were fixed on manual focus and taped at infinity and settings made to ensure fast shutter speeds to ensure that all images were sharp. Photographs were taken for any groups larger than 10 individuals for all ungulates and photographs were taken for all groups of elephants observed (including single individuals).

Voice recorders were used by the RSO's to capture information including the transect line number, subunit number along the line, species observed and number seen. These were transcribed onto datasheets immediately following the survey (either morning or evening) and then photos were checked to obtain the accurate numbers of animals in groups. A continuous recording of all people in the aircraft was also made starting from when the aircraft left the ground to when it returned. This allowed us to put a time-stamp on the recordings to help correct issues where it wasn't clear what had been said into the voice recorder.

Flight lines were uploaded to the pilots GPS unit and the lines and subunits were uploaded to the FSO's GPS unit to enable the FSO to call out both the line numbers and subunits along the line as well as record Radar altimeter readings about every 20 seconds.

Calibration

Calibration flights for the SRF were made for each of the two aircraft and their survey teams in KVNP. The planes flew between 250-500 feet above the ground over white boards placed at 20 metre intervals along the runway. Observers both counted the number of white squares they could see and also took photographs which were checked later for the number of white boards between

the streamers. Calibrations were entered in a computer by the FSO while in flight to check progress while the calibrations were being calculated and to ensure that flights with unexpected numbers were re-flown at the same height to check ground distances. Using this method we were able to ensure that the R^2 value exceeded 0.89 for each calibration and that the intercept was between +/- 20m.

Survey flights

The flights were flown early in the morning about one hour after dawn (7.30-8am) and ended by 11am. SRF flights were made on 26th and 27th June 2014. Each aircraft interleaved transects it flew so that they flew every second transect allowing us to compare results between planes and also between observers within the planes. This survey followed two previous surveys that had been made in Murchison Falls National Park and Queen Elizabeth National Park using the same observers and as a result there were no obvious errors between observers or planes and no repeat flights made of sections of the protected areas. Flights were only made in the morning to allow observers time to enter the data on datasheets and in the computer and also to check their counts of groups of animals from the photographs. The survey design for the two protected areas is shown in figure 1.

Total count flights were made between 28th-30th June 2014 and counted all elephants, buffalo, eland, giraffe, ostrich, and zebra observed. A block count survey design with grid and flight plan was developed with an average of 500m between flight lines. The census zone was divided into blocks of somewhat equal size. Each of the blocks were visited in sequence, reducing the time interval and reducing the probability that animals could move into neighboring blocks during the counts. Total counts were conducted in each of the blocks. Spatial coverage was maximized by use of a GPS tracklog and temporally a minimum "time in block" was defined to allow for a targeted 1.5km.sq. per min. search rate. Two aircraft were used for these surveys.

In addition, a grid segment recount exercise was undertaken for selected grids, which involves each survey aircraft surveying a set of grid squares already surveyed by the other aircraft after a short time span. This provides for a correction factor accounting for estimated amount missed by one team or the other. As this is experimental, these results are treated in a separate report.

Elephant Carcasses

All elephant carcasses sighted were recorded and classified according to the MIKE aerial standards: 1. Fresh; 2. Recent; 3. Old; 4. Very Old.

