

Technical Report

Aerial surveys of the Greater Virunga Landscape



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Executive Summary

In May-June 2014 an aerial survey was made of the large mammal populations in the savannas of the Greater Virunga Landscape (GVL), particularly the Queen Elizabeth National Park (QEPA) in Uganda and the Virunga National Park (Virunga) in Democratic Republic of Congo (DR Congo). A systematic reconnaissance flight (SRF) was made using a 2.5 km grid across these two parks, using a design that has been used in 2006 and 2010 for the GVL and since 1996 for QEPA alone. A total count of elephants was also made in QEPA following the SRF using a new method of surveying blocks of the park intensively. The results are presented in detail in this report.

The key results show that the elephant population in QEPA is relatively stable at around 2,913 (standard error: 932) individuals but that the population in Virunga has declined precipitously to an estimate of 35 (standard error: 27) individuals only. The latter estimate based on the SRF is the lowest estimate for elephants ever in Virunga. In 2006 a low estimate was obtained of elephant numbers (lower than the known number) from the SRF when we knew that there was a large herd of about 150 which was missed. In the survey reported here an effort was made to look for this herd by searching the Kabaraza area where they used to frequent but no herd was sighted and also no tracks of elephants in the grass were observed either. Rangers state they have seen herds up to 70 at Mabenga, 52 at Ishango recently and elephants move back and forth into the Lulimbi sector from QEPA and numbers here can fluctuate. It does appear though that elephants have decreased from the estimated 350 in 2006 and 2010 in Virunga. All large mammals in Virunga have declined in number except waterbuck. Buffalo are estimated at 586 (se: 371) individuals and Thomas's or Uganda kob are down to about 1/3 of the population size they were in 2006. In QEPA buffalo and topi appear to have increased in number while waterbuck and Uganda kob appear to be stable or fluctuating up and down between survey years over the past 10 years.

Of concern was the greatly increased number of carcasses of elephants observed in both parks in this survey compared with the 2006 and 2010 surveys when only one or two carcasses had been observed. We observed 10 elephant carcasses in Virunga and 13 in QEPA many of which were recently killed. This increased poaching has been occurring in Uganda's parks since 2011 as well as having been ongoing in Virunga and is of concern for the future of elephants in the GVL.

We make several recommendations to improve the protection of elephants in particular but also to conserve the other large mammal species. In particular we believe it would be of value to put radio collars on the remaining elephant groups in Virunga and monitor each of them regularly using both aerial and ranger surveillance. This is a method that has been used elsewhere in Africa with some effect. Ranger monitoring of the large herd at Kabaraza in Virunga used to happen between 2006 and 2010 during which time elephant numbers and likely helped protect that at that time. There is also a need to reinvigorate the transboundary collaboration between QEPA and Virunga as poaching is high at this border and also if Virunga's large mammals are to increase they need to rely on immigration from Uganda.

Of greatest concern though in Virunga was the increased area of the park that is now cultivated. The cultivation has expanded greatly since 2010 and now covers large parts of the western side of the park (not just the western coast of Lake Edward) and is now growing in the east of the central sector also. This needs to be addressed urgently and requires a high level press campaign as well as lobbying of local politicians, the government and international community.

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Introduction

The Greater Virunga Landscape (GVL) is one of the most biodiverse landscapes, and contains more vertebrate species than any other landscape in Africa (Plumptre *et al.* 2007a) and possibly the World. Straddling the borders of Democratic Republic of Congo (DRC), Rwanda and Uganda it encompasses a great variety of habitats due to its wide altitudinal range (600-5,100 metres a.s.l.) which contributes to this high species richness. A large part of the centre of the landscape is made up of savanna grassland and woodland (figure 1) in the Virunga National Park (Virunga) and Queen Elizabeth Protected Area (QEPA), a habitat which can be surveyed by aircraft to estimate large mammal numbers.

Historically aerial surveys of large mammals have been made separately in these two parks and censuses date back to the 1960s. However these parks are connected to the north and south of Lake Edward and it has been known for at least 50 years that animals move back and forth between the two parks. Plumptre *et al.* (2007b) showed the importance of this ability for animals to migrate between the parks for the survival of elephant populations in the landscape. In the 1970s heavy poaching in Queen Elizabeth National Park probably led to elephants fleeing into Virunga. The instability and rise in poaching in Virunga since 1996 has led to elephants fleeing back into Queen Elizabeth. We can be certain of this because the population in Queen Elizabeth National Park rose from 150 individuals to 2,950 in 2006 over a period of 25 years, an increase that could not have been achieved solely by births alone.

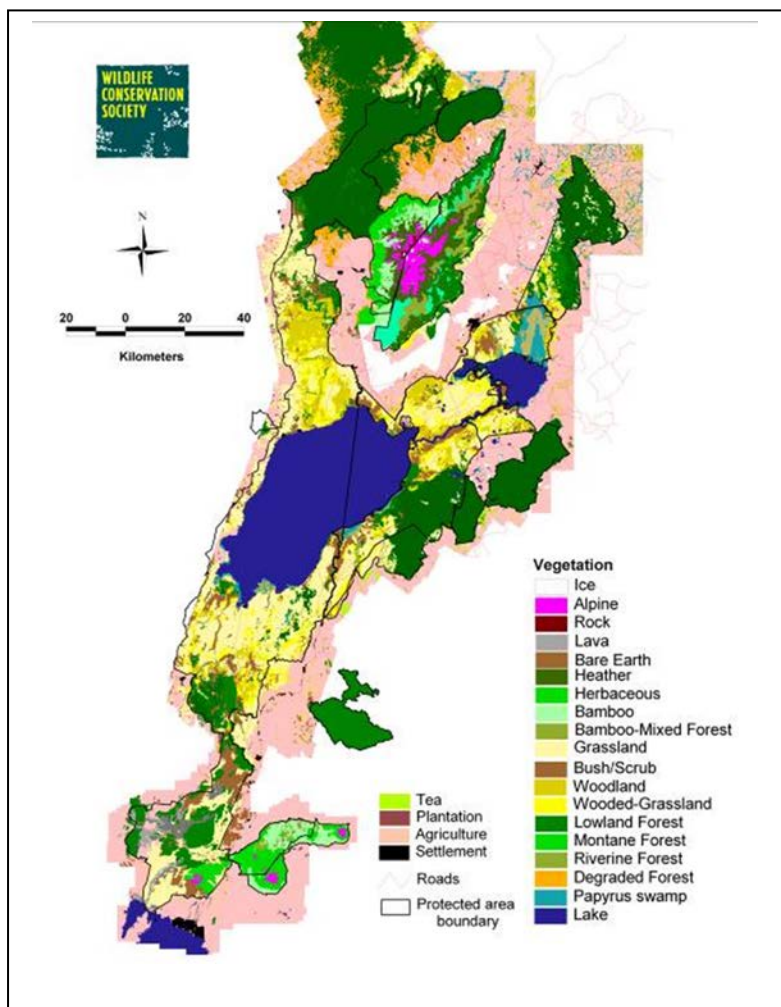


Figure 1. Map of the Greater Virunga Landscape showing the various vegetation types. This survey covers the savanna areas in the centre of the landscape.

QEPA consists of the Queen Elizabeth National Park and two adjacent Wildlife Reserves; Kigezi and Kyambura. These protected areas are located in the west of Uganda on the border with the Democratic Republic of Congo and are contiguous with Virunga. Virunga was established in 1925, Africa's first national park, and initially consisted of the Virunga volcanoes famous for their mountain gorillas. Over the next four years it was expanded to its current size by 1929. Queen Elizabeth National Park (QENP) was established in 1952 from the Lake George and Lake Edward Game Reserves. Rinderpest and sleeping sickness led to people emigrating from this region in the early 1900s which then led to the increase in large mammal numbers providing the reason to establish the national park.

Aerial surveys of QEPA have been made since 1963 and elephant numbers fluctuated between 1,300-4,000 during the 1960s and early 1970s because at this time elephants not only migrated between QEPA and Virunga but also northward to Kibale National Park, Rwenzori Mountains National Park and the grasslands surrounding these areas (Buss 1990; Wing & Buss 1970). Surveys of elephants in Virunga in the 1960s estimated about 3,500 elephants (De Merode *et al.* 2006) but numbers have dropped drastically in the 1990s and 2000s because of the insecurity and presence of rebel groups in the park. It is clear that the movements of animals across the protected area boundaries within the GVL movements hamper assessments of the large mammal populations in this landscape at an individual protected area scale because if the numbers decrease it is unclear whether it is due to mortality or to emigration. Since 2006 there has been an effort to make a joint aerial survey of large mammals in the savanna portion of the landscape by surveying Virunga and QEPA at the same time. Such surveys of the GVL were made in 2006 (Kujirakiwnja *et al.* 2006; Wanyama *et al.* 2006) and in 2010 (Plumptre *et al.* 2010). The survey reported here is the third of these surveys.

