PARC NATIONAL DE LA GARAMBA

Institut **C**ongolais pour la **C**onservation de la **N**ature

African Parks Network

Aerial Survey March 2014

Parc National de la Garamba,République Démocratique dCongo

Financed by Pan-African Elephant Aerial Survey (PAEAS) a Paul G Allen/Vulcan project

Prepared by
Marina Mònico
M.Sc Biodiversity Conservation and Management

Table of contents

Figures

Figures in Annex

Tables

Tables in Annex

1 Introduction

Some aerial surveys conducted to date in Garamba NP have been carried out using similar methodologies i.e. strip transects (Norton-Griffiths, 1978) however, sampling intensity, observers and the size of the area surveyed differed. The first aerial census was carried out in 1976; from 1983 to and including 2003, counts were done every two to three years. These were sample counts and included the entire park and hunting reserve areas,. During the last two censuses, carried out in 2007 and 2012, total counts were done in the south-middle sector of the park, and part of the hunting reserves, according to the abundance and distribution of key species

The elephant population in Garamba National Park is known to have decreased during the last few decades as substantiated by the data of the last two censuses conducted in 2007 (Reid 2007) and 2012 (Casado 2012), with 3,700 and 1,751 elephants recorded respectively. This decline has continued since then as a result of ongoing poaching pressure. Other animal populations have also been seriously affected by poaching including the white rhino population, now extinct, and currently the park's giraffe numbers, currently at a critical level. Garamba's giraffe are the only remaining population in the country.

According to the distribution and abundance of elephant observed during this past year, it was decided to implement a total count across the southern-middle section of the park, as in the previous years, but adding in part of the hunting reserve of Azande. (See Fig 3)

It was also decided to undertake a sample count in the north of the park and part of the reserves in order to establish wildlife densities and distribution as well as human numbers, both largely unknown and unmeasured due to security risks in the area.

This report presents the results of an aerial survey of elephants and other wildlife species in Garamba National Park during March and April 2014. The purpose of the survey is to provide information about elephant abundance and distribution, as other key species present in the park. This report compares the results of the total count with the last two conducted by Reid & Amube (2007) and Casado.N (March 2012), because they were done following the same methodology within the same surface (See Annex I)

2 Study area

Garamba National Park is located northeast of the Democratic Republic of Congo (N 3° 8' - 4° 4' and E29°-30°), bordering with South Sudan to the north. The park comprises 4 900km2 of strictly protected national park area as well as three surrounding hunting reserves, Azande (2,892 km²) to the west, Mondo Missa (1, 983km²) to the east and Gangala Na Bodio (2,652km²) in the south, making up a total protected area of 12,400 km2. (See Fig1)

Garamba was proclaimed a World Heritage Listed site in 1980 (UNESCO, 2010) owing to the presence of populations of rare and endangered species, including iconic elephant populations (*Loxodonta africana*), the last surviving giraffe populations of Congo (*Giraffa camelopardalis antiquorum*) and the already extinct, northern white rhino (*Ceratotherium simum cottoni*).

Garamba is located in the Soudan-Guinean savannah biome. The southern part of the park is predominantly grassland savannah with scattered trees while further north the vegetation is mainly mixed woodland, dense dry forests and riverine and small swamp forests. In contrast, the hunting areas are predominantly dense bush savannahs, mixed woodlands and forests. (Hillman Smith, 1995) (See Fig 2)

