Biodiversity Surveys of Kabwoya Wildlife Reserve and Kaiso Tonya Community Wildlife Area

Kabwoya Wildlife Reserve and escarpment

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EXECUTIVE SUMMARY

The Kabwoya Wildlife Reserve and the Kaiso-Tonya Community Wildlife Area were established following the revision of the protected area estate in Uganda in the late 1990s. A decree of parliament in 2002 created the two protected areas from the former Kaiso Tonya Controlled Hunting area which had been gazetted in 1963. No surveys of the biodiversity of these two areas have previously been made, although surveys of large mammals had been made by Uganda National Parks in 1982, 1992 and 1996 and by Uganda Wildlife Authority (UWA) in 2006 (ground count) and 2007 (aerial survey).

Survey teams from the Wildlife Conservation Society (WCS) and Makerere University assessed the species of large and small mammals, birds, amphibians and plants (ferns and higher plants) in this area in February and March 2009. A mixture of quantitative and qualitative methods were used to provide species lists for the park and also measures of relative abundance and species accumulation curves. A total of 30 mammal species, 20 reptile and 18 amphibian species, 176 bird species, and 167 plant species were recorded for the two protected areas. The area did not have any particularly threatened or endangered species but does seem to be an important area for migratory birds with large flocks of some species from Europe and north Africa.

Signs of illegal human impact were minimal with most concentrated in the Kaiso-Tonya Community Wildlife Area but compared with other sites in Uganda these were not abundant.

ACKNOWLEDGEMENTS

We would like to thank many people who helped WCS implement these surveys. The warden of Kabwoya Wildlife Reserve, Mr. Ghad Mugiri was very helpful in organizing logistics for the field teams and providing advice on where teams could access safely. We are grateful to the field assistants who collected the data for these surveys, particularly: Moses Gonya, Sam Isoke, Obed Kareebi, Dennis Tumuhamye, Julie Asiimwe and Julius Kyamanywa, and to the UWA rangers who also took part in the data collection. We also thank Richard Musumererwa Amooti for ably cooking for all the field teams. Robert Kityo at the Makerere University Museum identified the small mammals for this survey and Mathias Behangana identified the reptiles and amphibians.

Sarah Prinsloo and the WILD Team in Kampala played an important role in setting up the teams and organizing equipment. We want to thank USAID for its financial support for the surveys and also Uganda Wildlife Authority for permission to carry out the surveys in the Reserve.

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INTRODUCTION

Kaiso Tonya Controlled Hunting Area (KTCHA) was established in 1963 and covered most of the land below the escarpment on the shores of Lake Albert north of Hoima town. This controlled hunting area was established to conserve important populations of Uganda Kob, buffalo and Jackson's Hartebeest. During the late 1970s heavy poaching of large mammals reduced their populations to very low numbers. Sample counts made in 1982 found that the hartebeest had been exterminated from the area and buffalo and kob numbers were very low (Eltringham and Malpas, 1993). A later survey in 1992 (Olivier, 1992) and then in 1995 (Lamprey and Michelmore, 1996) showed further declines and the waterbuck population had been reduced to 17 individuals.

In 1996, with the merger between Uganda National Parks and Uganda Game Department to form the Uganda Wildlife Authority, a process to assess and revise the existing protected area estate was made (Lamprey, Buhanga and Omoding, 2003). During this process it was decided to upgrade the status of the Kaiso Tonya Controlled Hunting Area south of the Howha River to form the Kabwoya Wildlife Reserve (Kabwoya WR) and to establish the Kaiso Tonya Community Wildlife Area (Kaiso Tony CWA) to the North (Fig. 1).

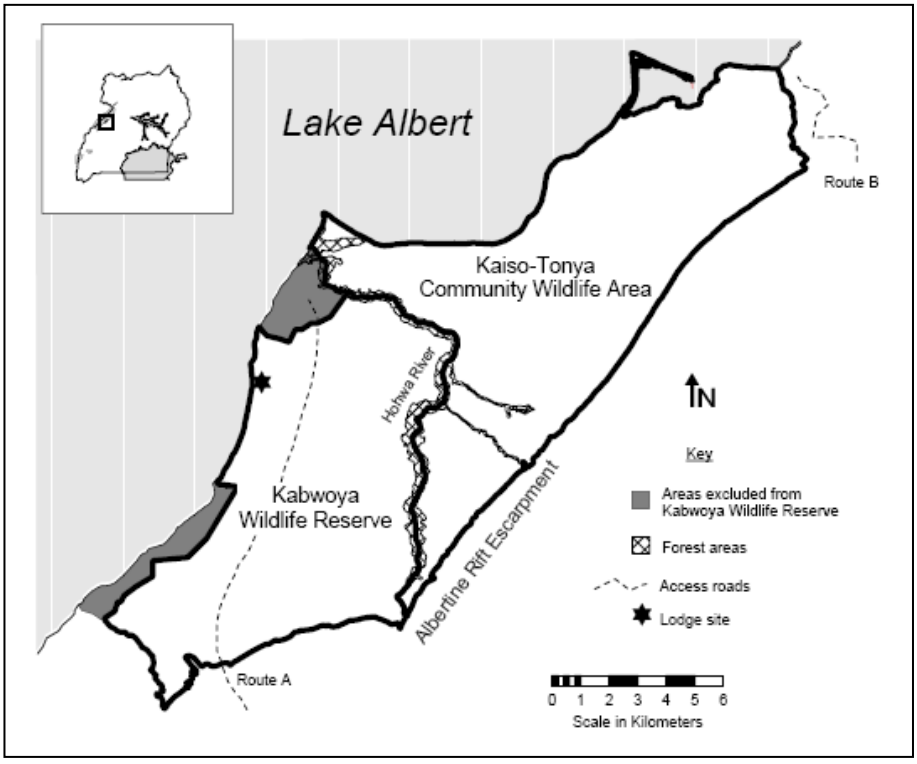

Figure 1. Map of the Kabwoya Wildlife Reserve and Kaiso Tonya Community Wildlife Area (Map courtesy of UWA).

These two areas form the Kabwoya and Kaiso Game Management Area (KKGMA). In 2002 Lake Albert Safaris approached UWA to obtain a concession to manage the KKGMA for both tourism and sport hunting. A lodge was constructed in Kabwoya WR and surveys were made in 2006 and 2007 of the large mammal populations to assess numbers and quotas for sport hunting. At about this time oil exploration also started in both protected areas and significant quantities of oil have since been discovered in this region.

As part of the WILD (Wildlife, Landscapes and Development for Conservation) project of the Wildlife Conservation Society a biodiversity survey was made of the KKGMA to assess its

contribution to the conservation of biodiversity in Uganda. Surveys focused on the following taxa: large and small mammals, birds, amphibians and plants as surrogates for overall biodiversity. This report summarises the results of this survey which was carried out between the 24th February and 14th March 2009.

Kabwoya WR and Kaiso Tonya CWA

The KKGMA covers 194 km^2 of *Hyparrhenia* and *Themeda* grassland interspersed with patches of undifferentiated dry thicket with *Grewia* spp and *Acacia brevispica* (Langdale-Brown, Osmaston and Wilson 1964). Along the Hohwa River are stretches of riverine forest. The land is undulating and at the foot of the escarpment along the shores of Lake Albert. The lake forms the boundary to the west while the escarpment forms the boundary to the east. The Hohwa river bisects the area and forms the boundary between the two protected areas.

A map was made from aerial photos that were taken in 2008 by the WCS flight program. These images were captured and joined using the ENSO Mosaic hardware/software package to produce a digital photographic map of the region. This was used to create a vegetation map of the area as well as allocate survey points for the bird and plant surveys (fig 2).

Historically this area has not been well surveyed for its biodiversity. An aerial survey was made by Eltringham and Malpas (1983) following the massive poaching that took place in Uganda in the late 1970s. Uganda Wildlife Authority (UWA) undertook aerial surveys of large mammals in this area in 1992, 1995 (Lamprey, Buhanga and Omoding, 2003) and 2007 (Wanyama, Tibesigwa and Kagoda, 2007) and a ground count of large mammals in 2006 (Lamprey and Rwetsiba, 2007). Other surveys of the biodiversity of the area have not been aimed at collecting data across the two protected areas but have only been concerned with Environmental Impact Assessments of the oil exploration and test drilling that have taken place here.

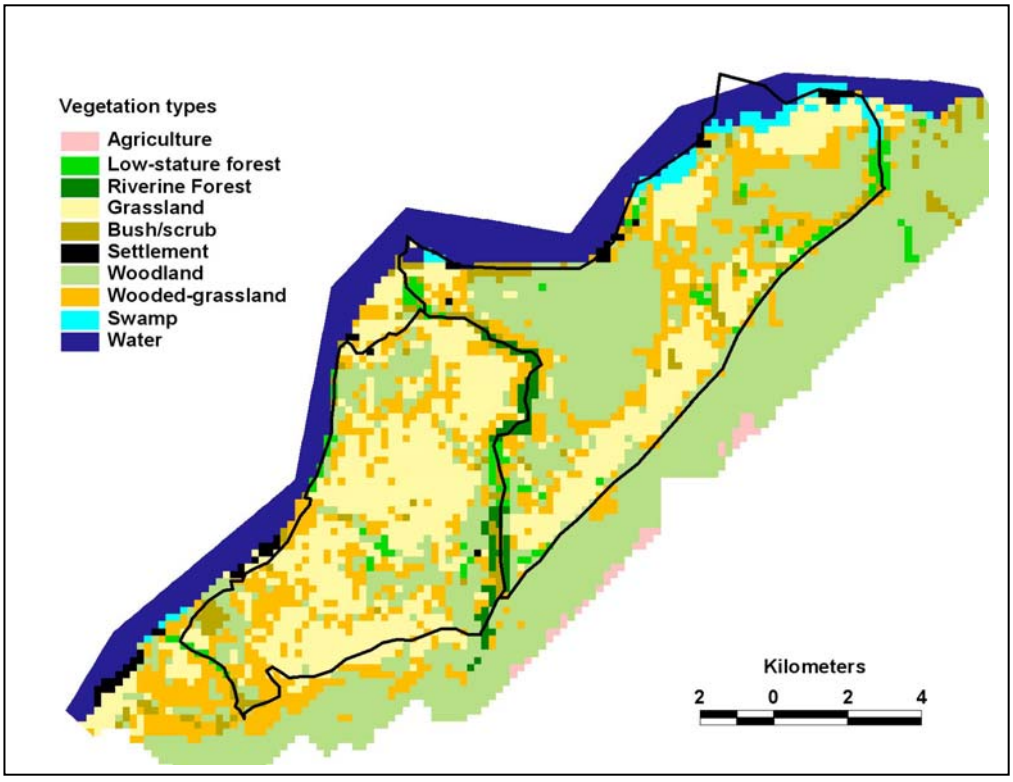

Figure 2. Vegetation map of Kabwoya WR and Kaiso-Tonya CWA.

METHODS

Large mammal surveys

The design used was identical to the design used in the 2006 ground count made in the same area (Lamprey and Rwetsiba, 2007). Transects were allocated systematically across the whole area from west to east and three teams would walk three adjacent transects simultaneously, recording all large mammals seen and the perpendicular distances to these mammals (fig. 3). The transects were spaced at 200 metre intervals and it was assumed that observers could see animals up to 100 metres either side of the transects which would have allowed a complete count of large mammals for the area surveyed. All large mammal species and human sign were recorded from these transects.

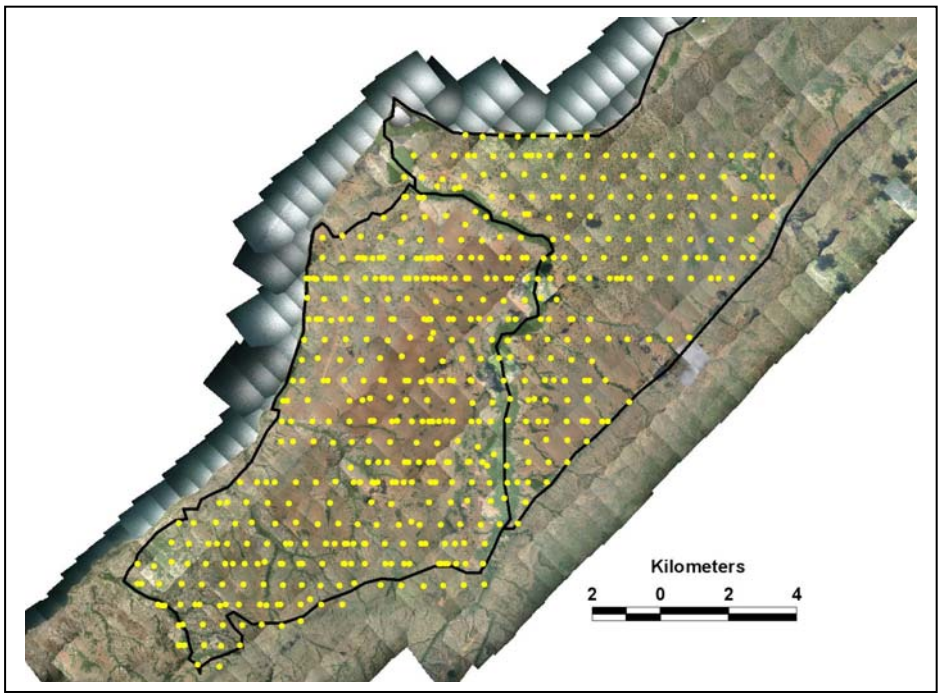

Figure 3. Transect GPS points during the survey of Kabwoya WR and Kaiso Tonya CWA. Note that not all of the Kaiso Tonya CWA was sampled for large mammals.

Large mammals were surveyed by three teams walking each main transect and adjacent transects that were 200 metres to the north and south of the main transect. Teams recorded sightings of all large mammal species. Perpendicular distances were measured to the centre of each group using a lazer range finder. A total of 720.54 km were walked in both Kabwoya WR and KaisoTonya CWA, with 449.55 km in the former and 270.99 km in the latter. Encounter rates of sightings were calculated per kilometer walked for each transect separately. Where sightings were greater than about 25 we attempted to calculate a density using DISTANCE.