This report summarises the results of aerial surveys of the savannas of the GVL including Virunga and QEPA. 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 this survey we conducted both a total count for elephant as well as an Systematic Reconnaissance Flight (SRF) survey with transect lines at 2.5km intervals superimposed over a UTM grid of 2.5 x 2.5 km. Stratified sampling of elephant was not used in any of the surveys in Uganda/DRC because of the need to survey all large mammal species. Survey zones were defined by management units (National Park boundary) and any non-savanna sections excluded. Transects were flown east-west for the SRF as had been done in previous surveys because of the topography. Nominal survey altitude was 300 ft with a targeted stripwidth of 300 meters.

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 (in the C182) developed a fault for part of the survey) and readings were collected from both altimeters to allow comparison and checking. In the analysis we ended up using the radar altimeters for height of the aircraft because of problems with the data flow and analysis from the laser altimeters.

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 QEPA. 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.

SRF survey flights

The flights were flown early in the morning about one hour after dawn (7.30-8am) and observation sessions were ended by 11am. 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. The SRF surveys were made between 8-9th June in QEPA and 21-23 June in Virunga. Training was carried out for the Virunga team over three days on the ground and two days practical in the aircraft before the surveys commenced. The survey team consisted of 5 ICCN staff (1 FSO and four RSOs), 1 WCS DRC staff (FSO), and 2 WCS pilots. A UWA observer was substituted in for one of

the ICCN observers who experienced difficulty counting consistently (which was discovered during the calibration exercises). Observers entered the data on datasheets and in the computer immediately after the flight. Group size estimates were compared with counts taken from the image. Between surveys time was taken to allow observers to catch up with the backlog of images. The survey design for the GVL SRF is shown in figure 2.

In addition, an SRF double observer test was undertaken in QEPA to examine observer sighting differences and provide for research and development of this potential analysis tool. The results of those experiments will be presented in a separate report.

Total count method

A total count was made of elephants in QEPA as part of this survey between 12th -15th June 2014. The very low number of sightings in the SRF survey in Virunga did not make it sensible to try and make a total count here. 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. This method was employed because in a 2010 survey of the Greater Virunga Landscape a distance of 1 km had led to 1000 elephants being missed). Both aircraft flew blocks within QEPA to count all the elephants they could find.

Elephant Carcasses

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

Results

Systematic Reconnaissance Flight (SRF)

Calibration figures

The calibration lines for both left and right observers are given in figure 3 for each aircraft used in the survey. These show that calibrations had R^2 values of between 0.88-0.96 and intercept were between +/- 20m as per the PAASE guidelines (PAASE 2014). Aircraft N242TC flew on the 1st, 2nd, and 3rd days of the Virunga survey. N22044 flew on the second day along with N242TC. Transects were interleaved for the southern sector. Due to heavy winds and dangerous flying conditions only N242TC (turbo C206) flew on the third day while N22044 (a C182 with much less power than the 206) stayed on ground for safety reasons. Flying conditions in the northern sector of Virunga were amongst the most difficult and dangerous encountered during the Uganda/Virunga survey 2014.

Aerial survey of the Greater Virunga Landscape 2014

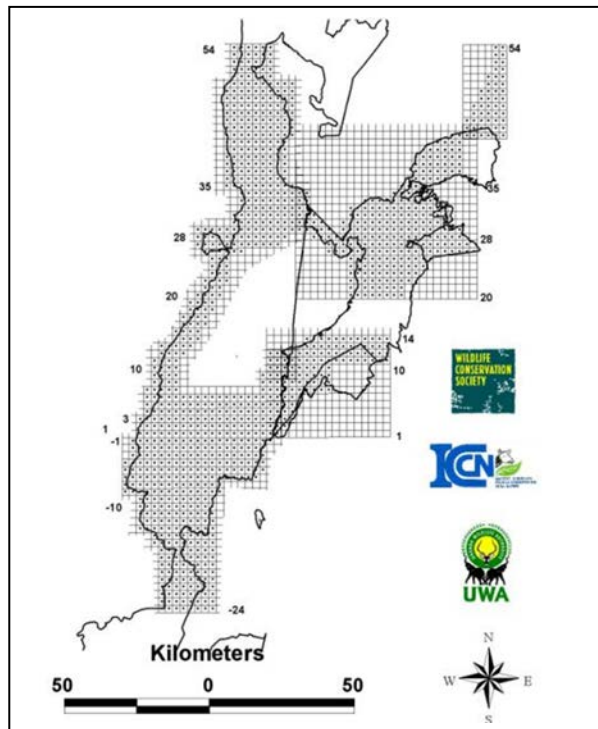
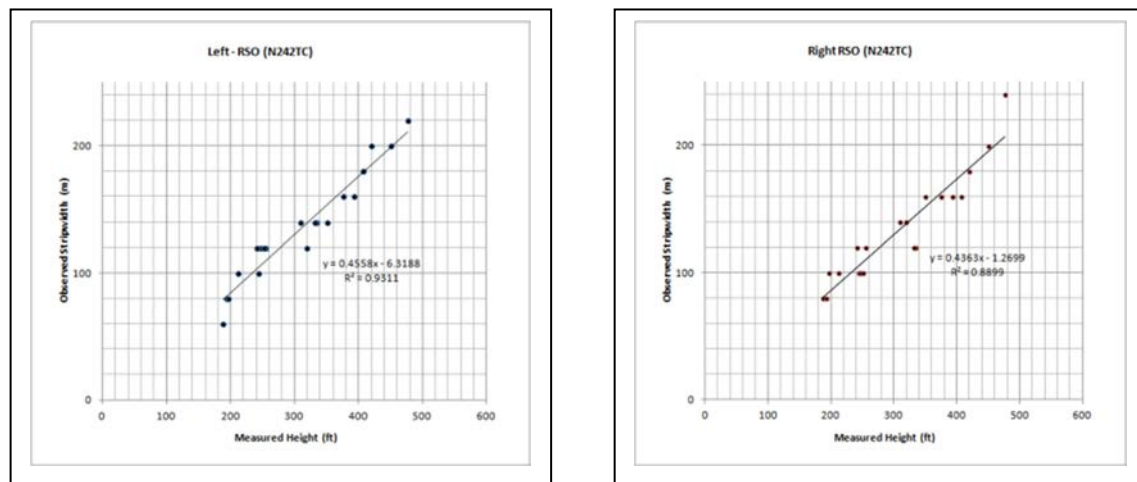
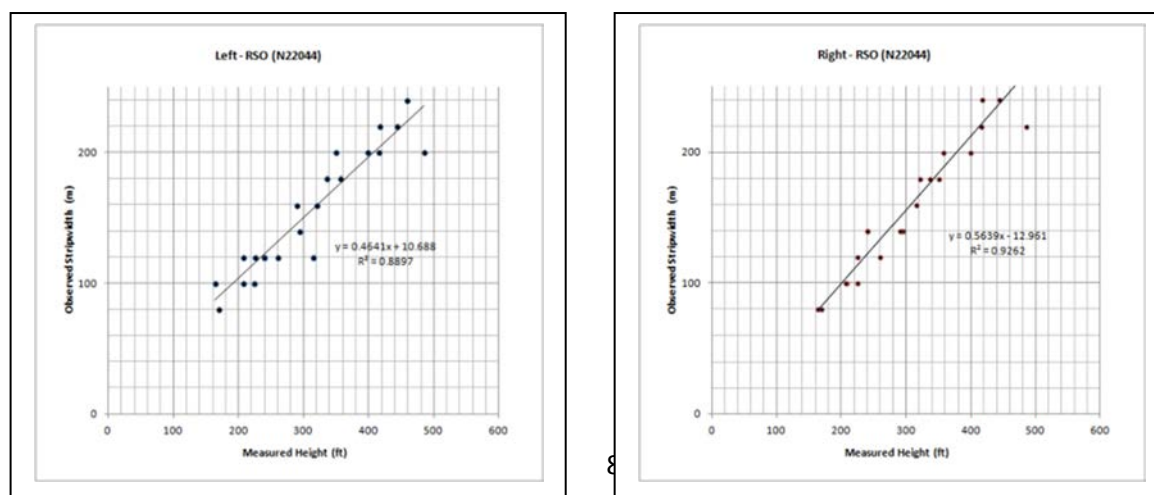