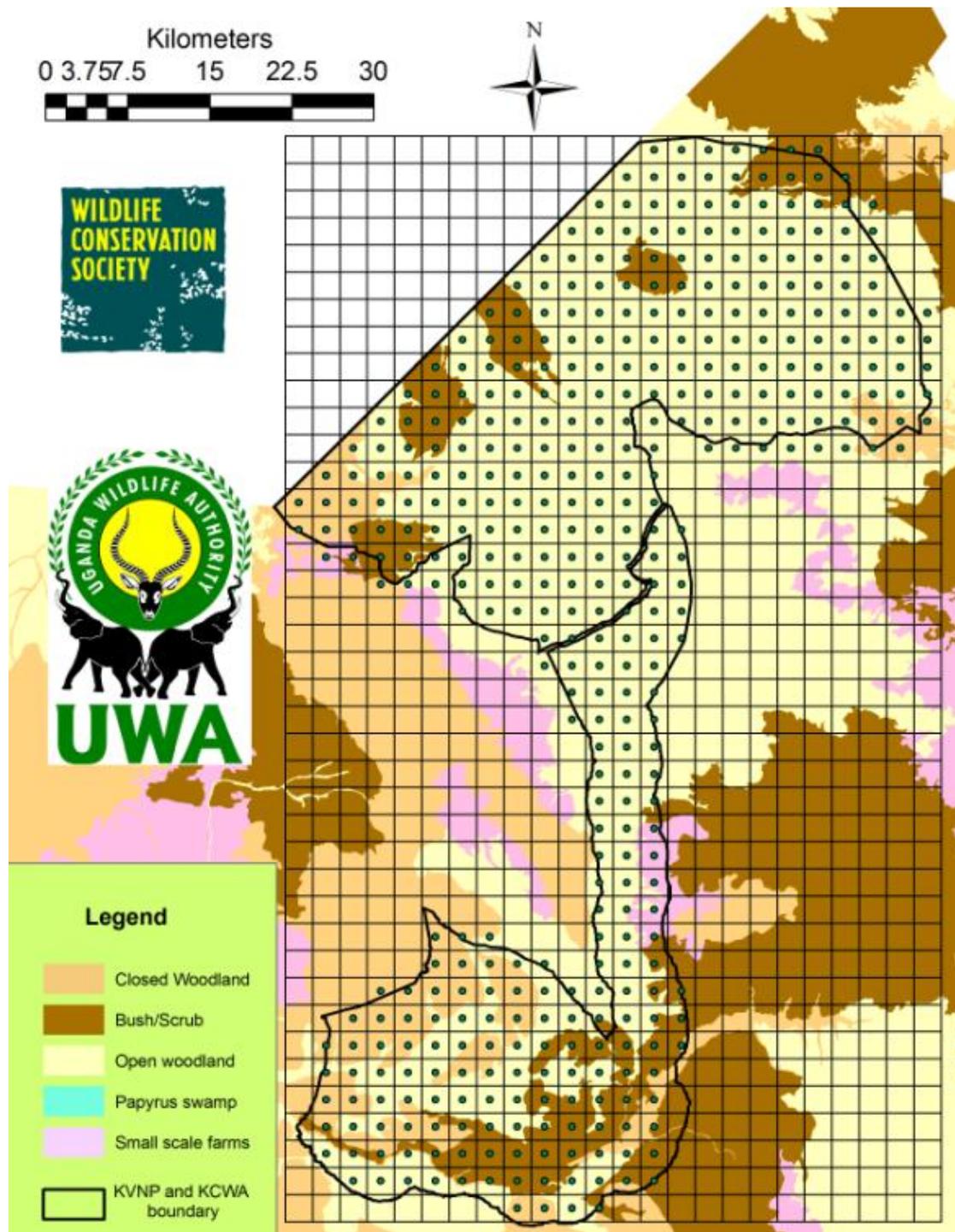


Figure 1. Survey grid cells for the design of the SRF survey of KVNP and KCWA

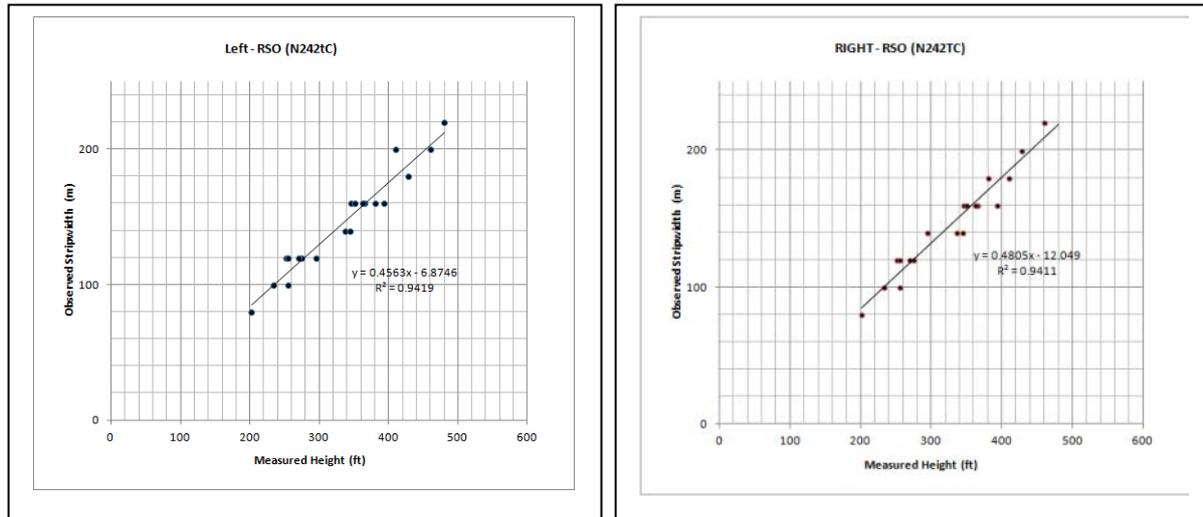
Results

Systematic Reconnaissance Flight (SRF)

Calibration figures

The calibration lines for both left and right observers are given in figure 2 for each aircraft used in the survey. These show that calibrations had R^2 values of between 0.89-0.94 and intercept were between +/- 20m as per the PAASE guidelines (PAASE 2014).

Aircraft N242TC



Aircraft N22044

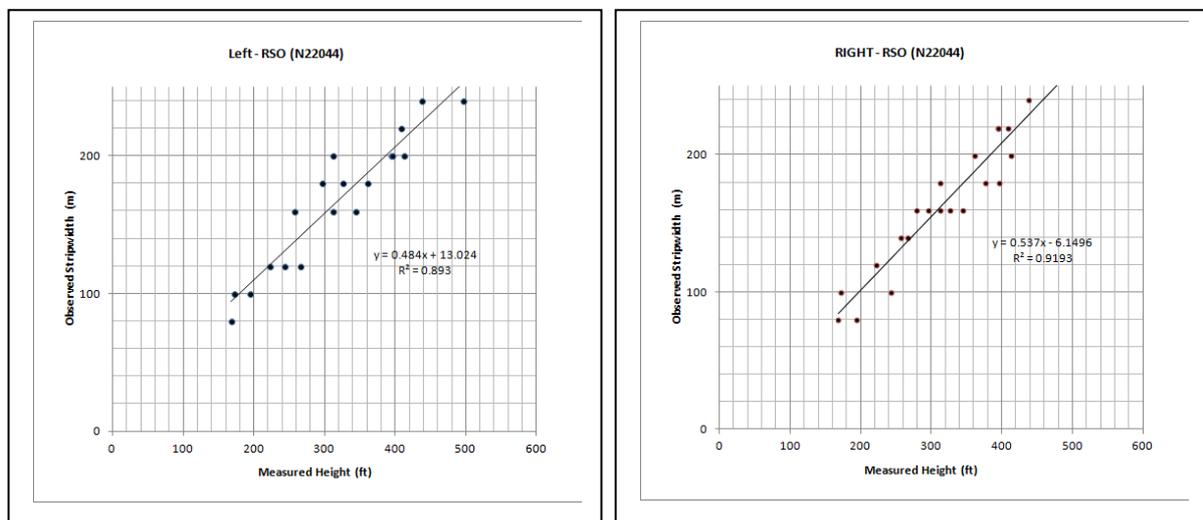


Figure 2. Calibration regression lines relating height of plane above ground to observed strip width on the left and right sides of each aircraft.

Subunits surveyed in 2014

Figure 3 shows the subunits that were surveyed for the SRF in 2014 with the flight lines actually flown.