Small mammal surveys

Small mammals were surveyed between 24th February to the 14th March 2009. It was a notably dry time of year throughout the area. All surveys were conducted at five locations starting with areas near the lake and then towards the foot of the escarpment. The locations of the small mammal sampling areas are shown figure 4.

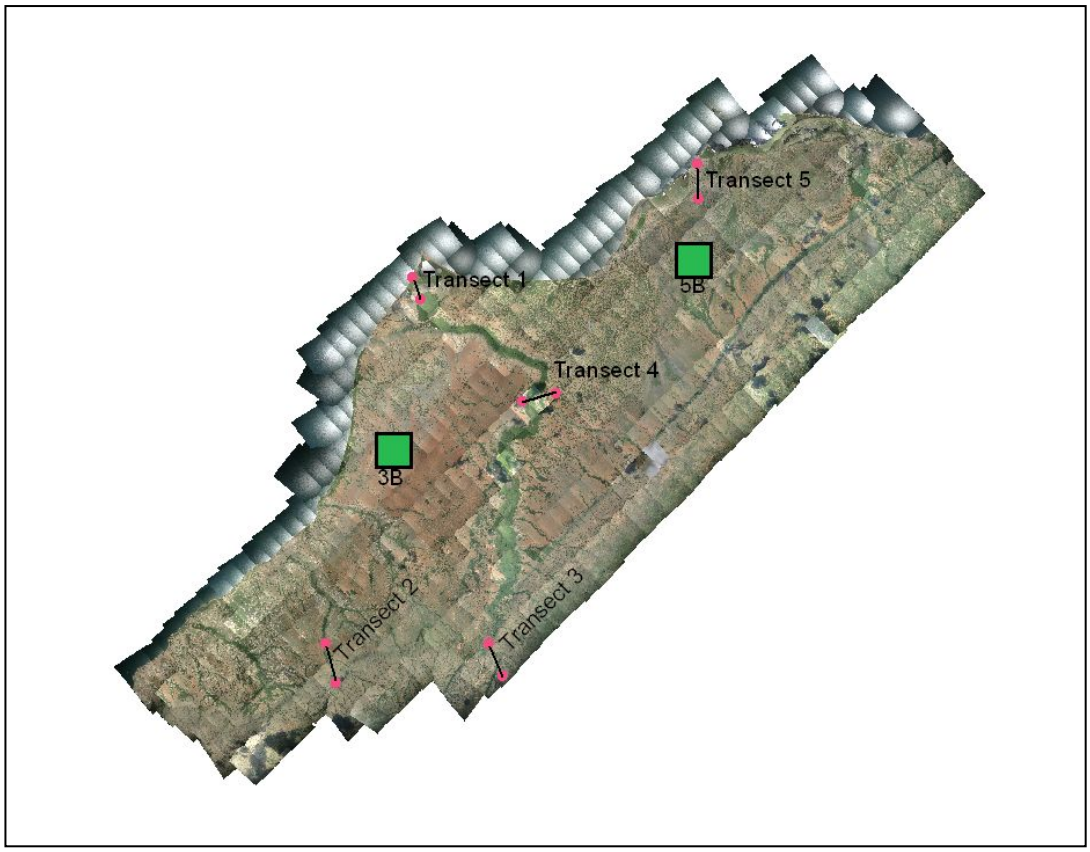

Figure 4. Map of Kabwoya and Kaiso Tonya showing the locations that were surveyed for small mammals

Five transects were initially planned as follows:

Transect 1:; was located around Ngassa lagoon area near Kyehoro village. Kobs were seen moving around there in search for water. Trap stations 1 and 2, pit fall station B, and netline 1 were established there.

Transect 2: was within the steep escarpments, near a UPDF camp. There was a forested but dry sandy riverbed near which the traps were placed. Trap station 6, pitfall trap C, and netline 4 were set up here.

Transect 3: traps were not laid out at any point along this transect because it was inaccessible due to bad terrain.

Transect 4: was across river Hohwa near the bridge on the main road entering the reserve from Hoima. Trap stations 3 and 4, pitfall station A and net line 2 were set up along this transect.

Transect 5: this transect was within Kaiso-Tonya area, which was very busy in the community land with a lot human activities taking place. No traps or nets were set up here.

However transect 3 and 5 were not suitable for the reasons given above and so the following two sites were selected to replace these:

3B - Was set up as another site to Transect 3. It was an open grassland near the campsite and the Albert Safari Lodge. Trap station 5 and net line 3 were set up here.

5B - Was set up to replace transect 5. It was located at the base of the escarpment close to a dry rocky river basin. Trap station 7 and netline 5 were set up here.

Sampling locations

Traps were placed in seven stations to survey for rodents and shrews and five netlines to survey for the bats. The small mammals (bats, insectivores and rodents) were surveyed using conventional trapping and netting methods. A mixture of Sherman, Museum special,

Victor rat traps and pitfall traps were used to capture the rodents and insectivores, while mist nets were used to sample the bat fauna. Table 1 summarises the location of the different sampling location and the dates when sampling was started at each.

Table 1. Coordinates for the locations in which the trapping and netting of the small mammals were done. The Coordinates are in UTM 36North and WGS 84 projection.

Date	East	North	Survey site/ station
25 - 27th Feb	272278	168820	Netline 1
25 - 27th Feb	271831	168800	Station 1
25 - 27th Feb	272260	168778	Station 2
27 Feb - 1 Mar	276536	163920	Netline 2
27 Feb - 1 Mar	276389	164429	Station 3
27 Feb - 1 Mar	277300	164653	Station 4
1 -13th Mar	276521	163937	Pitfall A
2 - 4th Mar	270546	166059	Netline 3
2 - 4th Mar	270507	166024	Station 5
4 - 13th Mar	272271	168881	Pitfall B
5 - 13th Mar	268703	156202	Pitfall C
5 - 10th Mar	268712	156194	Station 6
6 - 10th Mar	268749	156160	Netline 4
10 - 13th Mar	283624	167316	Netline 5
11 - 13 Mar	283715	167185	Station 7

Description of the different trapping/netting stations

Trap stations were set up on the transects as described above depending on the different vegetation and other physical factors e.g. rivers, grassland or escarpment. A trap station is described as the area of diameter about 200 metres in which traps are placed. Such a place is chosen depending on its vegetation cover and likeliness to have rodents. Where stations were near rivers beds, traps were placed along the river banks in suitable discrete patches of vegetation. Spacing of the traps within a station was random. Traps were placed in thick bushes or where the traps were not easily visible to larger mammals e.g. baboons and human beings. The number of traps per trap station was dependent on how large an area at the station was covered with vegetation (for example, stations with a lot of vegetation covering had more traps placed there than at stations whose vegetation had been burnt the previous season. Netlines were 10 metres long made up of a continuous line of mist nets. All netlines were set up in a continuous line near the habitat suspected to have any bats within it.

Pitfall trap stations were made by digging up 10 medium-sized pits arranged in a line following each other after every 10 metres. After identifying a site for setting up a pitfall station, 10 pits were dug and each was fitted with a 10-litre bucket. A drift fence was formed to stop small mammals from moving from one side of the bucket to another, instead the animals would have to move along this drift fence and eventually fall in the buckets, whose bottom was covered with formalin. All specimens trapped by this method were automatically killed by the formalin in the buckets. 3 pitfall trap stations were made, thus a total of 30 pits. They were located at Transect 1 (Pitfall P1), transect 2 (pitfall P2) and transect 4 (pitfall P4).

1. The Hohwa River Riverine Forest
Two transects (1 and 4) were in the Hohwa riverine forest (one other transect was also in riverine forest on a tributary). Each transect had two stations (a and b) where trapping took place making a total of four stations (1 a, 1b, 4a and 4b).

The river bed was dry at the time of conducting these surveys. The substrate was sandy nearer the lagoon (where sites 1a and 1b were) but became higher in clay content up the river where sites 4a and 4b were placed. The bordering vegetation was generally dry grass and thickets / shrubs of *Sesbania* spp, *Caparis tormentosa*, and some scattered *Ficus natalensis*. Stations 1a and 1b, Pitfall 1 and Netline 1 were set up on Transect 1 near the Ngassa Lagoon. Station 1a had 30 Sherman traps and 10 Museum Special traps deployed for two nights. Station 1b was located at Ngassa Lagoon, near the point where the river Hohwa drains into Lake Albert. 26 Sherman traps were deployed in this area and also left for two nights. In addition, ten pitfall traps were sunk into the ground in this area and left in place for 5 days. For purposes of sampling bats 3 nets were also set in this area and monitored for three nights.

Plate 1. Tall grassland near the lagoon, sometimes with patches cut out due to human influence. Stations 1a and 1b were placed here.

Stations 4a and 4b, Pitfall A and netline 4 were setup along Transect 4 still along the Hohwa River (as illustrated above). Trap station 4a, was established in the centre of a shrubby area with very tall elephant grass. There was evidence of baboons (1 baboon troop and their vocalization) and human activities in this area and hardly any tracks of rodents. 30 Sherman traps and 10 museum special traps were placed under the bushes and left for three days. Trap station 4b was generally more forested than the other stations, the river substrate was clay and was still wet, with foot prints of larger mammals/ ungulates. The banks were also thickly covered with water reeds of *Polygonom* spp. 26 sherman traps and 14 museum specials were placed here, as well as 3 mist nets were set up for netline 4.

2. Seasonal Rivers river beds
Besides the Hohwa River, transects were near/ or across other smaller seasonal rivers within the Kabwoya Wildlife Reserve and Kaiso Tonya Community Conservation Area. One of these rivers was at Transect 2, (see figure 3 above). Transect 2 was located among rugged hills, with a shallow seasonal river of sandy substrate surrounded by thickets. 56 sherman and 10 museum special traps were placed along the river banks here to form station 2a. 3 mist nets were set up to form netline 2, and 10 pit falls were dug up to form Pitfall trap P2.


Plate 2. *Left:* Open grassland near a riverine forest along river Hohwa in the background. Beyond the woodland is the Ngassa lagoon from which the kobs were going to drink. Stations 1a, 1b, pitfall 1 and netline 1 were placed in the wooded area as the presence of kobs made it impossible to place any traps in the grassland. *Right:* River Hohwa, clay substrate near which sites 4a and 4b were located.


Plate 3. *Left:* The wooded part of the sandy river bed at transect 2 at which station 2a, pitfall 2 and net line 2 were placed. *Right:* Sandy and rocky river bed at the foot of the escarpment (right). Stations 5B and netline 5 were laid out at the banks of this rocky/sandy river bed.

The other seasonal river was situated where station 5 was placed. The river was at the foot of the escarpment, the substrate of the river was sandy and rocky, with huge rocks on the river bank and not much vegetation cover. Some parts of the river bank were forested with tall old trees that provided shade and prevented any under growth to grow below them. 40 sherman traps and 10 museum special traps were placed here to form station 5B. And 6 mist nets were hang-up with in the river bed to form netline 5 (see plate 3, picture on the right).

3. Open grassland

Traps for station 3B were laid out in open grassland in the stretch of grassland between the ranger's camp and the Lake Albert Safari Lodge. The grass was long and dried on most of the station; there were many baboons in the small trees. The grass was generally dry but there were older tufts of grass that were probably remaining from the previous season's burning (plate 4).

Plate 4. The more wooded part of the grassland at transect 3 where station 3a, and netline 3 were established

Sampling procedures

Bait for use in/on the traps was made by mixing groundnut paste with ripe bananas, ground fish and ghee. After identifying a suitable location, baited traps were placed and left over night in areas suspected to have small mammals. Such areas were identified by checking for trails or areas with fairly dense ground level cover and in these traps were placed and left in place for 2 – 3 days.

Any captured animals were recovered from the traps and examined and several measurements (including total body length, tail length, ear and hind foot length) taken for the rodents and shrews. For the bats on the other hand, total body length, wing span length, the fore arm length and length of the fifth digit were measured. The measurements were taken as guide for identifying the different species of mammals captured.

Location details (UTM Coordinates and altitude) as well as the habitat description of the location where mammals were captured were recorded. Any individuals that were saved as voucher specimens for subsequent identification at the Makerere University Department of Zoology Museum were then labelled with a unique numbered tag and preserved in formalin.

Amphibian and reptile surveys

A scoping exercise showed that most of the reserve had been recently burnt and in several cases was still being burnt. This together with a limitation on the number of days budgeted for the area meant that the methods that were to be used would be applied to fewer sites than initially planned. Four sampling sites were originally planned corresponding to those predetermined by the project. Three of these were suitable for laying pitfall traps with drift fences while the fourth near the escarpment was in a steep gorge and too rocky to put in pitfall traps.

Study Sites and sampling procedure

Pitfall trapping and Visual Encounter Surveys (VES) were the main methods of sampling. Four sites were sampled at the same locations as the small mammal trapping sites: 4, 1, 2 and 5B with the following geo-referenced positions:

Table 2. Locations of amphibian surveys in KKGMA. UTM locations in 36N, WGS 84 Datum are given.

Site	UTM 36N E-W	UTM 36N N-S
4	276521	163937
1	272271	168881
2	268703	156202
5B	282215	170185

Pitfall trapping with a drift fence bucket pitfall traps

Several methods have been proposed as standards for sampling and monitoring amphibians. The use of drift fences with bucket pitfall traps has been the commonest technique for studies of individual species or herpetofaunal communities and has been used with success for amphibians (Mitchell *et al*., 1993; Heyer *et al*., 1994, Handley and Varn, 1994; Kok *et al*., 1997; Msuya, 2001). The results of studies employing drift fences with pitfall traps provide valuable insights into population and community ecology, and behavioural patterns of secretive and difficult to study species (Dodd, 1991). This method was used to determine relative abundance, sex ratio, habitat preference and movements of the anurans.