Figure 2. Survey design for SRF survey of the GVL

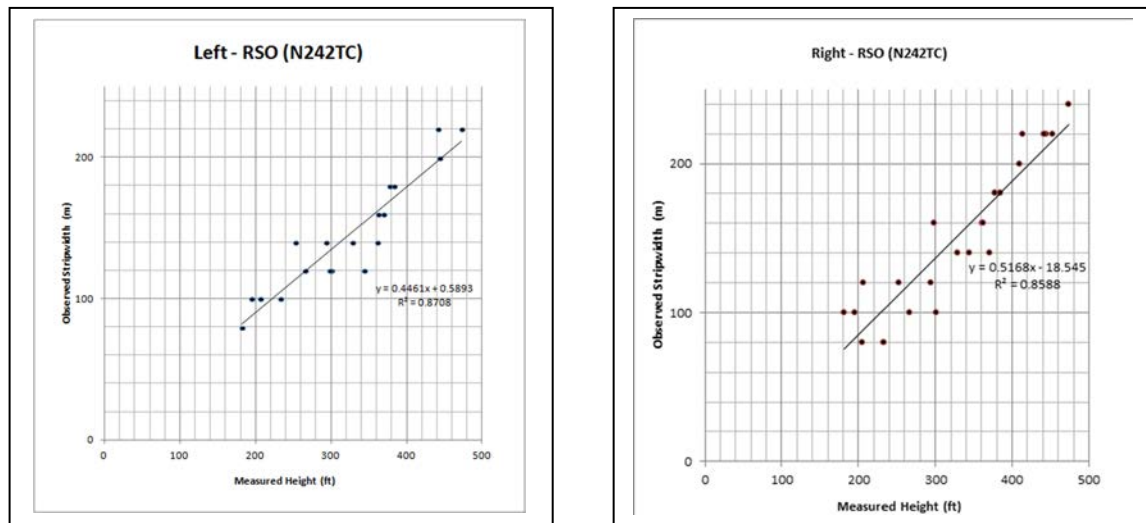
Aircraft N242TC - QEPA



Aircraft N22044 - QEPA



Aircraft N242TC - Virunga



Aircraft N22044 - Virunga

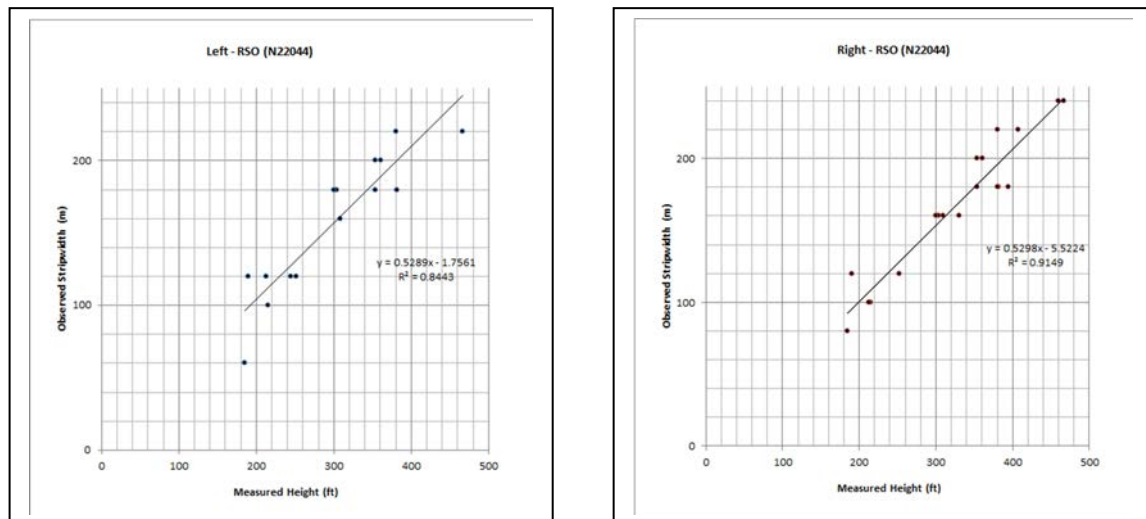


Figure 3. Calibration regression lines relating height of plane above ground to observed strip width on the left and right sides of each aircraft.

Subunits surveyed in 2014

Figure 4 shows the subunits that were surveyed during the 2014 SRF.

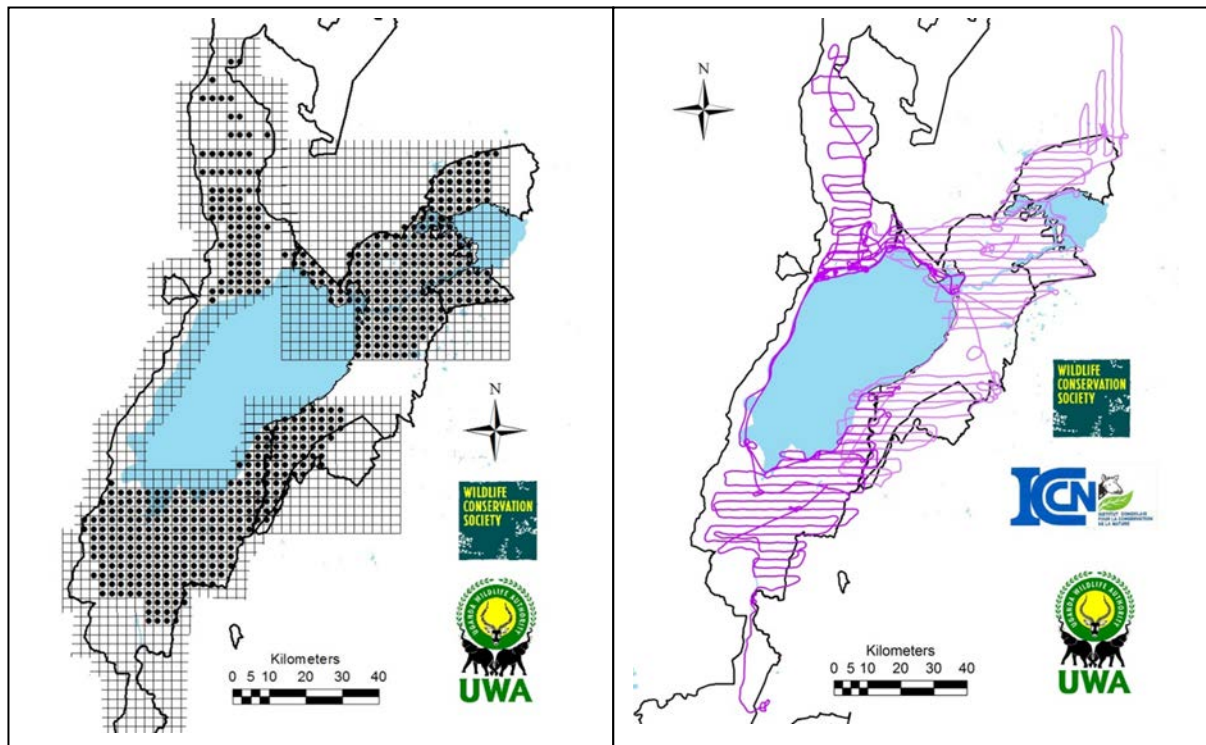


Figure 4. Map of the grid cells visited in the SRF survey (left) and flight tracks (right). The cells with points were the cells surveyed.

The average height of the plane in QEPA was 310 feet above the ground giving an average strip width searched of 293 metres. For Virunga average height was 384 feet and average strip width was 354 metres.

Estimated numbers of animals from SRF

The results of the estimate for each species in QEPA is given in Table 1 and for Virunga in table 2. Each species density is mapped for each 2.5 x 2.5 km grid cell in the landscape in figure 5 for the species which were most commonly observed (omitting those that generally are not surveyed using aerial surveys such as lions, duikers etc). Figure 6 shows locations of human habitation and cultivation at the edge or within the protected areas observed during the SRF.

A comparison of the number of sightings by the rear seat observers over QEPA (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 - $T=0.683$, $df=37.36$, $P=0.50$; N22044 - $T=0.952$, $df=31.38$, $P=0.34$). A comparison of average group size of animals seen from the plane also showed no significant differences although observers in N22044 had quite different group observations (N242TC: $T=1.07$, $df=646.66$, $P=0.28$; N22044: $T=1.78$, $df=460.39$, $P=0.07$). A comparison of the number of sightings by the rear seat observers over Virunga (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 - $T=0.805$, $df=19.33$, $P=0.43$; N22044 - $T=1.05$, $df=9.77$, $P=0.32$). A

comparison of average group size of animals seen from the plane also showed no significant differences between observers (N242TC: $T=1.325$, $df=114.1$, $P=0.19$; N22044: $T=0.361$, $df=69.5$, $P=0.72$).

