C L U N Y

Providing Aerial Wildlife Management Services

Report on an Aerial Census of Akagera National Park, Rwanda - August 2013

Photo credit: Mr. Jes Gruner

B Y D E R E K M A C P H E R S O N

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EXECUTIVE SUMMARY

Total Area Count methodology was used to count large herbivores resident in the survey area comprising the terrestrial part of Akagera National Park (ANP) and the fringes of the wetland associated with the Akagera River and system of lakes. A Robinson R44 helicopter was the aerial platform from which the count was conducted.

Successful aerial census depends on achieving a good counting efficiency. Counting efficiency is described as the fraction of the total population for any one species actually seen and counted in any one counting event. Counting efficiency depends on good visibility. Aerial visibility in Akagera is acceptable in most areas that feature either open or wooded grasslands occurring on flat topography but declines in the escarpment areas along the Mubari Range and parts were the vegetation type changes to riverine or dry forest. Counting efficiencies in ANP are better for larger, darker, bolder, gregarious species than for smaller, lighter, secretive, solitary species resulting in more accurate results for the former group of species than for the latter. The 2013 count was conducted during the long dry season when leaf cover was at a minimum and visibility at a maximum.

88 Elephant, 2,093 buffalo, 54 giraffe, 193 eland, 83 Roan, 948 waterbuck, 999 Zebra, 560 Topi, 1,057 impala, 741 warthog and 885 hippopotami were counted during this survey. These population estimates are considered to be accurate enough to be meaningful to wildlife management decision-making processes. Other species participating in the survey were considered to be significantly undercounted. Wildlife populations for many species are showing increasing trends most notably buffalo, waterbuck, zebra and warthog. Species that have attained or surpassed the ecological carrying capacity estimates for the Park as calculated by Goodman in 2003 include hippo, buffalo, waterbuck and warthog. The re-introduction of lion and black rhino is recommended. This action will introduce a natural force to govern herbivore populations and increase biodiversity and the tourism potential of the Park.

While poaching remains a significant force acting against the maintenance of wildlife populations, vigorous efforts in law enforcement are producing results and having the desired effect of reducing illegal activity in ANP and protecting wildlife populations which are now showing increases.

It is clear that the management intervention of the Akagera Management Company is being successful.

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INTRODUCTION

Literary review reveals that the following wildlife population surveys were conducted in Akagera National Park (ANP) during the last forty-five years (Lamprey, 2002 & Viljoen, 2010):

1. Guinness & Spinage conducted aerial total counts and ground counts of large mammals in 1968 & 1969 publishing in 1972.
2. Vande weghe & Dejace completed a census of the greater Park area in 1990 publishing in 1991.
3. Williams & Ntayombya conducted an aerial total count of the current Park area and the adjacent de-gazetted area in 1997 & 1998 publishing their results in 1999.
4. Lamprey conducted a wildlife census using Systematic Reconnaissance Flight (SRF) sample counting methods in addition to a survey of other important events taking place within the current Park area and adjacent areas in 2002.
5. Viljoen conducted the most recent census of the current Park area using SRF sample counting methods in 2010. His report also describes a separate count of the Gabiro Military Zone which lies to the west of and is contiguous with the Park.

The methods used to conduct these surveys differed, introducing bias when comparison is made between the results of the different surveys. Further complicating the equation is that the area of land variously protected as the Akagera National Park and the adjacent Mutara Domaine de Chasse (hunting area) has been reduced over time. Consequently wildlife population trend analysis for the current Park area is possible for period 1997 / 1998 through to the present only. Notwithstanding these limiting factors, trend analysis remains useful when focussed on those species that are tendered by the various authors as having the most reliable estimates. Relating wildlife population trends to historic events promoting human advance on the Protected Area and differing levels of wildlife management in ANP reveals a definite correlation between the ebb and flow of these two major forces and wildlife populations.

The Systematic Reconnaissance Flight sample count method used in 2010 by Viljoen produced reliable estimates for six species. The sample sizes for other species were

considered to be too small for the derivation of reliable estimates. In the case of elephant and buffalo all individuals of these species were counted both inside and outside of sample transects resulting in a total count for these species in the context of a flight path spacing of 1.5 kilometers. The possibility of undercounting in these circumstances is high and both species are considered to be undercounted in this instance. The recommendation for hippo, also considered to be undercounted in 2010, was a dedicated survey with methods appropriate to the species and the habitat (Viljoen, 2010). Taking advantage of this experience, it was decided that total count methods would be used for the aerial wildlife census conducted in 2013, the intention being to improve the accuracy of wildlife population estimates for the park across a broader range of species. This survey took place between the 16th and 18th of August 2013. The following report describes in some detail the method of data collection, the results of the investigation and the analysis of those results in comparison to three previous wildlife censuses that took place in 1997 / 8, 2002 and 2010 respectively, in the context of varying degrees of wildlife management input.

SURVEY AREA

Note:

Appendix 1 attached supplies the mapping illustrations associated with this report.

Appendix 2 attached supplies the photographic media associated with this report.

Please consult these appendices where referenced in the text.

A Brief History

The area currently known as Akagera National Park, along Rwanda's eastern boundary with Tanzania (Map 1) first came to the notice of Europeans in 1876 when John Rowlands, aka Henry Morton Stanley, explored the Akagera River from the Karagwe Mountain Range in present day Tanzania under the protection of King Rumanyika. In that year he was attempting to confirm the river as the most remote source of the White Nile (Vande weghe, 1990). The area was established as a national park in 1934. Adjacent to it, on its western boundary, the Mutara Domaine de Chasse or Hunting Area was also formed around that time (Map 2). The total area covered by the two categories of protected area was approximately 2,700 square kilometers (Vande weghe, 1990 & Lamprey, 2002).

In spite of being protected the Park has a long history of human occupation. The presence of mature sisal, prickly pear (*Opuntia vulgaris*) and eucalyptus in the lake region of the Park (Photograph 1) bear testimony to this (Vande weghe, 1990). The size of the Akagera National Park has been sequentially reduced as the force of human advance in the context of civil conflict and political change has been applied to the area over time. This story is complex and is not articulated here in any detail because it is only partially relevant to this wildlife census. Suffice to say that the

most significant, human induced, event in recent history, was the settlement of returning refugees mostly in the northern and western parts of the Park and the Mutara Domaine de Chasse in the 1990s. With these people came large herds of cattle - more than 86,000 in the total area under protection and more than 23,000 in the current Park area (Lamprey, 2002). Competition for grazing between domestic and wild livestock reached its height at this time resulting in the degradation of the grass sward, invasion of species like those from the genus *Dychrostachys* and subsequent erosion of the soil. Lamprey (2002) reported that with the influx of people into the park area so human wildlife conflict increased resulting in a decline in wildlife populations of between 50% and 80% for many species and local extirpation of Black Rhino and Lion. In 1997 a large area of the Park and the entire area of the Mutara Domaine de Chasse were de-gazetted from their protected status for the purpose of resettlement of the returning refugees. The Park's size was reduced to cover approximately 1,120 square kilometers (Maps 2 & 3).

In 1999, the German Government development agency, GTZ, started a project called "Protection des Ressources Naturalles" (PRORENA) with the principal objective of assisting the Rwandan Government with the rehabilitation of Akagera National Park. Key outputs of this project included some improvement to Park infrastructure, the survey and marking of the new western boundary of the Park, the wildlife census conducted by Lamprey in 2002 (Lamprey, 2002) and an estimate of carrying capacity by Goodman (2003).

In 2009 the Akagera Management Company Ltd (AMC), a joint entity formed by the African Parks Network and the Rwanda Development Board came into being. AMC assumed the management function of, and full responsibility for, Akagera National Park (ANP) in 2010. Since that time AMC has significantly improved infrastructure and law enforcement in the Park in addition to constructing a game fence along its western boundary. No human occupation other than that required to perform the functions of management and tourism and no domestic livestock is allowed within Park boundaries. With this improved wildlife management and security, wildlife populations, tourism and associated revenue are increasing rapidly.

Description

One of the principal topographical features of the area currently protected as ANP is Mubari Range, a north to south orientated line of significantly sized hills along the western boundary of the Park attaining a maximum height of 1,825 m (5980 feet) above sea level at Mutumba (Map 3). These hills fall away to form a narrow area of undulating surface before meeting a large wetland along the eastern boundary of the Park covering approximately 30% of the Protected Area at 1,250 m (4,100 feet) above sea level (Map 4). This wetland features a complex system of lakes fed by the

Akagera River (Photograph 2 & Map 3). The altitude differential is 575 m or about 1890 feet.

The Park is variously described as occupying part of the Interlacustrine Region (Map 5) (Vande weghe, 1990) or the Lake Victoria Regional Mosaic (Lamprey, 2002 quoting MacKinnon & MacKinnon, 1986), a region known for its extraordinary biodiversity. Akagera National Park represents a receding, isolated enclave of sub-arid savanna vegetation with an annual average precipitation of 750 - 850 mm occurring in two rainy seasons (Vande weghe, 1990 & Viljoen, 2010).

Lamprey (2002) classified the vegetation of the greater Akagera National Park into four categories based on observations by the rear seat observers during that survey and Pratt *et al's* (1966) definition of vegetation types:

1. Grassland: "Vegetation dominated by grasses, but dwarf-shrubs may be present; tree/shrub canopy cover < 2%." This vegetation type occurs predominantly on Mutumba Mountain and the Kilala Plain (photographs 3 & 4 respectively).

2. Bushed Grasslands: "Bushes and shrubs conspicuous, but scattered; canopy cover 2-20%." Photographs 5 & 6 illustrate this vegetation type occurring on many of the hill-slopes and lower undulating areas.

3. Wooded Grasslands: "Trees conspicuous, but scattered; canopy cover 2-20%." This vegetation type is found mostly on the plateau areas and hill-slopes (Photographs 7 & 8).

4. Bushland / Woodland: "Upper strata of woody plants, both trees and shrubs; minimum canopy cover 21%." In some cases this bushland / woodland is dominated by acacia species and in others by broad leafed species like those from the genera *Albizzia* and *Combretum* (Photographs 9 & 10).

Another 4 vegetation types can be added to this list as follows:

5. Dry Forest: Tree vegetation cover is very high at over 90%. Dry forests, relics of an ancient landscape (Vande weghe,1990), cover only a small percentage of the Park area. In the southern part of the park occurs the most extensive example of this vegetation type (Photographs 11 & 12). In other areas it occurs as patches in the steep valleys along the escarpment (Photograph 13).

6. Humid Forest: Often found in the form of narrow galleries bordering permanent bodies of water and dominated by palms (Photograph 14).

7. Wetland Fringes: A narrow floodplain area characterised by short grasses forming the interface between permanently wet areas and dry land (Photograph 15).

8. Wetlands: Featuring a mixture of papyrus (*Cyperus papyrus*), woody species such as Ambach (*Aeschynomene elaphoxylon*) and various species of tall grasses in different proportions ranging from almost pure Papyrus beds to a mosaic of these species (Photographs 16 & 17).

FACTORS AFFECTING VISIBILITY AND AERIAL COUNTING EFFICIENCY IN ANP

In the context of estimating populations of wildlife in protected areas using total count methodology, the greater the fraction of the total population for any one species actually seen and counted in any one counting event the greater will be the accuracy of the count. I have chosen to call this fraction "counting efficiency".

Successful aerial wildlife census using total count methodology relies on achieving a good counting efficiency which in turn is dependent on visibility. Visibility varies between and within different wildlife areas. Consequently not all wildlife areas are given to aerial census.

Factors, sometimes interrelated, that influence visibility from an aircraft and therefore counting efficiency include:

- *Cover and topography:* Visibility from the air is dictated primarily by changes in type of cover (vegetation) and topography, declining with increasing cover and hilliness.

- *Timing:* In as much as leaf cover is often a function of season, especially in systems dominated by deciduous plants, timing influences visibility. Conducting a census at the time of the year when leaf cover is at a minimum is critical to achieving good counting efficiency and therefore meaningful results.

- *Differences in size, colour & habits across species:* Larger, darker, bolder, gregarious species are more visible from the air than smaller, lighter, secretive, solitary species leading to a differential in counting efficiency between species. For example, total counts for elephant, buffalo and sable are likely to be more accurate than counts for species like kudu, bushbuck and duiker at the other end of these spectra.

- *Time of day:* Visibility from the air is affected by the position of the sun and the angle at which light strikes the ground. Generally, animals are more visible either early in the morning or late in the afternoon. To complicate matters many species rest in the shade of various forms of vegetation during the heat of the day making

them less visible at this time of the day than at others when, typically, they are more active. When logistical considerations force counting to be conducted during the heat of the day, some areas are counted under better conditions than others causing variations in counting efficiency.

- *Burning:* Burning causes there to be a dark background against which animals have to be counted. Typically this reduces visibility and makes spotting and counting difficult, negatively influencing counting efficiency. Exceptions to this occur in the case of lighter species.

- *Groundspeed of aircraft:* The faster an aircraft flies in relation to the ground the more difficult it becomes to spot and count animals on the ground and the lower the counting efficiency becomes. The ideal aerial platform from which to conduct aerial game counts is undoubtedly a helicopter. Failing this possibility, slow-flying, fixed-wing aircraft produce better results than fast aircraft in spite of a reduced crew capacity associated with slow-flying machines.

- *Altitude above ground:* The best altitude above ground to fly any survey is a function of cover and topography. Typically an altitude of between 250 and 350 feet above ground level produces the best results. When the topography becomes hilly it is necessary to fly at a higher altitude above ground in the interests of safety. This, perforce, reduces visibility and therefore counting efficiency in affected areas.

- *Skills of pilot and observer(s):* Variability in the skills of the pilot and observer(s) that conduct surveys over time introduce another dynamic affecting counting efficiency. Of course the higher the level of skill the higher the accuracy of the result. In the case of the analysis of trends in population estimates it is not only important to maintain a constant in counting methodology but also in the pilot / observer skill base.

In the context of counting the terrestrial species occurring in Akagera National Park most of the area is covered by grassland, and bushed or wooded grasslands. This provides for good visibility from the air and therefore adequate counting efficiency. Dry Forest covers a relatively small area of the park which suffers from reduced visibility and low counting efficiencies. The wetland area of the park is extensive and densely covered by papyrus, Ambach and tall grasses. Visibility in the wetland in the context of counting sitatunga, hippos, crocodiles and shoebill storks is limited.

The most significant challenge to aerial wildlife census in ANP is the hilly topography found in the western parts of the Park. This forces the aircraft to maintain a comparatively higher altitude above ground level in affected areas, reducing visibility.

In my opinion large terrestrial animals in Akagera National Park can be effectively counted from the air in spite of the forces at play working against achieving good counting efficiency.

OBJECTIVES

The primary and general objective of this survey was to conduct a comprehensive wildlife census of Akagera National Park using Total Area Count methodology in order to gain as much information as possible about wildlife populations at the time of the survey.

The specific objectives of this survey are as follows:

1. Arrive at a total count for as many species as is practical to count from the air covering as much of the Park as possible.
2. Obtain geo-spacial data that will provide information leading to a deeper understanding of the distribution and terrestrial ranges of as many species as can be reliably counted from the air.
3. Analyse changes in the populations of as many species as is possible over time by comparing population estimates from past censuses with those of the 2013 census in spite of the different counting methods used.
4. Evaluate the extent of illicit use of the Park using indicators easily seen from the air whilst conducting the census.
5. Evaluate current wildlife stocking rates against the ecological carrying capacity estimates and the population recovery projections provided by Goodman in 2003.

METHODOLOGY

Timing of Census

This census was carried out over three days from 16th to 18th of August 2013 during the long dry season when leaf cover of bushlands and woodlands is at a minimum and visibility at a maximum facilitating maximum possible counting efficiency from the air. Visibility was slightly inhibited by a dense atmospheric haze during most of the survey period, however this did not prevent a meaningful result from being achieved.

Aircraft Type

A Robinson R44, four seat, helicopter (Photograph 25), supplied by Akagera Aviation Ltd, based in Kigali, was used to conduct the survey. The type's low flying speeds, maneuverability, good visibility and adequate rate of climb provided an excellent

platform for counting animals in most areas of the Park with the exception of the steep escarpment areas where a higher altitude above ground level was maintained in the interests of safety and at the cost of some visibility in affected areas.

Procedures

The airborne crew was comprised of a pilot (Mr. Egide Rekambane), a front seat observer (Mr. Derek Macpherson), a rear right seat observer (Mr. Jes Gruner) and a rear left seat observer (Mr. Eugene Mutangana). The role of the pilot was to fly the aircraft. The front seat observer performed the functions of navigator and data recorder (on pre-designed data sheets) while assisting with spotting. The rear seat observers spotted and counted game while assisting with navigation due to their intimate knowledge of the Park. A GPS track log of survey flights was kept and waypoints of each observation made were saved on the same device. Where necessary still photographs were taken of large groups of animals to verify manual counts. This was used specifically in the case of buffalo, a species that has large herd sizes in some cases. The aircraft was ably supported by a ground crew in the form of Mr. Carey Martin-Ouelette.

Counting Strategy

Many large mammalian species occurring in Akagera National Park exhibit clumped distribution patterns, the dynamics of which are affected by social behaviour and the availability of food, water and cover which are influenced by the time of year. In this context aerial sample counting methods tend to produce results that are prone to inaccuracy and are less reliable than aerial total counts. For this reason a Total Area Count is the preferred method for aerial surveys conducted in relatively small Protected Areas.

Ideally each species in the entire survey area is counted during the course of a single day, avoiding the possibility of double counting caused by daily animal movements, and producing a Minimum Total Count. Also ideally the Total Area Count is repeated several times within a short time frame and the results averaged leading to improved reliability of the population estimates.

Unfortunately constraints often preclude the possibility of the ideal situation being realised. For example, it is not possible to cover the entire area of ANP as intensively as desired in the space of one day. Reducing the intensity of the counting effort by flying a looser flight pattern, which might allow all species to be counted in all areas on one day but risks missing significant numbers of animals, is not desirable.

In spite of the 2013 wildlife census taking more than one day to complete, the value of an intensive flight plan and high counting effort are tendered as outweighing the

possibility of errors occurring due to the overnight movement of animals in ANP. This is because of the long shape of the Park and the flight pattern stopping along the short axis of the Park, parallel to the direction of major daily movements of animals to and from water.

The terrestrial species occurring in ANP were the main focus of the census. Knowing that these species do not venture into the swamp area of the Park resulted in the survey covering the entire dry-land area of the park, the narrow floodplain and the wetland fringes in two days.

The method yields a meaningful total count for 10 terrestrial species.

The hippo population was surveyed using a different method. This specie in this area tends to spend most daylight hours on the wetland fringes near to dry land as opposed to in the greater wetland area. The strategy was, therefore, to count hippos along the dry land to wetland fringe and associated floodplain along the entire length of the Park in one day. This method yields a minimum total count for this specie in ANP while acknowledging the likelihood of undercounting. Should this easily repeatable method of counting hippo be used in future censuses, reliable retrospective comparison and therefore population trend analysis can be achieved in a cost-effective manner.

Increasing the number of counting repetitions for all species would result in the reduction of error from double counting or undercounting and improve both accuracy and reliability of the result. Unfortunately resources in 2013 did not extend beyond one counting replication.

Flight Plan

A total of 20.3 hours was flown overhead the survey area. This flying time to count animals consisted of:

- Five flights flown on 16th August during which all terrestrial species were counted in the southern part of the Park (Map 6).
- Five flights flown on 17th August during which all terrestrial species were counted in the northern part of the Park (Map 6).
- Two flights flown on 18th August during which the hippo population was counted (Map 7).

The terrestrial part of the Park was counted by flying parallel strips in an east – west direction regulating the distance between flight paths by assessing lateral visibility at the end of each path flown ensuring that the total survey area was adequately

covered. The average observation path width is estimated to be 750 meters. The best visibility was found by flying at an altitude of between 200 and 300 feet above ground level and at a speed of about 40 knots. Exceptions to this occurred in the north of the Park where the terrain in relation to the flight abilities of the aircraft forced a less regular flight pattern to be followed along the grain of the topography (Map 6).

The dedicated hippopotami count followed the wetland fringe (Map 7).

Where necessary animal groups were circled to facilitate accurate counting.

Statistical Treatment of Data

The results of this survey are submitted as a legitimate Total Count for eleven species occurring in Akagera National Park as at August 2013. These species include elephant, buffalo, giraffe, eland, roan, waterbuck, zebra, topi, impala, warthog and hippopotamus. Other species were significantly undercounted due to being cryptic and secretive in nature.

RESULTS

Population Totals

The survey results for the 2013 aerial census using total count methodology are presented in the form of a summary in Table 1, showing for each specie the total number counted, the average group size, the minimum and maximum group sizes and the number of observations (N).

Table 2 provides a comparison between the results of the August 2013 total area count and the Akagera Management Company's estimates for listed species prior to the census based on field experience and observation.