Drift fences with bucket pitfall traps were established in different habitat types. Each drift fence comprised 10, 20-litre plastic buckets placed at an interval of 10 m, covering a total length of 100 m (figure 5). The buckets were placed in holes dug in the substrate such that their rim was level with the ground. A 100-meter long and 0.5 m high drift fence of black polythene supported vertically by wooden laths was set in an alternating manner with the buckets in the line to permit detection of directional movement of anurans. The pitfall traps were inspected twice a day at 0600 and 1800 hours. The amphibians that entered traps were identified to species level. For each sampling period, drift fences with bucket pitfall traps were left open for 10 consecutive days before being removed.

Visual Encounter Surveys

Visual Encounter Surveys (VES) are a time-honoured technique. VES is similar to the Timed Constrained Count (TCC) method described by Heyer *et al*., (1994). Formalised by Campbell and Christman (1982) and Corn and Bury (1989), visual encounter surveys are used to document presence of amphibians and are effective in most habitats and for most species that tend to breed in lentic habitats. This method is similar to Timed Species Count (TSC) method (Heyer et al, 1994) used in the study of birds (Kasoma and Pomeroy, 1996) and generates encounter rates of species in their habitats. It involves moving through a habitat, turning logs or stones, inspecting retreats and watching out for surface-active species. Boundaries are not usually specific except that the collections remain inside the specific habitats and replicates assume standard time limits. In this case the time length used was one hour. The data gathered using this procedure provides information on species richness of the habitat.

Opportunistic Recordings

Opportunistic recording were used to maximize the number of species encountered in the study area. This method involves recording any reptilian or amphibian species brought in by the local people or encountered anywhere and at any time in the study area. This method is especially useful in inventorying the reptilian fauna.

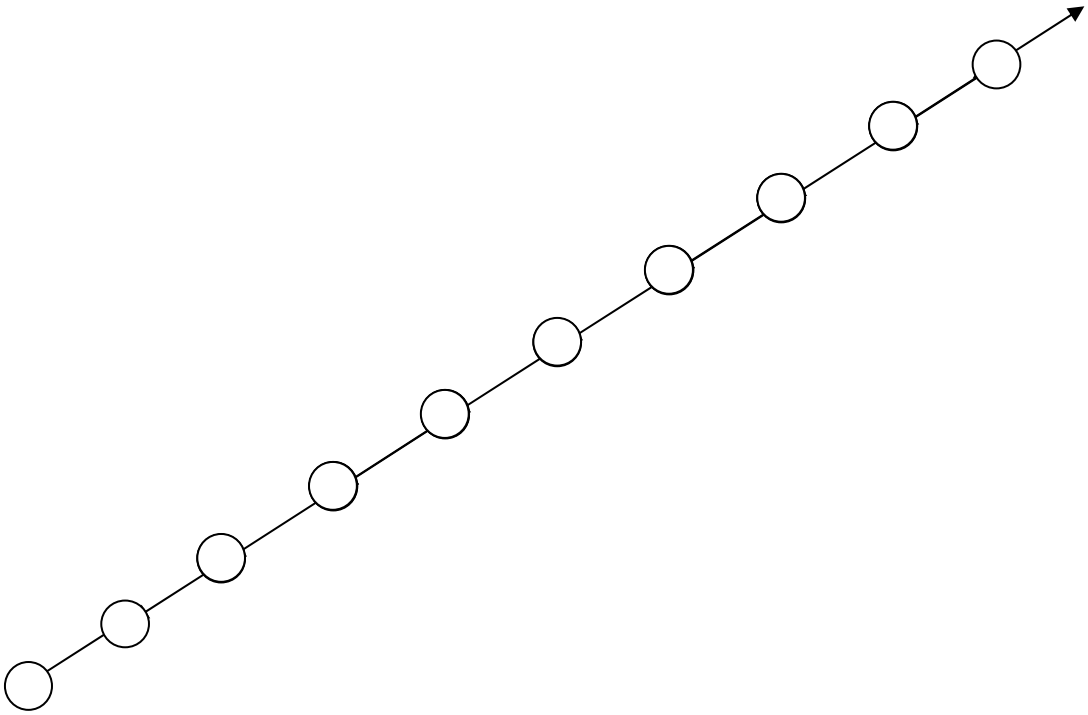

Figure 5. Graphic display of arrangement of bucket pitfall traps with drift fence.

Arrows indicate direction of drift fence made out of black polyethene; circles represent bucket pitfalls; inter bucket distance = 10 metres.

Identification

Amphibian and reptilian fauna were identified in the field to specific levels by morphology while amphibians were also identified by their calls. Morphological characters were compared with descriptions in the literature by Channing and Howell (2006), Schiøtz, (1999) Spawls *et al*., (2002) and Pitman (1974). Voucher specimens of species whose identification could not be ascertained were taken and preserved using humane methods. Photographs of live specimens were also taken to assist in the identification process in future, this is because herpetofauna tend to shrink and lose colour when preserved.

Bird Surveys

Points were established in a stratified random manner (Buckland et al. 2004) across the KKGMA(fig. 6). Additional points were located on the aerial photo maps in rare habitat types to ensure good sampling of these areas. An example is the riverine vegetation along the River Hohwa.

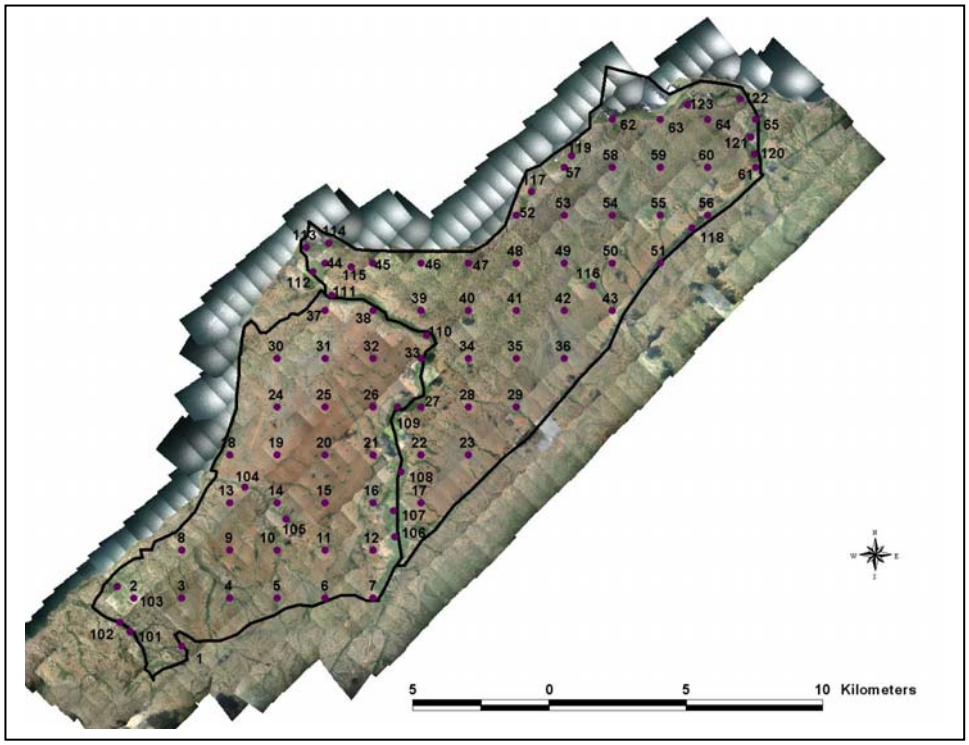

Figure 6. Map of The KKGMA with the location of points used to sample for bird and plant species.

At each point birds were recorded during 5 minute point counts by two experienced ornithologists who know most bird calls in Uganda. A total list of birds was also recorded for both protected areas by recording any observations or calls identified during the team's time at the site. In this way nocturnal species were recorded as being present even if no quantitative data were obtained.

A total of 37 point counts were made in Kabwoya WR and 49 in Kaiso-Tonya CWA, totaling 86 point counts for both areas.

Plant surveys

At each point used for the bird counts a nested circular plot was measured with all herbs identified within a radius of two metres, all lianas, woody shrubs and trees less than 10cm DBH but greater than 2.5 cm DBH within a radius of 10 metres and all trees greater than 10 cm DBH within a radius of 20 metres. Plant specimens were collected and dried for all species identified to confirm IDs and also to make identifications of unknown species. These identifications were made at the Makerere University Herbarium by Ben Kirunda.

A total of 37 point were measured in Kabwoya WR and 47 in Kaiso-Tonya CWA, totaling 84 plots for both areas.

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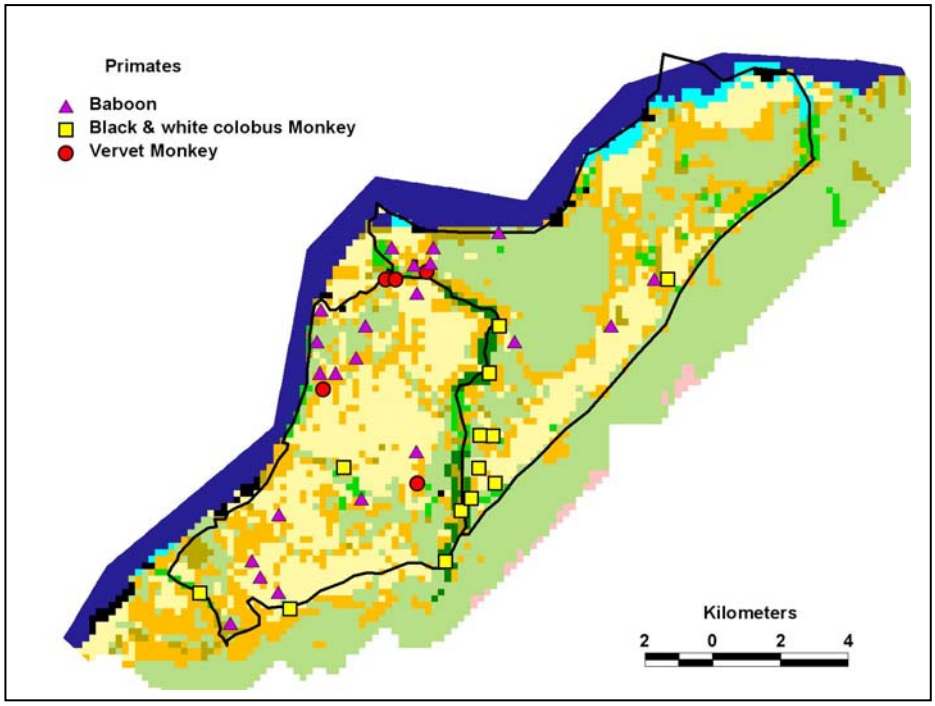
RESULTS

Large mammals

Sightings of large mammals were reasonable from the transect surveys (fig. 7a&b) and it was possible to calculate densities for seven species that were reasonably abundant.

Primates



Larger antelopes and pig sightings

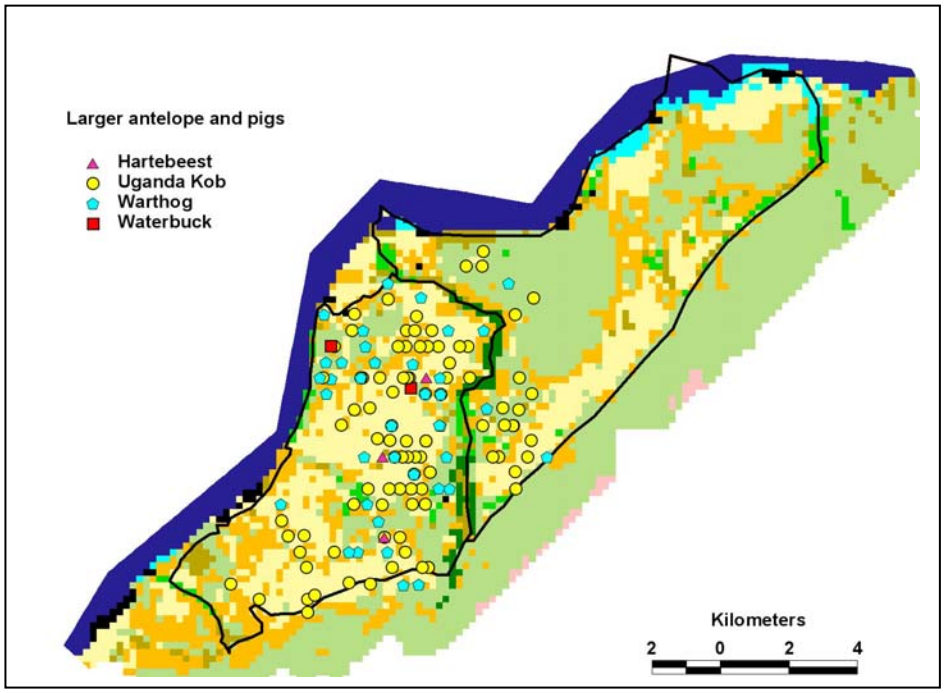


Figure 7a. Locations of sightings of primates (top) and large antelope and pig species (bottom) along the transects.