Table 1. Estimated species abundance in QEPA north and south of the Maramagambo forest and for the whole conservation area.

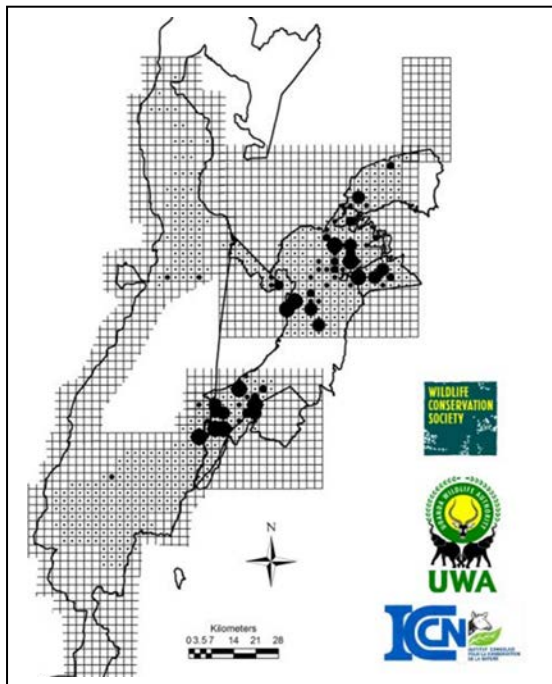
Species	QEPA North			Ishasha sector QEPA			QEPA Total		
	Est	SE	95% +/-	Est	SE	95% +/-	Est	SE	95% +/-
Elephant	2,501	907	1,995	403	144	317	2,913	932	2,050
Buffalo	9,594	1,976	4,348	6,243	2,034	4,474	15,771	2,865	6,303
Hippo	2,781	697	1,534	1,383	961	2,114	4,155	1,164	2,561
Topi				2,049	1,031	2,268	2049	1,107	2,435
Uganda Kob	6,243	1,608	3,537	6,847	2,325	5,114	12,987	2,877	6,329
Warthog	2,399	360	792	508	161	354	1,456	294	647
Waterbuck	953	518	1,140	578	163	359	2,981	550	1,210
Cattle	4,235	2,133	4,694				4,266	1,921	4,225
Shoats	434	421	927				437	408	897

Table 2. Estimated species abundance in Virunga north and south of Lake Edward and for the whole conservation area.

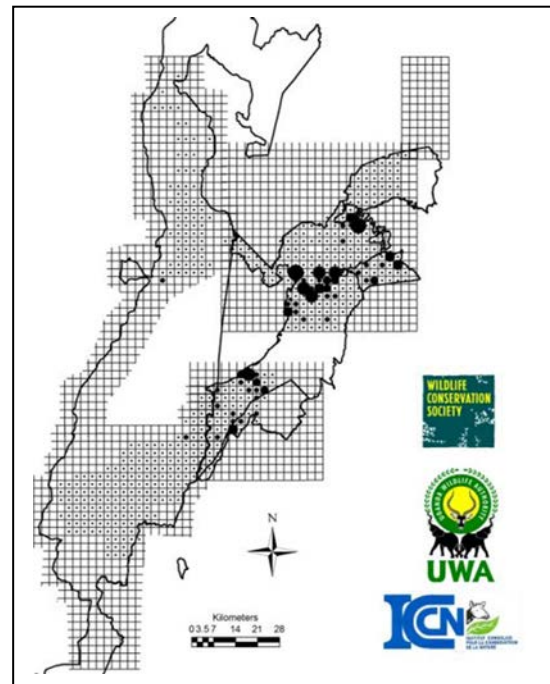
Species	Virunga North			Virunga south			Virunga Total		
	Est	SE	95% +/-	Est	SE	95% +/-	Est	SE	95% +/-
Elephant	15	27	59	19	12	28	35	27	60
Buffalo	61	101	222	551	303	668	586	371	816
Hippo	130	127	279	448	190	417	569	251	553
Topi				672	526	1,158	630	635	1,397
Uganda Kob	2,441	2,417	5,319	1,904	497	1,094	4,584	2,475	5,446
Warthog	23	38	84	215	80	176	227	122	268
Waterbuck	168	163	358	47	30	66	236	160	351
Cattle									
Shoats									

Looking at tables 1 and 2 and also at figure 5 it is clear that most of the large mammals in the savannas of the GVL are residing in the QEPA area. Buffalo and elephant were particularly rare in the Virunga compared with previous surveys. An important population of topi and hippo continue to be present in the Virunga South contiguous with QEPA. Cattle were only found in QENP around the Nyakatonzi area of the park, a well know area where cattle are brought into the park for water and grazing. Cultivation and human habitation were outside QEPA's borders but were fairly extensive within Virunga north of the Kabaraza region (figure 6). Cultivation was not noted within the park in this region in the 2010 survey.

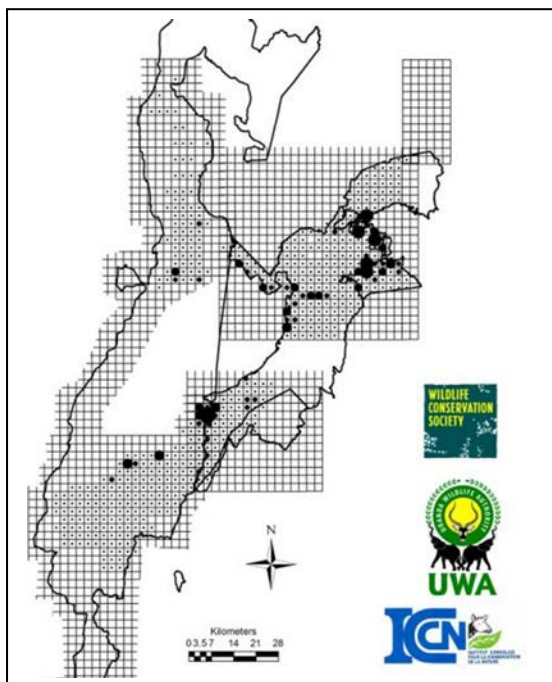
a. Buffalo



b. Elephant



c. Hippo



d. Topi

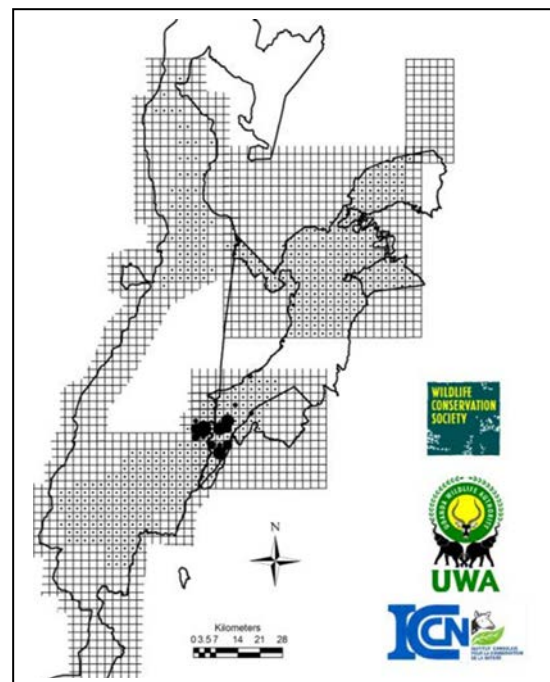
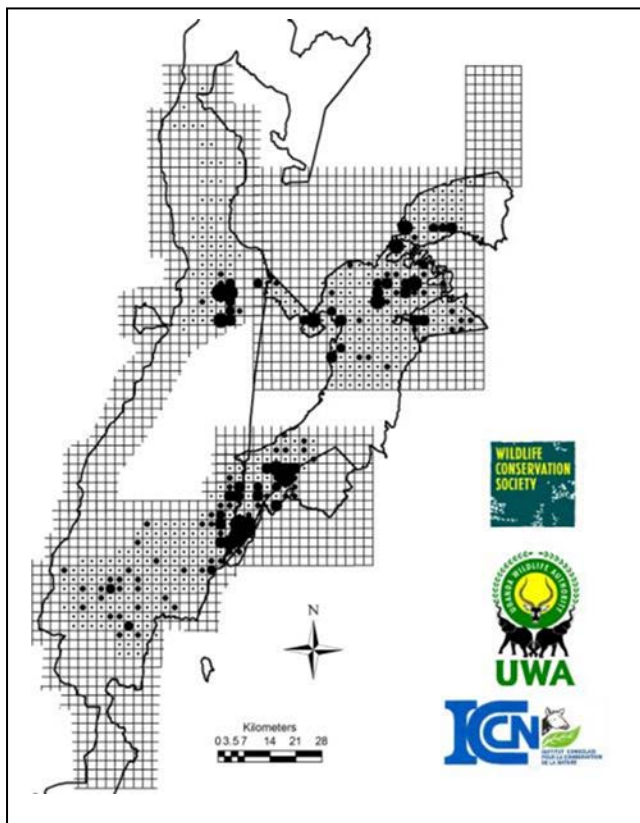
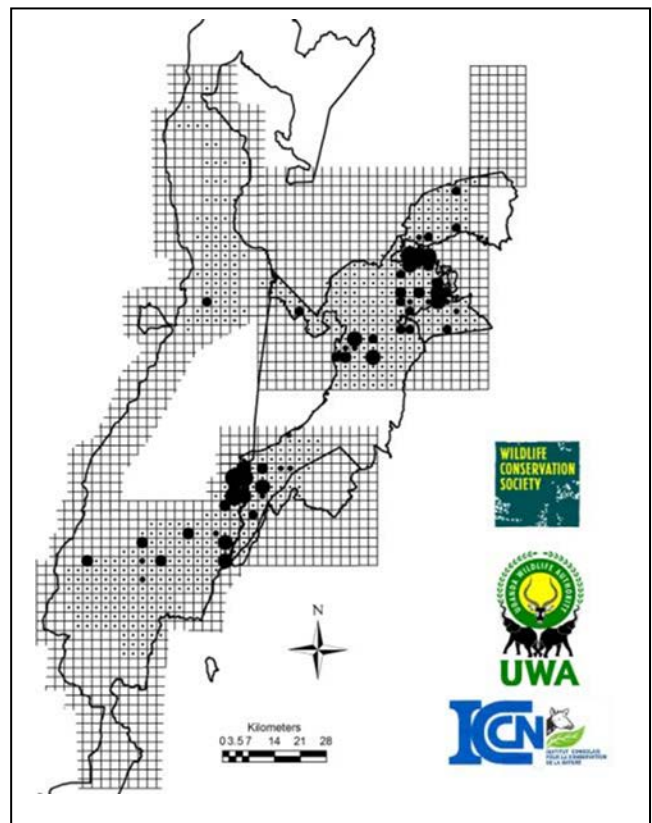