Table 1: The total number of animals per specie & group sizes recorded for the total area count in Akagera National Park, August 2013

Species	Average	Minimum	Maximum	N	Total
Birds					
Shoebill					**1**
Primates					
Baboon Troops					**61**
Vervet Troops					**7**
Blue Monkey Troops					**2**

Table 1 Continued:

Species	Average	Minimum	Maximum	N	Total
Other Large Mammals					
Elephant	8.00	1	40	11	**88**
Buffalo	22.27	1	250	94	**2,093**
Giraffe	3.86	1	8	14	**54**
Eland	8.39	1	31	23	**193**
Roan	9.22	1	27	9	**83**
Waterbuck	3.82	1	31	248	**948**
Zebra	5.68	1	40	176	**999**
Topi	5.71	1	72	98	**560**
Impala	8.52	1	37	124	**1,057**
Reedbuck	2.15	1	6	22	**47**
Warthog	2.88	1	16	257	**741**
Bushbuck	1.20	1	3	46	**55**
Oribi	2.50	1	7	8	**20**
Duiker	1.12	1	2	33	**37**
Bushpig	4.17	1	8	6	**25**
Hyena	1	1	1	1	**1**
Leopard	1	1	1	3	**3**
Sitatunga	1	1	1	3	**3**
Hippopotamus	4.12	1	44	215	**885**
Total (Large Mammals Only)					**7,892**

Table 2: A comparison between the total area count in Akagera National Park, August 2013 and AMC's Estimate before the census took place

Species	Census Totals	AMC's Estimate
Large Mammals		
Elephant	**88**	**80**
Buffalo	**2,093**	**1,000**
Giraffe	**54**	**60**
Eland	**193**	**120**
Roan	**83**	**45**
Waterbuck	**948**	**400**
Zebra	**999**	**1,000**
Topi	**560**	**800**
Impala	**1,057**	**2,000**
Reedbuck	**47**	**150**
Warthog	**741**	**250**
Bushbuck	**55**	**150**

Table 2 Continued:

Species	Census Totals	AMC's Estimate
Oribi	**20**	**150**
Duiker	**37**	**200**
Bushpig	**25**	**150**
Hyena	**1**	**40**
Leopard	**3**	**35**
Sitatunga	**3**	**-**
Hippopotamus	**885**	**600**
Crocodile	-	**300**
Total (Large Mammals Only)	**7,892**	**7,530**

Population Trends

The numerical results of the wildlife censuses for the years 1997/8, 2002, 2010 and 2013 are presented in Table 3. These figures provide the basis for meaningful, if not reliable, population trend analysis for six species. These species are buffalo, waterbuck, zebra, impala, topi and warthog.

Table 3: Showing comparative figures of wildlife populations from 1997/8 to 2013

	YEAR			
Census Method	**1998** Aerial Total Count	**2002** SRF	**2010** SRF	**2013** Aerial Total Count
SPECIES				
Domestic Livestock				
Cattle	23,430	2,529	76	0
Sheep & Goats	n/a	0	32	0
Wildlife				
Primates				
Olive Baboon	n/a	20	19 troops	61 troops
Vervet monkey			1 troop	7 troops
Blue Monkey			1 troop	2 troops
Large Mammals				
Elephant**	n/a	n/a	27	88
Buffalo**	680	309	882	2093
Giraffe	n/a	20	n/a	54
Eland	59	114	n/a	193
Roan	n/a	n/a	n/a	83

Table 3 Continued:

Waterbuck	80	141	1144	948
Zebra	580	390	571	999
Topi	770	531	235	560
Impala	1890	982	948	1057
Reedbuck	n/a	74	n/a	47
Warthog	240	262	669	741
Hippopotamus**	n/a	552	n/a	885
Totals	**4299**	**3375**	**4476**	**7748**

Notes:

1. Results for all surveys refer to the current area considered to be Akagera National Park.
2. Survey method for 2002, & 2010 was SRF. Survey method for 1997/8 & 2013 was Total Area Count.
3. ** species counted both inside and outside sample transects in 2010.
4. 2010 estimates for Elephant and Buffalo considered to be total counts.
5. 2010 count of Hippo considered to be undercounted and therefore not a valid estimate.

Different counting methods were used, over time, to make population estimates in Akagera National Park by different ecologists. This makes retrospective comparison of population estimates for any given specie difficult because of errors introduced by bias derived from the different survey methods. While this is acknowledged no effort is made here to quantify the bias and make corrections. The comparisons that are made focus on those species tendered as having accurate estimates by the various authors across all four surveys recorded between 1998 and 2013.

Figures 1 - 6 show, graphically, the individual population trends for the six species over the period 1998 to 2013.

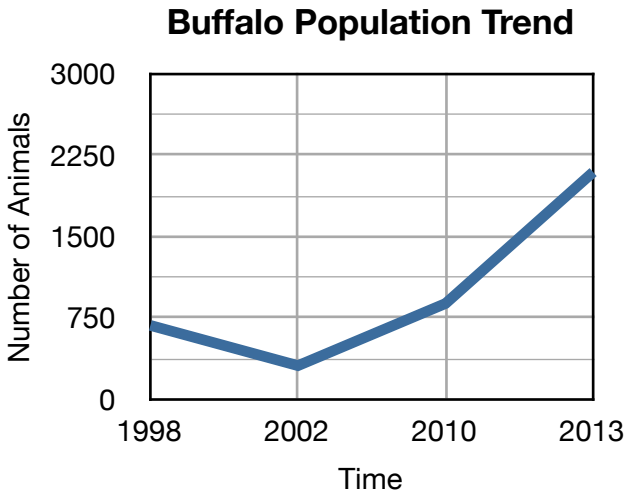

Figure 1: Showing the population trend for buffalo in Akagera National Park

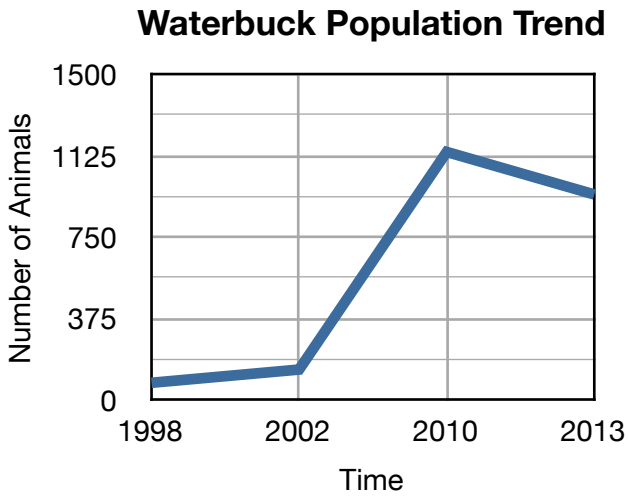

Figure 2: Showing the population trend for waterbuck in Akagera National Park

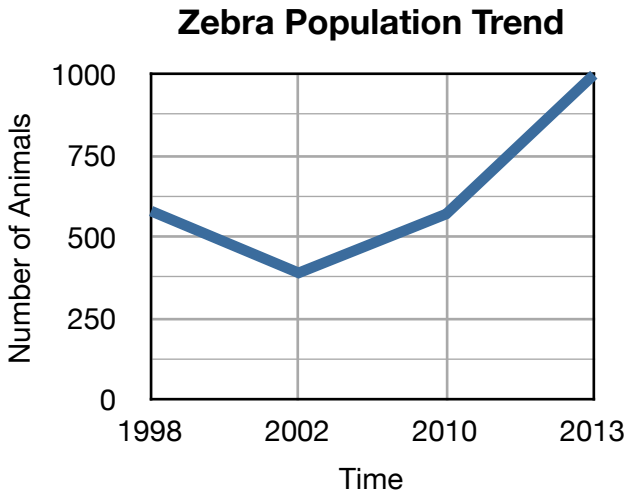

Figure 3: Showing the population trend for zebra in Akagera National Park

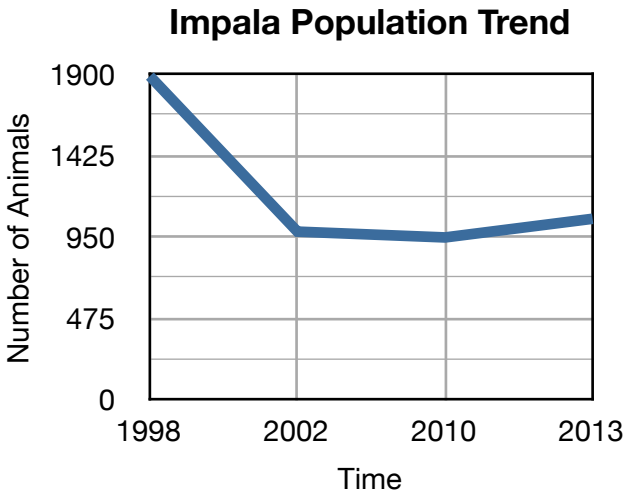

Figure 4: Showing the population trend for impala in Akagera National Park

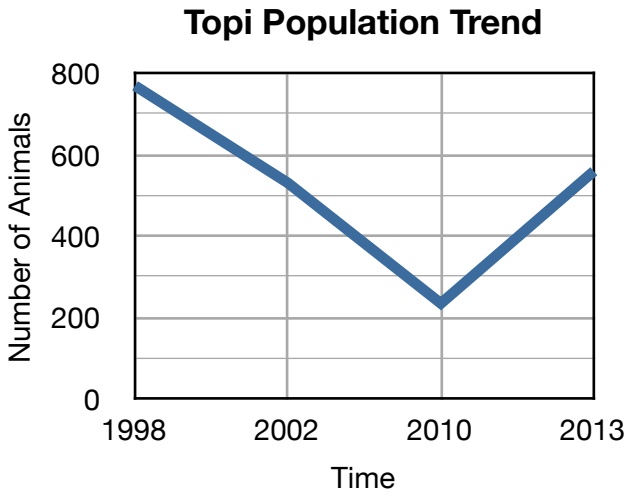

Figure 5: Showing the population trend for Topi in Akagera National Park

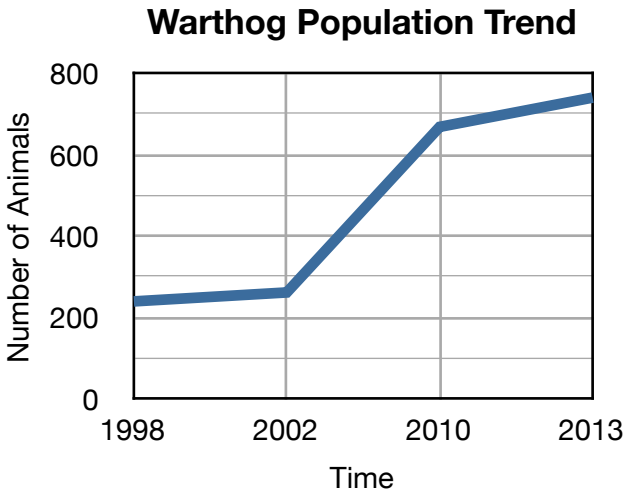

Figure 6: Showing the population trend for warthog in Akagera National Park

Animal Distribution

The distribution of each specie observed in ANP during the 2013 survey is presented in graphic form in Maps 8 to 31 in Appendix 1. Distribution data for the species elephant, buffalo, eland, waterbuck, zebra, topi, impala, warthog and hippopotamus, as recorded during the 2010 wildlife census is also presented here for comparative purposes (Maps 8 - 16).

Animals Occurring Outside of the Park

During the survey several groups of animals of different species were spotted outside of the Park. These included 18 impala, 6 topi, 45 zebra and 3 buffalo along the boundary fence (Map 31) and 84 hippo and 2 buffalo along the Nyamaswi River known formally as the "Central Valley" in Akagera National Park before much to the area was de-gazetted. During the period after the completion of the western boundary fence and prior to the survey AMC has made efforts to push as many animals as possible occurring outside of the park back into the Park. This has been done with the use of a helicopter driving herds through deliberately collapsed portions of the fence. Species that have successfully been moved into the Park in this manner include Buffalo, zebra, topi and waterbuck (Jes Gruner and Eugene Mutangana, Pers. Com.). This action will have had an impact on current population estimates for the species affected.

Bones and Carcasses

All bones and carcasses that were observed during the census were recorded and waypoints marked on a GPS. Unfortunately it was not possible in every event to establish the identity of the species concerned as this exercise was of secondary priority after the collection of census data. The species that were noted, however, included elephant, hippo, buffalo, crocodile and eland. Of these species only one elephant carcass was identified. This death was due to poaching and was known to Park management (Jes Gruner, Pers. Com.). The majority of the bones and carcasses spotted were from hippo. The next most frequent was buffalo followed by eland and crocodile. The distribution of bones and carcasses observed during the survey is illustrated in Map 32. Noticeable is the location of most of the carcasses along the wetland fringe corroborating the assertion that hippo is the specie from which most of the deaths observed come.

Illicit use of Park Resources

All visual evidence of illegal human activity occurring in the park was recorded during census flights. Following is a list of those observations:

- 17 poachers camps
- 41 boats
- 3 poachers access routes
- 3 beehives
- 5 large trees cut to make canoes
- Sisal cut for making rope
- Approximately 35 people seen
- 6 people arrested

Maps 31 to 37 show the location and Photographs 18 to 23 provide a graphic illustration of some of the kinds of illegal human activity going on within the boundaries of ANP at the time of the wildlife census in August 2013.

ANALYSIS OF DATA

Wildlife Populations

Elephant

While elephants formerly occurred in Akagera National Park, by 1975 the species had been extirpated in the area. During this year some elephants were reintroduced to the Park. Lamprey estimated a population of approximately 80 in 2002 while Viljoen estimated a much lower figure of 27 in 2010. In 2013, 88 individuals were counted. Most of this population was observed in the southern part of the Park, just north of where the most extensive area of Dry Forest is found. It is probable that this species was undercounted to some degree. I speculate that the population is around 100 elephants at this time.

The distribution for the specie for both 2010 and 2013 is provided in Map 8. Noticeable is a greater use of the northern part of the Park in 2010 compared to 2013 when most of the population was compressed into a small area not far from Ruzizi Tented Lodge.

No abnormalities are detected with respect to group size or number of observations for this specie.

Buffalo

The estimate for buffalo in 2013 is 2,093 individuals. It was noticed that this specie tends to spend the heat of the day in patches of thicket and therefore some individuals may have been missed. Two herds were spotted and counted during a ferry flight in an area that had been recently surveyed but the groups had gone undetected. These two herds comprised 32 individuals. The figure was not included in the census because the observation did not occur during a counting flight. The largest herd recorded of 250 individuals was sighted on the fringes of a dense copse of Dry forest in the north of the Park. On being approached by the helicopter they moved under the canopy of the forest. An accurate manual count and photographic count were made impossible because of this. The consensus of participating observers was that this group was made up of at least 250 individuals, probably more.

The buffalo population declined between 1998 and 2002 but has exhibited an increasing trend since 2002. The increase from an estimated 882 in 2010 to 2,093 in 2013 represents a 137% increase over three years or an average annual increase of nearly 46%. At first glance this appears to be improbable. Goodman (2003) suggests a maximum annual rate of increase for this specie of 17%), however, there are several factors that can possibly explain this extraordinary increase: Firstly, the 2010 population estimate was submitted as a total count based on a wide flight path separation of approximately 1,5 km (Viljoen, 2010). This method of survey will likely yield an undercount. Secondly, nearly 350 buffalos were pushed into the current Park area after the western boundary fence was put in place (Eugene Mutangana, Pers. Com.). Thirdly, improved management, decreased poaching and a lack of lion as an apex predator in the Park coupled with adequate food, water and cover leads to near-perfect breeding conditions for the specie.

Group size and number of observations are within normal ranges for a population of this size for this specie.

In spite of the 2013 estimate exceeding AMC's estimate by over 100% and one large herd being difficult to count, the population estimate of 2,093 is submitted with confidence as being conservative.

Reference to Map 9 reveals that buffalo were widely distributed during both the 2010 and 2013 wildlife censuses with a concentration in the Kilala Plain, Gishami and Gihinga areas in the north of the Park.

Giraffe

Giraffe do not occur naturally in Akagera National Park (Giraffe conservation Status Report published by IUCN, 2012) Six individuals (2 male & 4 female) of the Masai subspecies of giraffe (*Giraffa camelopardalis tippelskirchi*) were introduced to the Park in 1986. These were a gift from the Kenyan Government at that time. Lamprey reported in 2002 that most (80%)of the giraffe seen during that survey were outside of the current Park area. His population estimate for the specie over the greater park area was 101. The estimate of 54 in the Total Area Count of 2013 for the current Park area is considered by Park Manager Mr. Jes Gruner to be conservative (Pers. Com.). His opinion is based on encounters with giraffe on the ground while driving a circuitous route during the course of one day exceeding this figure.

Map 17 reveals that the specie appears to prefer the wooded grasslands of the northern parts of the Park to the bushlands and dry forest more dominant in the southern parts.

Eland

One hundred and ninety-three eland were counted during the 2013 aerial survey exceeding AMC's estimate prior to the survey by 63. The eland in ANP are showing a marked recovery since 1998 when the estimate was 59 individuals. No abnormalities are detected with respect to group size or number of observations for this specie. As in 2010, distribution in 2013 was confined mostly to the northern part of the Park (Map 10).

Roan Antelope

Thought to be on the verge of local extinction in the 2000s (Lamprey and Goodman) this specie is making a significant recovery in Akagera National Park. The 2013 estimate is 83 individuals with a maximum herd size of 27 and an average herd size of 9.22. This estimate exceeds AMC's estimate of 45 by a significant margin. The distribution of roan antelope in 2013 (Map 18) shows a distinct preference for the highland areas along the Mubari Range focussing on the Mutumba Hills, parts of which had been burned prior to the time of the survey and were covered in new green shoots of grass.

Waterbuck

The 2013 survey yielded an estimate of 948 waterbuck. This is lower than the 2010 estimate of 1144. Nevertheless the specie shows a general increasing trend in population size. The 2013 estimate is more than double AMC's estimate prior to the census. In areas that have large open floodplains this specie is known to aggregate into large herds. For example in Liwonde National Park in Malawi the largest herd size recorded in the aerial wildlife census conducted in 2012 was 236 (Macpherson, 2012). In areas that have narrow floodplains and large areas of woodland group size for waterbuck appears to be small. For example in Majete Wildlife Reserve Malawi, in 2012 the maximum group size recorded during an aerial census was 15 (Macpherson, 2012). In Akagera N.P. the maximum group size observed during this census for this specie was 31 and average group size 3.82, indicating a dispersed population of small herds or groups. This is corroborated by the widespread distribution pattern in low-lying areas near water recorded on Map 11. This distribution is similar to that recorded in 2010 by Viljoen.

Zebra

The estimate for Zebra in 2013 is 999 individuals, almost exactly the same as AMC's estimate of 1000. This specie is showing an increasing trend in population size with no abnormalities shown in the group size data set. The distribution of the specie continues to be skewed towards the northern part of the Park as it was in 2010. In

2013 many observations were recorded in the valley linking Nyamatete with Nyungwe (Maps 3 & 12). Although this concentration appears alarmingly close to the newly constructed western boundary fence it was due more to the emergence of green grass shoots after burning in the valley than a desire to vacate the Park. This statement is made with the knowledge that the former range for this specie would have covered an area beyond the current boundary of the Park as evidenced by tracks following the fence indicating that there is a certain amount of "fence walking" taking place in Akagera.

Topi

The 2013 estimate for Topi is 560 individuals with a maximum group size of 72 and an average group size of 5.71. Topi exhibit a slightly declining population trend in ANP. This is not alarming in as much as the specie is not conspicuous from the air and was probably undercounted in the survey of 2013. AMC's estimate of 800 may be more accurate than the 2013 census result. This specie is known to aggregate in large herds in areas that have extensive plains (Estes, 1993). In Akagera in 2013 the distribution focussed around the Kilala Plain and the highland areas of Mutumba that had been burnt (Map 13). In 2010 Viljoen also recorded a preference of this specie for the Kilala area.

Impala

This specie is well known as being small, well camouflaged and difficult to spot from the air especially in wooded regions. As a result it is often undercounted in aerial surveys. This census produced an estimate of 1,057 individuals. The population trend for impala appears to be slightly declining. This result is not alarming because impala are often undercounted from the air. AMC's estimate of around 2,000 probably a more accurate figure. The value of the 2013 result lies in its repeatability and therefore if future censuses make use of similar methodology trend analysis for the specie will become increasingly reliable and meaningful. The largest group size recorded was 37 and the average group size was 8.52 which is within normal limits for the specie. Similar to Viljoen's result in 2010 the distribution recorded in 2013 is skewed towards the lowland areas in the north of the Park (Map 14).

Warthog

The Warthog population estimate for 2013 was 714, significantly more than AMC's estimate of 250. The population appears to be growing in size. Being a specie that is prone to snaring this may indicate an effective job being done by AMC's anti-poaching unit. The largest group size is 16 while the average group size was normal at 2.88. There was evidence during the survey that some females had begun to drop

young which may account for this large record. Warthog are widespread in low-lying areas near water, particularly in the north of the Park (Map 15).

Hippopotamus

Eight hundred and eighty-five hippos were counted during the 2013 census, significantly more than AMC's estimate of 600. In spite of an undercount in 2010 (Viljoen), hippo appear to be increasing in number over time. The distribution is widespread along the wetland fringes with focal points in Lakes Rwanyakizinga and Hago (Map 16). This distribution pattern is similar that recorded by Viljoen in 2010. While the flight path of the survey did not cover the entire area of the wetland and therefore perhaps not the entire habitat used by hippo it did cover the preferred habitat. Furthermore the count took place all on one day. This estimate is tendered therefore as a Minimum Total Count for the specie. The method used is easily repeatable and if used in the future will produce data from which population trends can be analyzed in a reliable way.

Sitatunga

This specie was not specifically counted during the survey because priority was given to the terrestrial species occupying the Park. In spite of this three individuals were spotted, the location of which has been recorded on Map 24. Should it become important for the specie to be counted a dedicated survey is recommended due to the difficult nature of the terrain in which this cryptic species lives.

Baboons

Estes (1993), records that while the group size of baboons can vary greatly, typically they are made up of 30 - 40 members. Applying the figure of 35 to the number of troops of baboons recorded during the census in 2013 (being 61) a population estimate for ANP is derived of 2,135 individuals. This population is widespread as illustrated by Map 27.

Other species

The other species recorded during the survey are difficult to spot from the air and are typically undercounted during aerial wildlife census. In spite of this, census totals and distribution data are presented here. Specific mention should be made of sightings of three leopard and one shoebill stalk (Photograph 24). The latter was sighted in a location that is potentially accessible by vehicle, a situation that could be exploited for tourism purposes as this specie is much sort after by bird watchers.