Small antelopes

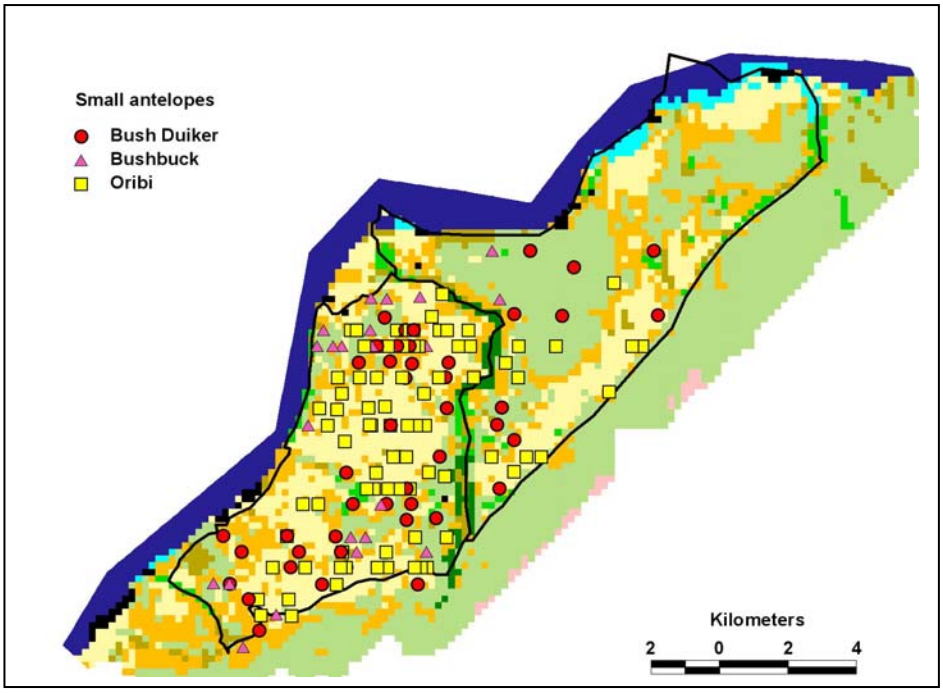


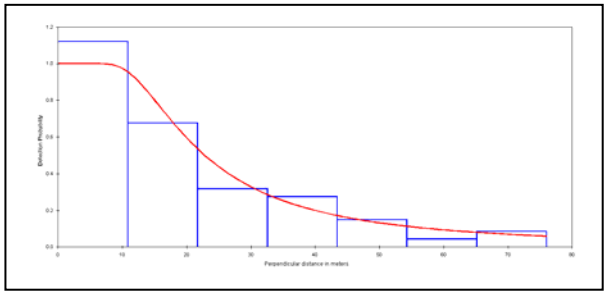
Figure 7b. Locations of sightings of small antelope species (bottom) along the transects.

Densities were calculated for seven species using the DISTANCE software. These were multiplied by the area of the reserve for Kabwoya to estimate the total population in the reserve. The numbers were compared with the counts from the parallel transects which were assuming they were making a total count (if observers were spotting all animals within 100 metres of the transect). The results show that the total counts are smaller than the estimates from density calculations (Table 3). Examination of perpendicular distance data for the species (fig. 8) show that there was a drop off in visibility for all species before 100 metres were reached, many start to drop by 10-30 metres, indicating that total counts in future will need more closely spaced transects.

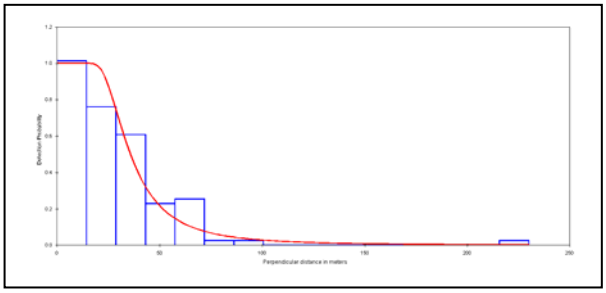
Table 3. The estimated density of different species, their total number in Kabwoya and Kaiso Tonya from these density estimates and the total number observed from the transects (total count). Total counts are given for waterbuck and Jackson's Hartebeest but the number of observations were too few to calculate a density in DISTANCE.

	Kabwoya			Kaiso-Tonya			Total numbers	
	Density	Density x area	Total count	Density	Density x area	Total count	Sum density x area	Sum Total Count
Olive Baboon	12.3	1,070	765	7.7	824	287	1,894	1,052
Guereza	1.3	113	50	1.5	161	61	274	111
Bush Duiker	4.5	392	118	2.5	268	39	659	157
Bushbuck	2.9	252	110	1	107	24	359	134
Oribi	9.8	853	547	3.4	364	115	1,216	662
Uganda Kob	41.2	3,584	3,416	10.5	1,124	459	4,708	3,875
Warthog	8.9	774	514	0.7	75	20	849	534
Waterbuck			34			0		34
Hartebeest			24			0		24

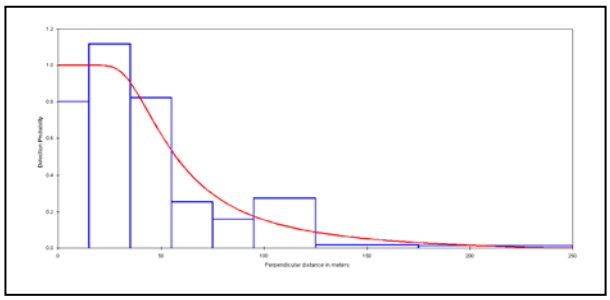
It should be noted that transects did not cover all of Kaiso-Tonya (fig. 2) but the estimates for the reserve have multiplied the density by the reserve size assuming similar densities outside the area surveyed. The total count is also only for the area surveyed.



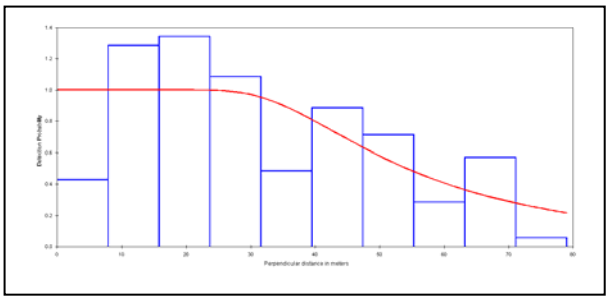
Bush duiker



Bushbuck



Uganda Kob



Oribi

Figure 8. Perpendicular distance plots for four ungulate species. All curves fall before 50 metres and the probability of detection at 100 metres is only about 10-20%.

In addition to the 10 species mapped in figures 7a and 7b a species of jackal, rabbit and squirrel were observed but not identified to species. Giant Forest Hog and buffalo were also observed in the reserve but not while on the transects. Therefore there were 15 large and medium mammal species observed by these teams.

Small mammals

Rodents and shrews

A total trapping effort of 852 trap-nights were used to capture a total of 30 individuals. This gave a very low trap success of 3.5% and resulted in the capture of 9 species of small mammals (3 insectivores and 6 rodents (Table 4)) altogether from the different locations.

Table 4. Species of rodents and shrews recorded for KKGMA

Order	Family	Species	No. per station / pitfall										
			St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	PF A	PF B	PF C	Total secimens collected per site
Insectivore	*Soricidae*	*Crocidura turba*	1										1
		Crocidura olivieri					1						1
		Crocidura jacksonii								1		1	2
Rodentia	*Muridae*	*Mus minutoides*					15		2	1			18
		Grammomys dolichurus							1				1
		Lemniscomys striatus			1			2					3
		Lophuromys sikapusi			1	1							2
		Mastomys hildebrandtii					2						2
		Dendromus mystacalis									1	1	2

The species recorded are species that are fairly common and widespread throughout the country. No species have been identified to be restricted to this part of the country so far. *Mus minutoides* was the most abundant species found in two of the stations surveyed and in one pitfall trap. Most individuals were collected at station 5 (open grassland). *Lemniscomys striatus* was the second most abundant species collected and was collected at stations 3 and 6. *Grammomys dolichurus* was the most scarce rodent as only one individual was collected.

The shrews were generally scarce with only *Crocidura jacksonii* collected from two pitfall traps while *Crocidura turba* and *Crocidura olivieri* were collected singly from stations 1 and 5 respectively.

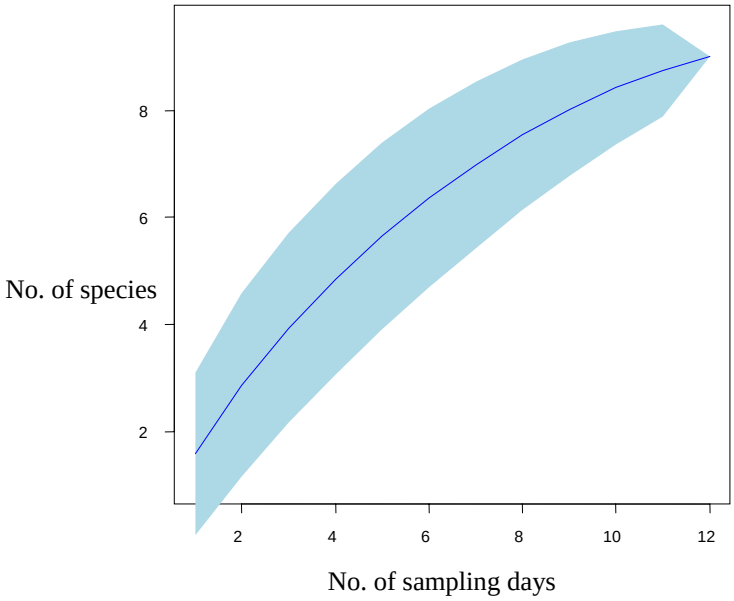


Figure 9. Cumulative species curve for rodents and shrews recorded in the Kabwoya area.

Figure 9 shows a growing species accumulation curve and an indication that with the amount of sampling effort we used a plateau was not attained. Hence several more species could have been recorded in the area. This observation would suggest that the surveys may not have been exhaustive enough. The fact that the sampling was made in a dry season where the ground cover was mostly sparse and/or dry and the low absolute number for individuals for each species captured suggests that the species densities might have been lower at the time of sampling and hence the low number of species recorded.

Bats

A total netting effort of 103 net-nights were used to capture a total of 40 individuals. This gave a trap success of 39% and resulted in the capture of 10 Species of bats altogether from the different locations

Table 5 lists 10 species of bats that were recorded in KKGMA. They include two megachiropteran bat species (*E. labiatus* and *M. pusillus*) and eight microchiropteran bats belonging to 5 families. All the species of bats that were recorded are widely occurring in other parts of Uganda.

Epomorphorus labiatus was the most abundant species and was found at four of the five net lines set up, with it absent at Net line 4. *Lavia frons* was the next most abundant collected from stations 3, 4 and 5. Family Molosidae was represented by only one species while the other families of bats were represented by more species.

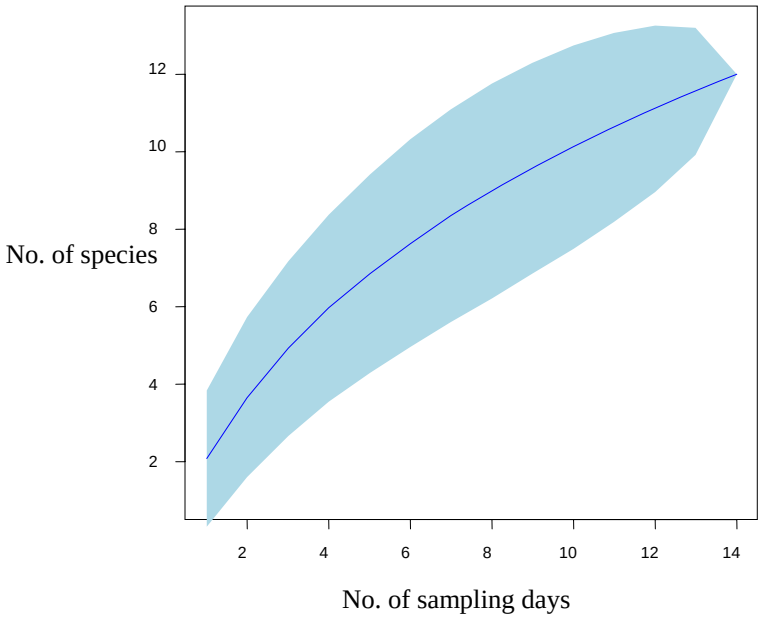


Figure 10. Cumulative Species number of bats

Table 5. Bat species recorded in KKGMA

Order	Family	Species	No. of specimens collected per Netline					
			NtL. 1	NtL. 2	NtL. 3	NtL. 4	NtL. 5	Total secimens collected per site
Microchiroptera	Molossidae	*Chaerephom pumilus*		2			4	6
	Megadermatidae	*Lavia frons*			2	3	1	6
		Hipposideros ruber				4	1	5
	Nycteridae	*Nycteris hispida*	1		3			4
		Nycteris thebaica	1					1
	Vespertilionidae	*Scotoechus hirundo*						
		Pipistrellus nanus					1	1
		Pipistrellus rueppellii					1	1
Megachiroptera	Pteropodidae	*Epomorphorus labiatus*	5	1	1			7
		Micropteropus pusillus						31

As found for the rodents and shrews (fig 9), the number of bats species increased with the increase in sampling days (fig. 10). The graph doesn't level off which suggests that there are likely to be more bat species that were not recorded by these surveys.

Conclusion

These surveys were conducted in a dry season which might have had an effect on the relative abundance of most species of small mammals. The catch rates were quite low for all species of rodents and shrews, an indication of a probably low relative abundances of species. Both figures 7 & 8 showed the cumulative number of species did not exhaust all possible species that may occur in the area.

All species of mammals recorded are of species that are fairly common and quite wide spread. None is particular conservation concern as all are considered of least concern by IUCN (2009), although it adds a note that population trends are unknown for each of these species. A total of 15 large and medium sized mammal and 19 small mammal species were recorded on these surveys. The total list of mammals recorded for the two protected areas is therefore 31 but would increase with more focus on the small and medium sized mammals such as squirrels, rats, shrews and bats.

Amphibians and reptiles

A total of 14 amphibian species belonging to four families, six genera and from 532 specimens were recorded using the VES and Pitfall trapping methods during the 10 days of sampling. When opportunistic records were added, the number of amphibian species increased to 18 (Table 6). Nine reptilian species belonging to four families, 7 genera and from 20 specimens also were recorded using the VES and Pitfall trapping methods during the 10 days of sampling and the total number increased to 20 with opportunistic records (Table 7).