Figure 5 (part 1). Distribution and relative density of Buffalo, Elephant, Hippo and Topi.

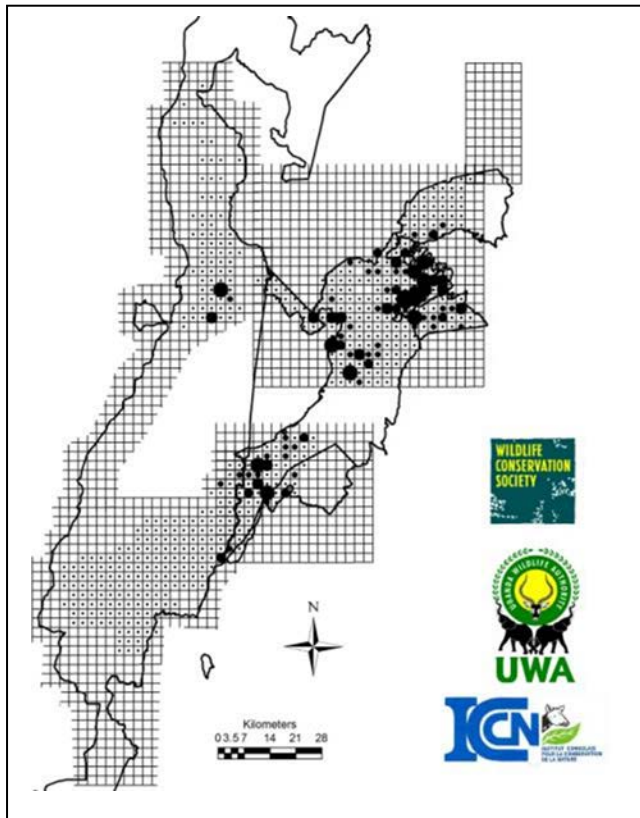
e. Uganda kob



f. Warthog



g. Waterbuck



h. Cattle

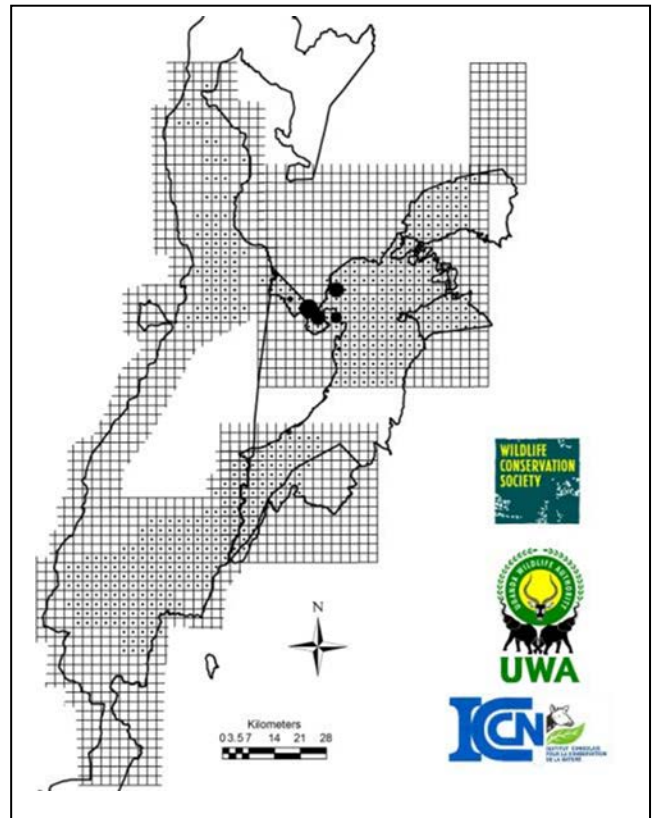


Figure 5 (part 2). Distribution and relative density of Uganda kob, warthog, waterbuck and cattle.

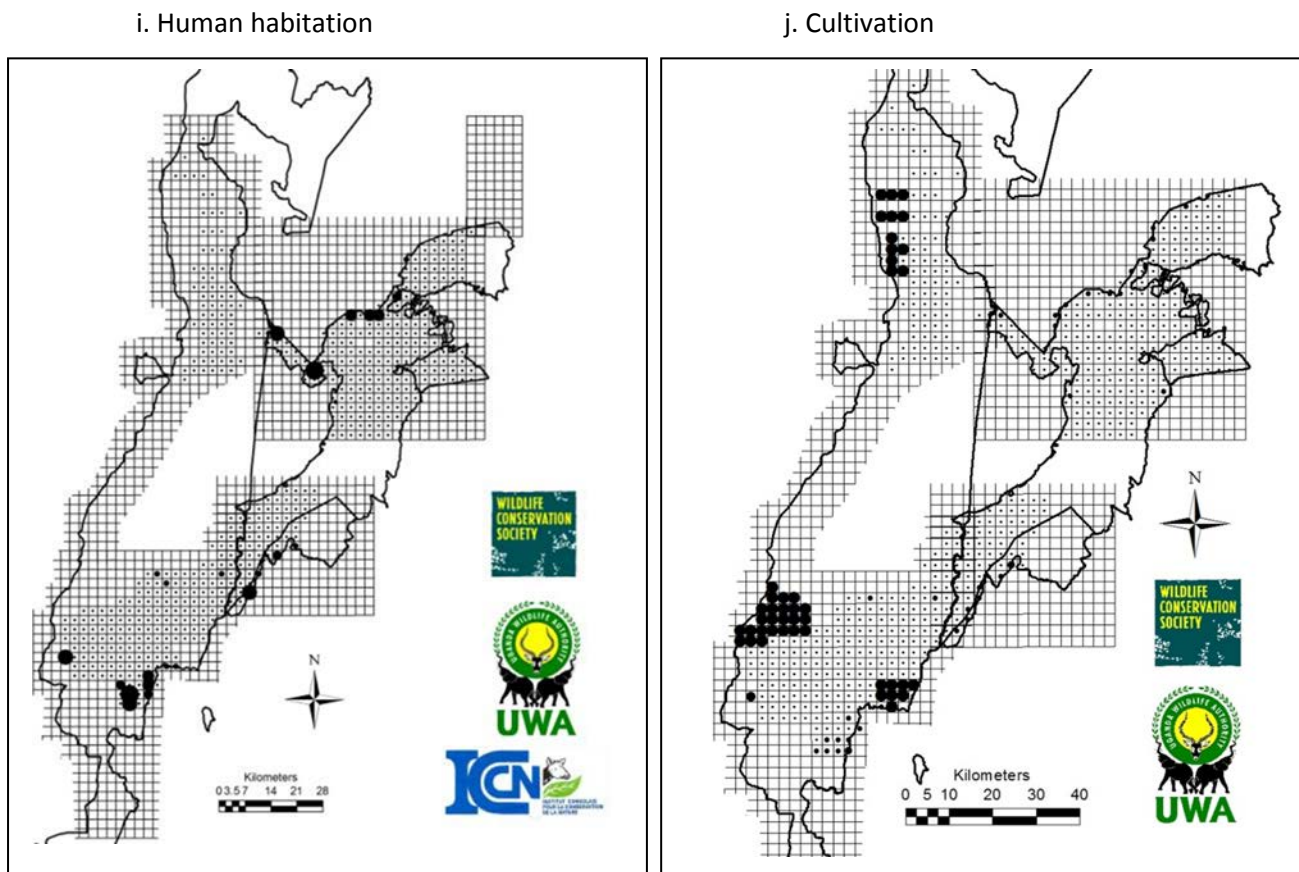


Figure 6. Distribution and relative density of human habitation and cultivation.