Illicit Use of Park Resources

While it appears that poaching in Akagera National Park has been significantly reduced by the law enforcement efforts of AMC, it is clear that it remains to be a problem in the Park. Reference to Maps 32 and 33 shows a general correlation between the location of poaching camps and bones observed during this survey in the central areas of the Park. Note is also taken of the location of most of the poaching camps and boats observed along wetland fringes or in wetlands often not far from the Tanzanian border (Maps 33 & 34). This leads to the conclusion that the most significant types of poaching at the current time are fish poaching and the poaching of hippo. It would appear too that poachers are taking advantage of an international border and the prohibition of security forces from one country following them into another country evidenced by access routes leading into the park from Tanzania (Map 35).

During the survey, observation of poachers from the helicopter followed by communication with law enforcement rangers lead to the arrest of 6 poachers (Photograph 23). The potential role of an aircraft in law enforcement action and general surveillance in ANP is obvious and recommended.

It is clear that the law enforcement team currently functioning under the management of AMC is both motivated and effective.

CARRYING CAPACITY

Overpopulation of wildlife in any given ecosystem is not desirable as this causes changes in vegetation structure and species composition and eventually soil erosion which can lead to long term declines in wildlife carrying capacity. Similarly very low stocking rates of wildlife can result in undesirable changes to the vegetation of an ecosystem which in turn can lead to a reduction in biodiversity. Defining the animal carrying capacity of any wildlife system and articulating desired levels of stocking rates for different species is an important management function.

The growth of a recovering wildlife population, as in the case of most species in ANP, follows a sigmoidal pattern (Goodman, 2003). Growth slows when competition for resources becomes a limiting factor. At this point breeding rate declines and mortalities increase in vulnerable age classes (the very old and very young). Under stable environments the population then fluctuates around an equilibrium. The number or density of the population in question at this equilibrium where forces causing increase equal the forces causing decrease in the population size is termed the ecological carrying capacity (Figure 6).

The economic carrying capacity of a wildlife system is defined as that point on the recovery growth curve where breeding rate is at a maximum (Figure 6). At this point food resources are not limiting and production will always exceed consumption. In closed systems, without predators, where the harvest of wildlife is required as a source of income it is desirable to maintain populations at this point of maximum sustained yield (Figure 7)(Goodman, 2003).

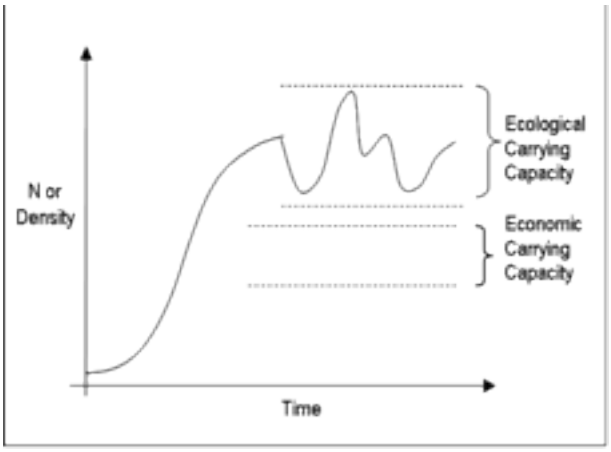

Figure 6: Schematic representation of a population growing to ecological carrying capacity and it relation to economic carrying capacity (After Goodman, 2003)

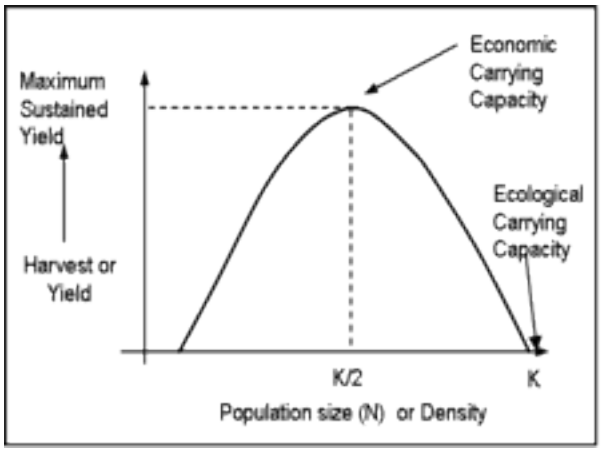

Figure 7: Idealised relation between yield from a herbivore population and its density (After Goodman, 2003)

In systems, like Akagera National Park, where natural resource based income is derived from non-consumptive tourism, stocking rates closer to the ecological carrying capacity are desirable as this maximizes the chances of tourists seeing wildlife enhancing their experience and increasing turnover.

The relationship between economic and ecological carrying capacity is not constant for all species. For example, in the case of smaller antelope species economic carrying capacity is approximately ½ of the ecological carrying capacity. For mega herbivores this level is closer to ¾ of the ecological carrying capacity.

Recommending a wildlife stocking rate close to the ecological carrying capacity, Goodman (2003) used a model in which rainfall, soil and species diversity in relation to habitat type and extent are the principal determining factors to the establishment of an estimate of ecological carrying capacity for Akagera National Park. He estimated the biomass carrying capacity at 4,700 kilograms per square kilometer in contrast to Lamprey (2002) who estimated the carrying capacity of the Park at between 8,000 and 12,000 kilograms per square kilometer. Goodman relates his figure to animal units and assigns an animal unit equivalent to each species, deriving from this an estimate in terms of numbers of animals for the ecological carrying capacity of seventeen species in four different feeding classes. Some species that

occur in ANP have been excluded from the carrying capacity estimate, namely sitatunga and the smaller forest dwelling antelope. This is due either to numerical anomalies associated with making a meaningful estimate (sitatunga) or because there is no empirical basis available upon which to make such an estimate (duiker) (Goodman, 2003). Goodman included in his ecological carrying capacity estimate for ANP herbivore species that are known to have existed previously in the Park but are now locally extinct (e.g. black rhino) and species that could have occurred in the Park but for which historical information is limited (e.g. white rhino). Integrated into Goodman's model is the prediction of the time at which each specie will achieve ecological carrying capacity. Predicting a fast rate of recovery in the absence of predators and removals from human elements, he applied high breeding rates to Lamprey's populations estimates of 2002 to calculate these predictions. Goodman pointed out the potential for rapid increase of large herbivore populations under these conditions and the risk of populations of some species increasing beyond desirable levels in a relatively short time frame. This leads to the possible requirement for management intervention in controlling population "overshoots".

Table 4 supplies Goodman's ecological carrying capacity estimates and time predictions, in relation to Lamprey's population estimates of 2002 and the wildlife population estimates for 2013.

Table 4: A comparison between the ecological carrying capacity of ANP as estimated by Goodman (2003), the population estimate in 2002 (Lamprey 2002) and the population estimate in 2013 in relation to the predicted year of achievement of ecological carrying capacity by Goodman (2003).

Species	Ecological Carrying. Cap.	Predicted Yr of Achievement	Pop. Est. 2002	Pop. Est. 2013
Bulk Grazers				
Rhino / white	120	-	0	0
Hippo	560	2003	552	885
Buffalo	1400	2012	309	2093
Roan	110	>2012	10	83
Zebra	1100	2007	390	999
Waterbuck	300	2006	141	948
Concentrate Grazers				
Topi	900	2005	531	560
Reedbuck	130	2004	74	47
Warthog	430	2004	262	741
Oribi	50	-	-	20

Table 4 Continued:

Mixed Feeders				
Elephant	250	>2010	80	88
Eland	300	2008	114	193
Impala	4500	2006	982	1057
Duiker	350	-	-	37
Browsers				
Rhino / black	80	-	0	0
Giraffe	200	>2012	20	54
Bushbuck	200	2004	100	55

As at August 2013, the stocking rates for the species hippo, buffalo, waterbuck and warthog all exceed the Goodman's ecological carrying capacity estimates. Goodman recommends intervention in the absence of predators in the case that stocking rates exceed the ecological carrying capacity. Alternatively the introduction of lion could be considered to perform a governing function on these populations showing tendencies to "overshoot" the ecological carrying capacity. Both lamprey 2002 and Goodman 2003 pointed out that roan antelope is a species that is particularly vulnerable to extirpation in ANP. The most recent estimate derived from a total area count indicates that there is a population of at least 83 individuals of this species in ANP. Under circumstances when the buffalo population is in excess of 2000 individuals and several other species have shown significant recovery patterns, the risk to the roan population of introducing an apex predator in the form of a pride of lions is low. It is my opinion that lions could be introduced to ANP in conservative numbers with appropriate monitoring at this time.

The species elephant, giraffe, eland, roan, zebra, topi, impala, reedbuck, oribi, duiker and bushbuck have not yet reached their optimum stocking rates. In the case of topi, impala, oribi, reedbuck, bushbuck and duiker, populations for these species have probably been underestimated for reasons already explained. Their current population sizes may be closer to the carrying capacity than recorded here. Eland, roan and zebra are likely to achieve the estimated ecological carrying capacity in the near future given continued protection. Elephant has a slower breeding rate than most other herbivores (rmax = 0.1 (Goodman, 2003)). This specie is likely to take some time to reach its estimated ecological carrying capacity of 250. Similarly the giraffe population is likely require some time to reach its ecological carrying capacity estimate of 200. Neither giraffe nor elephant are likely to form a major part of the diet of lions in the event of a re-introduction of this specie.

There are no rhinos left in Akagera National Park. With the improved security status of the Park reintroduction of black rhino, in particular, can be considered.

RECOMMENDATIONS

I have the following recommendations to make:

Survey Methods

It is recommended that total count methods are used for future wildlife censuses in Akagera National Park. This will yield both the most accurate population estimates and reliable population trend analysis. Taking advantage of experience gained during the 2013 game count in ANP I believe consideration should be given to altering the east to west flight path orientation in favour of following the "grain" of the topography. The effect of this will be to improve safety in flight, to maintain a constant altitude above ground level and to provide for the precise counting of wildlife in accordance with its distribution. It is my opinion that wildlife census in Akagera could be adequately achieved with the use of a Bathawk two seat, light sport, aircraft or a Bantam B22J conventional control microlight. This is likely to reduce costs and provide an added benefit in terms of surveillance.

Aircraft

In my opinion the permanent station of either a Bathawk or Bantam aircraft at Akagera N.P. would not only serve the purpose of conducting censuses but would also become an invaluable tool in assisting law enforcement activity and management interventions across a park with very varied terrain some of which is otherwise inaccessible, namely the wetland areas. I recommend the purchase and station of such an airplane in the Park.

Provision of a Quality Tourist Facility in the North of the Park

Clearly there is a concentration of wildlife in the northern parts of the Park (refer to the distribution maps in Appendix 1). This area also features some of the most spectacular scenery in the Park. I support Mr. Gruner's conclusion that a quality tourist accommodation facility should be positioned somewhere in the north of the Park to contribute to the development of tourism in the area and to the business agenda of AMC.

Introduction of Lion and Black Rhino

With the increase in the populations of several species, particularly buffalo, to levels that exceed the ecological carrying capacity as estimated by Goodman in 2003, consideration of the re-introduction of lion as a governing factor to those populations can now be made. The introduction of an apex predator into any system does need to be considered carefully in the light of the complex primary effects that this can have on prey species and the secondary effects on vegetation. Similarly the

re-introduction of black rhino to ANP can be considered. The challenges associated with the protection of such a valuable specie are complex and will require dedicated planning. These considerations are, however, beyond the scope of this report.

The re-introduction of lion and black rhino into ANP would undoubtedly play a part in restoring the area's biodiversity and improve the tourism potential of the Park. I recommend the consideration of re-introduction of both species.

CONCLUSION

In 2002, Lamprey estimated a general decline in wildlife in Akagera National Park of between 50% & 80% since the previous survey conducted by Williams & Ntayombya in 1997 / 8, five years before. The GTZ funded PRORENA project which started in 1999 heralded an improvement in park management. Since 2010 the Akagera Management Company has been vigorously addressing factors limiting healthy wildlife populations, the principal force being poaching. Today upward trends are being observed in the case of some species, most notably buffalo, waterbuck, zebra and warthog (Figures 1,2,3 & 6). Further to this Lamprey warned of the possible local extirpation of roan antelope in 2002. This vulnerable species now numbers at least 83 individuals. There is an obvious correlation between improved wildlife management and increasing wildlife populations.

It is clear that the Akagera Management Company's efforts to rehabilitate Akagera National Park are in great measure being successful.

ACKNOWLEDGEMENTS

I would like to acknowledge the following people and organizations for their assistance and participation in the production of this report:

The Rwanda Development Board for granting permission to conduct this wildlife census of Akagera National Park.

The Akagera Management Company for commissioning the survey and providing the logistical services required to complete the exercise.

Akagera Aviation Ltd for providing a well-maintained helicopter ensuring the safety of all parties involved in the survey.

Mr. Egide Rekambane for piloting the helicopter in a competent fashion.

Mr. Carey Martin-Ouelette for acting as ground support for flight operations.

Messrs. Jes Gruner and Eugene Mutangana, senior managers of AMC, who acted as very competent observers during the survey.

Ms. Sarah Hall who assisted with digitizing the raw data.

Mr. Jes Gruner & Ms. Sarah Hall for accommodating me in their home during the survey.

Mrs. Shannon Macpherson for proofreading the document.

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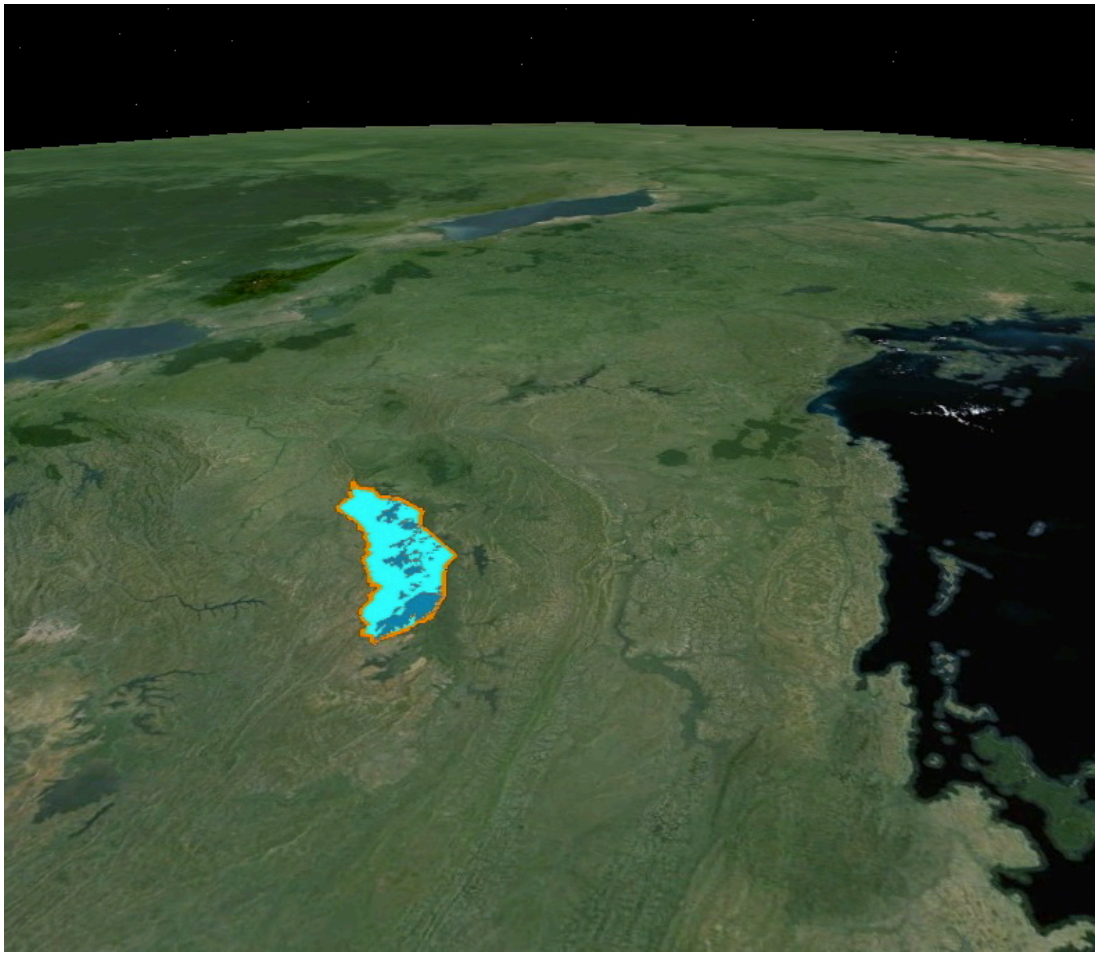
C L U N Y
Providing Aerial Services

Appendix 1

Maps Serving a Report on an Aerial Wildlife Census of Akagera National Park - August 2013



B Y D E R E K M A C P H E R S O N

18 September 2013

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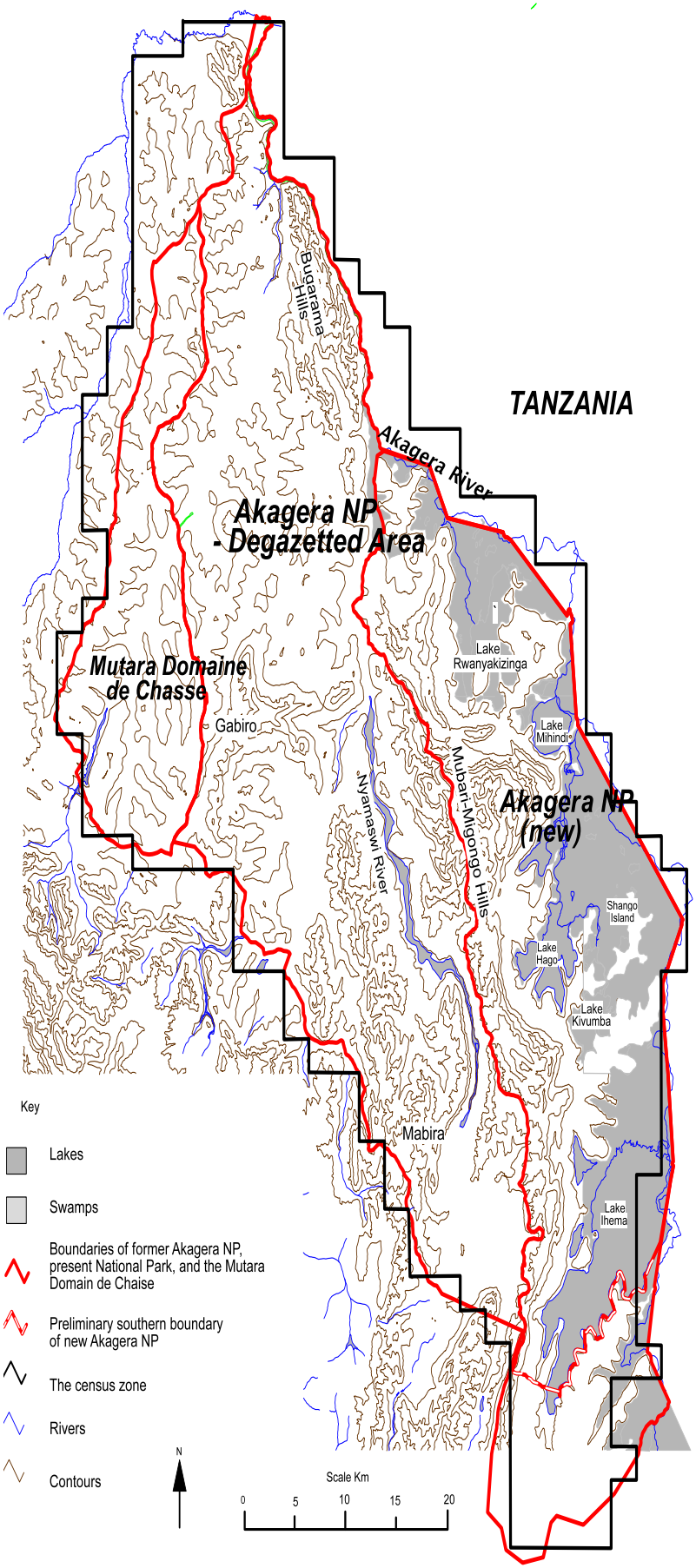
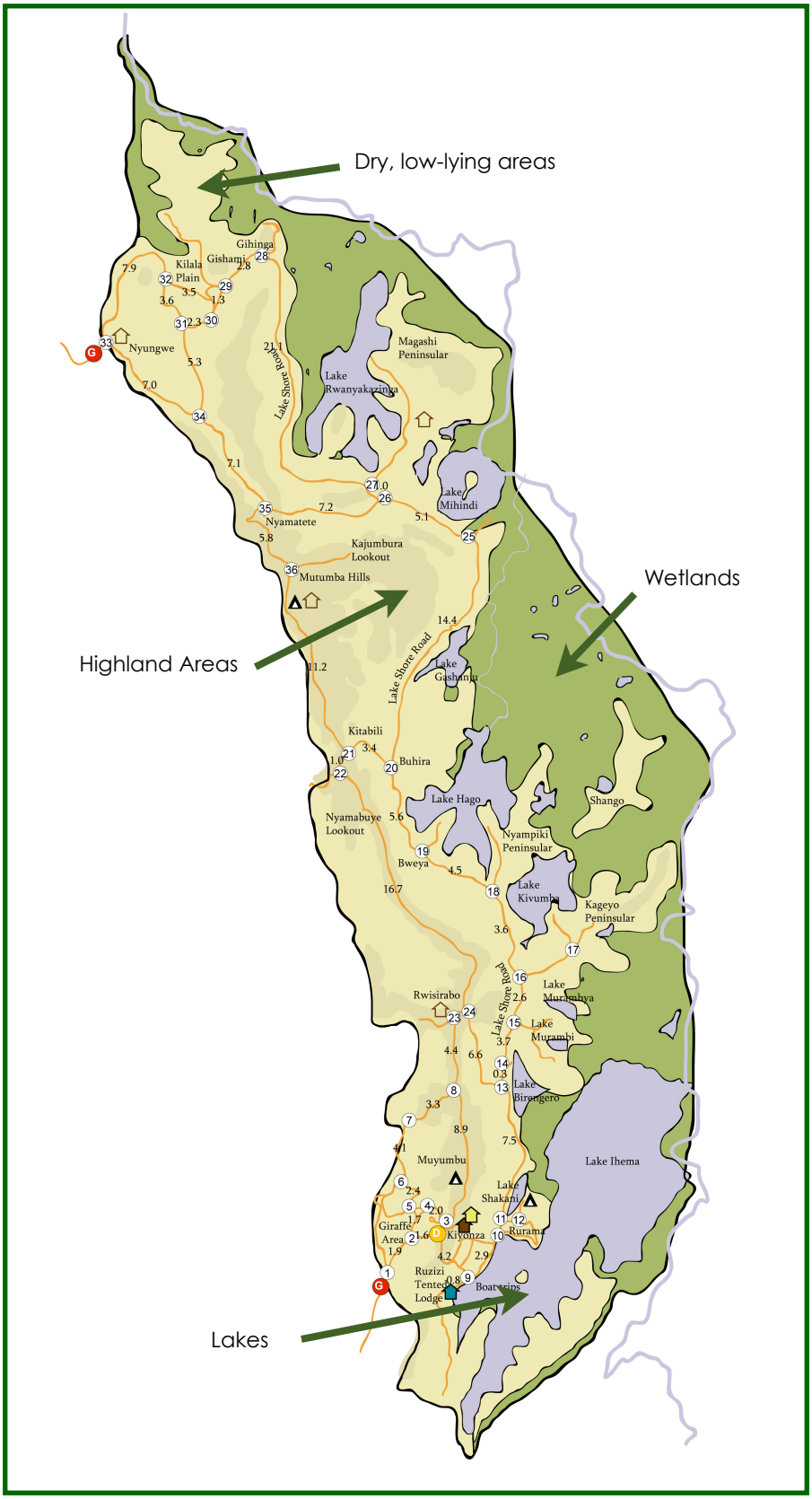
clunyafrica@gmail.com