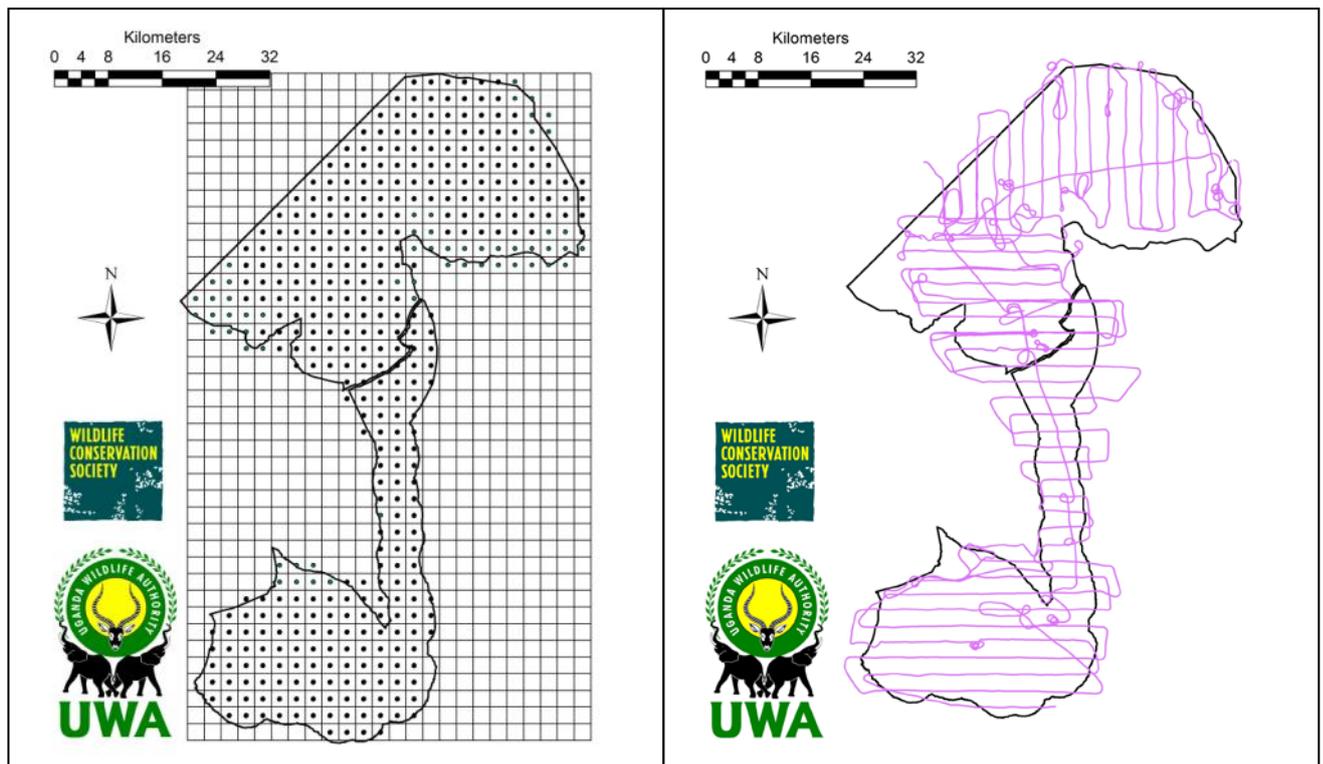


Figure 3a. Map of the subunits surveyed in the SRF (left) and flight lines for the SRF (right)

The average height of the plane was 296 feet above the ground giving an average strip width searched of 283 metres.

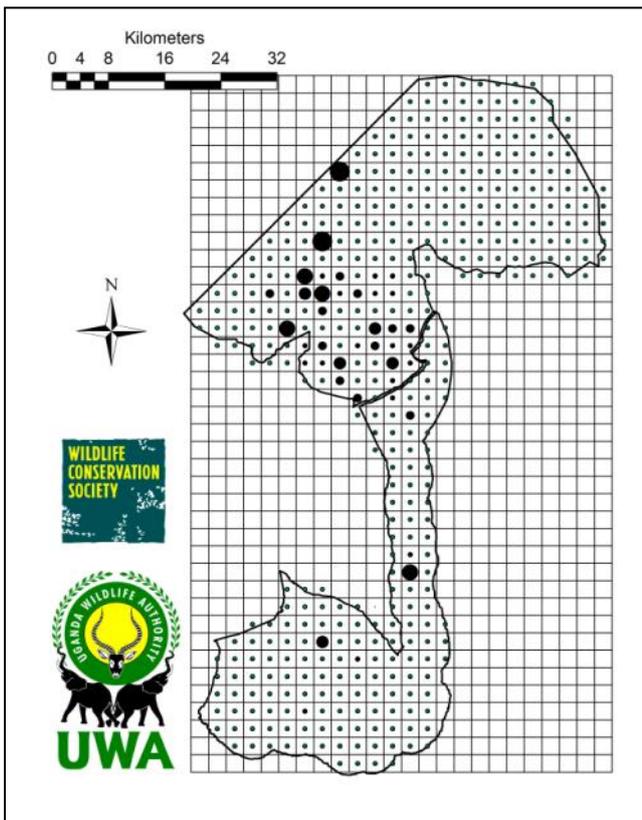
Estimated numbers of animals from SRF

The results of the estimate for each species is given in Table 1 for both KVNP and KCWA as well as for the area as a whole. Each species density is mapped for each 2.5 x 2.5 km grid cell in figure 4. The same is done for human sign (figure 5).

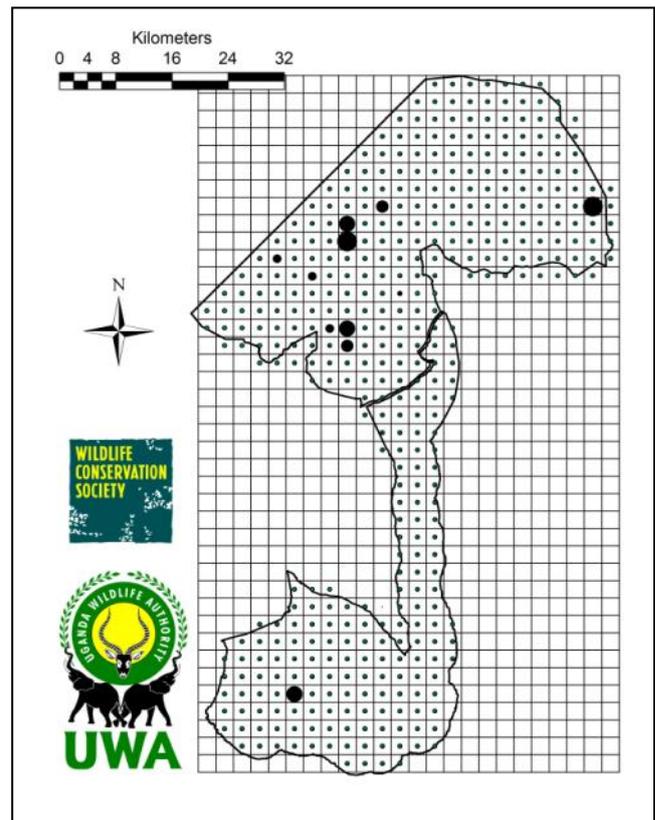
Table 1. Estimated species abundance in KVNP and KCWA and for the whole area combined.

Species	KVNP			KCWA			Kidepo Landscape		
	Est	SE	95% +/-	Est	SE	95% +/-	Est	SE	95% +/-
Elephant	552	262	576	42	39	85	656	301	663
Buffalo	6,835	2,444	5,376	870	592	1,303	8,491	2,896	6,370
Hartebeest	1,785	462	1,016	535	300	659	2,544	698	1,535
Oribi	184	69	153	84	26	57	292	82	180
Ostrich	304	122	268				336	136	301
Reedbuck	136	71	157	234	59	130	399	101	222
Warthog	520	133	293	201	57	125	789	160	351
Waterbuck	312	193	424	42	28	62	390	214	472
Zebra	384	263	579				425	289	636
Cattle				209	206	452	222	211	463