Table 6. Amphibian fauna of Kabwoya-Kaiso Tonya WR (1=presence-0=absence)

Family	**Species**	**Common name**	**Red List Category & Criteria:**
Bufonidae	*Amietophrynus gutturalis* (Power, 1927)	African Common Toad	Least Concern
	Amietophrynus maculatus (Hallowell, 1854)	Flat-backed Toad	Least Concern
	Amietophrynus regularis (Reuss, 1833)	African Common Toad	Least Concern
Hyperoliidae	*Hyperolius kivuensis (*Ahl, 1931)	Kivu Reed Frog	Least Concern
	*Leptopelis kivuensis (*Ahl, 1929)	Kivu Tree Frog	Near Threatened
	Kassina senegalensis (Dumeril & Bibron, 1841)	Burbling Kassina	Least Concern
Hemisidae	*Hemisus guineensis marmoratus* (Cope, 1865)	Guinea Snout-burrower	Least Concern
Ranidae	*Hoplobatrachus occipitalis* (Gunther, 1858)	Crowned Bullfrog	Least Concern
	Phrynobatrachus dendrobates (Boulenger, 1919)	Disk-toed Puddle Frog	Least Concern
	Phrynobatrachus acridoides (Cope, 1867)	Eastern Puddle Frog	Least Concern
	Phrynobatrachus mababiensis (FitzSimons, 1932)	Mababe Puddle Frog	
	Phrynobatrachus minutes		
	Phrynobatrachus sp1		
	Phrynobatrachus natalensis (Smith, 1849)	Natal Dwarf Puddle Frog	Least Concern
	Ptychadena anchietae (Bocage, 1867)	Anchieta's Ridged Frog	LC
	Ptychadena- mascareniensis (Dumeril & Bibron, 1841)	Mascarene Grass Frog	LC
	Ptychadena oxyrhynchus (Smith, 1849)	Sharp-nosed Ridged Frog	LC
	Ptychadena porosissima (Steindachner, 1867)	Grassland Ridged Frog	LC

Table 7. Reptilian fauna of Kabwoya-Kaiso Tonya WR (1=presence-0=absence). None are classified by IUCN as threatened.

Family	Species	Common name
Geckonidae	*Hemidactylus brookii*	Brook's House Gecko
	Lygodactylus picturatus	Chevrotain-throated gecko
	Mabuya maculilabris	Speckle-lipped Skink
Scincidae	*Mabuya quinquetaeniata*	Five-lined Skink
	Leptosiaphos kilimensis	Kilimanjaro Five-toed Skink
	Lygsoma sundevalli	Sundeval's Writhing Skink
Agamidae	*Agama agama*	Orange-headed Agama
Testudinidae	*Pelusios williamsi*	Williams' Hinged Terrapin
Chamaelionidae	*Chamaeleo gracilis*	Gracile chamaeleon
Gherrosauridae	*Gerrhosausrus major*	Great Plated Lizard
Varanidae	*Varanus exanthematicus*	Western Savanna Monitor lizard
Sertpentes	*Naja melanoleuca*	Water Cobra
	Hapsidophrys smaragdina	Yellow bellied Snake
	Python sebae	Rock python
	Aparallactus jacksoni	Jackson's Centiped-eater
	Aparallactus lunulatus	Plumbeous Centipede-eater
	Apparallactus modestus	Western Forest Centipede-eater
	Leptotyphlops scutifrons	Peter's Worm Snake
	Psammophis sudanensis	Northern Stripe-bellied Sand Snake
	Typhlops punctatus	Spotted Blind Snake

Amphibian and reptile richness and diversity

Species added by opportunistic records included: *Hyperolius kivuensis, Leptopelis kivuensis, Phrynobatrachus acridoides* and *Phrynobatrhachus* sp for amphibians and *Lygodactylus picturatus, Mabuya quinquetaeniata, Agama agama, Pelusios williamsi, Chamaeleo gracilis, Varanus exanthematicus, Naja melanoleuca, Hapsidophrys smaragdina, Python sebae, Aparallactus lunulatus* and *Psammophis sudanensis* for reptiles. The genera *Hyperolius* and *Leptopelis* were not trapped using the Pitfalls traps. Four families (Agamidae, Testudinidae, Chamaeleonidae and Varanidae) and 9 genera (*Lygodactylus, Agama, Pelusios, Chamaeleo, Varanus, Naja, Hapsidophrys, Python* and *Psammophis*) were recorded using opportunistic methods.

The most commonly recorded amphibians were *Phrynobatrachus mababiensis* (292 individuals) (Fig. 11) followed by *Phrynobatrachus minutus* (124) and *Hemisus marmoratus* (42). The least encountered species were *Ptychadena porosissima, Hoplobatrachus occipitalis, Kassina senegalensis* and *Amietophrynus maculatus* whereby only one specimen was recorded for each species. Sites 4 had more amphibian specimens and species recorded than sites 1 and 2.

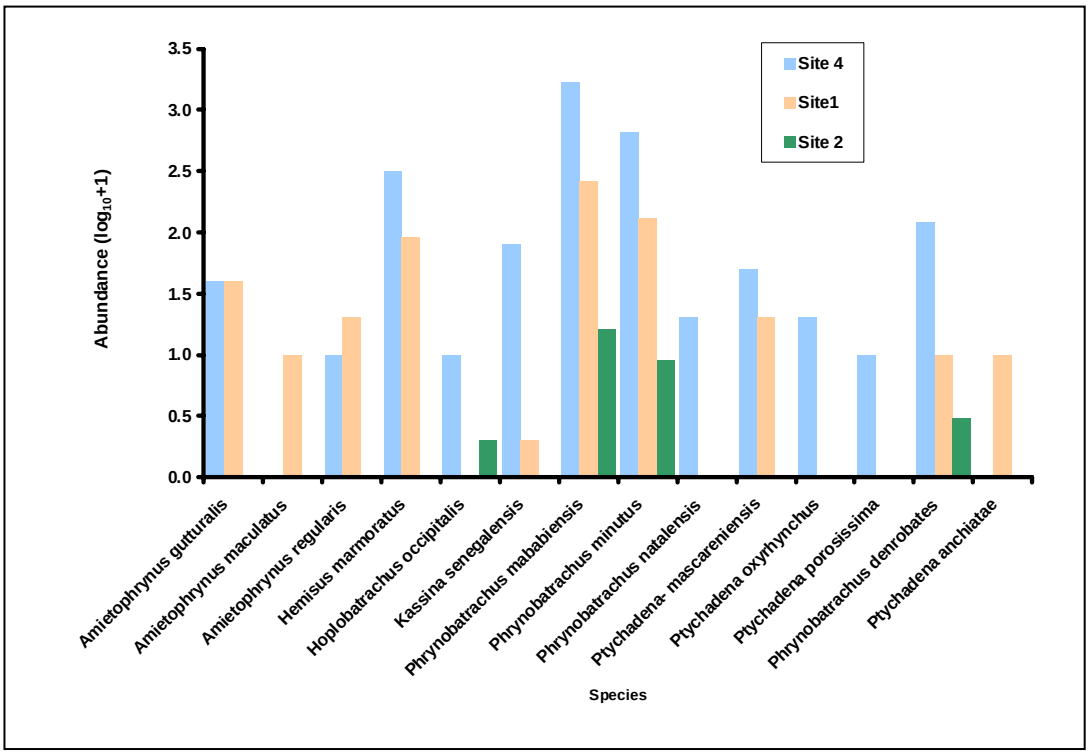


Figure 11. The abundance of the more common amphibian species at the three sites surveyed.

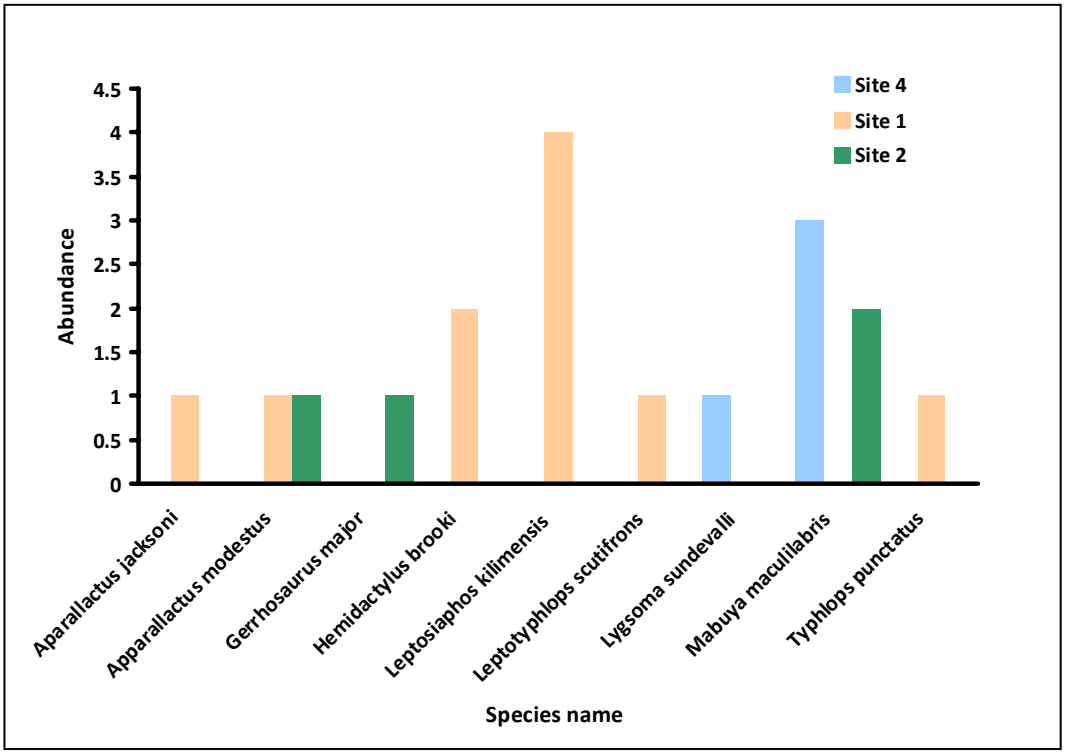


Figure 12. Numbers of reptile species at each site.

Leptosiaphos kilimensis had the highest abundance of any reptile and was recorded only in site 1 and this contributed to site 1 having the highest total number of individuals recorded. *Mabuya maculilabris* in site 4 was the second most abundant species (fig. 12). *Apparallactus modestus* was the only reptile that showed overlap in two sites (1 and 2) whiles the rest of the species

showed no species overlap. Site 1 showed the highest species richness and abundance while diversity for sites 4 and 2 was the same but the abundance was higher in 4.

Two reptile species namely *Aparallactus jacksoni* and *Typhlops punctatus* were only recorded using pitfall trapping while 11 (namely: *Lygodactylus picturatus, Mabuya quinquetaeniata, Agama agama, Pelusios williamsi, Chamaeleo gracilis, Varanus exanthematicus, Naja melanoleuca, Hapsidophrys smaragdina, Python sebae, Aparallactus lunulatus* and *Psammophis sudanensis*) were encountered outside sampling time using opportunistic methods.

Discussion and Conclusions

The 18 amphibian and 20 reptilian species recorded for the WR are only fractions of the total diversity. Behangana et al. (2003a &2003b) recorded a total of 119 amphibian and 175 reptilian species for the whole of the Albertine Rift. This study was important in that it documented for the first time the amphibian and reptilian fauna of Kaiso-Tonya Kabwoya WR. The study was equally important because it added new species to the checklist of the reptilian fauna to this section of the Albertine Rift: specifically *Aparallactus jacksoni, Apparallactus modestus, Gerrhosaurus major, Hemidactylus brooki, Leptosiaphos kilimensis, Leptotyphlops scutifrons* and *Lygsoma sundevalli*. This underlies the importance of using several methods when studying the herpetofauna of an area so as to come up with as complete as possible a checklist of an area. The ten days of data collection were however not sufficient enough to document all the herpetofauna of the WR. This would need more sites for placement of pitfall traps with drift fences, sampling in a rainy season as well as sampling before the reserve is burnt.

Plate 5. *Lygsoma sundevalli*

Plate 6. *Python sebae*

Plate 7. *Hemidactylus brooki*

Plate 8.*Phrynobatrachus mababiensis*

Plate 9. *Agama agama* female

Plate 10. *Mabuya maculilabris*

Birds

A total of 176 bird species were recorded in the KKGMA area during these surveys; 106 species in Kabwoya WR, and 138 species in Kaiso-Tonya CWA with an additional 11 species recorded away from the points in the region. Data from point counts were used to calculate rarefaction curves for the three sites (figure 13). These show some leveling off but indicate that with more time and effort more species would be found. The bird community composition is very different at the two sites with only a 58% similarity in species composition. Plotting species richness found at each point count shows that species richness tends to be higher in Kaiso-Tonya CWA (figure 14).

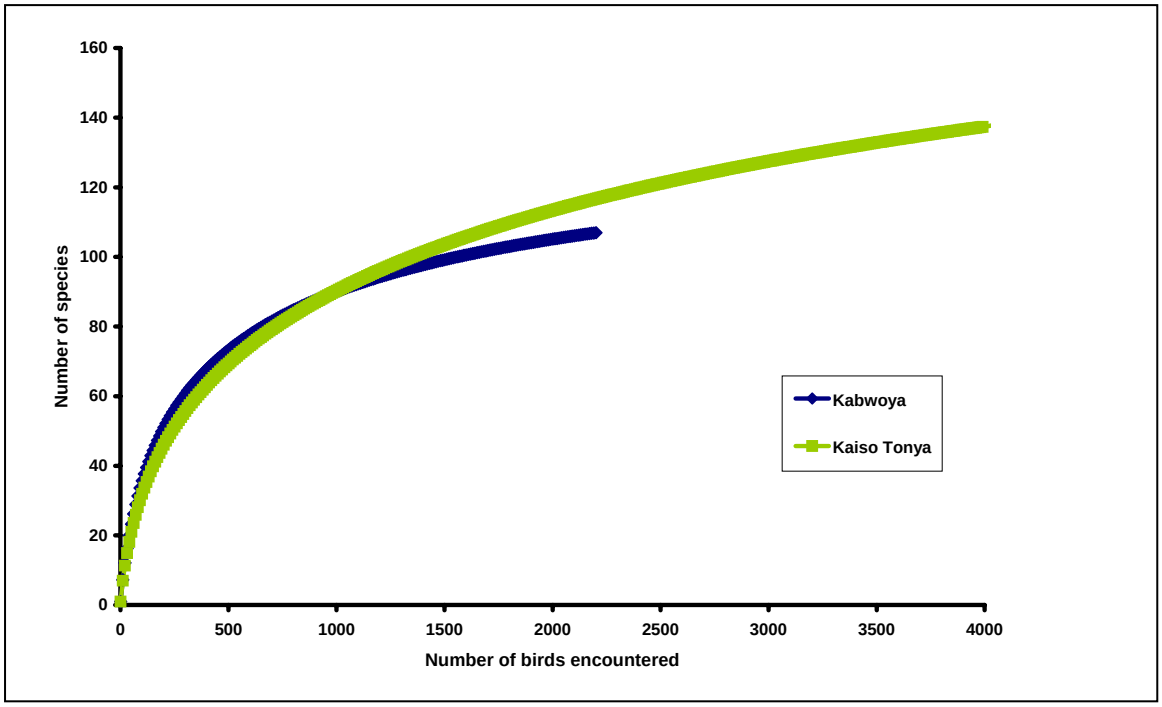


Figure 13. Rarefaction curves for the three sites plotted against the number of birds observed. Data from point counts.