Map 1: The location of Akagera National Park in Rwanda on the eastern boundary of the country with Tanzania (After the Giraffe Conservation Status Report, 2012)

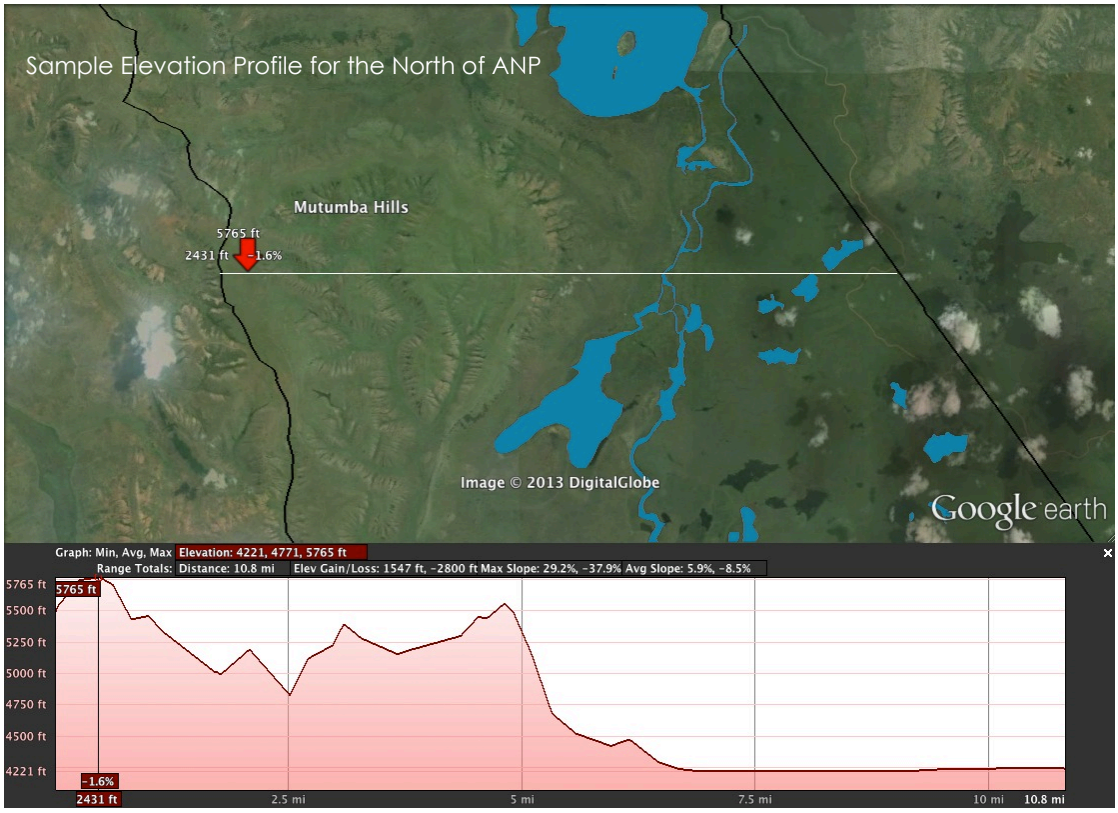
Map 2: Defining the areas associated with the Mutara Domaine de Chasse, the de-gazetted area of ANP and the "new" Akagera National Park Boundaries (After Lamprey 2002)

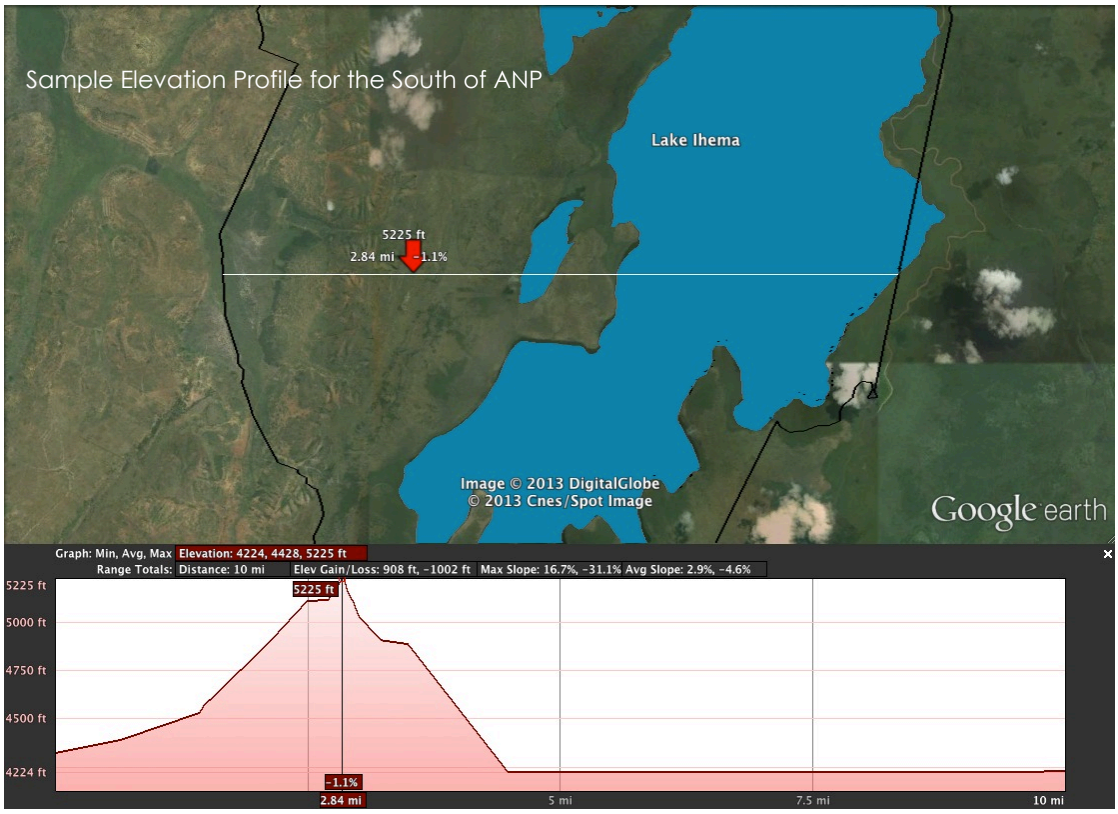


Map 3: Map of present-day Akagera National Park showing the location of wetlands versus dry low-lying areas and hill country (Modified Park Map Courtesy of AMC)

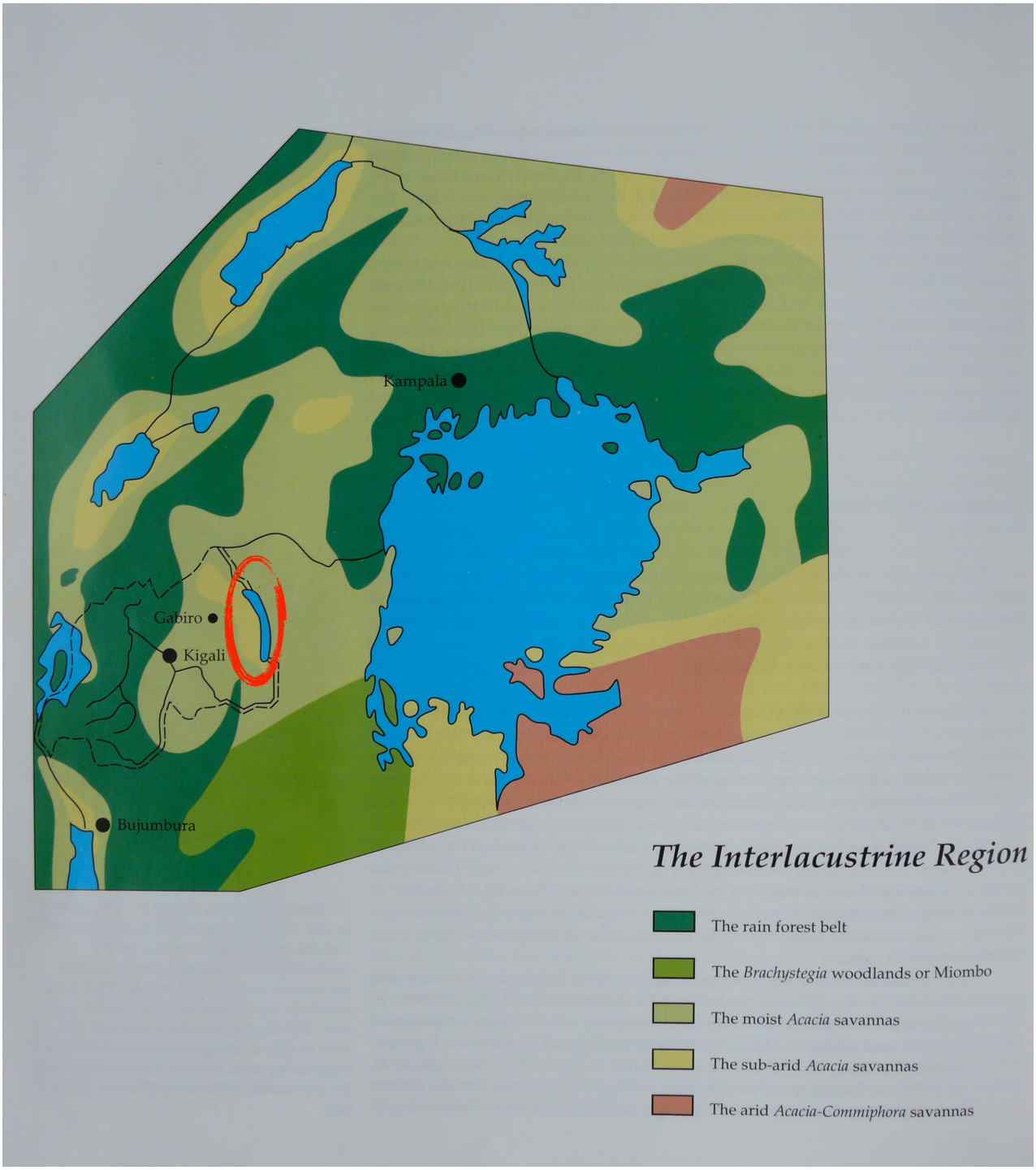


Map 4: Sample Elevation Profiles for the northern and southern parts of Akagera National Park illustrating the hilly, elevated topography in the western part of the area giving way to lower-lying dry land areas and a vast wetland in eastern parts of the Park

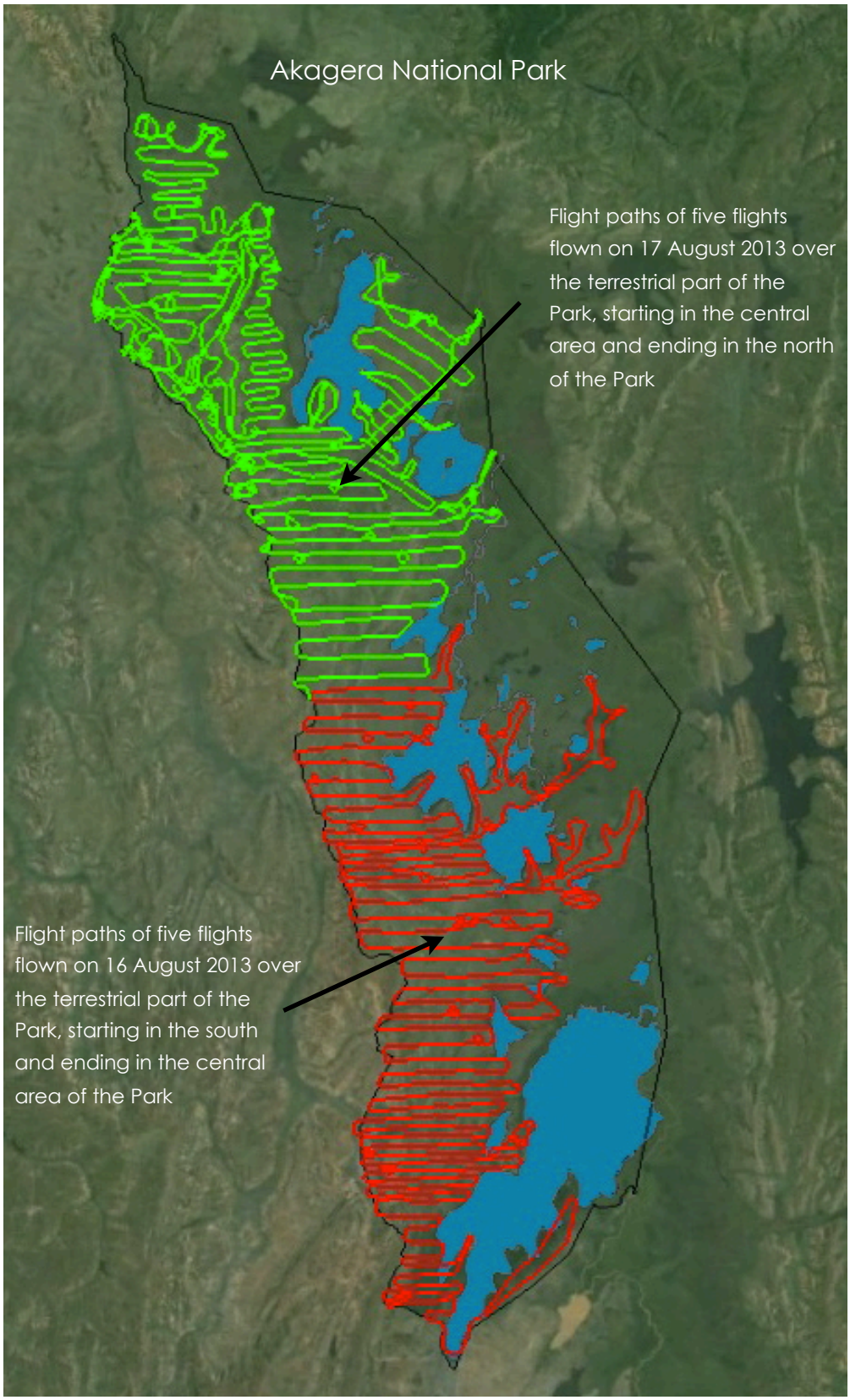




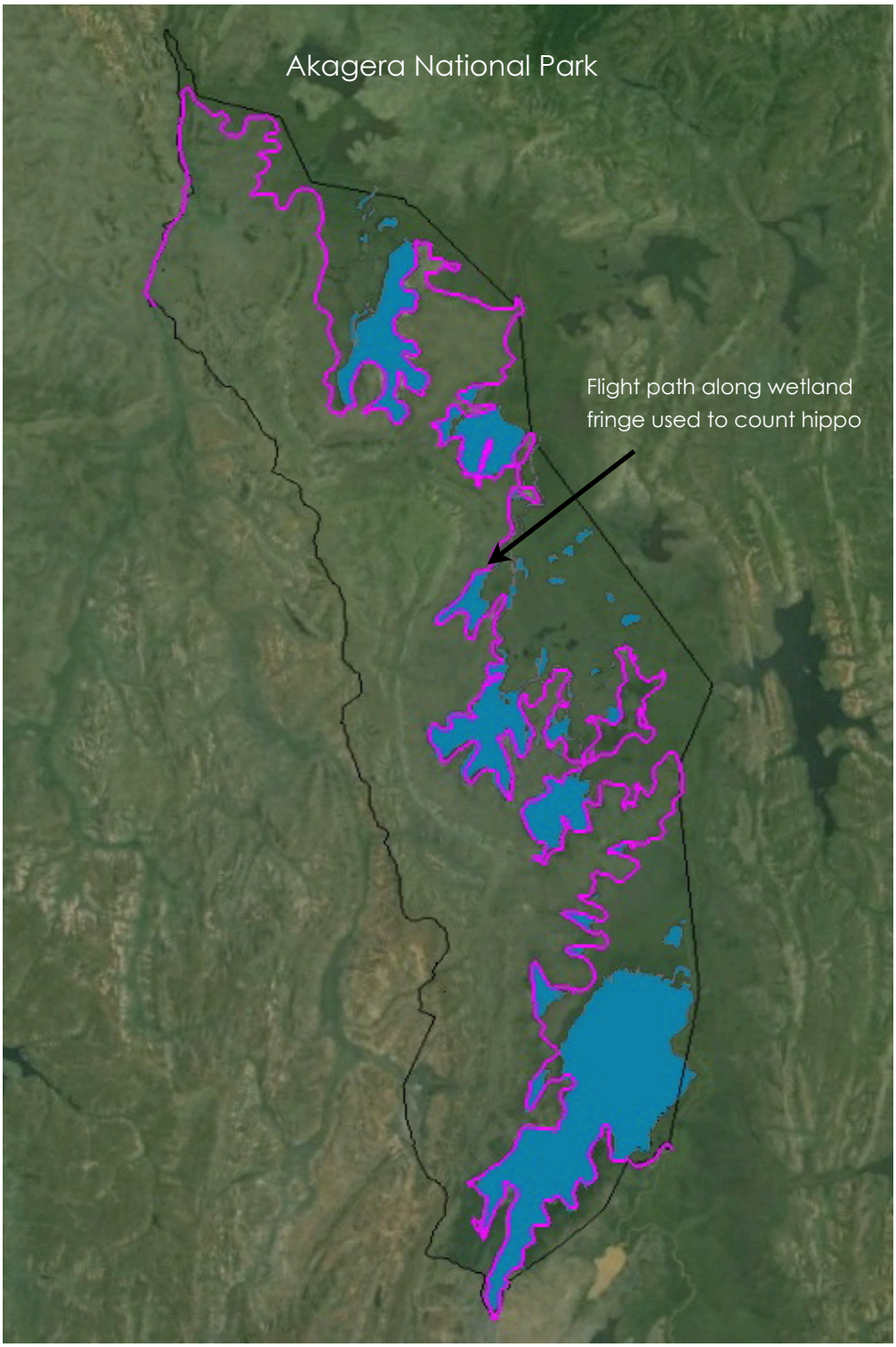
Map 5: The Interlacustrine Region of East Africa and the location of Akagera National Park which represents an isolated enclave of sub-arid Acacia savanna (After Vande weghe, 1990)



Map 6: Flight paths flown during the census of the terrestrial species of mammal occurring in Akagera National Park

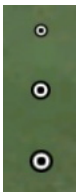


Map 7: Flight path flown along the entire wetland fringe of Akagera National Park from north to south used to count hippopotami



Notes for Maps 8 to 35

- Maps 8 - 16 show the distribution of relevant species for the 2010 (After Viljoen, 2010) and 2013 wildlife surveys.
- Maps 17 - 31 show the distribution of relevant species only for the 2013 wildlife survey.
- Map 32 shows the distribution of bones of dead animals observed without differentiating species.
- Maps 33 - 37 provide information relating to illicit use of Park resources.
- With reference to the maps referring to distribution of wildlife and other matters of interest during the 2013 survey please note the following:
  - The red line on maps corresponds to the interface between the wetland and dry-land areas of the park.
  - The following symbols are given associated definitions in terms of observation group size:

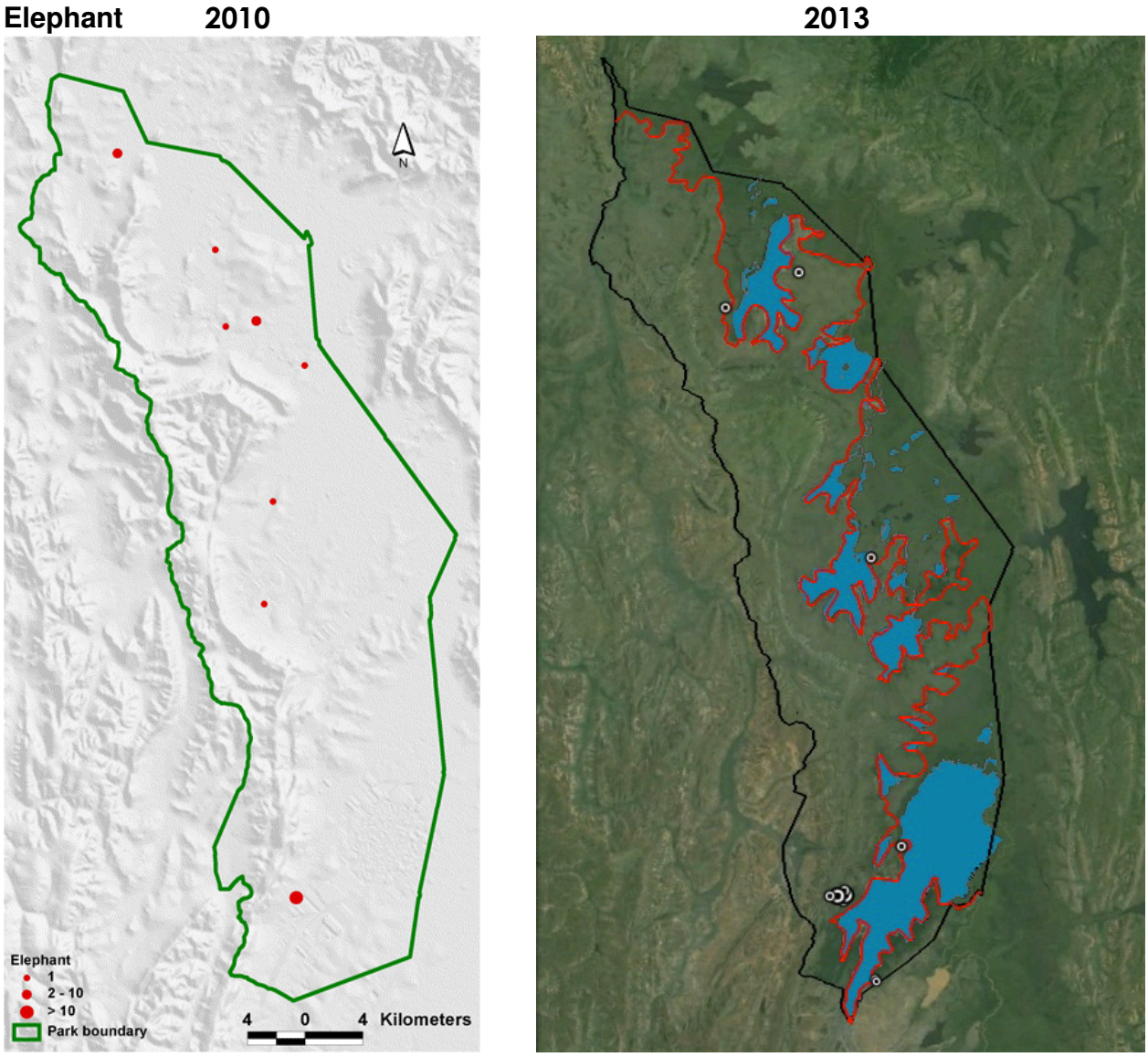


Animal / observation group sizes 1 - 19

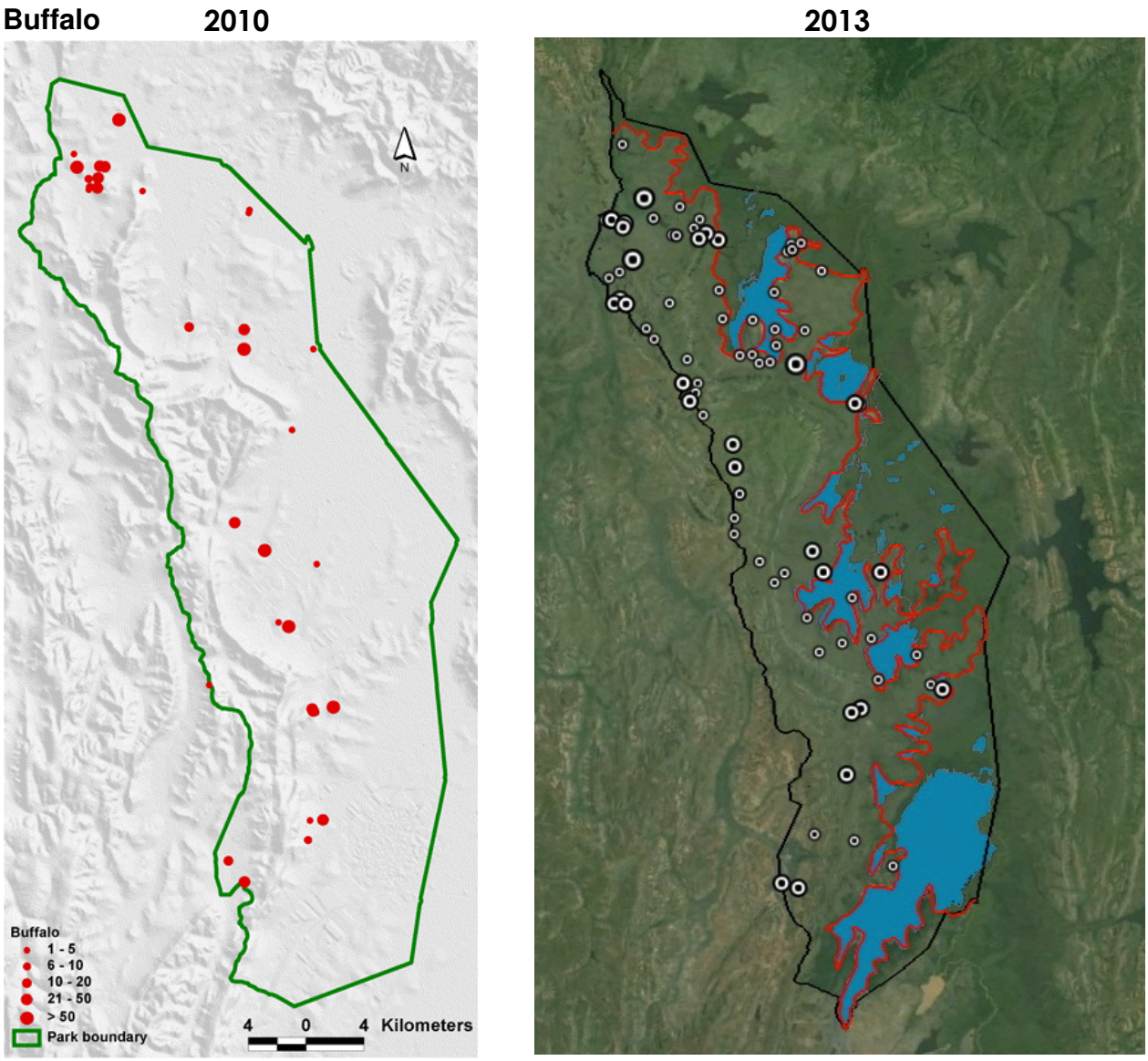
Animal / observation group sizes 20 - 99

Animal / observation group sizes 100 and above

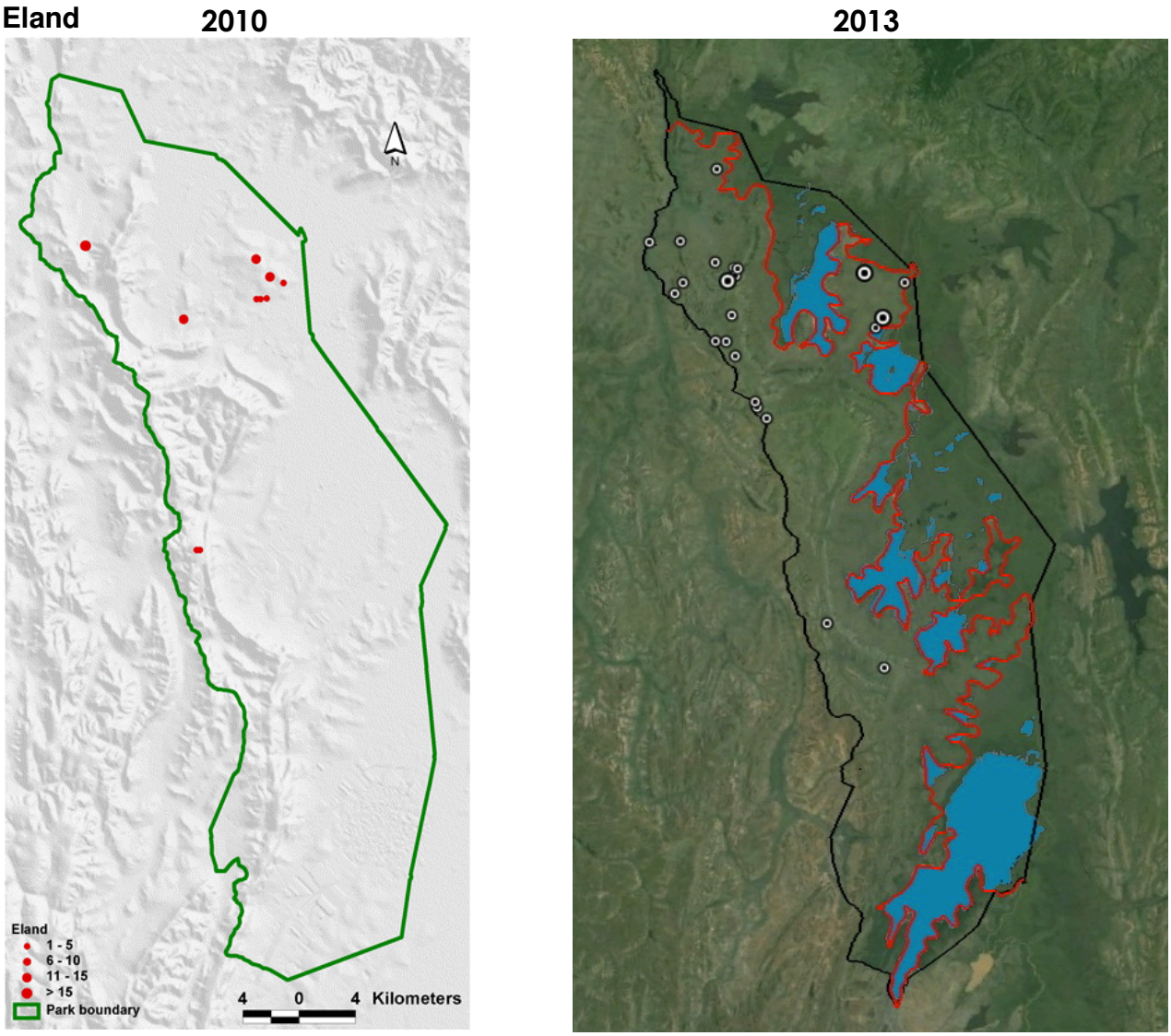
Map 8: Elephant distribution during the 2010 and 2013 wildlife censuses of Akagera National Park



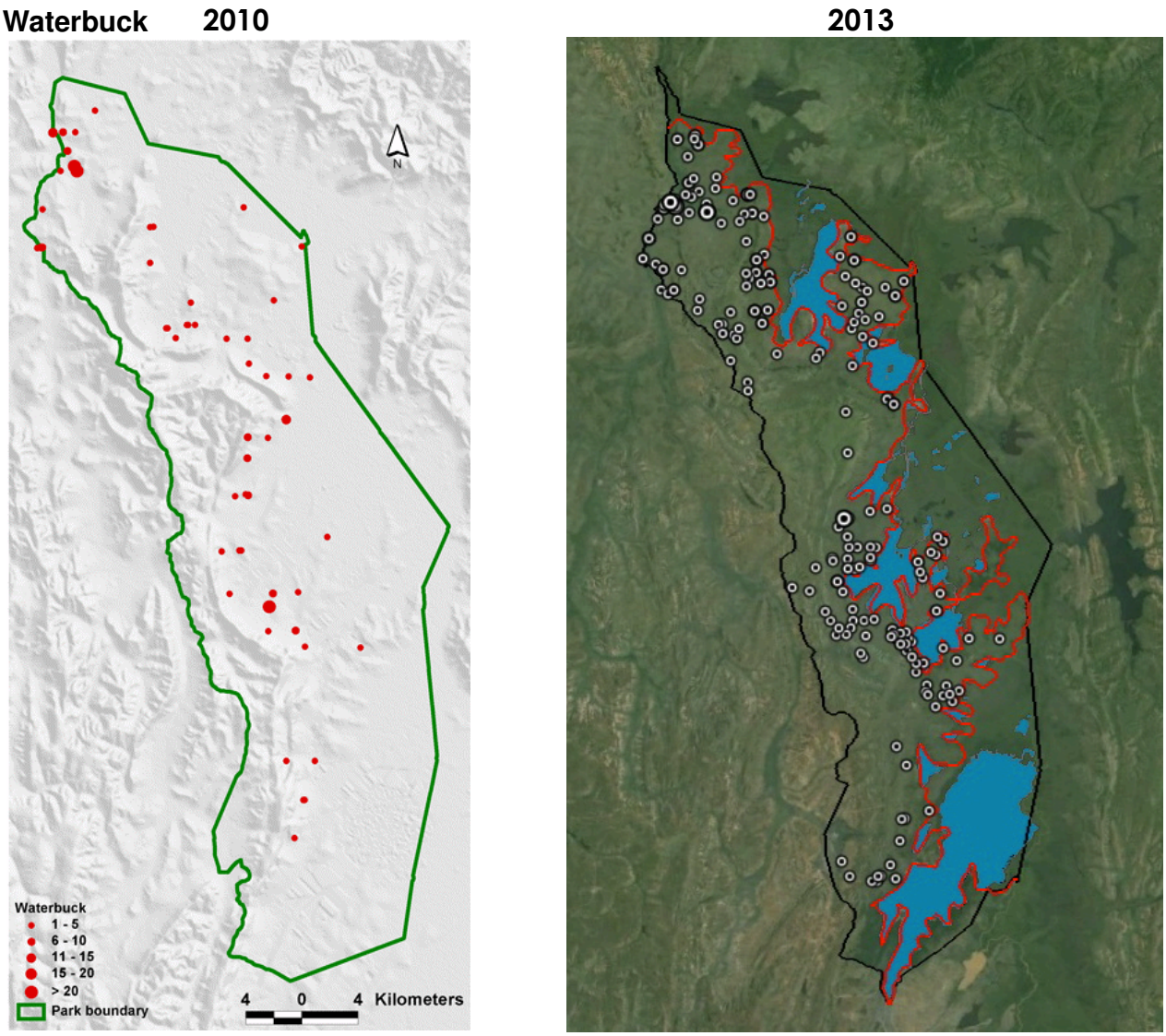
Map 9: Buffalo distribution during the 2010 and 2013 wildlife censuses of Akagera National Park



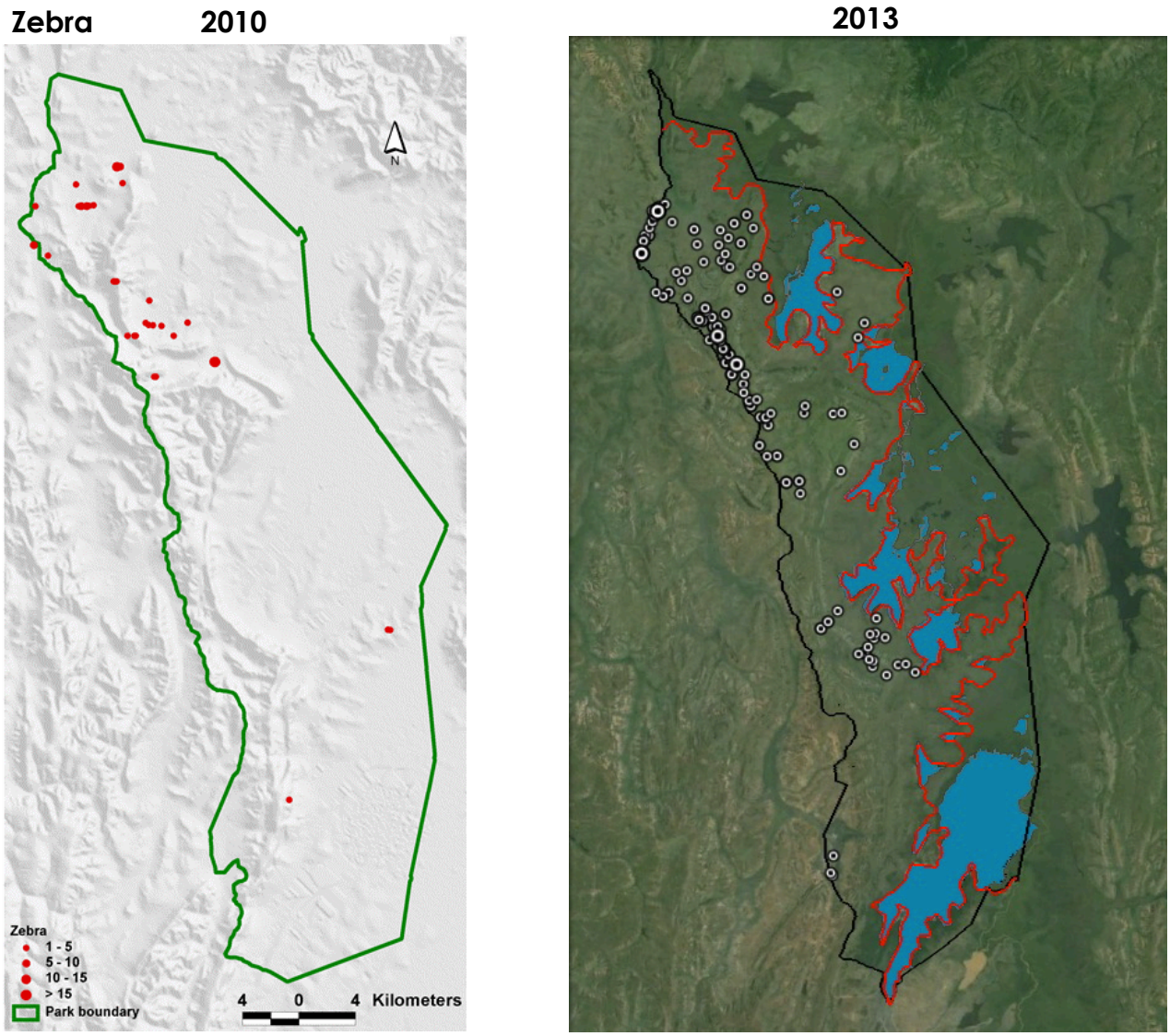
Map 10: Eland distribution during the 2010 and 2013 wildlife censuses of Akagera National Park



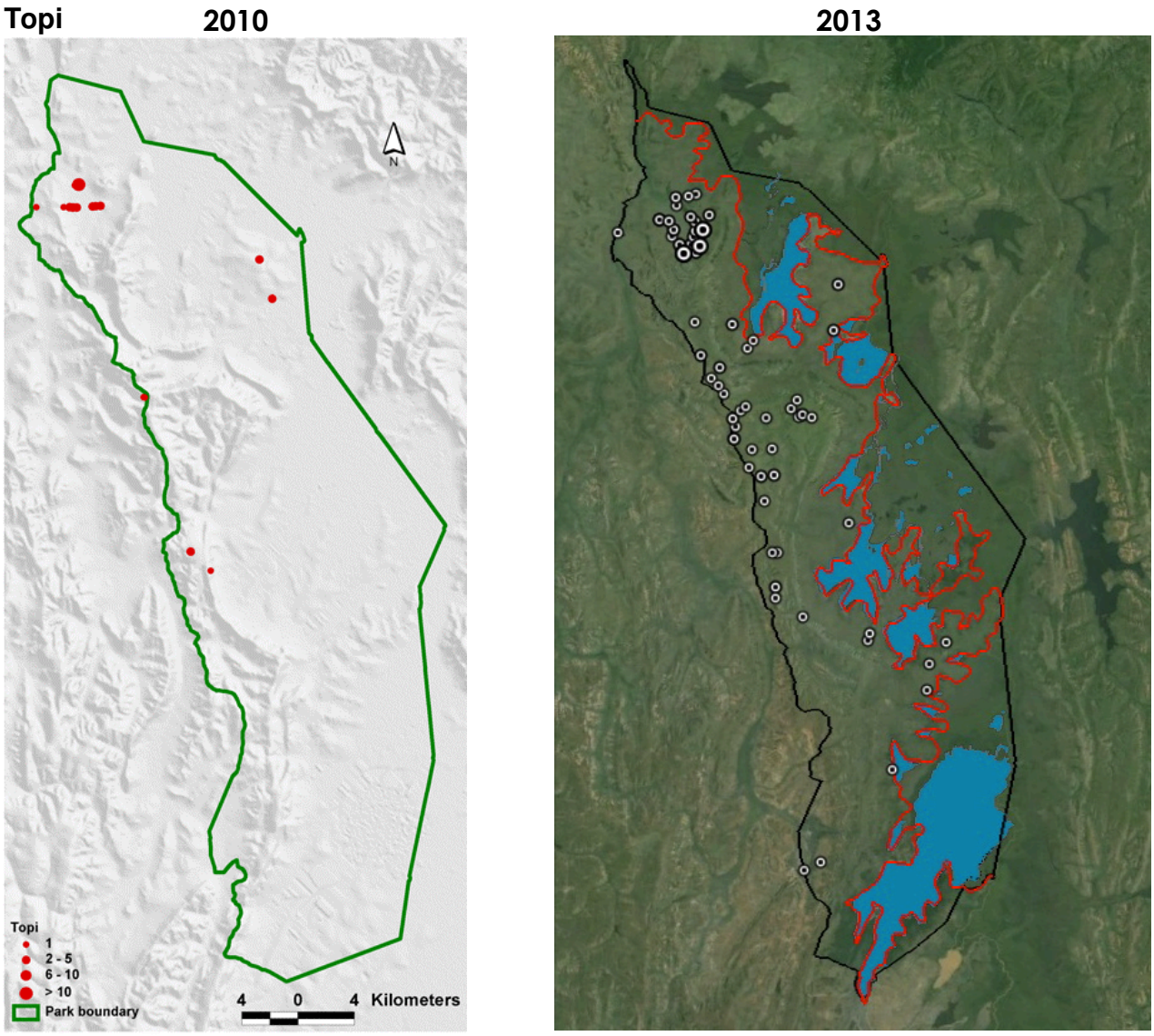
Map 11: Waterbuck distribution during the 2010 and 2013 wildlife censuses of Akagera National Park