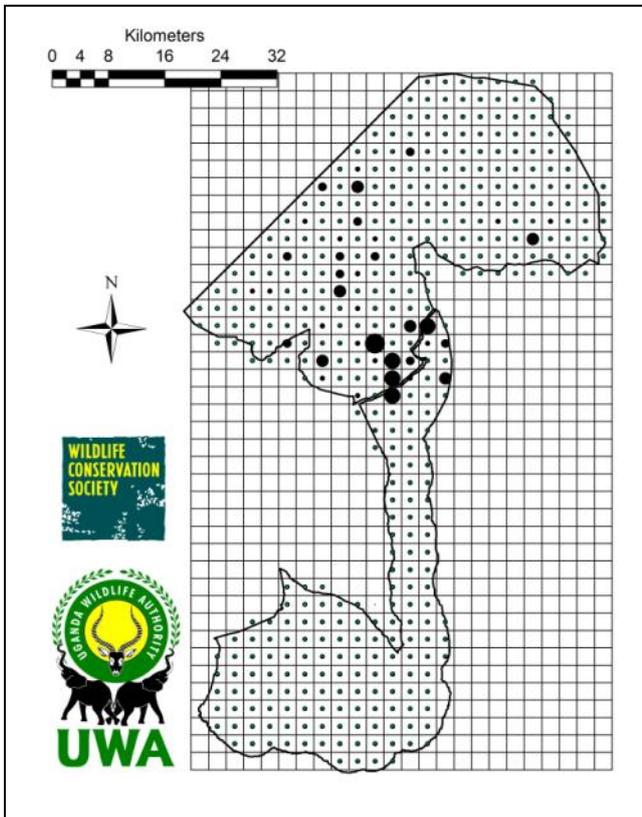
a. Buffalo



b. Elephant



c. Hartebeest



d. Oribi

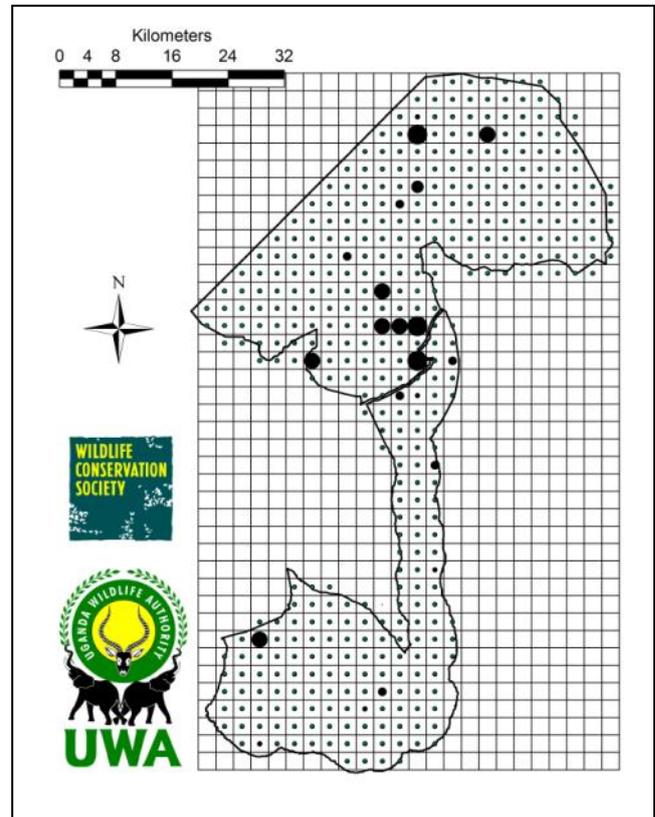
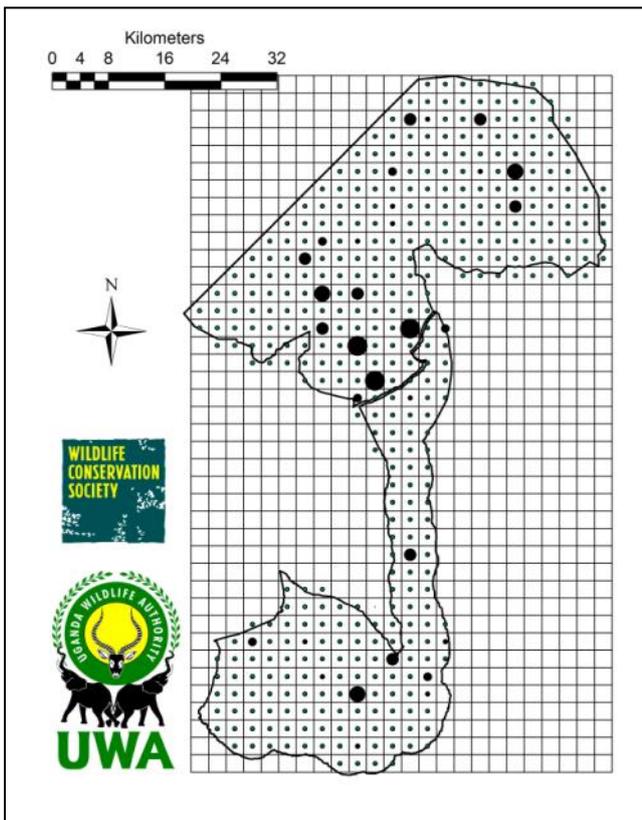
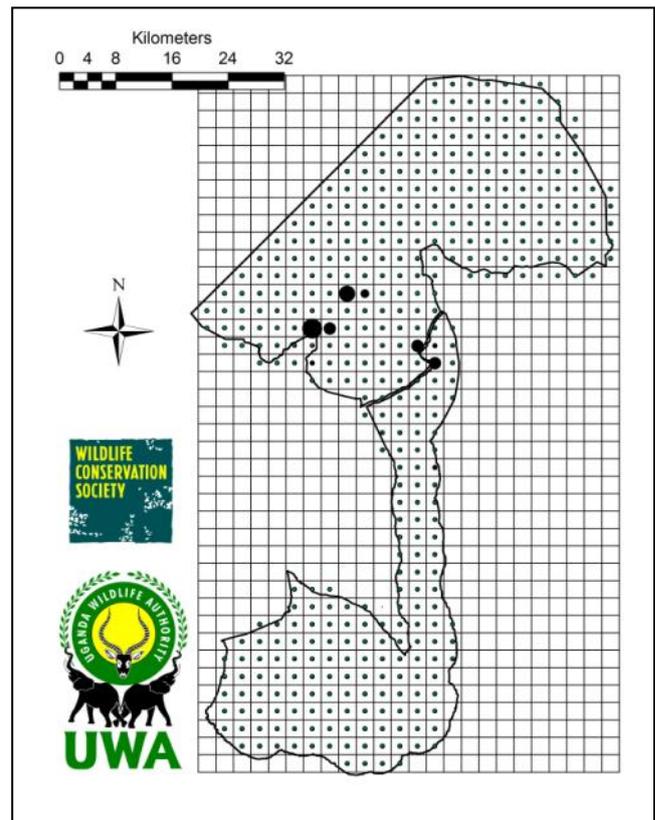


Figure 4 (part 1). Distribution and relative density of Buffalo, Elephant, Hartebeest and Oribi.