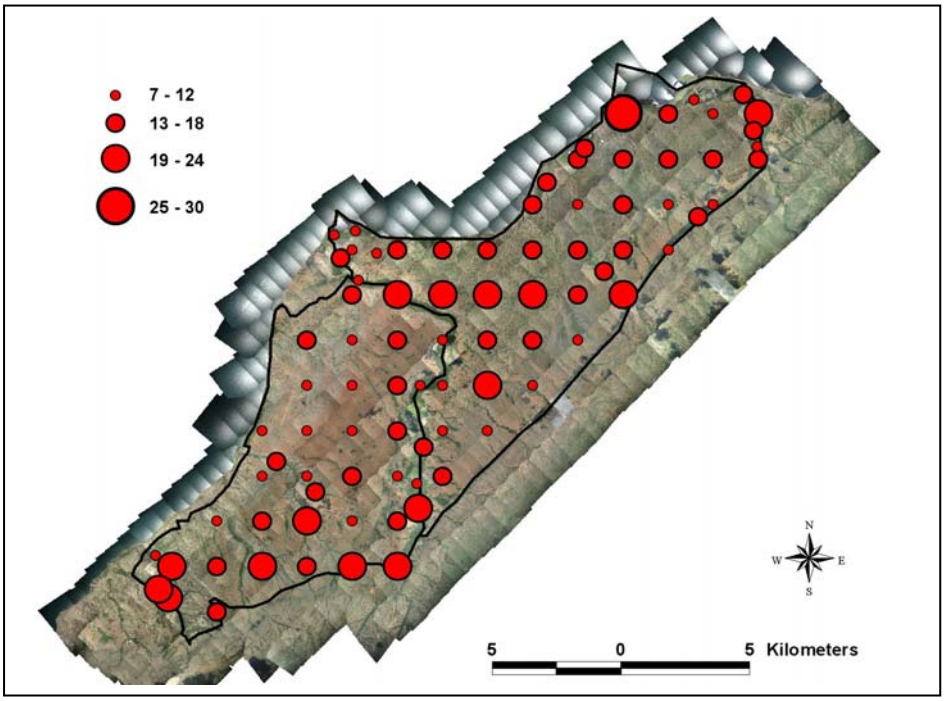


Figure 14. Relative species richness at each point surveyed in the two protected areas.

Bird diversity was calculated using the Shannon-Wiener Index and the alpha index and shows that Kabwoya is more diverse when calculated with the Shannon-Wiener index (which weights rarer species) but is less diverse using the alpha index (table 8).

Table 8. Shannon Wiener diversity and evenness and the Alpha diversity index calculated for the two sites.

Index	Kabwoya	Kaiso-Tonya
Shannon H' Log Base 10.	1.355	1.298
Shannon Hmax Log Base 10.	2.029	2.14
Shannon J'	0.668	0.606
Alpha	23.52	27.576

Of particular interest were the numbers of migrant species that were observed in this region. Large numbers of barn swallows, plain martins, sand martins, banded martins and yellow wagtails were observed here and it appears the site is an important stop-over point for these migratory species. Kabwoya WR and Kaiso-Tonya CWA should therefore receive more attention and should be managed for the migratory species as well as the species that are present all year round.

Plant species

A total of 167 plant species were identified as separate species for both sites combined with 113 species in Kabwoya WR and 137 species in Kaiso-Tonya CWA. There is no prior listing of plant species for this region that is published so that these numbers cannot be compared with previous lists.

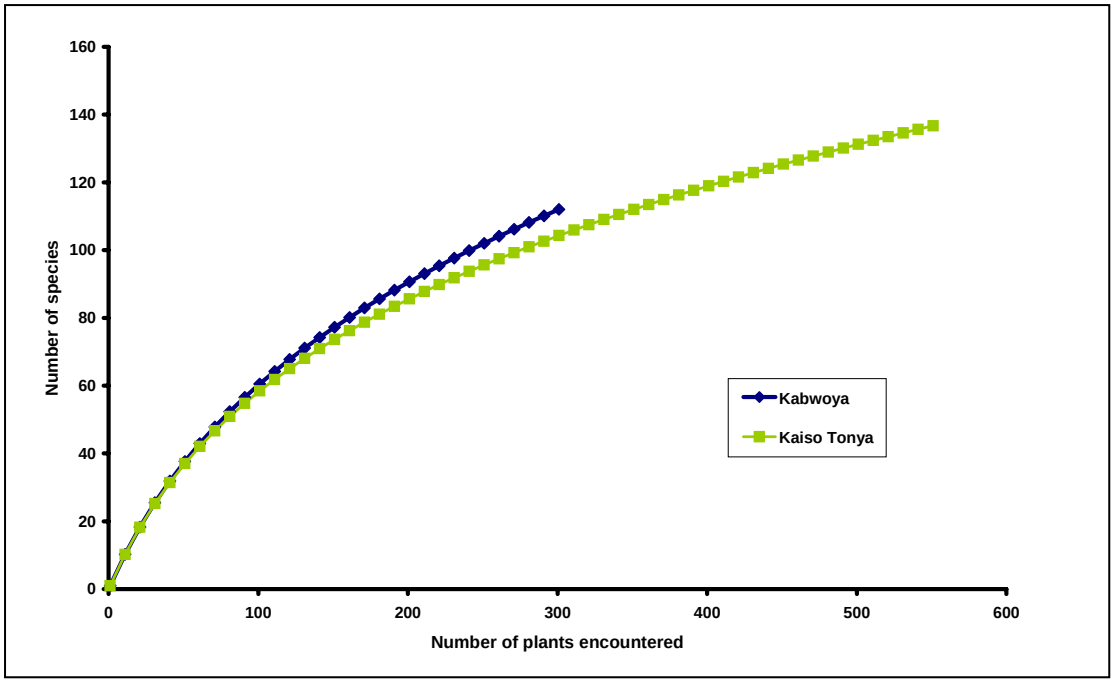


Figure 15. Rarefaction curves for plant species. Data from plots.

The rarefaction curves in figure 15 show that the relative species richness of plants at both sites are similar as the curves follow similar trajectories. However, the species composition is quite different with only a 52% overlap in species composition between Kabwoya WR and Kaiso-Tonya CWA.

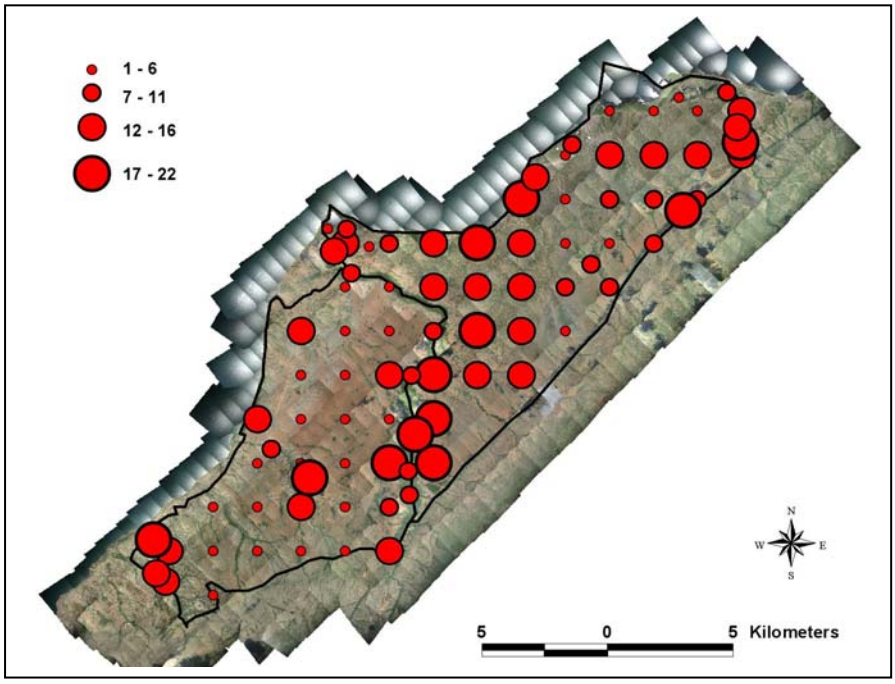


Figure 16. Plant species richness at each of the plots in the two protected areas.

Plant species richness tended to be higher in plots in Kaiso-Tonya CWA than in Kabwoya WR (fig. 16). This may be an effect of partial grazing by cattle as well as wildlife.

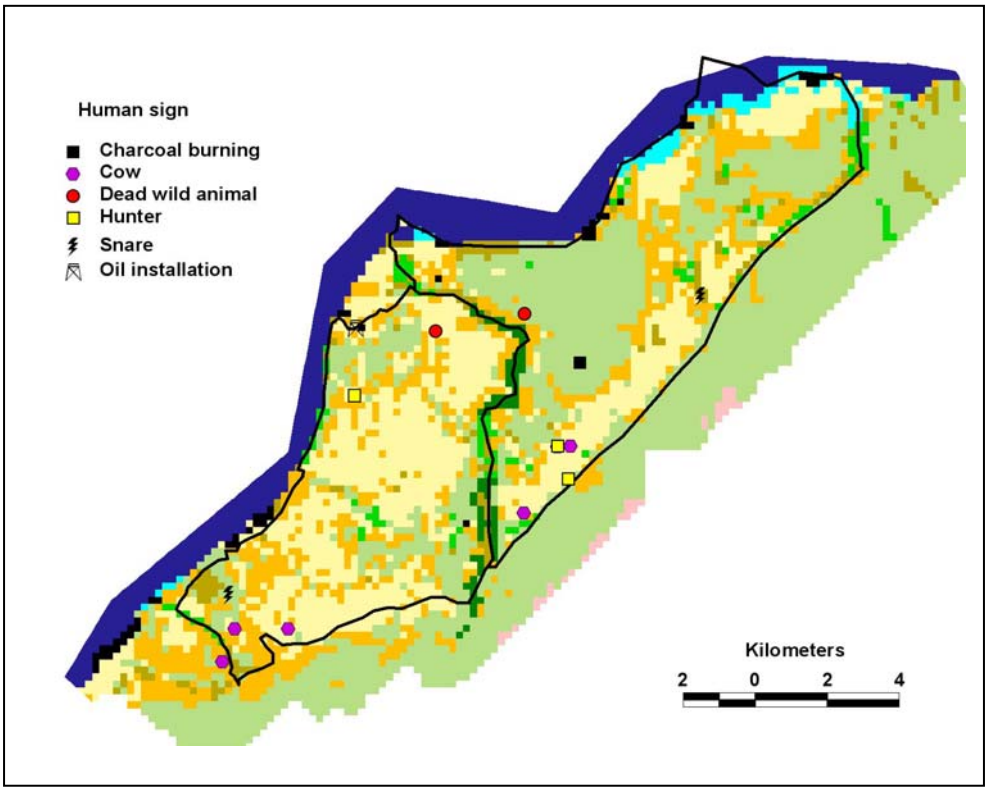
Plant species diversity indexes were also calculated as for the bird community: Shannon-Wiener and Alpha diversity (table 9). These also show that the diversity of the sites were similar but that the Shannon-Wiener index ranked Kaiso-Tonya CWA as slightly higher while the alpha diversity index ranked it as slightly lower. Rarer species are weighted in the Shannon-Wiener index.

Table 9. Diversity of the plant community at each site.

Index	Kabwoya	Kaiso Tonya
Shannon H' Log Base 10.	1.889	1.92
Shannon Hmax Log Base 10.	2.053	2.137
Shannon J'	0.92	0.898
Alpha	64.749	58.218

Human Impacts

Signs of human activity were recorded along the transects by the team looking for large mammal signs. These included sightings of cattle, charcoal burning, people in the park, snares and dead animals. In general signs of human activity were very limited (figure 17).



Fgure 17. Locations of signs of human impact along transects.

Cattle herded by pastoralists in the Kaiso-Tonya CWA were also noted and a few were seen in Kabwoya WR where they are not allowed to range.

CONSERVATION IMPLICATIONS

Large and medium-sized mammal numbers

A total of 14 large and medium sized mammal species (including a giant forest hog, jackal, rabbit and unidentified squirrel species). Comparisons with previous ground censuses of large mammals show that numbers of many species have been increasing in Kabwoya Wildlife Reserve and Kaiso-Tonya CWA since 1995 (table 10). Uganda Kob in particular have recovered very well from a very small population estimated in 1995. Counts of other species have remained fairly stable since the 2006 ground count. It is interesting to note that ground counts estimate much larger numbers of the smaller antelopes such as oribi, bush duiker and bushbucks than the aerial counts. It is probably worth repeating ground counts at this site in future and dropping the aerial counts.