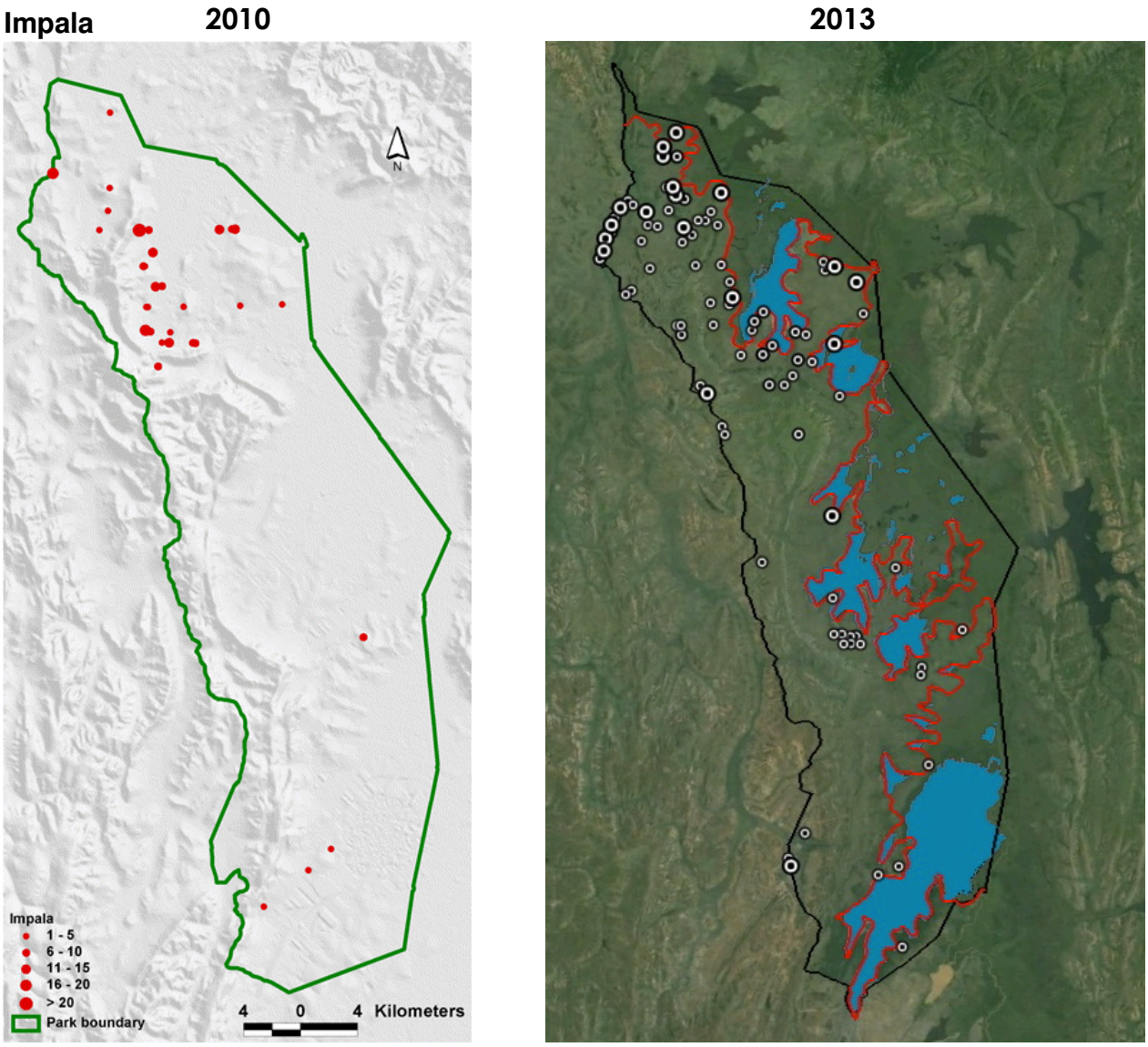
Map 12: Zebra distribution during the 2010 and 2013 wildlife censuses of Akagera National Park



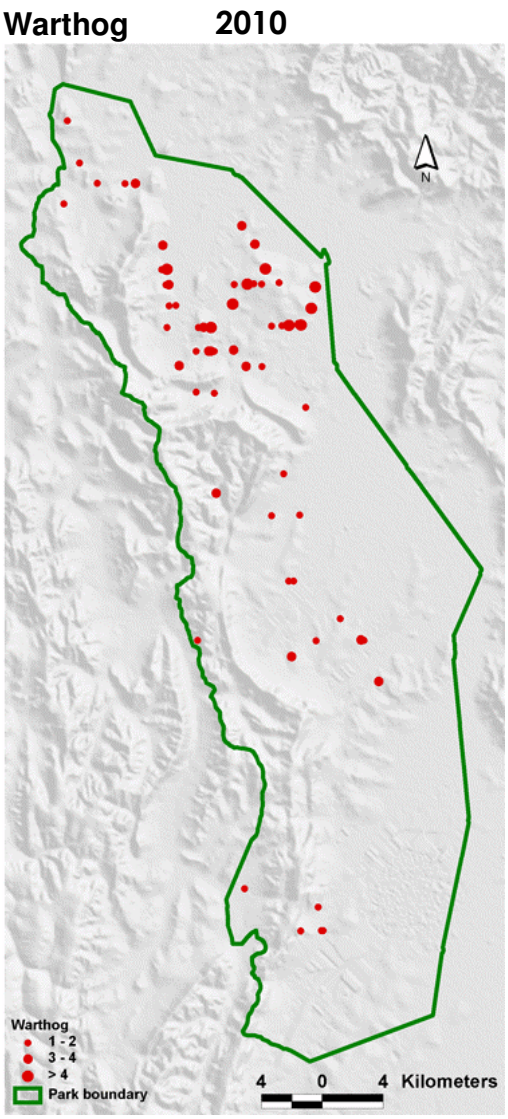
Map 13: Topi distribution during the 2010 and 2013 wildlife censuses of Akagera National Park

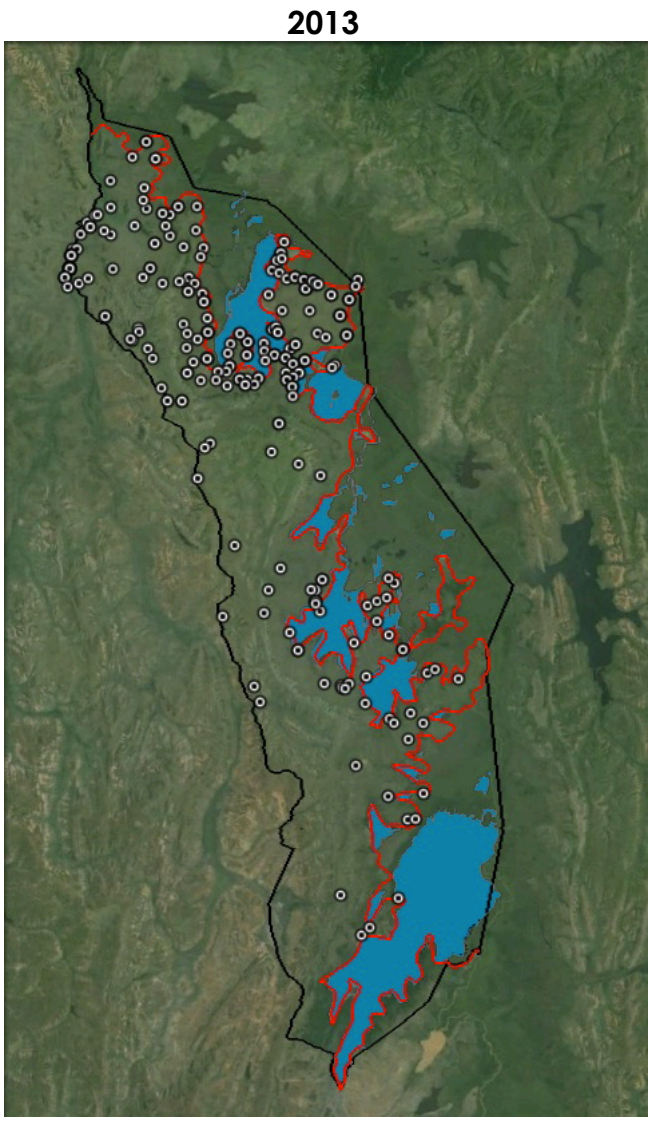


Map 14: Impala distribution during the 2010 and 2013 wildlife censuses of Akagera National Park

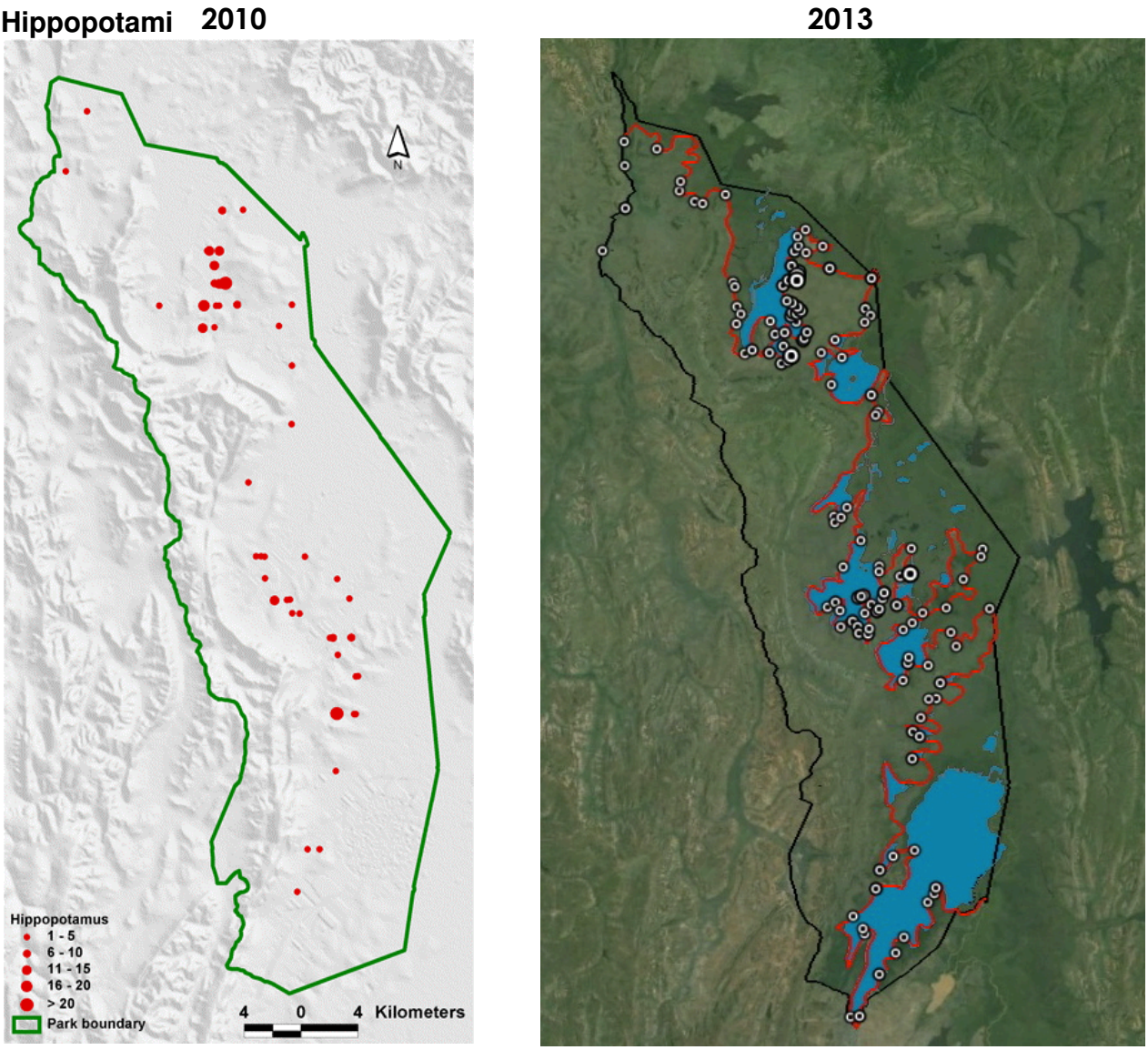


Map 15: Warthog distribution during the 2010 and 2013 wildlife censuses of Akagera National Park





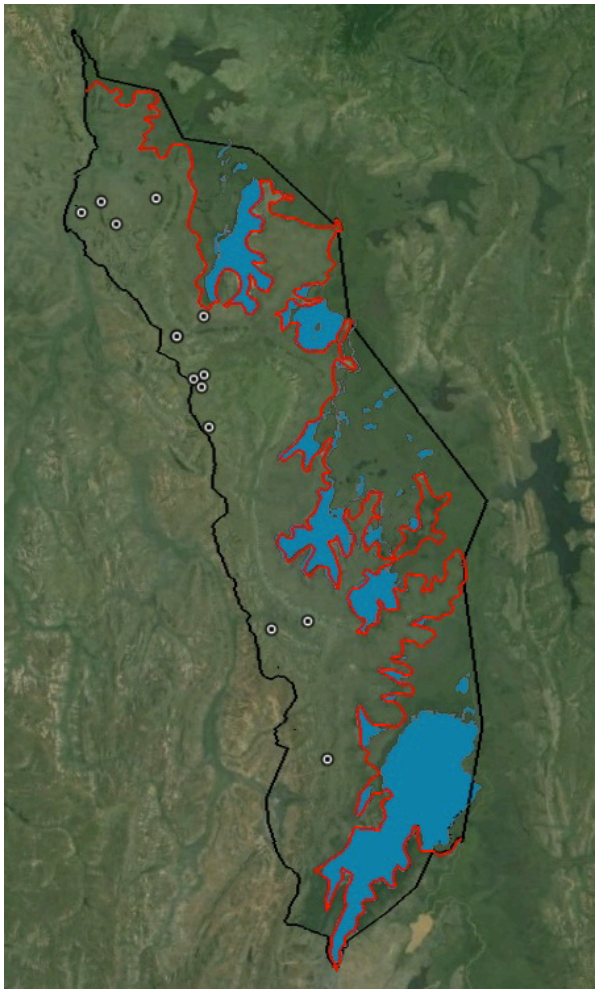
Map 16: Hippopotami distribution during the 2010 and 2013 wildlife censuses of Akagera National Park



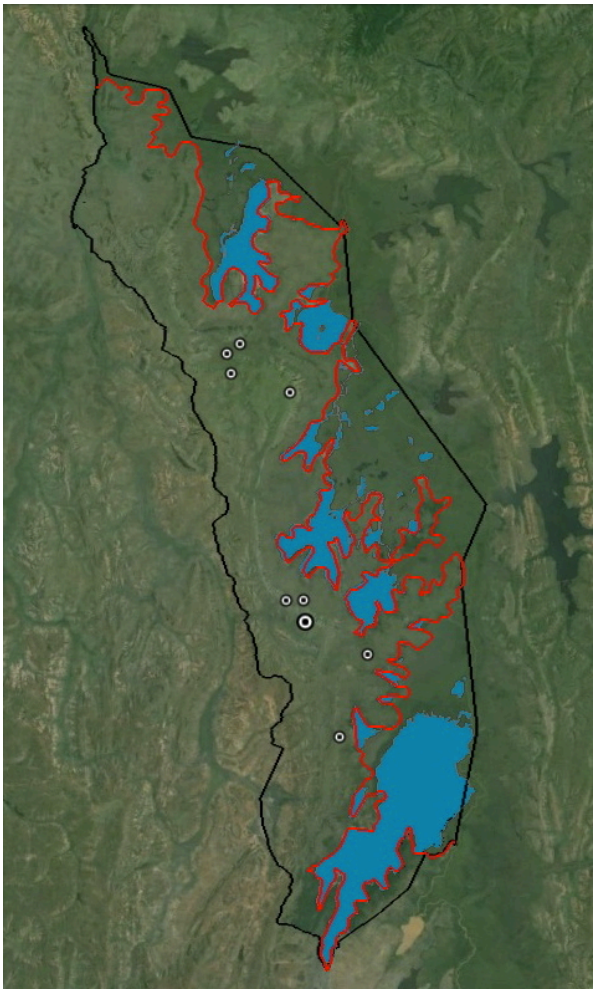
Map 17: Giraffe distribution during the 2013 wildlife census of Akagera National Park

Map 18: Roan distribution during the 2013 wildlife census of Akagera National Park

Giraffe 2013

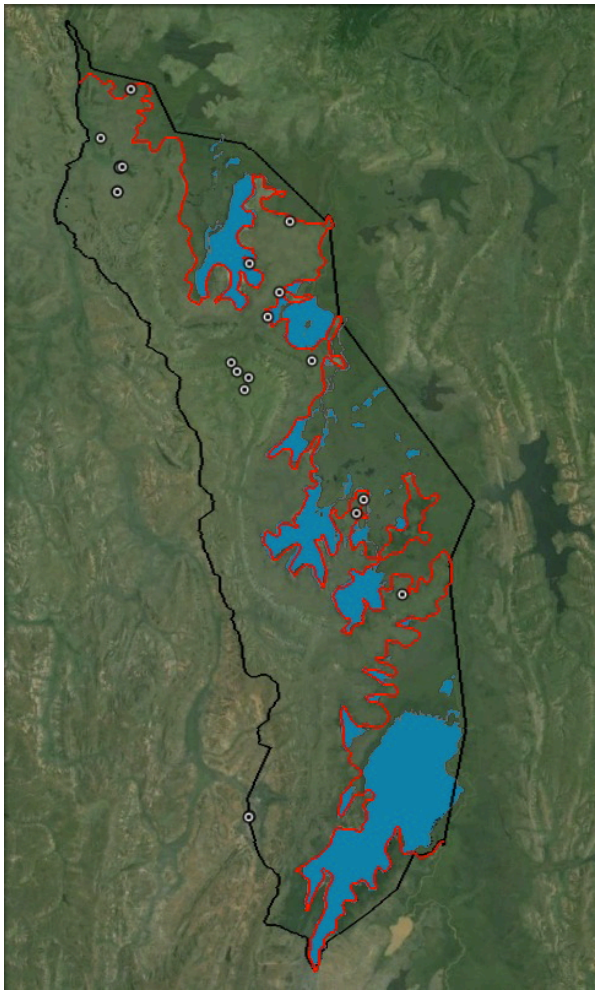


Roan 2013



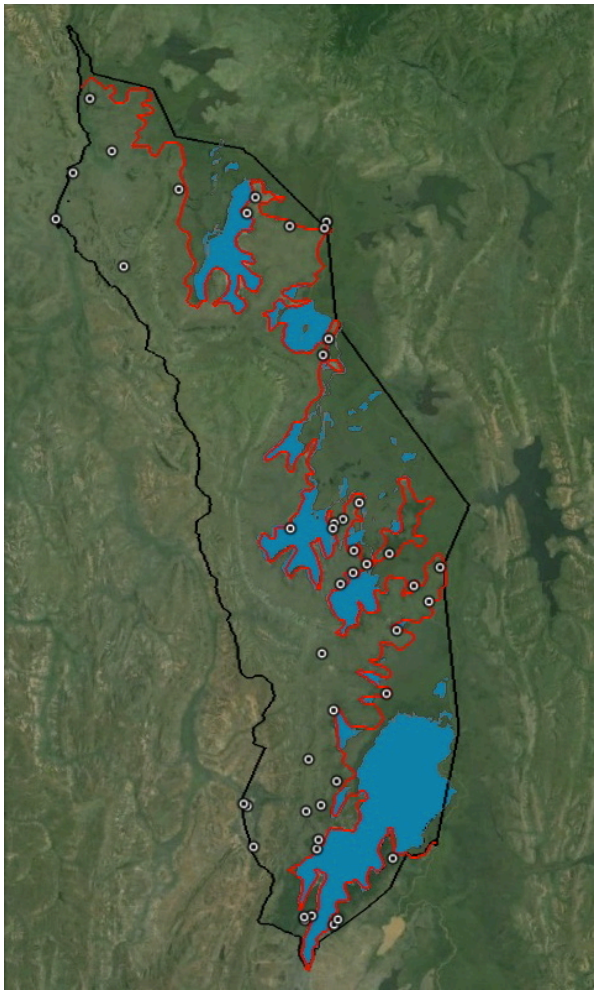
Map 19: Reedbuck distribution during the 2013 wildlife census of Akagera National Park

Reedbuck 2013



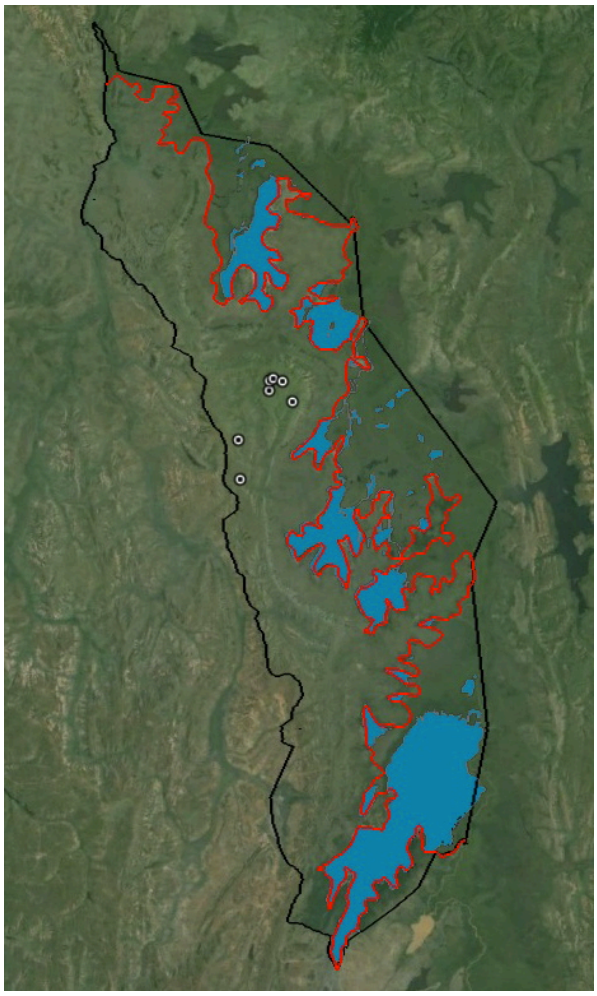
Map 20: Bushbuck distribution during the 2013 wildlife census of Akagera National Park