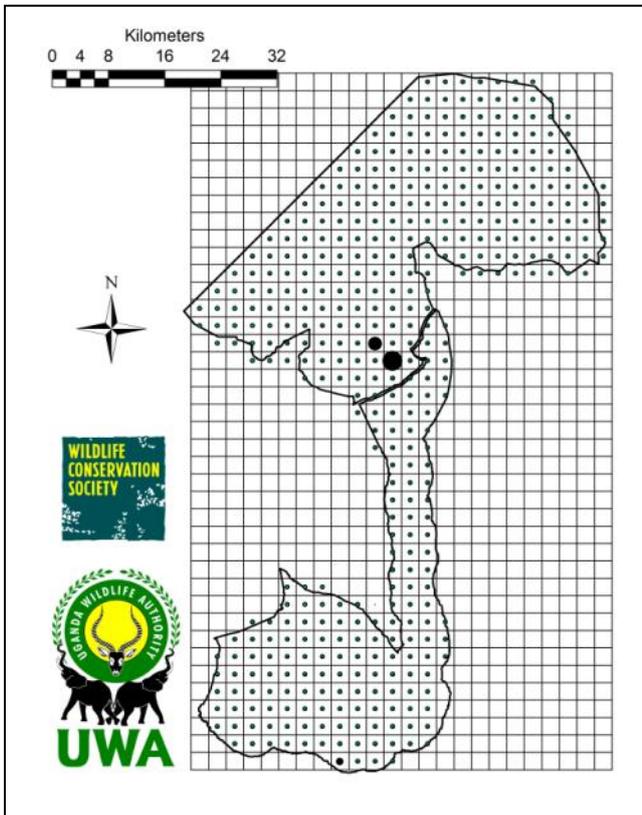
e. Warthog



f. Waterbuck



g. Zebra



h. Ostrich

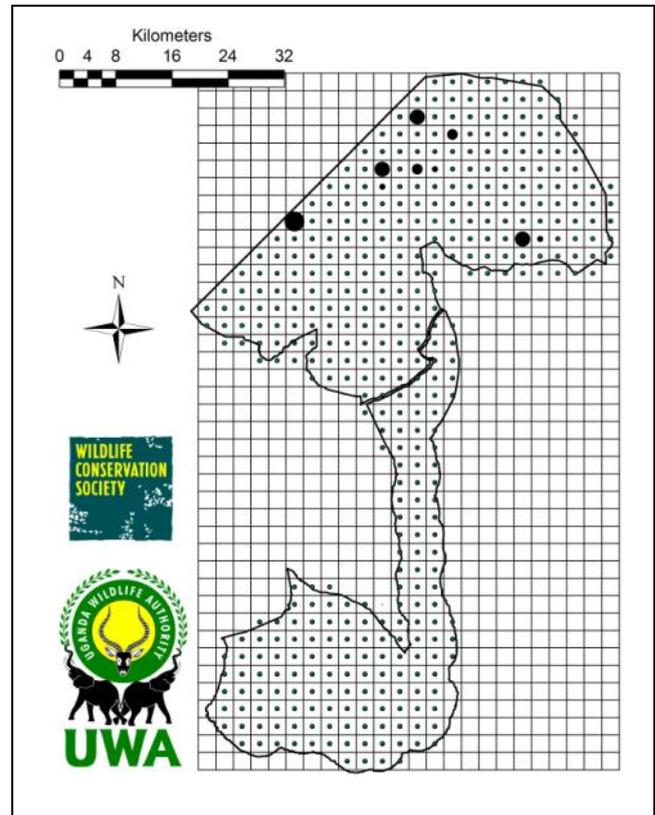


Figure 4 (part 2). Distribution and relative density of warthog, waterbuck, zebra and ostrich.

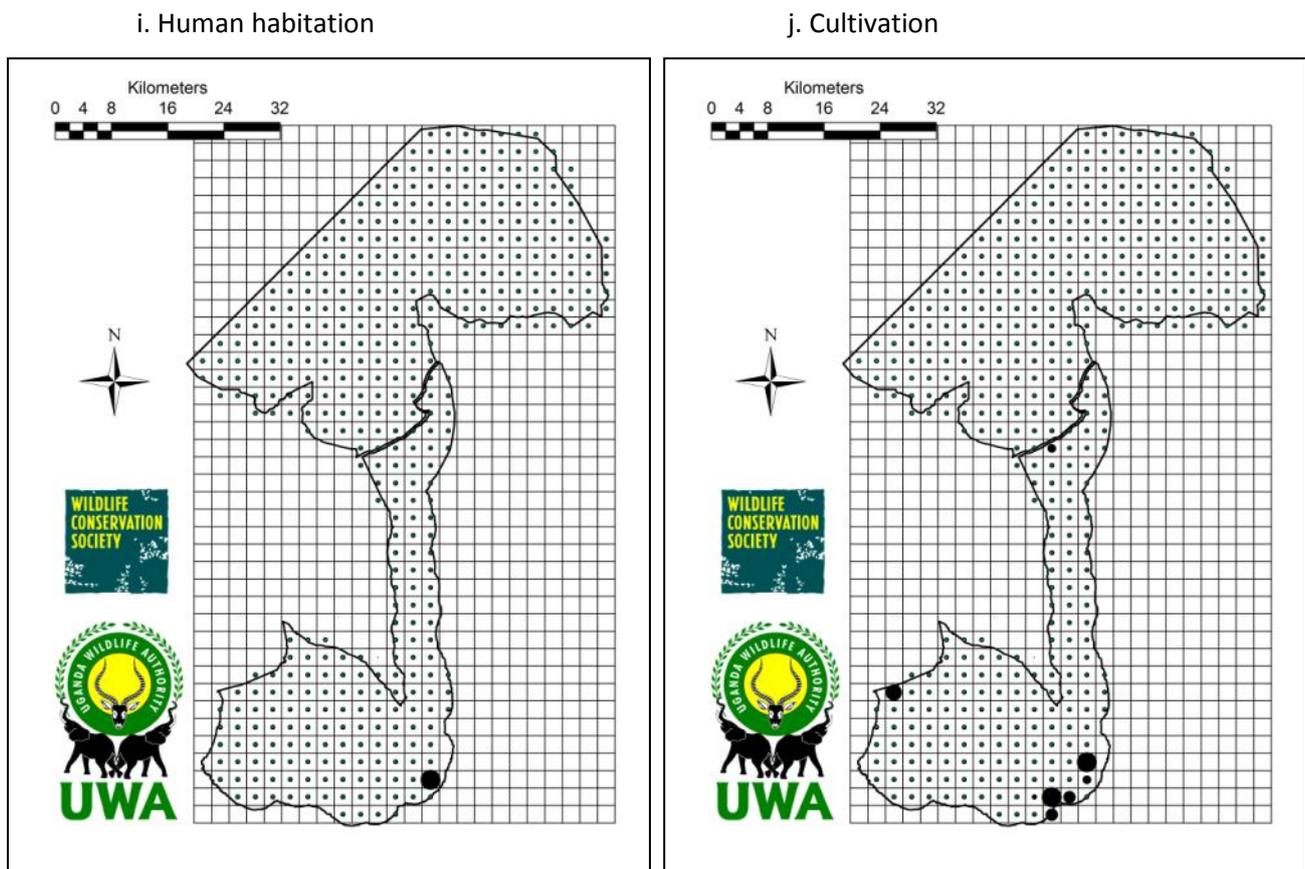


Figure 5. Distribution and relative density of human habitation and cultivation.

A comparison of the number of sightings by the rear seat observers (appendix 2) using a paired T-test on the mean number of animals seen per transect indicates that the two rear seat observers for N242TC and N22044 had similar numbers of sightings of large mammals (N242TC - $T=0.628$, $df=29.98$, $P=0.53$; N22044 - $T=0.521$, $df=35.02$, $P=0.60$). A comparison of average group size of animals seen from the plane also showed no significant differences (N242TC: $T=0.884$, $df=63.54$, $P=0.38$; N22044: $T=0.715$, $df=272.37$, $P=0.48$).