Total Count results

The tracklog for the total count over QEPA is shown in figure 7. A total of 2,561 elephants were counted during the total count in QEPA, in 222 groups or singletons. All singletons were Bulls and these numbered 67. The largest agglomeration observed was 108 individuals. Average group/agglomeration size was 16 individuals. The percentage of juvenile and infant elephants is relatively high at 38.8% where this was determined (707 elephants)

Quite a number of carcasses were found in QEPA, 11 in number with two fresh ones, six recent ones and three old (figure 8). Four carcasses were observed also in Virunga; two fresh, one recent and one very old.

The discrepancy between the total count (2,561) and SRF (2,913) is within the standard error of the SRF count but given some of the large group sizes (fourteen were greater than 40 individuals) there is a possibility that some young animals may have been missed in the thickets despite photographs being taken at several angles of all groups/agglomerations. As elephants are inevitably missed during Total Counts, it is normal in East Africa for SRF estimates to be higher than Total Counts. However, the Total Count was within 12% of estimated numbers further strengthening the certainty of the sample estimate and confidence of the results. The total counts did provide additional data on carcasses (n= 13 detected compared to none on transects) as well a detailed dataset on the

distribution and spatial use of elephants during the survey window, group sizes and basic demography.

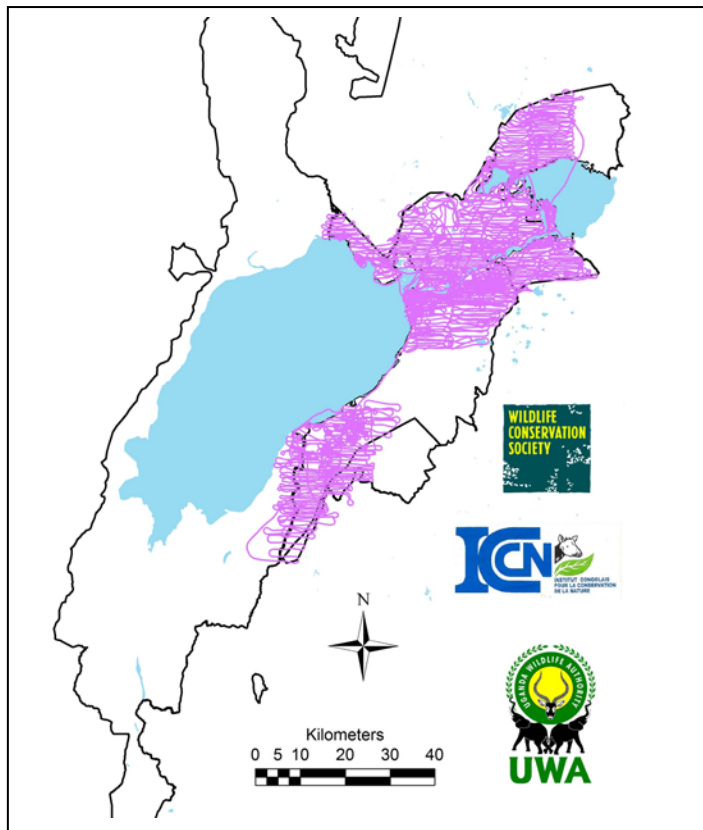


Figure 7. Tracklog of the actual flight for the total count survey of elephants and buffalos in QEPA.

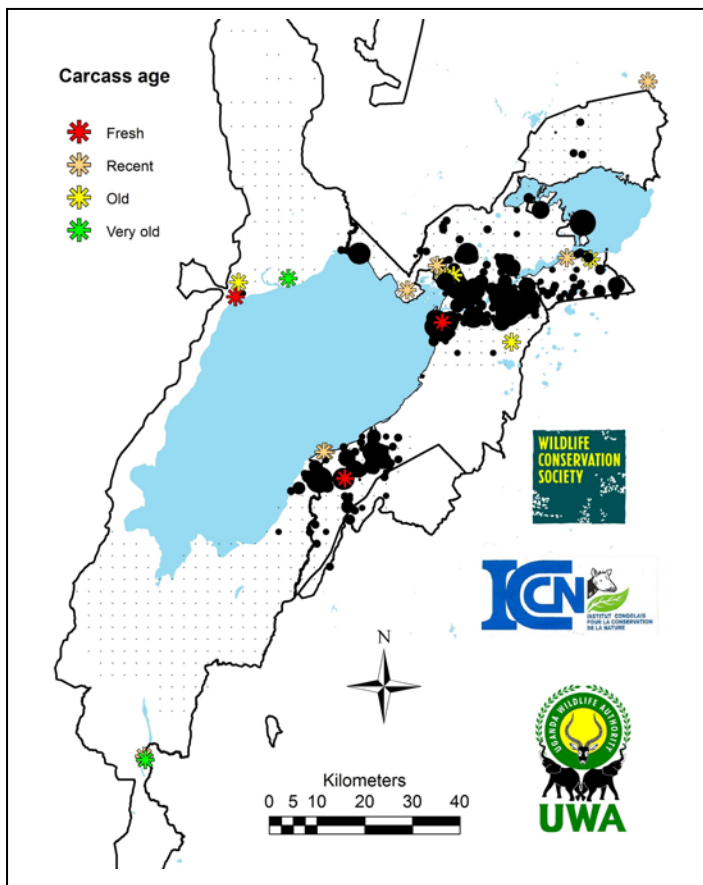


Figure 8. Location of herds of different sizes (black circles) from the Total count survey with location of 13 elephant carcasses in QENP and 5 carcasses in Virunga.

The chief anti-poaching warden, Haruna Kirya, of QEPA conducted a one day overflight with the WCS survey aircraft and other UWA colleagues to verify all fresh and recent elephant carcasses, evaluate threats, discuss with field rangers, and take action to follow up with investigations and protection measures.

Discussion

Trends in elephant and other large mammals

WCS has compiled aerial survey data from QEPA and Virunga from as many records we have been able to find by reviewing the published literature and working through old records in the library at QENP (table 3). In the 1960s and early 1970s total counts of elephant and buffalo were made and the switch to SRFs was made in the mid 1970s. Numbers of elephants fluctuated greatly between years in the 1960s (figure 9) which may have been partly a result of the method and partly because at this time elephants migrated out of QEPA in the wet seasons (Buss, 1990). Figure 9 shows that elephant numbers have recovered to around the mean value of their 1960-1970s levels (when they were at their peak numbers).