The large mammal survey data were analysed differently in this survey to the analyses made in the 2006 ground count survey. Here we used perpendicular distance data to estimate animal densities. In the 2006 survey the data were analysed as a total count but the report noted that there was a marked drop off in visibility of animals beyond 50 metres and that observers walking transect lines at 200 intervals probably omitted to see some individuals. As we repeated the same transects in this survey we decided to analyse the perpendicular distance data. The data presented in figure 6 which shows that only 10-20% of observations were being made at 100 metres distance indicates that this was valid.

Table 10. Estimates of large and medium mammal numbers from aerial and ground counts undertaken in the past 15 years.

	1982 Aerial a.	1995 Aerial b.	2006 Ground * c.	2007 Aerial d.		2009 Ground * e.	
		Total	Total	Kabwoya	Total	Kabwoya	Total
Uganda Kob	92	20	2,729	1,994	2,184	3,416	3,875
Oribi		0	838	9	11	547	662
Jackson's Hartebeest		0	0	0	0	24	24
Buffalo	10	0	27	28	28	0	0
Waterbuck		0	2	0	0	34	34
Warthog		0	529	94	109	514	534
Bushbuck	16	0	198	5	6	110	134
Bush duiker	163	0	194	0	0	118	157
Olive Baboon		0	798	59	125	765	1,052
Colobus guereza		0	140	0	0	50	111

* - not all of Kaiso-Tonya was covered in the ground surveys
a. Eltringham and Malpas (1993); b. Lamprey, Buhanga and Omoding (2003); c. Lamprey and Rwetsiba (2007); d. Wanyama, Tibesigwa and Kagoda (2007); e. This survey.

Biodiversity of Kabwoya and Kaiso-Tonya

In addition to the 15 large and medium sized mammal species, 176 bird species, 19 small mammal species, 18 amphibians, 20 reptiles and 167 plant species were recorded for Kabwoya and Kaiso-Tonya. Species richness of birds and plants were lower in Kabwoya than in Kaiso-Tonya, partly because of fewer sampling points in Kabwoya. Rarefaction curves show that the species richness was fairly similar although the curve for Kaiso-Tonya shows it may be richer for bird species.

We are aware that there is a bird list for Kabwoya WR that has been compiled by the Albertine Rift Safari's lodge in this reserve which numbers over 400 species. This list need to be looked at by ornithologists to be approved but it is clear in the short time that we spent in this region that there are

likely to be many more species to be found. Our data show though that this region is very important for migratory bird species which probably use it as a watering and feeding point on their migrations along the Albertine Rift.

Several studies on herpetofauna of the Albertine Rift have been carried out in recent times. The most current include Behangana (2009) on amphibian fauna of the Albertine Rift, Aguti (2008), Behangana (2003a, 2003b) on reptiles and amphibians respectively, Vonesh (1998) on amphibians and reptiles of Kibale National Park, Drewes and Vindum (1994) and Drewes *et al*. (1992) on amphibians and reptiles of Bwindi Impenetrable National Park and adjacent areas, Kaija-Baguma (1996) and Hutton (1991) handled some aspects of crocodiles in Murchison Falls National Park, while Stubblefield (1997), Sivell *et al*. (1997) and Allan (1997) collected some data on amphibians and reptiles during the Biological Surveys of Semliki and Bugungu WR respectively. The works of Spawls *et al*. (2002) Spawls *et al*. (2006) and Channing and Howell (2006) provide us with habitat and distribution of reptilian and amphibian fauna of East Africa, including those that range into the Albertine Rift based on available species distribution data. Pitman (1974) had earlier on documented snakes fauna of Uganda and his works cover their distribution in the Albertine Rift while Schiøtz (1999) focussed on amphibian fauna that range into this area. From all the available literature, none of these studies have ever focused on KKGMA and this study was the first of its kind ever to document the species richness and distribution of amphibian and reptilian fauna of the area.

We are not aware of any prior surveys of small mammals or plants except for short visits to undertake Environmental Impact Asessments on the oil installations in this region.

Conservation of Kabwoya and Kaiso-Tonya

While not as diverse as some of the savanna parks in Uganda it is clear that Kabwoya WR and Kaiso-Tonya CWA are important for biodiversity conservation and it is likely that further survey work would find several more species. Unfortunately these surveys were made at a particularly dry time of the year and as a result species richness is likely to be lower than we would have found at a wetter time of year. It is also clear that increased protection of the area by upgrading part of the old controlled hunting area to form Kabwoya Wildlife Reserve has led to major increases in the large mammal populations compared with surveys in 1995 (Lamprey, Buhanga and Omoding, 2003).

Large flocks of migratory birds, particularly Sand Martins (*Riparia riparia*), banded martin (*Riparia cincta*), Plain martin (*Riparia paludicola*), Abdim's Stork (*Cinconia abdimii*) and Yellow Wagtail (*Motacilla flava*) occurred in large numbers in the area at this time of year (late February to mid March). The ornithologist who led the bird survey work (H. Mugabe) has surveyed or visited many protected areas in Uganda including all the large savanna parks and he had never seen such large numbers of migratory bird species anywhere else in Uganda. It is clear therefore that these two protected areas should be conserved for this value.

The oil explorations in Kabwoya and Kaiso-Tonya will undoubtably have impacts on this area. The oil companies are being asked to minimize their impacts on the environment and for the most part this is happening at individual well sites. However, the location of roads and camps has been determined without regard for the wildlife movement patterns within the park, and have tended to interrupt the access route to the wetland and lake for animal species, critical in a park with little other alternative water supply in the dry season. There is therefore a need to minimize road construction through improved planning of routes in the area and also to look carefully at the location of camps and storage yards, which tend to be long term and likely to attract further settlement and development activity and their impact on vegetation, soils and fauna can extend well beyond the site boundaries. These impacts may be easily mitigated through better site selection and planning. The recovery of test well sites is pretty good where the companies have rehabilitated the sites, although the practice of storing muds in

uncovered pits for extended periods is highly dangerous to biodiversity. Continued monitoring of the areas to ensure good practice is maintained and the environmental laws of Uganda are complied with is necessary to ensure this continues .

Cattle numbers in Kaiso-Tonya CWA need to be regulated so that their impacts on the habitat are not too destructive. There is a danger that with increased traffic of people to the area because of the oil explorations that numbers of cattle and other livestock species will increase dramatically to the detriment of the grazing land available. This in turn will lead to increased pressure for grazing within the Kabwoya WR. There is a need to work with the communities in Kaiso-Tonya to help them plan and manage their livestock as well as potentially benefiting from the income from the tourism, sport hunting and oil that is developing in their area. Other than these impacts the other signs of human impact that are commonly found in protected areas in Uganda were few (figure 13).

REFERENCES

Aguti, C. 2008. *Comparative study of amphibian diversity in Semliki and Rwenzori Mountains National Parks and Sango bay area in Uganda*. Unpubl. M.Sc. Thesis, Makerere University.

Allan C.L. 1997. *Biological survey of Bugungu Game Reserve, Uganda*. Frontier-Uganda Game Reserves Project Report No. 6. Society for Environmental Exploration, London and the Ministry of Tourism, Wildlife and Antiquities, Kampala.107 pp. ISSN 1369-0485. download pdf

Behangana, M. 2009. *The Diversity and Distribution of amphibian fauna in the Albertine Rift.* Unpubl. PhD Thesis, Makerere University.

Behangana, M., D. Meirte, A.J. Plumptre, K. Howell & H. Hinkel 2003a. Reptiles. In: Plumptre, A. J., Behangana, M., Davenport, T. R. B., Kahindo, C., Ndomba, E. R., Ssegawa, P., Eilu, G., Nkuutu, D. & I. Owiunji. The Biodiversity of the Albertine Rift. *Albertine Rift Technical Reports Series Number 3. Wildlife Conservation Society*.

Behangana, M., D. Meirte, A.J. Plumptre, K. Howell, S. Stuart & H. Hinkel 2003b. Amphibians. In: Plumptre, A. J., Behangana, M., Davenport, T. R. B., Kahindo, C., Ndomba, E. R., Ssegawa, P., Eilu, G., Nkuutu, D. & I. Owiunji. The Biodiversity of the Albertine Rift. *Albertine Rift Technical Reports Series Number 3. Wildlife Conservation Society*.

Buckland ST, Anderson DR, Burnham KP, Laake JL, Borchers DL, Thomas L (eds). 2004. *Advanced Distance Sampling.* Oxford: Oxford University Press.

Bury R.B. and Corn, P.S. 1987. Evaluation of pitfall trapping in northwestern forest: trap arrays with drift fences. *J. Wildl. Man.* 5: 112-119.

Campbell, H.W. and Christman, S.P. 1982. Field techniques for herpetofaunal community analysis. Pp. 193-200. In: N.J. Scott, Jr. (ed.), Herpetological Communities. U.S. Department of the Interior, Fish and Wildlife Service, *Wildlife Research Report* 13.

Channing, A. and Howell, K.M. 2006. *Amphibians of East Africa.* Edition Chimaira,

Corn, P.S., and Bury, R.P. 1989. Logging in western Oregon: responses of headwater habitats and stream amphibians. *Forest Ecology and Management* 29:39-57.

Dodd, C. K. Jr. 1991. Drift fence associated sampling bias of amphibians at a Florida Sandhills temporary pond. *Journal* of *Herpetology* 25: 296 – 301.

Drewes, R.C. & Vindum J.V. 1994. Amphibians of the impenetrable forest, south-west Uganda. *J. Afr. Zool*. 108 (1), 55–70.

Drewes, R.C., Vindum, J.V., and O'Brien, J.P. 1992. *Amphibians of the Impenetrable forest, Uganda.* Dept. Herp. CAS. Rept. San Francisco.

Eltringham, S. K., & Malpas, R. C. 1993. The conservation status of Uganda's game and forest reserves in 1982 and 1983. *African Journal of Ecology, 31*, 91-105.

Heyer, W.R., Donnely, M.A., Mc Diarmid, R.W., Hayek L.C., and Foster M.S. (Eds.). 1994. *Measuring and Monitoring Biological Diversity*: Standard Methods for Reptiles and Amphibians. Smithsonian Institution Press, Washington.

Hutton, J.M. 1991. *Crocodiles and their management in the Murchison Falls National Park of Uganda.* Agriconsulting/Uganda Institute of Ecology.

IUCN 2009. *IUCN Red List of Threatened Species. Version 2009.1.* <www.iucnredlist.org>. Downloaded on 13 October 2009.

Kaija-Baguma, R. 1996. *Some ecological aspects of the Nile Crocodile (Crocodylus niloticus Laurenti 1768) in the Murchison Falls National Park, Uganda*. Progress Report No.2/96 for an M.Sc. of Makerere University.

Kasoma, P. and Pomeroy, D. E. (Eds), 1996. *Biodiversity of the Sango Bay Area.* The GEF Regional Project Institutional Support for the Protection of the East African Biodiversity.

Kok, O.B., Du Preez L.H. and Kok, A.C. 1997. Anura diversity in pure grassland as determined by pitfall trapping. *Journal of African Zoology* 111: 437-440.

Lamprey, R. and Rwetsiba, A. 2007. *Report on a Large Animal Count of Kabwoya Wildlife Reserve, Hoima District*. Unpublished Report of USAID Prime West Project.

Lamprey, R., Buhanga E., and Omoding, J. 2003. *A study of Wildlife Distributions, Wildlife Management Systems and Options for Wildlife Based livelihoods in Uganda.* Unpublished report for IFPRI/USAID. 145pp.

Lamprey, R.H. & Michelmore, F. 1996. Surveys of Protected Areas, Phase I and Phase II. Ministry of Tourism, Wildlife and Antiquities, Kampala, Uganda

Langdale-Brown, I., Osmaston, H.A. and Wilson, J.G. 1964. *The Vegetation of Uganda, and its Bearing on Landuse.* Government Printer, Entebbe.

Mitchell, J. C., S. Y. Erdle and J. F. Pagels 1993. Evaluation of capture techniques for amphibians, reptiles, and small mammal communities in the saturated forested wetlands. *Wetlands* 13 Special issue 130-136.

Msuya, C.A. 2001. *Habitats, distribution and feeding of amphibians in Zaraninge Forest Reserve, Tanzania. A case study of the ecology of a community of amphibians in coastal forest ecosystem in Bagamoyo District, Tanzania.* Unpublished PhD Thesis. University of Dar es Salaam.

Olivier, R.C.D 1992. Aerial total counts in Uganda National Parks. Unpubl. Report to Uganda National Parks.

Pitman, C.R.S. 1974. *A guide to the snakes of Uganda. Revised Edition*. xxii + 290 pp. Codicote: Wheldon & Wesley. London

Plumptre, A.J., Davenport, T.R.B., Behangana, M., Kityo, R., Eilu, G., Ssegawa, P., Ewango, C., Meirte, D., Kahindo, C., Herremans, M., Peterhans, J.K., Pilgrim, J.D., Wilson, M., Languy, M. and Moyer, D (2006) The biodiversity of the Albertine Rift. *Biological Conservation* doi:10.1016/j.biocon.2006.08.021.

Schiøtz, A. 1999. *Tree frogs Africa.* Edition Chimaira, Frankfurt am Main.

Sivell D, Lee T and Allen C 1997. *Biological Survey of Semliki Wildlife Reserve. Frontier-Uganda Game Reserves* Project Report No. 8. Society for Environmental Exploration, London and the Ministry of Tourism, Wildlife and Antiquities, Kampala. 97 pp. ISSN 1369-0485.

Spawl, S.; Howell, K. and Drewes, C. 2006. Pocket Guide to the Reptiles and Amphibians of East Africa. A & C Black Publishers, London.

Spawl, S.; Howels, K.; Drewes, C. & Ashe, J. 2002. *A field guide to the reptiles of East Africa*. A & C Black Publishers, London and San Diego.

Stubblefield, L. 1997. *Biological Survey of Semliki (Toro) Game Reserve, Uganda. Frontier-Uganda Game Reserves* Project Technical Report No. 1. Society for Environmental Exploration, London and the Ministry of Tourism, Wildlife and Antiquities, Kampala. 101 pp.