Total Counts

The results of the total counts made over KVNP and KCWA are given in Table 2 and the flight lines are plotted in figure 6. Figure 7 shows the distribution of species. A total of 656 elephants were estimated from the SRF surveys and 621 were found on the total counts which are relatively close estimates. Buffalo numbers from the total count were lower by about 1,550 but within the 95% confidence intervals of the SRF. The low density high conservation importance species were also counted in the total count because it was expected that the errors in the SRF would be high. For species such as the Rothschild giraffe, ostrich and zebra the total count estimates are likely to be more realistic and these are the only estimates for eland as none were seen on the SRF.

The patterns in figure 7 are similar to those found in the SRF counts.

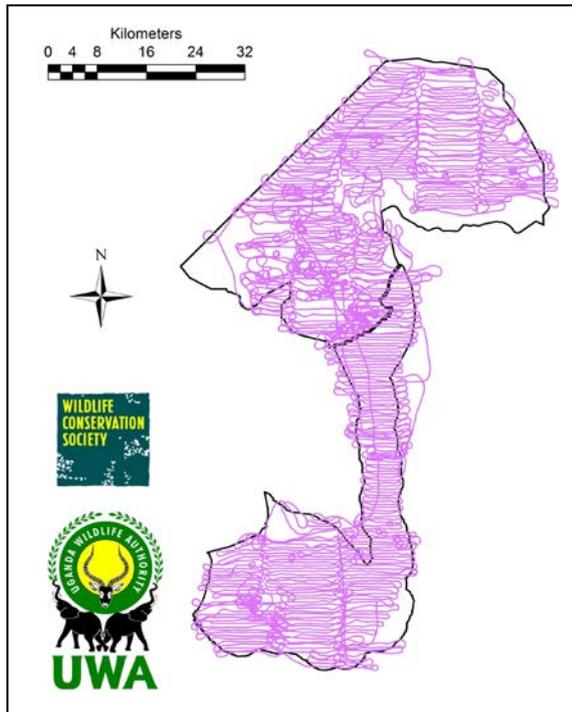
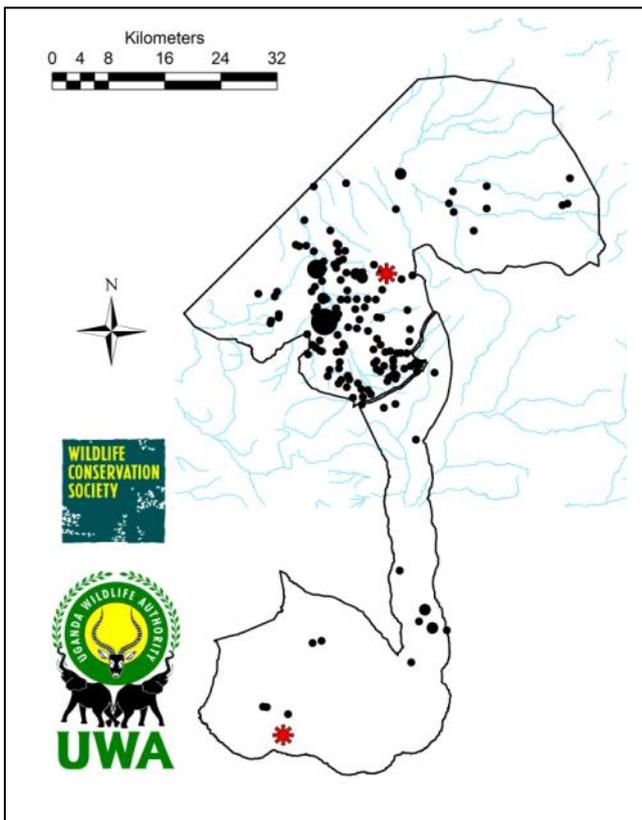


Figure 6. Flight lines for total count surveys over KVNP and KCWA.

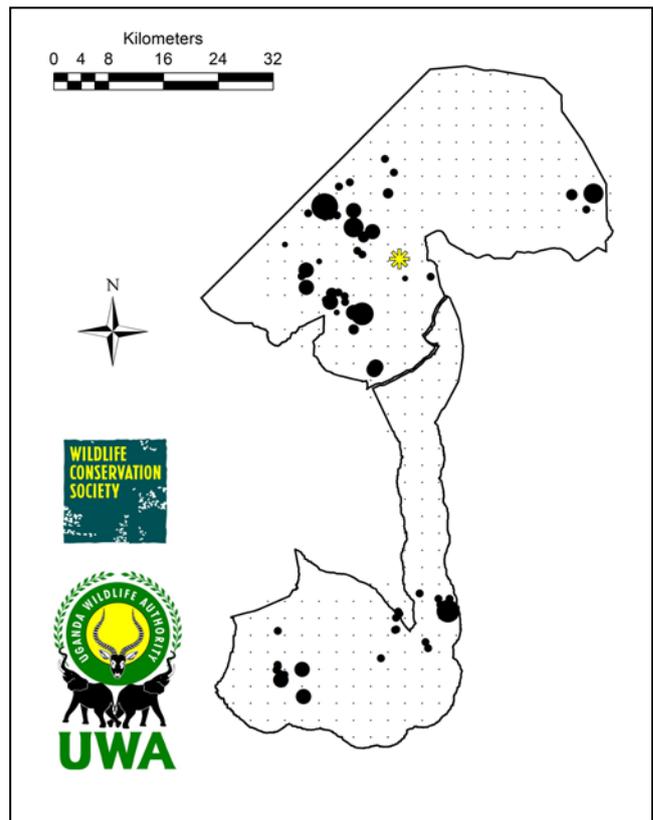
Table 2. The number of adults (male or female), juveniles and infants where these were identified and number of unidentified age or sex (unidentified) observed from the total count flights across KVNP and KCWA.

Species	Adult Male	Adult Female	Juvenile/Infant	Unidentified	Total
KVNP					
Elephant	42	60	48	257	407
Buffalo			1	6,146	6,147
Eland				28	28
Giraffe			4	16	20
Ostrich	57	45	3	108	213
Zebra			3	150	153
KCWA					
Elephant	50	95	42	27	214
Buffalo				788	788
Ostrich	2	5		8	15
Kidepo Landscape					
Elephant	92	155	90	284	621
Buffalo	0	0	1	6,934	6,935
Eland				28	28
Giraffe			4	16	20
Ostrich	59	50	3	116	228
Zebra			3	150	153