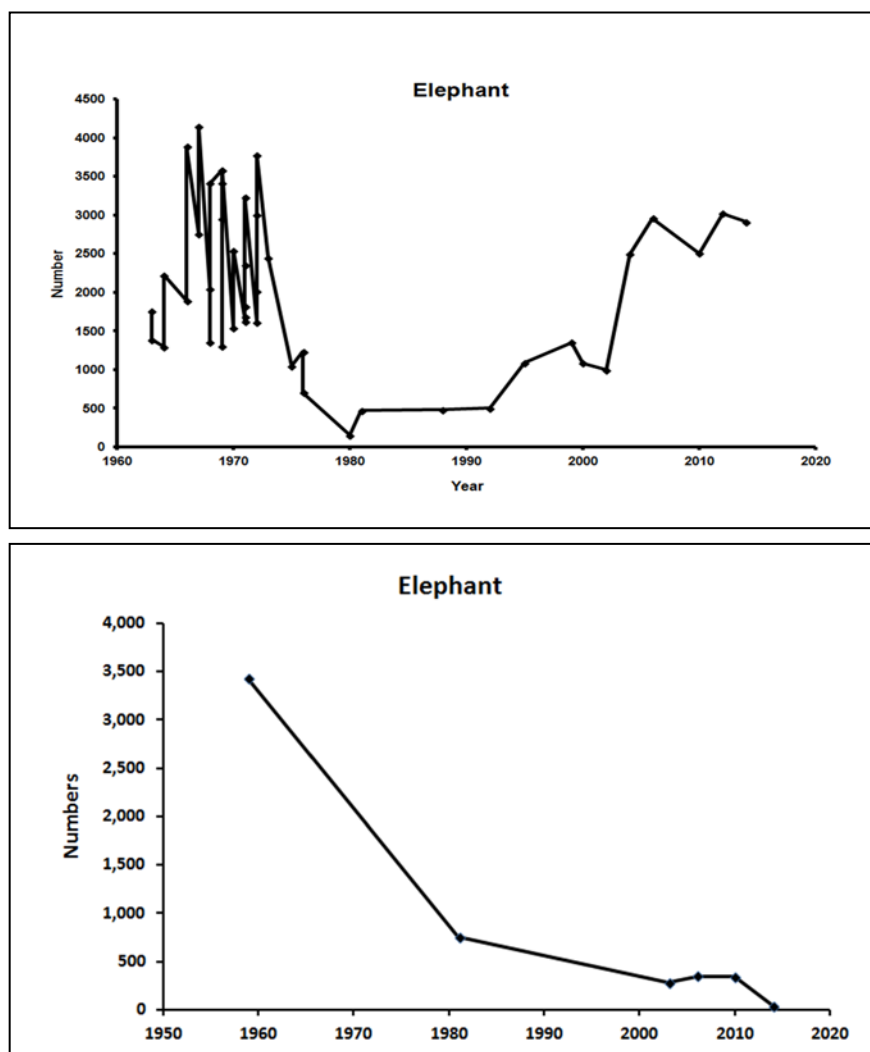


Figure 9. Plot of numbers of elephants for each year since 1963 in QEPA (top) and Virunga (bottom).

Table 3. Counts from aerial surveys in QEPA since the early 1960s. Numbers for all surveys that WCS have been able to compile information from published and unpublished records are given.

Year	Elephant	Buffalo	Topi	Uganda Kob	Waterbuck	Warthog
1963	1,758					
1963	1,389					
1964	1,295					
1964	2,222					
1966	1,891	16,036				
1966	3,884					
1967	2,757					
1967	4,139					
1968	2,039	17,478				
1968	1,353					
1968	3,410					
1969	3,581	18,040		19,117		
1969	2,948					
1969	1,299					
1969	3,410					
1969	3,581					
1970	1,543	17,953				
1970	2,540					
1971	1,678	13,449	1,477	10,654	3,559	2,175
1971	1,814	12,922				
1971	2,355	14,610				
1971	1,624	14,060				
1971	3,230	17,180				
1972	1,616	14,358	4,600	11,500	3,000	1,500
1972	3,002	13,836				
1972	2,009	14,645				
1972	3,769					
1973	2,447	18,000	5,000	10,000	3,500	4,000
1975	1,047					
1976	1,232					
1976	704			12,500		4,000
1977			2,575		3,500	
1980	150	4,206	1,500	20,000	2,100	1,100
1981	471					
1988	480	5,000	400	18,000	1,500	1,600
1992	500					
1995	1,088	16,549	493	31,899	1,860	1,175
1999	1,353	7,250	325	20,588	2,227	1,931
2000	1,086	10,674	94	32,245	4,666	2,423
2001			100			
2002	998	6,807	157			
2004	2,497	6,777	440	17,440	3,382	1,880
2006	2,959	14,858	1,521	20,971	3,548	1,388
2010	2,502	8,128	262	8,483	2,483	1,466
2012	3,018	12,825	1,097	19,855	2,767	1,465
2014	2,913	15,771	2,005	12,987	2,981	1,456

Much fewer surveys were made in Virunga over the years. At one time the national parks in then Zaire refused to allow planes to overfly the parks because it would disturb their pristine nature. As a

result there are only a handful of surveys (Table 4). Poaching mainly has targeted the larger species with elephant and buffalo numbers dropping precipitously in Virunga. However, recently even the smaller species such as the Uganda Kob which had remained stable until 2006 have started to decline.

Table 4. Counts from aerial surveys in Virunga since the late 1950s. Numbers for all surveys that WCS have been able to compile information from published and unpublished records are given.

Year	Elephant	Buffalo	Topi	Uganda Kob	Waterbuck	Warthog
1959	3,425	28,307	5,939	11,218	2,223	
1981	751	9,715	3,460	10,300	780	
2003	286	2,292	855	12,121	211	
2006	348	3,822	1,353	12,982	374	
2010	347	2,154	1,040	6,954	169	296
2014	35	586	630	4,584	236	227

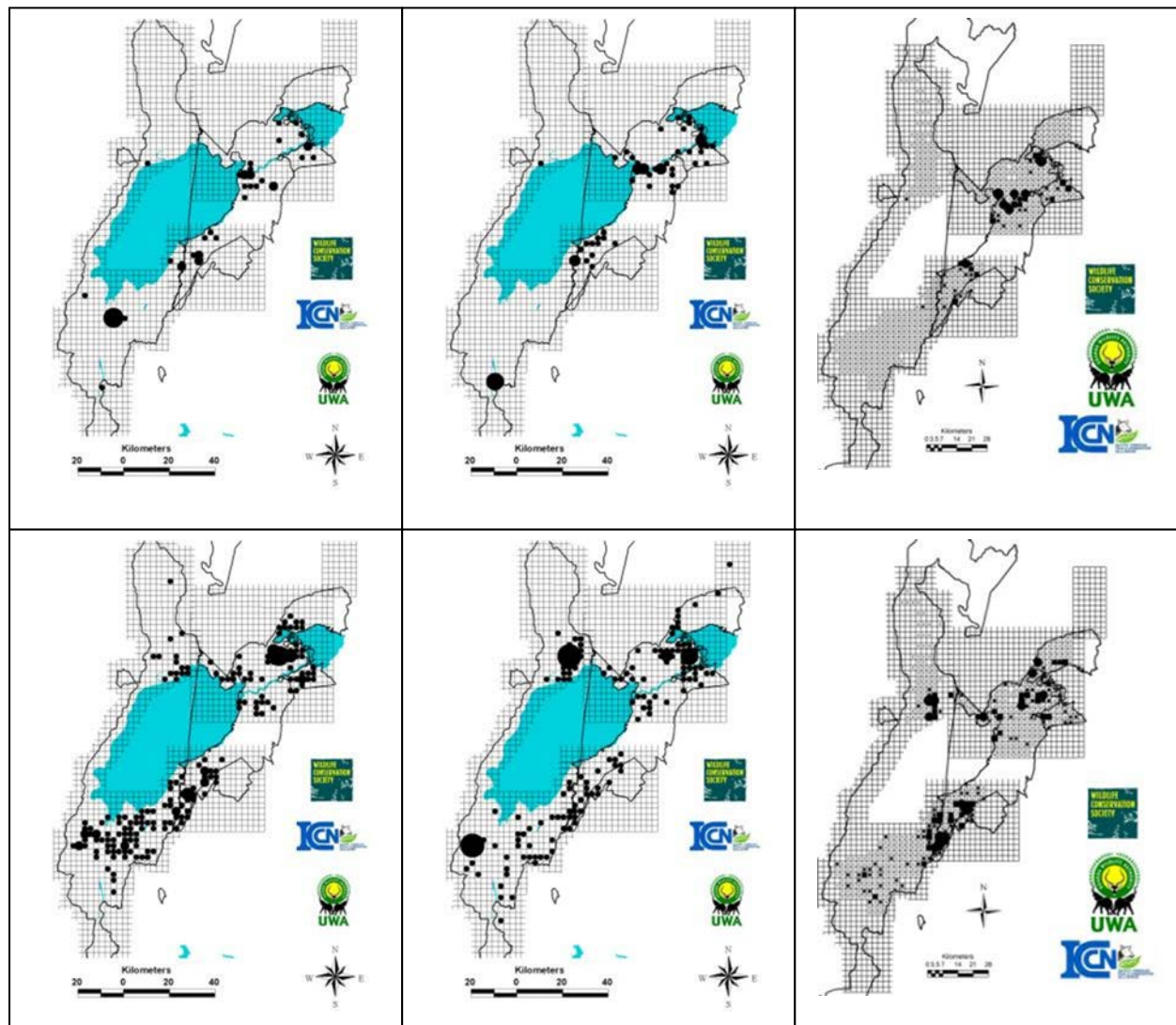


Figure 10. Changes in distribution of elephant (top) and Uganda kob (bottom) for the three GVL surveys in 2006 (left), 2010 (centre) and 2014 (right)

The results for elephant and Uganda kob from the last three surveys of the GVL show a dramatic decline in elephant and Uganda Kob in Virunga in both abundance (table 4) and distribution (figure 10). There is particularly a reduction in the distribution of kob. This survey shows that most animals are concentrated at the border with Uganda, where they probably represent animals migrating into Virunga from QEPA, and near the Semliki River, north of Lake Edward and highlights the importance of transboundary collaboration and management now for the Virunga large mammals.