Wanyama, F., Tibesigwa, J.J., and Kagoda, E. 2007. *Aerial Total Count of Medium-Large Mammals, Kabwoya Wildlife Reserve and Kaiso-Tonya Community Wildlife Area.* Unpublished Report, Uganda Wildlife Authority.

APPENDICES

Appendix 1. Bird species sighted or heard at each site from the point counts. At the end of the list are 11 species which were sighted outside the points but it wasn't noted in which protected area they were seen.

Species	Kabwoya	Kaiso Tonya
Abbysinian Ground Hornbill	1	
Abdim's Stork		1
African Black-headed Oriole	1	
African Fish Eagle	1	1
African Grey Hornbill	1	1
African Harrier Hawk	1	
African Hoopoe	1	
African Jacana		1
African Palm Swift	1	1
African Paradise-flycatcher		1
African Pygmy Kingfisher	1	1
African Reed Warbler	1	1
African Thrush		1
African Wattled Lapwing	1	1
African White-backed Vulture	1	
Alpine Swift		1
Angola Swallow		1
Baglafecht Weaver		1
Banded Martin	1	1
Barn Swallow	1	1
Bateleur	1	1
Beautiful Sunbird	1	1
Bennet's Woodpecker		1
Black Crake		1
Black Kite	1	1
Black-and-white Cuckoo	1	1
Black-bellied Bustard	1	1
Black-billed Barbet	1	1
Black-chested Snake-Eagle		1
Black-crowned Tchagra	1	1
Black-headed Gonolek	1	1
Black-headed Heron	1	
Black-headed Lapwing	1	
Black-winged Pratincole		1
Blue-breasted Kingfisher		1
Blue-cheeked Bee-eater		1
Blue-naped Mousebird	1	1
Blue-spotted Wood-Dove	1	1
Brown Babbler	1	1
Brown Snake-Eagle	1	1
Brown-crowned Tchagra	1	1
Brown-throated Wattle-eye	1	1
Buff-bellied Warbler	1	1
Cape Wagtail		1
Cardinal Quelea	1	
Cardinal Woodpecker	1	
Cattle Egret	1	1
Collared Pratincole		1
Common Bulbul	1	1
Common Buzzurd		1

Species	Kabwoya	Kaiso Tonya
Common Squaccol Heron		1
Crested Francolin	1	1
Croaking Cisticola		1
Crowned Lapwing		1
Dark Chanting Goshawk	1	
Diederick Cuckoo	1	1
Eastern Grey Plantain-eater	1	
Eurasian Bee-eater		1
Eurasian Marsh Harrier		1
Eurasian Reed Warbler		1
Eurasian Swift		1
Flapet Lark	1	1
Greater Honeyguide	1	1
Green Crombec	1	1
Grey-backed Bush-shrike		1
Grey-backed Camaroptera	1	1
Grey-backed Fiscal	1	1
Grey-capped Warbler	1	1
Grey-headed Bush-shrike		1
Grey-headed Kingfisher	1	1
Hadada Ibis	1	1
Hamerkop		1
Helmeted Guineafowl	1	
Laughing Dove	1	1
Lead-coloured Flycatcher	1	1
Lesser Honeyguide		1
Lesser-striped Swallow	1	
Levaillant's Cuckoo		1
Little Egret		1
Little Swift	1	
Little Weaver	1	1
Long-crested Eagle	1	
Long-toed Plover		1
Marabou Stork	1	1
Marico Sunbird	1	1
Marsh Sandpiper		1
Martial Eagle	1	
Montagu's Harrier	1	
Namaqua Dove		1
Northern Crombec	1	1
Northern Puffback	1	1
Northern Wheatear	1	1
Olive-bellied Sunbird		1
Pallid Harrier	1	1
Palm-nut Vulture	1	
Papyrus Gonolek		1
Pin-tailed Whydah	1	1
Plain Martin	1	1
Purple Starling	1	
Purple-banded Sunbird	1	1
Rattling Cisticola		1
Red-billed Firefinch	1	1
Red-billed Quelea	1	1
Red-checked Cordon-bleu	1	1
Red-chested Cuckoo	1	1
Red-chested Sunbird		1
Red-eyed Dove	1	1

Species	Kabwoya	Kaiso Tonya
Red-faced Cisticola	1	1
Red-faced Crombec		1
Red-headed Quelea	1	
Red-throated Bee-eater	1	1
Ring-necked Dove	1	1
Rufous-naped Lark		1
Ruppell's Long-tailed Starling	1	1
Sacred Ibis		1
Saddle-billed Stork		1
Sand Martin	1	1
Scarlet-chested Sunbird	1	1
Sedge Warbler		1
Senegal Thick-knee		1
Slender-billed Weaver		1
Snowy-headed Robin-Chat	1	
Speckled Mousebird	1	1
Spectacled Weaver	1	1
Spot-flanked Barbet		1
Spotted Morning Thrush	1	1
Spur-winged Lapwing		1
Steppe Eagle		1
Striped Kingfisher	1	1
Sulphur-breasted Bush-shrike	1	1
Swallow-tailed Bee-eater		1
Swamp Flycatcher		1
Swamp Warbler		1
Tambourine Dove		1
Tawny-flanked Prinia	1	1
Temminck's Courser	1	
Trilling Cisticola	1	1
Vinaceous Dove		1
Wahlberg's Eagle	1	
Water Thick-knee		1
Western Banded Snake-Eagle		1
Western Nicator	1	1
Western Violet-backed Sunbird		1
Whinchat	1	
White-browed Coucal	1	1
White-browed Robin-Chat	1	1
White-browed Scrub-Robin	1	1
White-fronted Black Chat		1
White-fronted Plover		1
White-headed Saw-wing	1	
White-spotted Flufftail	1	1
White-tailed Lark	1	
White-throated Bee-eater	1	1
Winding Cisticola	1	1
Woodchat Shrike	1	1
Woodland Kingfisher	1	1
Yellow Wagtail	1	1
Yellow-backed Weaver	1	1
Yellowbill		1
Yellow-billed Stork	1	
Yellow-fronted Canary		1
Yellow-fronted Tinkerbird	1	1
Yellow-throated Longclaw	1	1
Yellow-throated Tinkerbird		1

Species	Kabwoya	Kaiso Tonya
Zitting Cisticola	1	1
Black-headed Weaver		
Black-lored Babbler		
Greater Swamp Warbler		
Grey Heron		
Little Bee-eater		
Little Greenbul		
Long-tailed Nightjar		
Purple Heron		
Red-chested Bee-eater		
Snowy-headed Robinchat		
Western Buzzard		

Appendix 2. Plant list for Kabwoya WR and Kaiso-Tonya CWA with presence/absence data for each site.

Species	Kabwoya	Kaiso-Tonya
Abrus fruticulosus	1	
Abrus precatorius		1
Abutilon mauritianum	1	
Acacia brevispica	1	1
Acacia nilotica		1
Acacia pentagona	1	
Acacia sieberiana	1	1
Acalypha bipartita		1
Achyranthes aspera	1	1
Acmella caulirhiza		1
Ageratum conyzoides		1
Albizia coriaria	1	
Allophylus abyssinicus	1	1
Allophylus africanus	1	1
Aloe volkensii	1	
Aloe wollastonii	1	1
Alstonia boonei		1
Amaranthus dubius		1
Aneilema johnstonii	1	
Aphania senegalensis	1	1
Aristida adoensis	1	
Aristida adscensionis		1
Asparagus africanus	1	1
Asparagus racemosus		1
Aspilia africana	1	1
Asystasia gangetica		1
Balanites aegyptiaca	1	1
Barleria ventricosa	1	
Basella alba	1	1
Blepharis integrifolia	1	1
Blepharis maderaspatensis	1	1
Brachiaria comata		1
Brachiaria decumbens		1
Brachiaria jubata		1
Capparis erythrocarpos	1	1
Capparis fascicularis	1	1
Capparis tomentosa	1	1
Cardiospermum grandiflorum		1
Cardiospermum halicacabum		1
Carisa edulis	1	1
Chasmenthera dependens	1	1
Chloris gayana	1	1
Chloris pilosa	1	1
Chloris pycnothrix	1	
Cissampelos mucronata	1	1
Cissus oliveri		1
Cissus petiolata	1	1
Cissus quadrangularis	1	1
Cissus rotundifolia	1	1
Coccinia barteri		1
Combretum adenogonium	1	
Combretum racemosum		1
Commelina africana	1	1

Species	Kabwoya	Kaiso-Tonya
Commelina benghalensis	1	
Commelina capitata	1	
Commelina diffusa		1
Commelina erecta	1	1
Commiphora africana	1	1
Cordia monoica		1
Crateva adansonii	1	1
Ctenium somalense	1	
Cyanotis barbata	1	
Cyanotis polyrrhiza		1
Cymbopogon nardus	1	
Cynodon dactylon		1
Cynometra alexandri		1
Cyperus dives	1	1
Cyphostemma adenocaule	1	1
Cyphostemma serpens		1
Dichrostachys cinerea	1	1
Digitaria abyssinica	1	1
Digitaria ciliaris		1
Digitaria gayana	1	
Diospyros abyssinica	1	
Echinochloa pyramidalis	1	1
Eragrostis tremula	1	
Erythroxylum fischeri	1	1
Euclea racemosa		1
Euphorbia candelabrum	1	1
Euphorbia tirucalli	1	1
Ficus asperifolia		1
Ficus mucuso		1
Ficus sur		1
Ficus sycomorus		1
Ficus vallis-choudae		1
Flueggea virosa	1	1
Grewia bicolor	1	1
Grewia similis	1	1
Grewia trichocarpa	1	1
Haplocoelum foliolosum	1	1
Harrisonia abyssinica	1	
Heteropogon contortus	1	1
Hoslundia opposita	1	1
Hygrophilla auriculata		1
Hyparrhenia filipendula	1	1
Hyperthelia dissoluta	1	1
Hypoetes forskaolii	1	1
Indigofera spicata		1
Ipommea blepharophylla	1	1
Ipommea obscura	1	
Ipommea recta		1
Ipommea rubens	1	1
Jasminum pauciflorum	1	1
Justicia fulva		1
Kalanchoe laciniata	1	1
Kedrostis africana	1	
Lannea schweinfurthii	1	1
Leersia hexandra	1	1
Loeseneriella africana	1	1
Ludwigia abyssinica		1

Species	Kabwoya	Kaiso-Tonya
Maerua angolensis	1	1
Maerua duchesnei	1	1
Maerua triphylla	1	1
Maytenus heterophylla	1	1
Melanthera scandens	1	1
Metaporana densiflora	1	1
Millicia excelsa		1
Mimosops bagshawei		1
Monanthotaxis buchananii	1	
Ochna inermis	1	1
Ocimum gratissimum		1
Oncoba spinosa	1	1
Opilia amentalea	1	1
Panicum deustum	1	1
Panicum maximum	1	1
Panicum pansum	1	
Panicum stapfianum		1
Paullinia pinnata	1	1
Pavetta gardeniifolia	1	
Periploca linearifolia		1
Periploca nigrescens		1
Phragamites mauritianus	1	1
Phyllanthus engleri		1
Phyllanthus muellerianus		1
Pistia stratiotes		1
Polygonum strigosum	1	
Potulaca quadrifida		1
Psilotrichum axilliflorum		1
Psydrax parviflora	1	1
Psydrax schimperiana		1
Rhus natalensis	1	1
Ricinus comminis	1	1
Saba comorensis		1
Sansiviera nilotica	1	1
Scutia mytina	1	1
Secamone africana		1
Sesbania sesban		1
Setaria kagerensis	1	1
Sida alba	1	
Solanecio angulatus	1	
Solanum incanum	1	1
Solenostemon sylvaticus	1	1
Sporobolus africanus	1	1
Sporobolus festivus	1	1
Sporobolus iocladus	1	
Sporobolus panicoides	1	
Sporobolus pyramidalis	1	1
Sporobolus stapfianus	1	1
Strychnos congolana	1	1
Tacazzea apiculata		1
Tapura fischeri		1
Tarenna graveolens	1	1
Teclea nobilis	1	
Tephrosia interrupta		1
Terminalia brownii	1	1
Trimeria grandifolia	1	1
Typha domingensis	1	1

Appendix 3. Small mammal captures at each site surveyed

Species Name	**Locality**	**No. of individuals collected per station**
Chaerephom pumila	Netline 2	2
Epomorphorus labiatus	Netline 1	5
Epomorphorus labiatus	Netline 2	1
Epomorphorus labiatus	Netline 3	1
Epomorphorus labiatus	Netline 5	4
Hipposideros ruber	Netline 4	2
Hipposideros ruber	Netline 5	1
Lavia frons	Netline 3	2
Lavia frons	Netline 4	3
Lavia frons	Netline 5	4
Nycteris thebaica	Netline 1	1
Micropteropus pusillus	Netline 2	1
Micropteropus pusillus	Netline 4	2
Nycteris hispida	Netline 1	1
Nycteris hispida	Netline 2	2
Nycteris hispida	Netline 3	3
Pipistrelles nanus	Netline 2	2
Pipistrelles ruepelli	Netline 5	1
Pipistrellus nanus	Netline 5	1
Scotoechus hirundo	Netline 2	1
Crocidura jacksonii	pitfall A	1
Mus minutoides	pitfall A	1
Dendromus mystacalis	Pitfall B	1
Crocidura jacksonii	Pitfall C	1
Dendromus mystacalis	Pitfall C	1
Crocidura turba	Station 1	1
Lemniscomys striatus	Station 3	1
Lophromys sikapusii	Station 3	1
Lophromys sikapusii	Station 4	1
Crocidura olivieri	Station 5	1
Mastomys hildebrandtii	Station 5	2
Mus minutoides	Station 5	13
Lemniscomys striatus	Station 6	2
Grammomys dolichurus	Station 7	1
Mus minutoides	Station 7	2