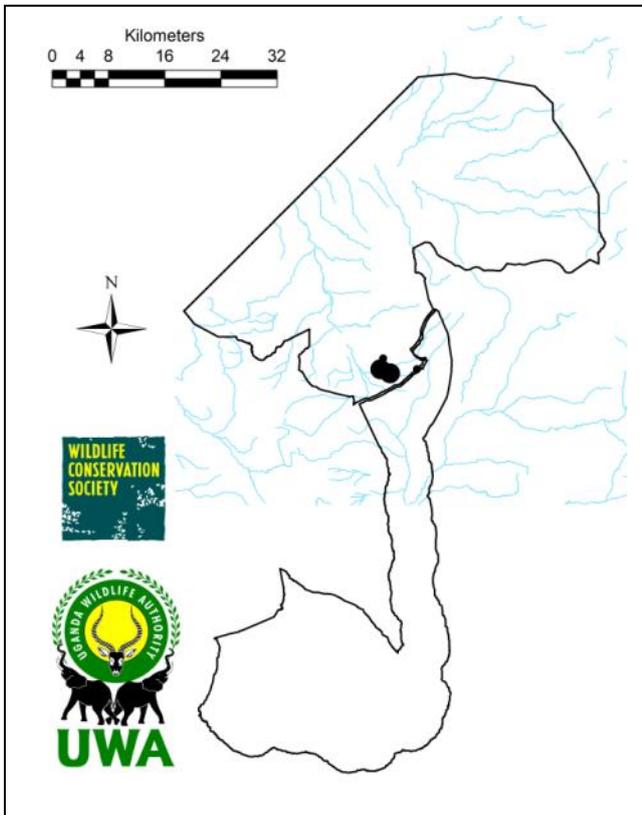
b. Buffalo



b. Elephant



d. Eland



d. Giraffe



Figure 7 (part 1). Distribution of Buffalo, Elephant, Eland, and Rothschild giraffe from total counts. The red stars on the buffalo map and yellow star on elephant map indicate the location of carcasses.

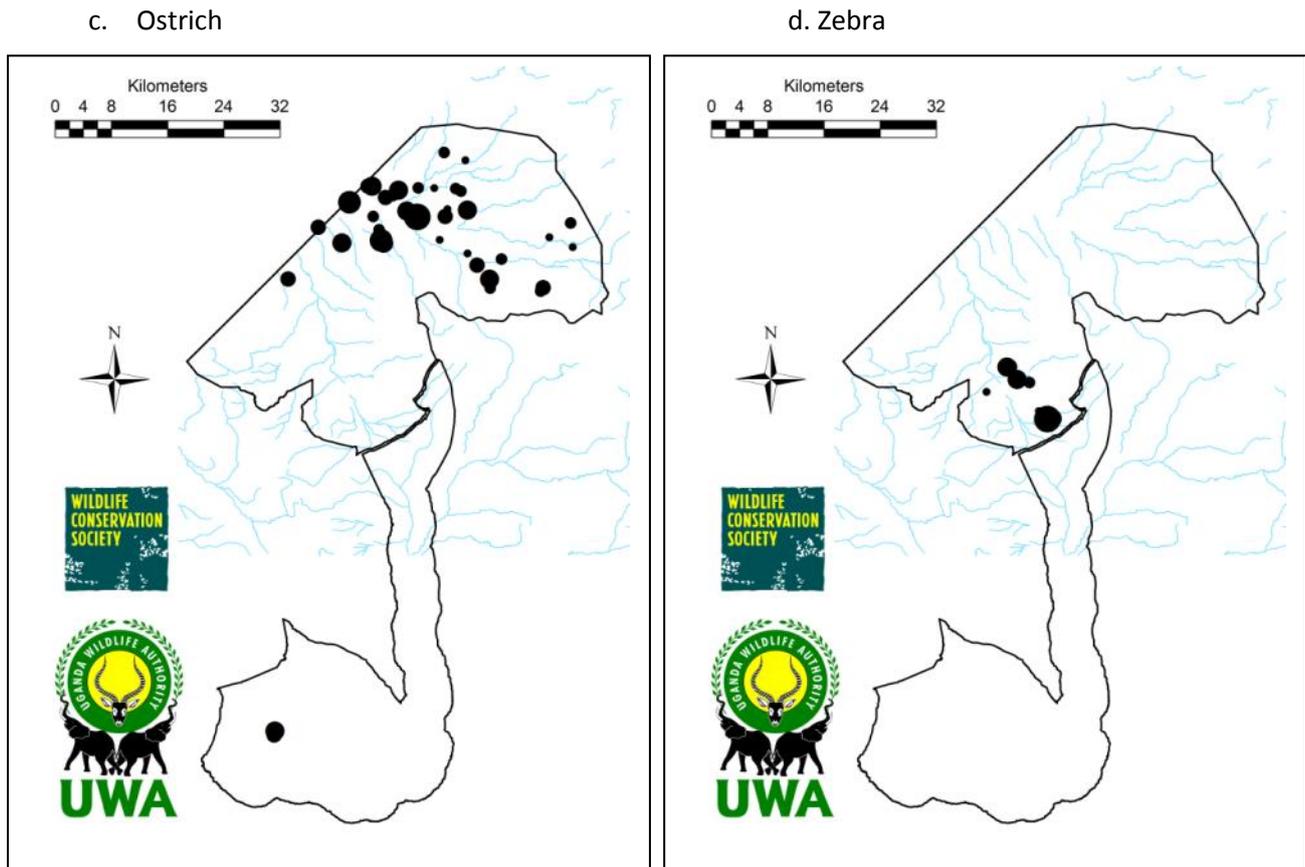


Figure 7 (part 2). Distribution of Ostrich and Zebra from total counts.

Elephant carcass ratio

Only two carcasses were seen of buffalo and one elephant carcass seen on the Total count indicating that poaching as well as natural mortality is low here. No carcasses were observed on the SRF survey. Taking the total count data therefore the carcass ratio is $1/621 = 0.002$ carcasses per live animal. This is very low for elephant populations in Africa.

Discussion

Trends in elephant and other large mammals

WCS has compiled aerial survey data from KVNP from as many records we have been able to find by trawling the published literature and working through old records in the library at Queen Elizabeth National Park which used to host the Institute of Ecology, the main research unit in the Uganda National Parks in the 1960s and 1970s (table 3). These results show that elephant (figure 8) and Jackson's hartebeest numbers have rebuilt to similar levels to those they reached in the 1960s and 1970s and buffalo numbers are exceeding the numbers at this time. Other species such as zebra and Rothschild giraffe are still relatively low in number compared to this time, particularly if we take the total count estimate as the true value. There are no records of ostrich numbers from previous aerial surveys to compare with apart from the survey made in 2012 and numbers have significantly increased since 2012 from either the SRF or total count estimate.