Bushbuck 2013



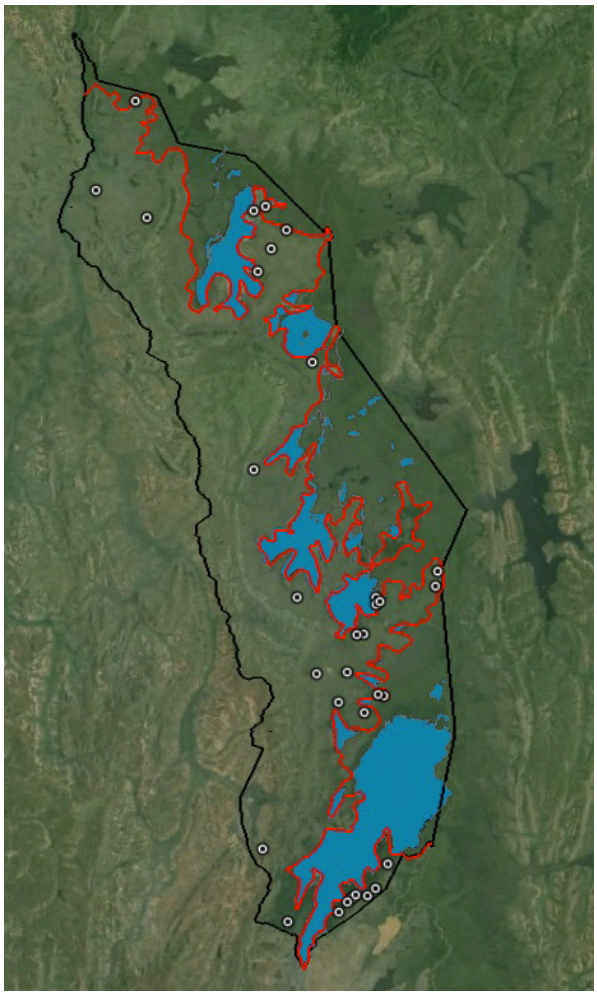
Map 21: Oribi distribution during the 2013 wildlife census of Akagera National Park

Oribi 2013



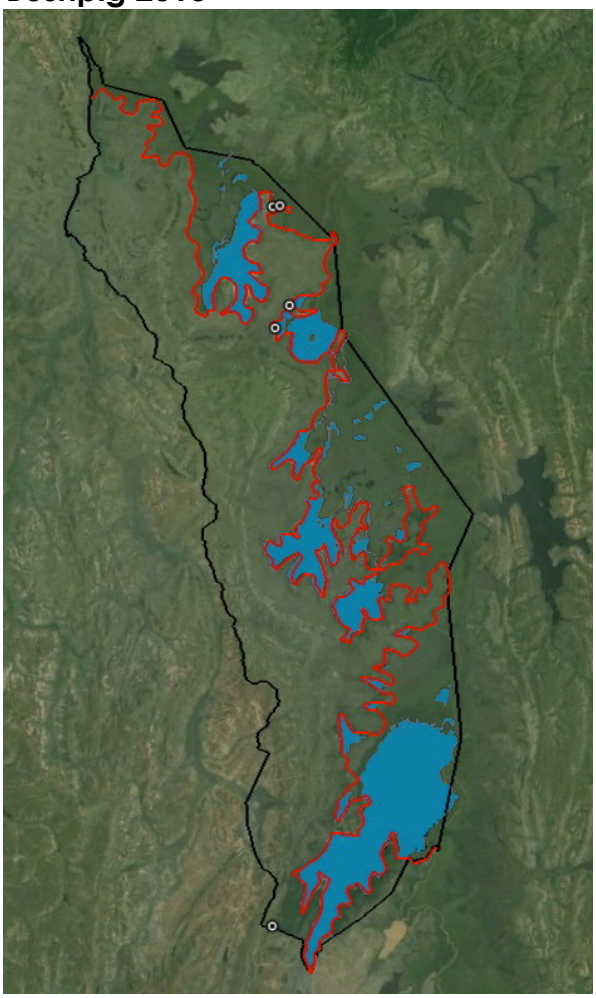
Map 22: Duiker distribution during the 2013 wildlife census of Akagera National Park

Duiker 2013



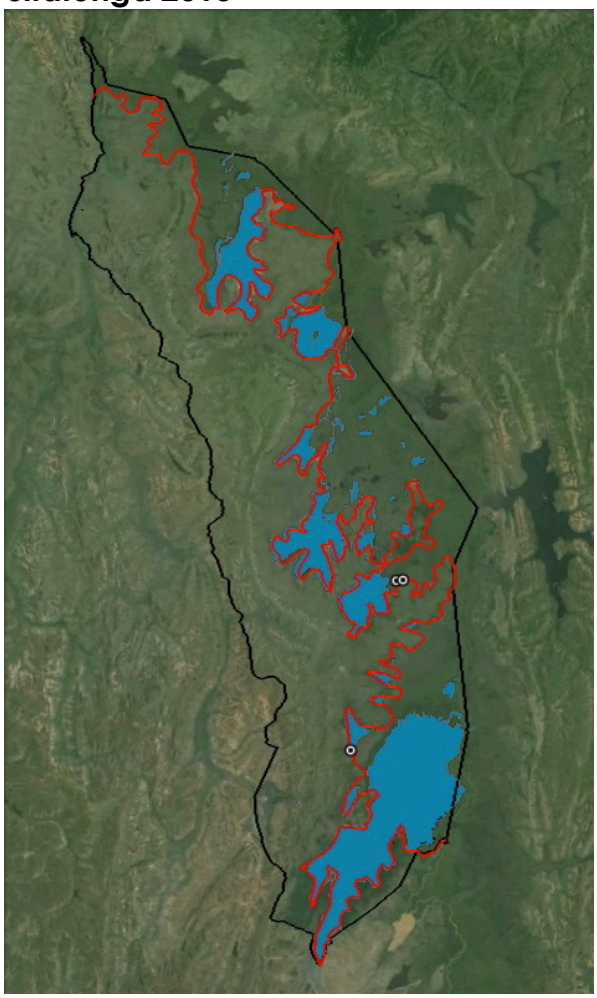
Map 23: Bushpig distribution during the 2013 wildlife census of Akagera National Park

Bushpig 2013



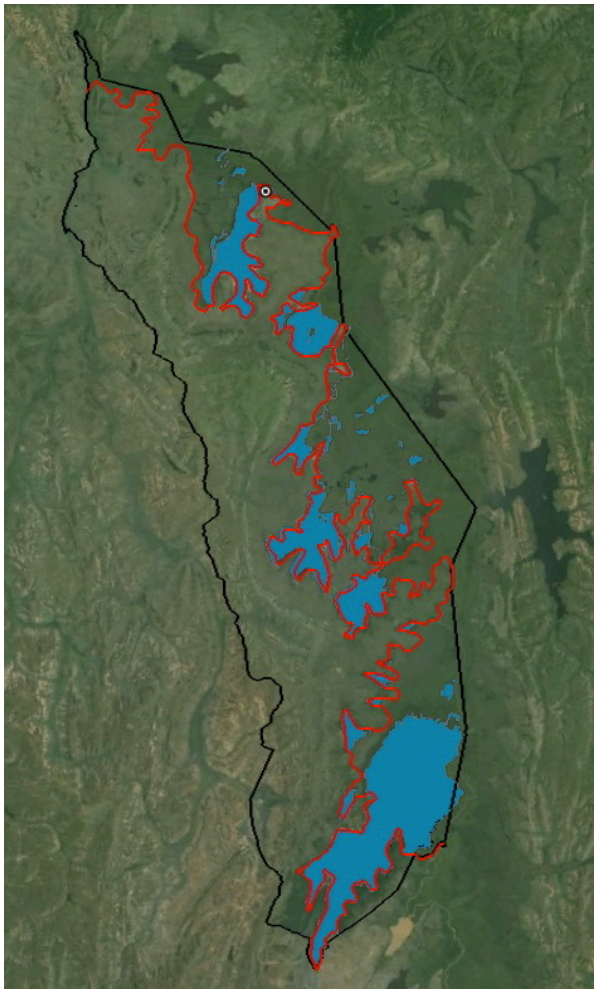
Map 24: Sitatunga distribution during the 2013 wildlife census of Akagera National Park

Sitatunga 2013



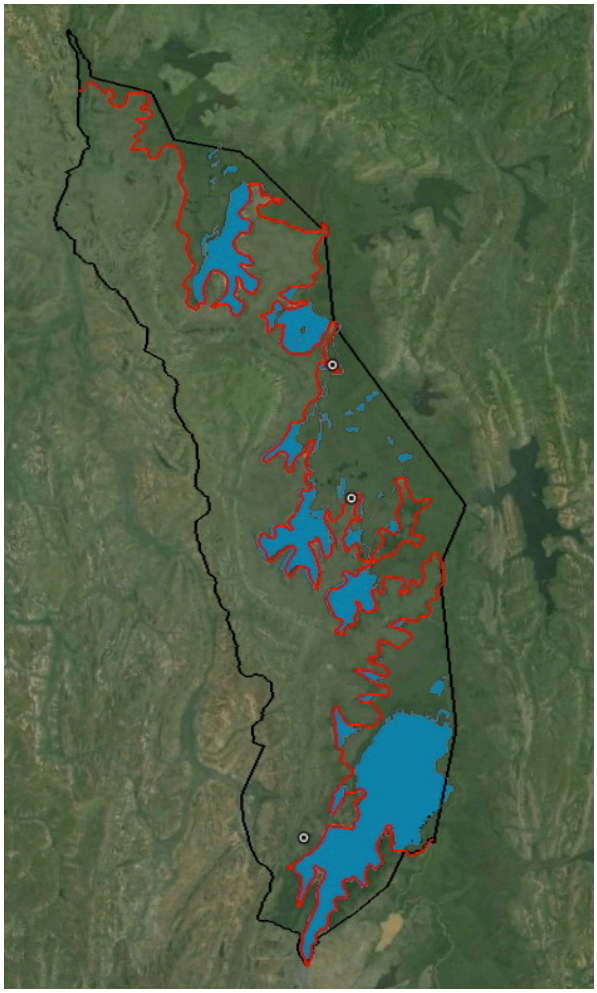
Map 25: Hyena distribution during the 2013 wildlife census of Akagera National Park

Hyena 2013



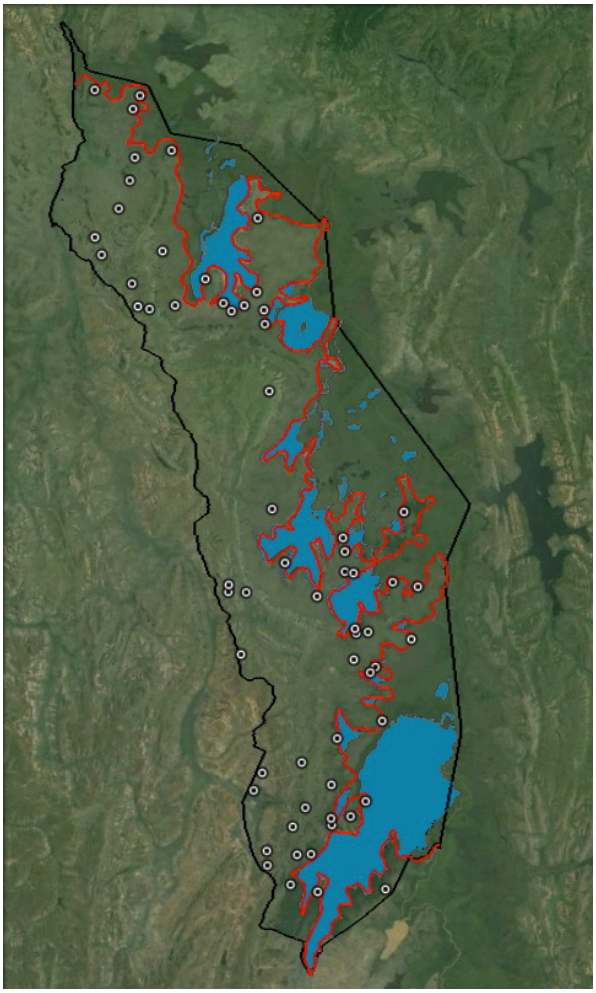
Map 26: Leopard distribution during the 2013 wildlife census of Akagera National Park

Leopard 2013



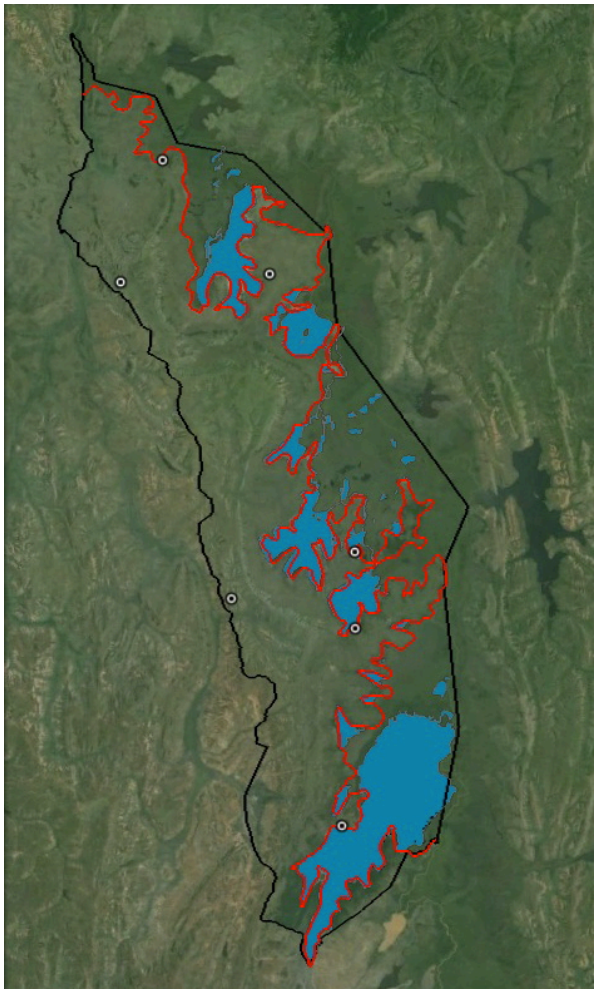
Map 27: Baboon Troop distribution during the 2013 wildlife census of Akagera National Park

Baboon Troops 2013



Map 28: Vervet Monkey distribution during the 2013 wildlife census of Akagera National Park

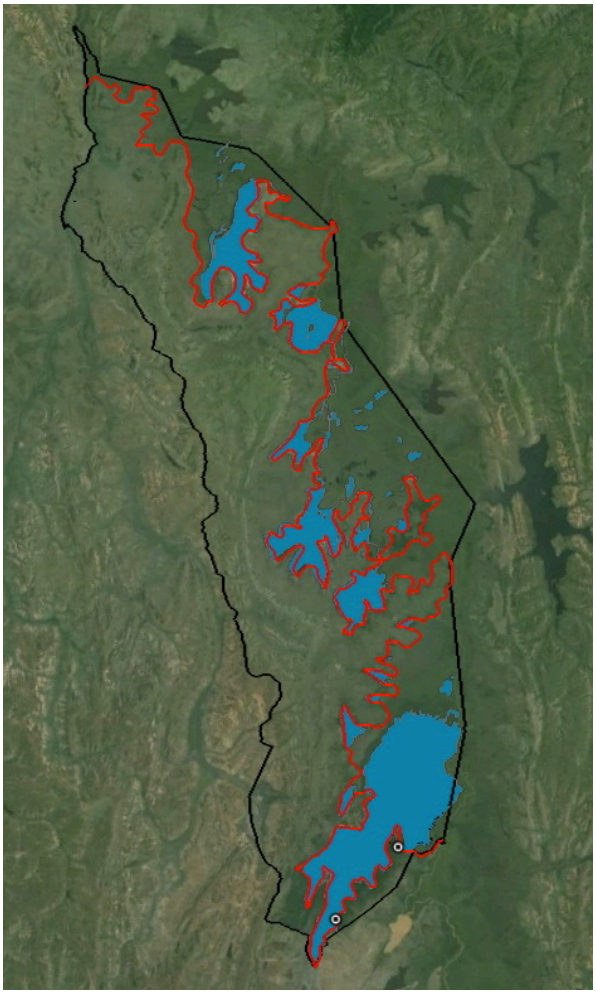
Vervet Troops 2013



Note: Observation group size for primates is per troop

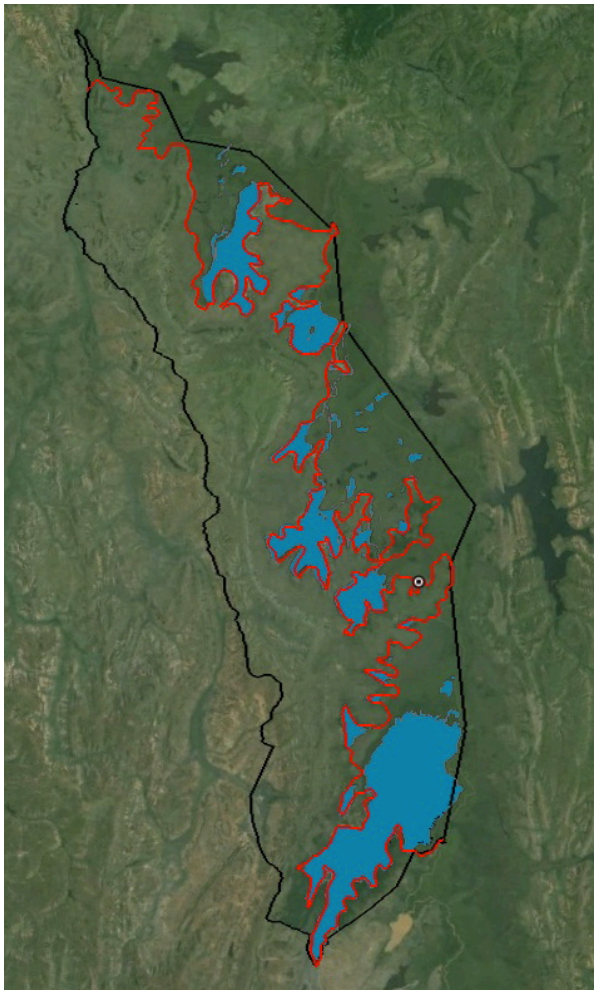
Map 29: Blue Monkey distribution during the 2013 wildlife census of Akagera National Park

Blue Monkey Troops 2013

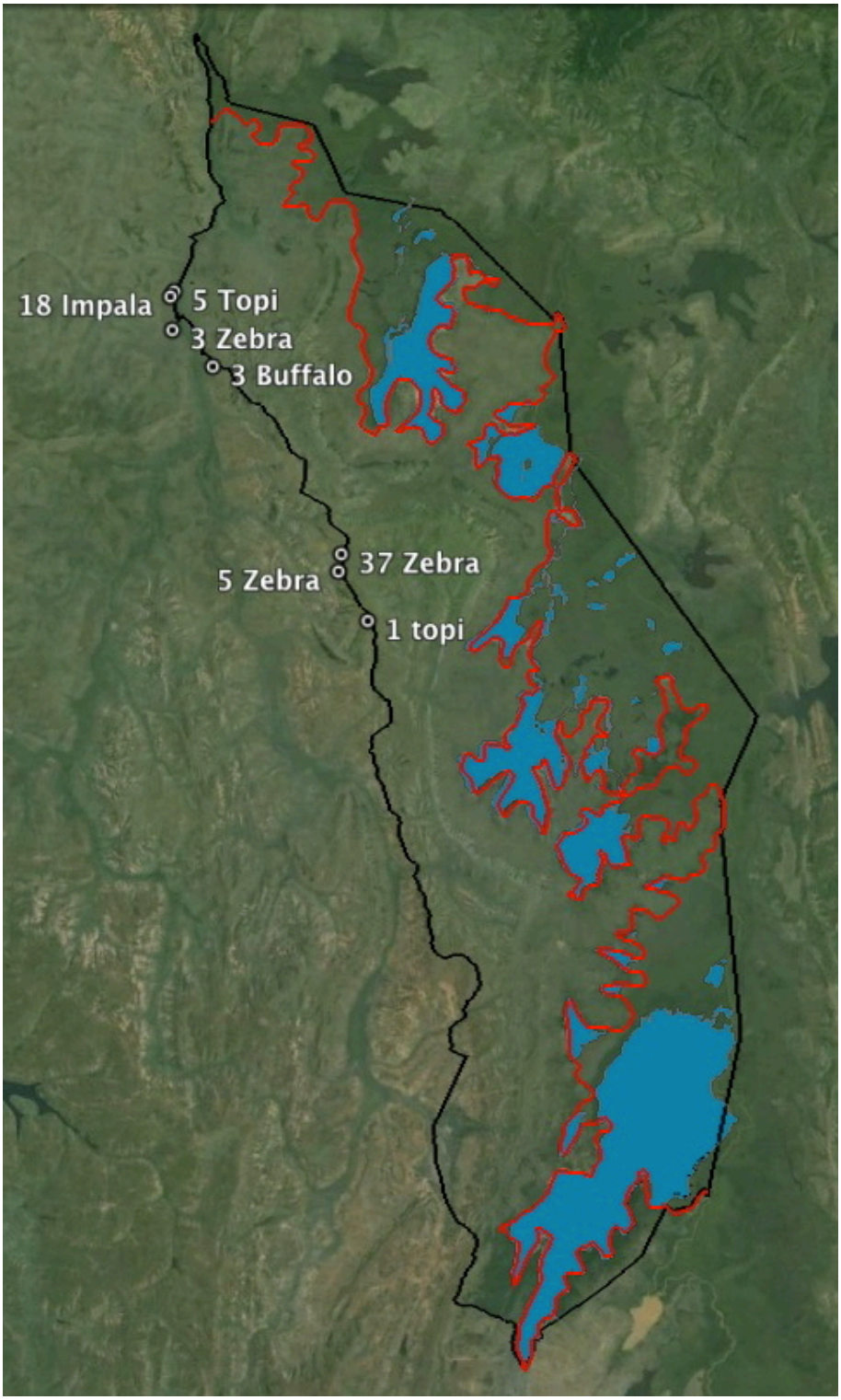


Map 30: Shoebill distribution during the 2013 wildlife census of Akagera National Park