The counts obtained from these total count surveys was much higher than the previous ones conducted in 2010, with 1,010 elephants more individuals spotted in this survey. A higher search rate as well the subdivision of the census zone into blocks minimizing the effects of movement and double recording are probably important variables affecting the census outcomes. In addition the distribution data from the total count data demonstrates the expansion of elephant range to the north and west in QENP.

We did not observe any carcasses while on the SRF surveys so that we cannot compute a carcass ratio for the SRF. For the total count we have $13/2561 = 0.0051$ carcasses per elephant. Prior surveys in 2010 and 2006 did not record any carcasses in QEPA or Virunga Park so although the carcass ratio is low it is a concern that we identified 13 relatively fresh carcasses in QEPA and 5 in Virunga.

Elephant status and conservation

The SRF results for QENP indicate lower numbers but when employing confidence intervals the 2014 and 2012 estimates are not significantly different. However, high numbers of fresh and recent carcasses observed in QENP compared to previous surveys reveals a significant poaching problem at this time well inside Uganda. In addition there is active poaching along the border with Virunga DRC and inside DRC. The low number of elephant encountered in Virunga south compared to previous years is due to no observation of a previously observed large herd of about 150 individuals that used to roam near Kabaraza and which for a while were monitored on a daily basis by ICCN rangers. While it is possible that this herd may still persist in Virunga and was missed by the survey, the observers did look for tracks in the grass that indicate elephant presence and did not observe any indicating the absence of large groups of elephants in Virunga north and south with only a few individuals observed. Reports from rangers indicate that a herd up to 70 individuals was seen in July near Mabenga and up to 52 individuals at Ishango so numbers of elephants may be a bit higher than the estimate from the SRF but the comparison between SRF's between years does indicate a major decline in elephant numbers in the park. A fresh elephant carcass was observed within 2 km of the Kyavinyonge village in north Virunga and within 1 km from ICCN training school at Ishango where the river Semliki leaves Lake Edward. Upon query by ICCN senior staff the ICCN stationed at Ishango stated they were not aware of the carcass. An ICCN ranger team were observed deployed to the site of recent killing of two elephants 5 km inside QENP in Uganda. While deploying rangers to sensitive areas, it would seem logical that ICCN Virunga would do this jointly with UWA, particularly since it was inside Uganda.

If the trend continues it is likely that Virunga will lose all its elephants within the next few years. While the QENP elephant poaching issues are reported in some cases to be related to retaliation by

local Ugandan villagers for elephant crop raiding, the number of carcasses, several of which were not known by UWA, suggest that there is a deeper issue of poaching going on.

The following actions are urgently needed:

- Virunga must reinforce its anti-poaching efforts in both south and north Virunga savanna sector, with a focus on elephant security. Collaring of all remaining elephant groups and then regular aerial surveillance and ground patrols should be employed to effectively secure the remaining groups (as it has been applied in other areas of Africa).
- The North still is very much intact with low pressures in general, except for the presence of the fishing village at Kyavinyonge. The northern sector has excellent potential for the recovery of wildlife populations if properly managed. The south sector has the remaining Topi and borders QEPA elephant populations which likely will return to use the area if well protected. A large section of the south Virunga is invaded by agriculture, much greater than observed in the 2010 and 2006 surveys of the park. This is of most critical concern as this expansion of farming will destroy the park in the long term. While much lobbying has rightly been taking place against the oil exploration in Virunga Park the impacts of this agricultural expansion are in fact greater and just as important that this is brought up as a major issue that the government of DR Congo and the International Community needs to address.
- Coordinated patrolling between ICCN and UWA should be undertaken along the border of Virunga North and Virunga South with QEPA.
- There is a need to develop an intelligence database on elephant poachers and ivory traffickers for each Park and sharing of intelligence. WCS has supported UWA to establish such a database for all wildlife crime and could do so with ICCN.
- Collaring of QEPA elephants in both north and south to ascertain movements into Virunga and communicate with Virunga authorities to ensure they are protected by ICCN while in Congo.
- An independent evaluation of elephant security efforts in Virunga including investigation of any allegations of ICCN corruption or involvement with poaching and trafficking.
- An independent evaluation of elephant security efforts in QEPA including investigation of any allegations of UWA corruption or involvement with poaching and trafficking.
- Deployment of regular aerial surveillance in both Virunga and QEPA to detect and deter poaching. Overflights should be taken of all key elephant sectors at least once a week.
- QEPA forces need to reinforce patrolling efforts in the western sector in the north and south to address poaching hotspots.
- Transboundary law enforcement meetings should be held every quarter to plan joint work plans and patrolling along border.
- Transboundary radio communication and coordination should be undertaken on a daily basis.

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Appendices

Appendix 1. Survey teams

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

Observer	QEPA – N242TC	QEPA – N22044	Virunga –N242TC	Virunga-N22044
FSO	Frederick Wanyama	Sam Ayebare	Papy Shamavu / Ephrem Balole	Ephrem Balole
RSO left	Fred Kisame	Samuel Loware	Bertin Tumonakiese	J. Wathaut
RSO Right	Kato Robinson	David Okiring	Damien Mashigiro	David Okiring
Pilot	Paul Elkan	Soqui Mendiguetti	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:

QEPA

	Plane N242TC		Plane N22044	
Species	Fred Kisame Eria	Kato Robinson	Okiring David	Samuel Loware
Baboon		1	2	
Buffalo	582	519	494	246
Elephant	83	154	60	43
Giant Forest Hog		5	16	15
Hippo	83	149	119	134
Topi	69	23	88	54
Uganda Kob	595	508	266	147
Waterbuck	101	106	56	85
Warthog	45	36	37	52
Grand Total	1,558	1,501	1,138	776
Mean number per transect	76.4	95.9	62.1	41.3
Mean group size seen	4.8	6.1	4.9	3.0

Virunga Park

Species	Plane N242TC		Plane N22044	
	Bertin Tumonakiese	Jean de Dieu Wathaut	Okiring David	Damien Mashagirot
Baboon	17	3		
Buffalo	41	6		20
Elephant	3	1		
Giant Forest Hog	1			
Hippo	7	37	2	19
PERS	1			
Reedbuck		2		
Topi	23	35	6	11
Uganda Kob	104	223	85	112
Waterbuck		10	3	11
Warthog	2	3	11	10
Grand Total	199	320	107	183
Mean number per transect	12.2	18.9	14.5	23.3
Mean group size seen	3.4	5.0	3.3	3.6

Appendix 3 – SRF population estimates from each plane separately

We here present the results of the estimated numbers for QEPA analyzing the two planes independently. This effectively assumes they were flying transects of 5 km width with blocks of 2.5 x 5 km being sampled. We did not do this analysis for Virunga because of the few sightings made.

	N242TC			N22044		
	Population	SE	95%	Population	SE	95%
Buffalo	20,680	9,444	20,776	11,604	12,977	28,549
Elephant	4,452	2,776	6,108	1,615	1,760	3,873
Giant Forest Hog	94	87	192	486	576	1,268
Hippo	4,358	2,258	4,968	3,967	4,622	10,169
Topi	1,728	1,457	3,206	2,227	2,995	6,589
Uganda Kob	20,718	10,174	22,382	6,476	7,356	16,183
Waterbuck	3,888	1,907	4,196	2,211	2,406	5,292
Warthog	1,521	730	1,606	1,396	1,552	3,413
Cattle	9,354	5,693	12,525	0	0	0
Shoats	958	1,045	2,299	0	0	0

The results show a large difference in estimates between the two planes, particularly for elephants and buffalo. The reason plane N22044 did not observe any cattle or ‘shoats’ was because it did not fly over the pastoral grazing lands to the west of QEPA. None of the estimates for the wild animals are significantly different between aircraft (Z-tests). We do not believe these differences are due to

observer detection problems in this plane because one of the sharpest observers was David Okiring throughout the surveys we made in this park as well as in Murchison Falls Protected Area and Kidepo Valley National Park. It is likely due to the clumped nature of the animals being counted.