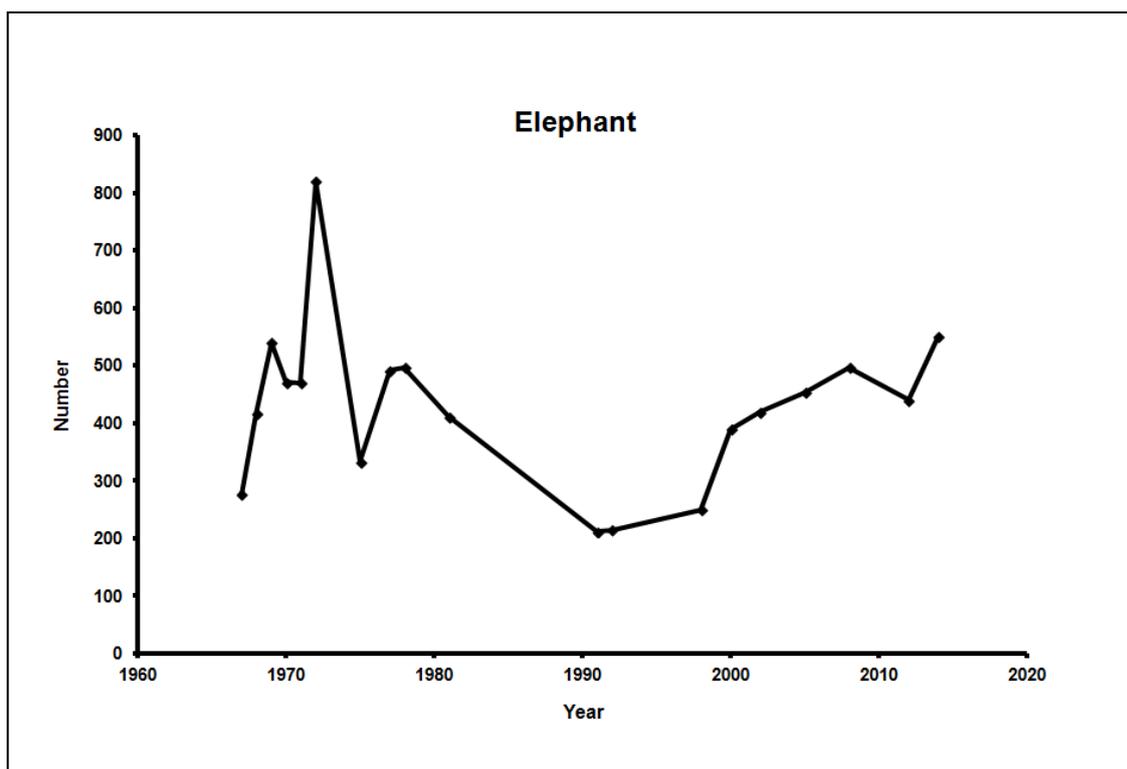


Figure 8. Plot of numbers of elephants for each year since 1957 in KVNP.

Table 3. Counts from aerial surveys in KVNP since the early 1960s. Numbers for all surveys that WCS have been able to compile information from published and unpublished records are given. In most cases these results are from Total counts and the 2014 results from both are given with the SRF numbers in parentheses.

Year	Elephant	Buffalo	Eland	Giraffe	Hartebeest	Oribi	Ostrich	Warthog	Waterbuck	Zebra
1967	277			72						262
1968	417	741	300	143	1,348					368
1969	540									
1970	471									
1971	470	2,000		400	3,000					651
1972	820	1,245		165	1,569					637
1975	333			76						449
1976		1,417		64						408
1977	492	1,071		143	1,409					484
1978	497	1,270								
1981	411	564	200	160	1,400					450
1991	212			5						
1992	215			8						
1998	250	700	50	8						400
2000	390	1,500		8	130					300
2002	420	1,800	7	9	250					150
2005	454	2,750	13	14	338	39		42		94
2008	497	2,760	44	44	295	132		107	44	25
2012	440	3,912	17	17	524	19	58	25	178	75
2014	(552) 407	(6,835) 6,147	(0) 28	(0) 20	(1,785) n/c	(184) n/c	(304) 213	(520) n/c	(312) n/c	(384) 153

Comparison of SRF and Total Count results

In the case of KVNP and KCWA the total counts are likely to be more accurate than the SRF surveys. The standard errors and 95% confidence limits are wide in the SRF results because of the clumped nature of the animals along the transects flown and as a result we would recommend using the results of the total counts. We have not compared the results of each plane separately in this report (unlike for Murchison Falls Protected Area and Queen Elizabeth Protected Area) because of the wide confidence limits.

Elephant status and conservation

The results for KVNP reveal a continued steady increase in elephant numbers following the general pattern indicated by surveys in 2005, 2008, but a slight decrease in 2012 and 2014 for the Total counts. While this might be concerning we believe it is because of the movement of elephants outside the park and into KCWA. Historically the KCWA has not been surveyed and it was only surveyed last in 2012. The number of elephants here has increased from 62 estimated in 2012 to 214 in 2014. The increased protection and management of this area is leading to animals migrating into the area.

Only one elephant carcass (n=1 old) was observed from the Total count despite several hours of flying in the SRF and reconnaissance flying before and after the survey. This supports UWA's MIKE data which indicate that poaching has decreased in the Park over the past years.

While UWA efforts to secure the elephants in KVNP and KCWA are to be commended there are still risks that the situation could change quickly. Threats from South Sudan are significant with little protection of the adjacent Kidepo Game Reserve in that country. Northern Kenya has also not been so stable recently and it would be fairly easy for armed groups to move in from there to poach elephants.

The following conservation actions are recommended:

- It is clear that Karenga has potential to be upgraded to National Park status. Ground based socio-economic surveys are needed to map the human use in the area. A proposal then needs to be developed for changing its legal status and protecting it.
- Continued support to the Anti-poaching and LEM efforts of UWA and deployment of UWA staff to the south into KCWA will be important for protection efforts throughout the entire Kidepo Landscape.
- Increased frequency of aerial monitoring visits by UWA aircraft to support Park monitoring of threats, particularly in the north and east of KVNP and KCWA which are logistically more difficult to access.
- Collaring and monitoring with GPS/satellite collars of elephants should be expanded for all major herds.
- Support transboundary cooperation with South Sudan for elephant surveillance, anti-trafficking, and anti-poaching.
- Collaboration with KWS needs to be planned and supported to protect elephants in the northeast.

- UWA staff and particularly the Park Warden should be recognized for the work they are undertaking.

Acknowledgements

We are grateful to the support of the Warden and his staff in Kidepo Valley National Park and to the Paul Allen Foundation for funding these surveys.

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Appendices

Appendix 1. Survey teams

The composition of the survey teams are given by plane and survey here:

Observer	N242TC	N22044
FSO	Frederick Wanyama	Alex
RSO left	Fred Kisame	Samuel Loware
RSO Right	Kato Robinson	David Okiring
Pilot	Paul Elkan	Soqui Mendiguetti

Appendix 2. Comparison of observers

The number of animals seen for each species are given for each plane and rear seat observer together with the average number of sightings per transect flown and average group size of observations:

Species	Plane N242TC		Plane N22044	
	Fred Kisame Eria	Kato Robinson	Samuel Loware	David Okiring
Baboon		6	2	
Buffalo	259	67	232	400
Elephant	1	7	38	28
Hartebeest	92	61	61	73
Oribi		3	18	12
Ostrich	8	1	17	12
Reedbuck	13	20	4	8
Waterbuck		4	23	17
Warthog	6	31	34	18
Zebra	6	11		31
Grand Total	385	211	429	599
Mean number per transect	14.8	9.1	17.4	24.1
Mean group size seen	4.2	3.2	2.8	4.8