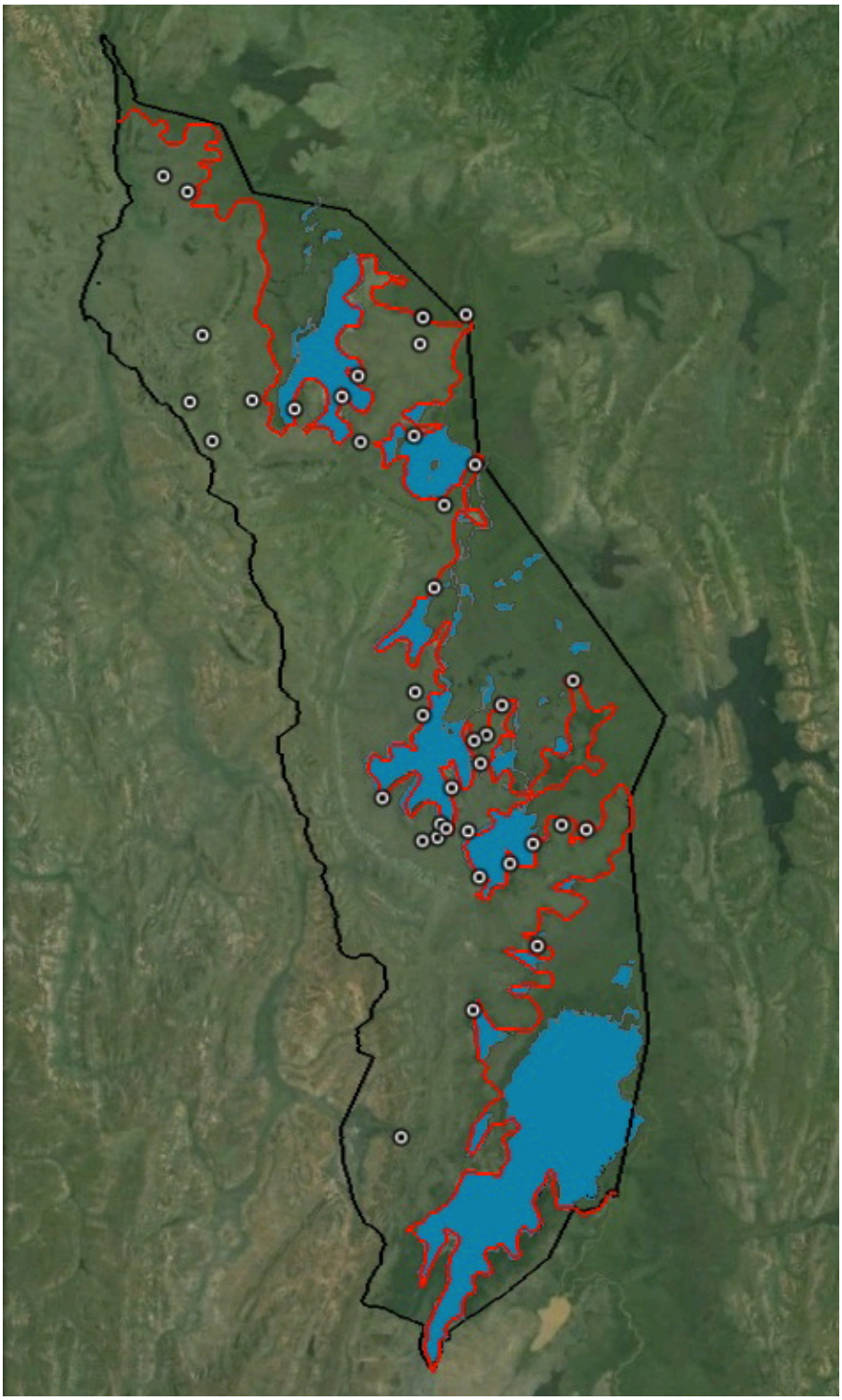
Shoebill 2013



Map 31: Species, location and number of animals observed outside of Akagera National Park along the western boundary fence during the 2013 wildlife census

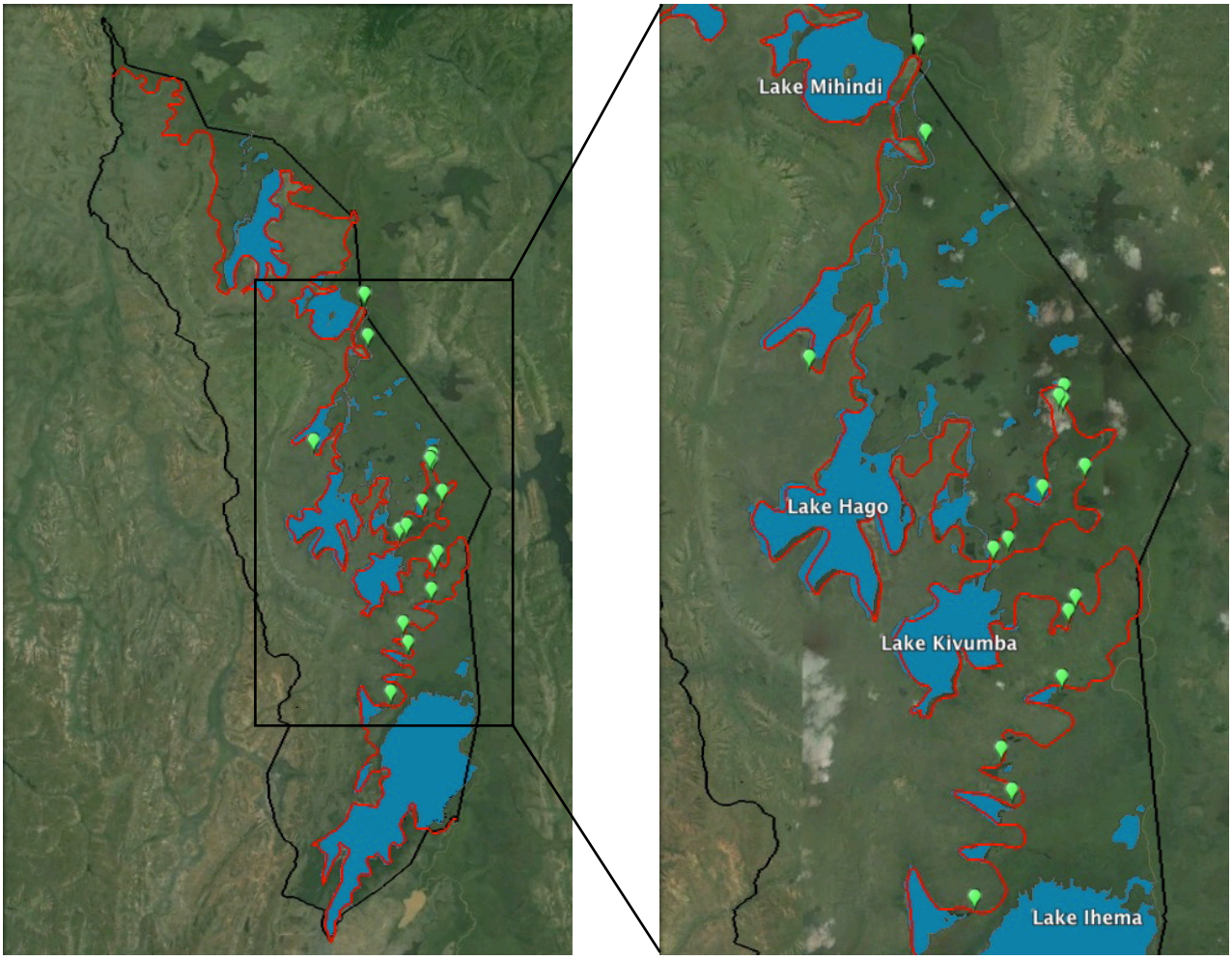


Map 32: The location of bones and carcasses of dead large animals (hippo, elephant, buffalo, crocodile and eland) observed in Akagera National Park during the 2013 wildlife census

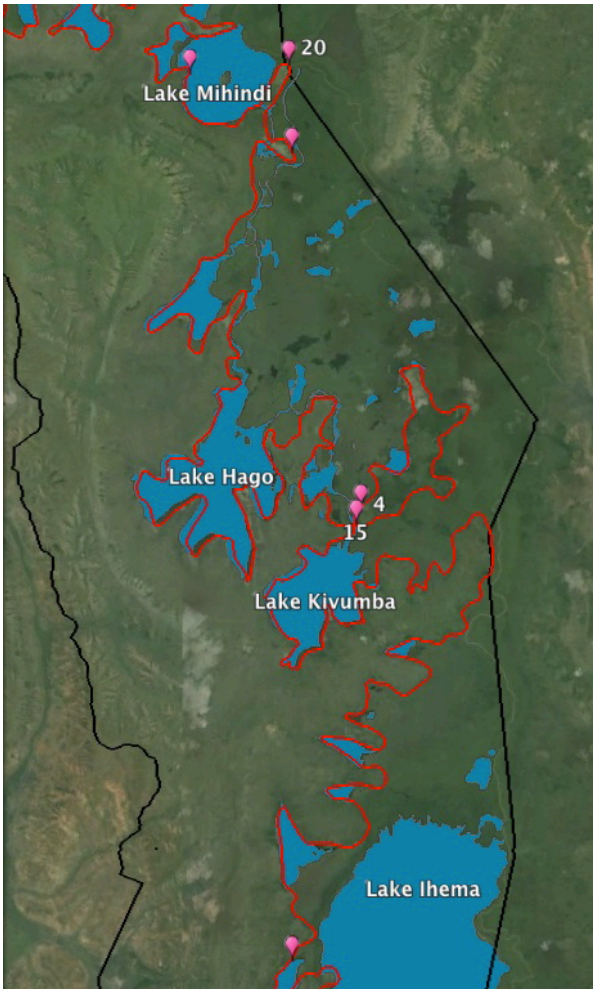


Note: Observation group size for bones & carcasses is 1

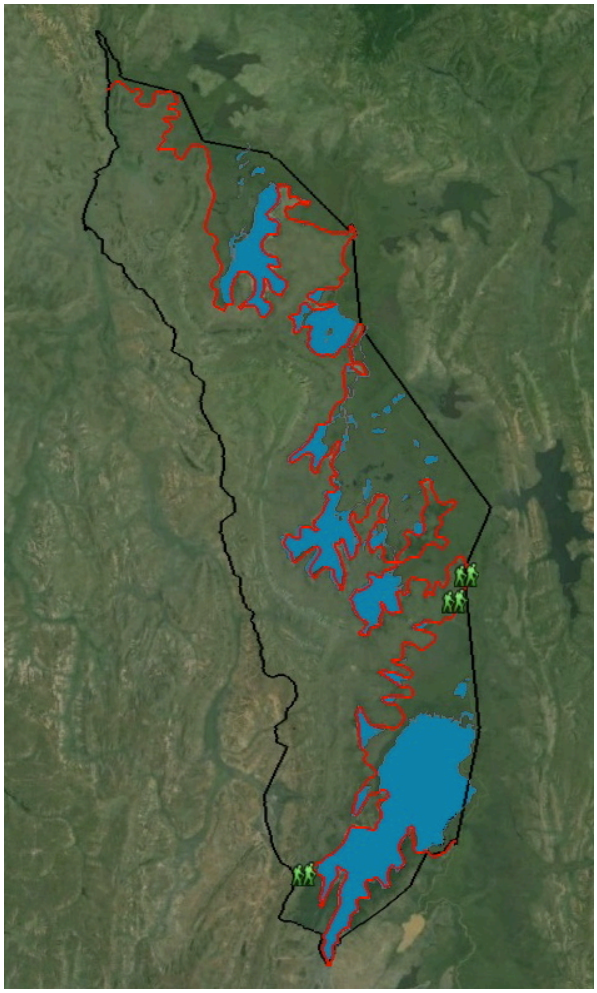
Map 33: The location of poachers' camps in Akagera National Park observed during the 2013 wildlife census



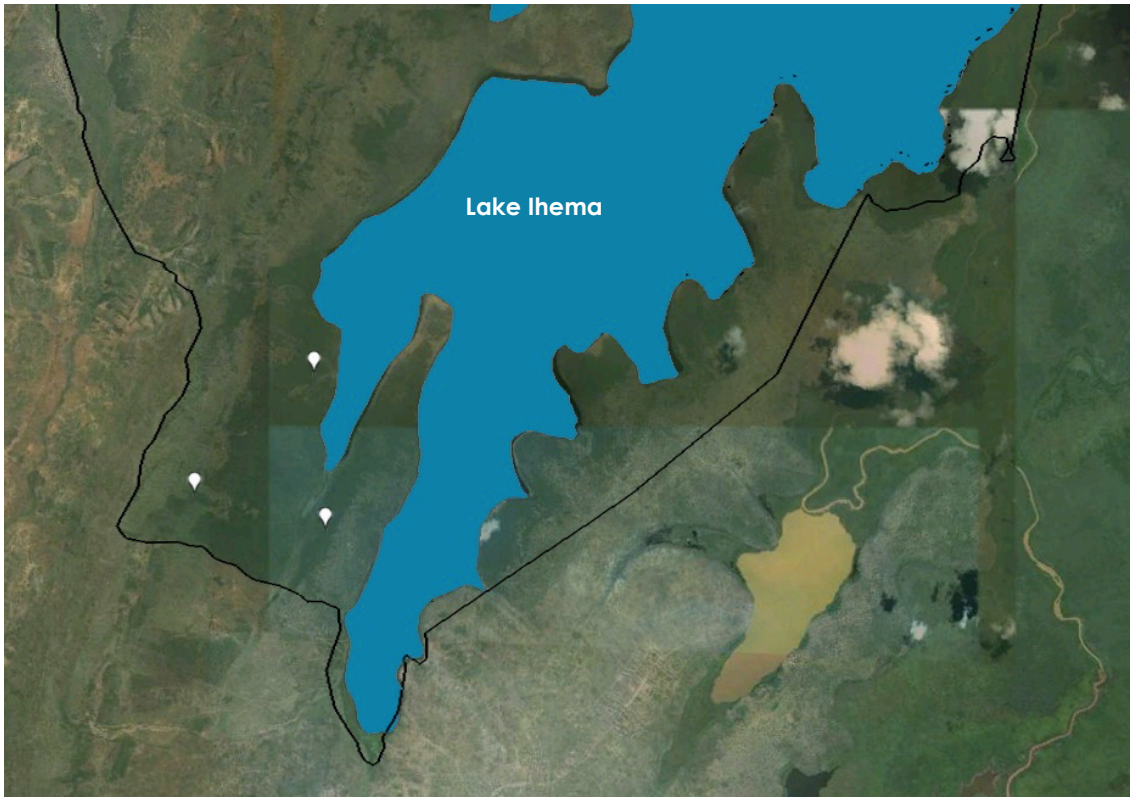
Map 34: The location and number of poachers' boats in Akagera National Park observed during the 2013 wildlife census



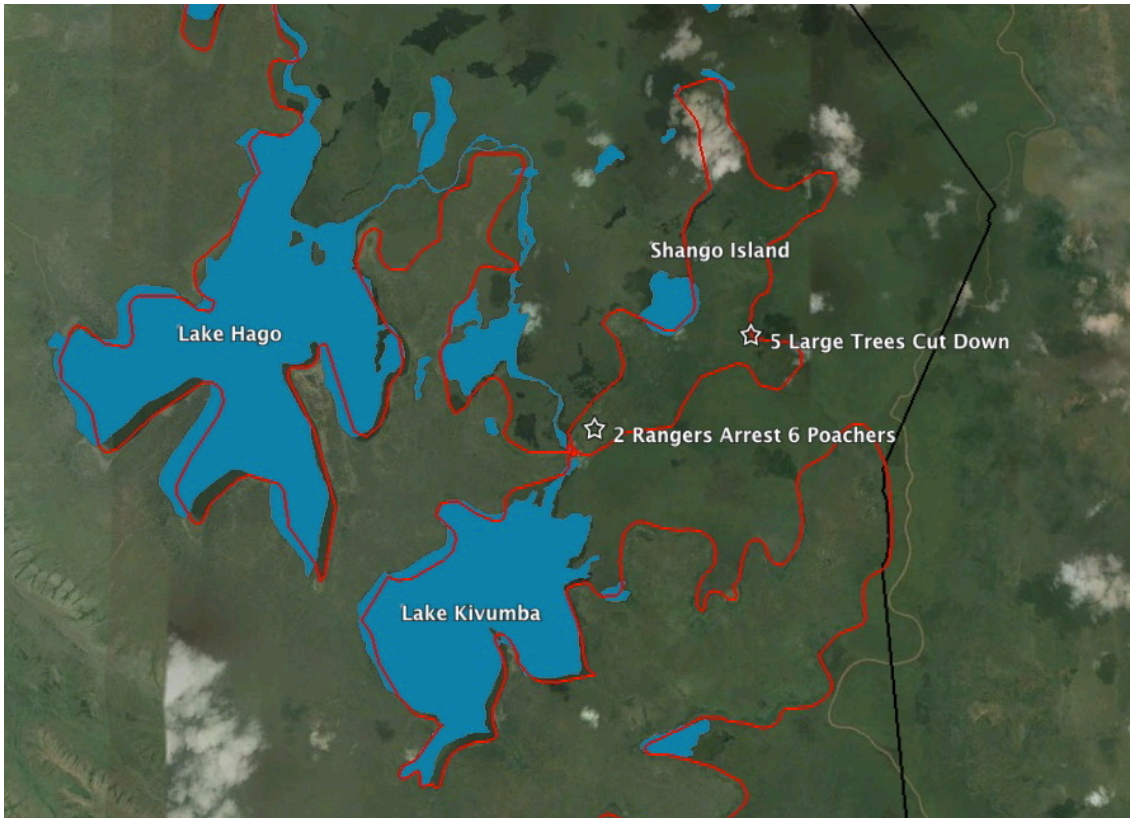
Map 35: The location of poachers' access routes into Akagera National Park observed during the 2013 wildlife census



Map 36: The location of beehives observed during the 2013 wildlife census in Akagera National Park



Map 37: The location and nature of other illicit activity observed during the 2013 wildlife census in Akagera National Park



C L U N Y

Providing Aerial Services

Appendix 2

Photographs Serving a Report on an Aerial Wildlife Census of Akagera National Park - August 2013

B Y D E R E K M A C P H E R S O N

18 September 2013

Kanongo Estate, P.O. Box 250, Namitete, Malawi • Tel: +265 999 512 620 •
clunyafrica@gmail.com

Photograph 1: An example of some eucalyptus trees planted in the lake region of ANP illustrating a history of human occupation in the area

Photograph 2: Lake Mihindi in the Foreground and Lake Rwanyakizinga in the distance, both of which form part of the vast wetland system that is located in the Eastern Part of Akagera National Park

Photograph 3: Highland grasslands on Mutumba Mountain

Photograph 4: Low-lying grassland on the Kilala Plain in the north of the Park (Map 3)

Photograph 5: Bushed grassland in Akagera National Park

Photograph 6: Bushed grassland in Akagera National Park

Photograph 7: Wooded grassland dominated by broad-leafed species

Photograph 8: Wooded grassland on hill-slopes

Photograph 9: An example of the vegetation type "Bushland / Woodland" on a hill side

Photograph 10: "Bushland / Woodland" in a valley in Akagera National Park

Photograph 11: A large area covered by Dry Forest in the southern part of Akagera National Park

Photograph 12: Illustrating the low aerial visibility associated with Dry Forest in Akagera National Park

Photograph 13: Dry Forest on the escarpment slopes in the northern part of the Park

Photograph 14: Palm-dominated Humid Forest along the shores of Lake Ihema

Photograph 15: Showing an example of the wetland fringe and narrow floodplain Akagera National Park

Photograph 16: An almost pure stand of papyrus on part of the wetland along the Akagera River

Photograph 17: A mosaic of different water plants in the Akagera Wetland

Photograph 18: Illustrating an occupied poachers' camp and the smoking of either fish or meat

Photograph 19: An example of a fish poacher's camp showing sorting and smoking of the catch

Photograph 20: An example of illegal sisal collection inside of Akagera National Park boundaries

Photograph 21: Example of a large tree being illegally cut down to make a dugout canoe

Photograph 22: Fifteen boats observed on Shango Island during the 2013 wildlife census

Photograph 23: Six poachers arrested on Shango Island by AMC Field Rangers during the 2013 wildlife census of ANP

Photograph 24: Shoe bill observed on the Kageyo Peninsular during the 2013 wildlife census of ANP

Photograph 25: Jes Gruner, Eugene Mutangana and Egide Rekambane (L to R) standing next to the Robinson 44 helicopter 9XR-SE used to conduct the wildlife census of Akagera National Park in August 2013