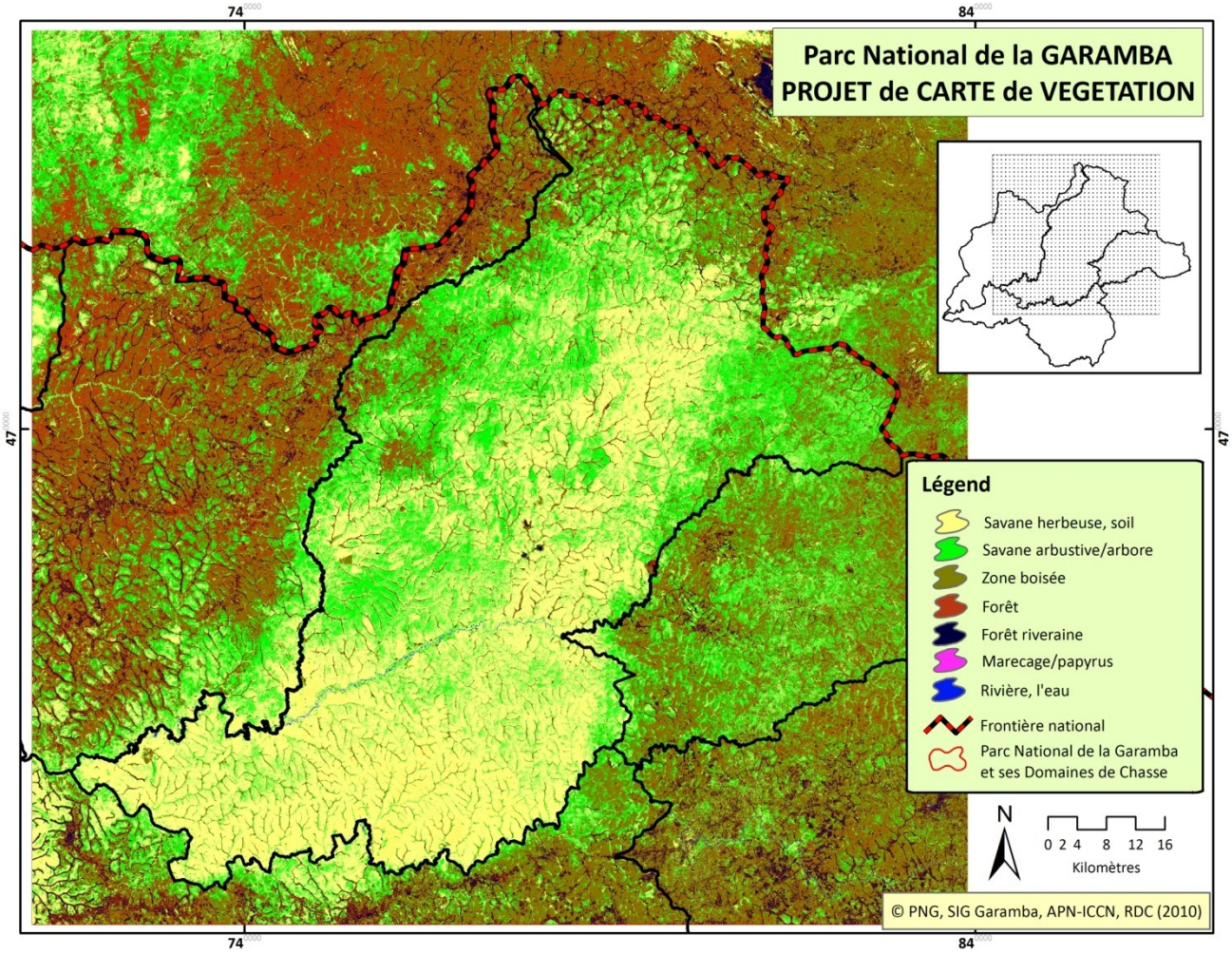
Fig 1:Garamba National Park and Hunting reserves.

The climate is considered tropical, semi-humid, with two clearly different seasons- a dry season from December to February and a rainy season from March to November. The average total rainfall for the year is between 1,400 and 1, 500 mm, with an average temperature of 23,45˚ C and with maximums of between 36º and 40º and minimums between 10º and 14º. (*Research and Monitoring Department Parc National de la Garamba*)

Population density in the region does not exceed four habitants per km ². Several ethnic groups occupy the land of the Garamba complex including tribes such as the Zande, Logo, Mondo, Kakwa, Baka and Padjulu. The principal activity of 55 percent of people living around the park is agriculture (FFI and APN, 2009).

Since 2005 the park has been managed through a public private partnership between African Parks Network, a conservation NGO, and the ICCN (*Institut Congolais pour la Conservation*) a governmental wildlife authority.

Fig 2: Vegetation map for Garamba National Park.



3 Method

3.1 Aerial survey

This survey followed the standards and guidelines facilitated by Pan African Aerial Survey of Elephants, 2014 (PAASE), which is a guidebook integrating the MIKE 2.0 aerial survey standards.

This survey was divided into two parts and was dependent on the distribution and abundance of elephants and the vegetation present in the areas. We performed a total count in the southern-middle section of the park (sub Blocks 1-12), together with part of the hunting reserves (sub blocks A3 and part of GB3, GB4 and MM1). The total area covered was 3, 581km2. Subsequently there has been a sample count in the northern sector of the park (sub Blocks 13-20) and other parts of the hunting reserves (part of MM2, MM3, A3), an area of 4,118km2. (See Fig1and Fig2 and Annex VI Table 3)

Fig 3: Map of the sub Blocks of the park.

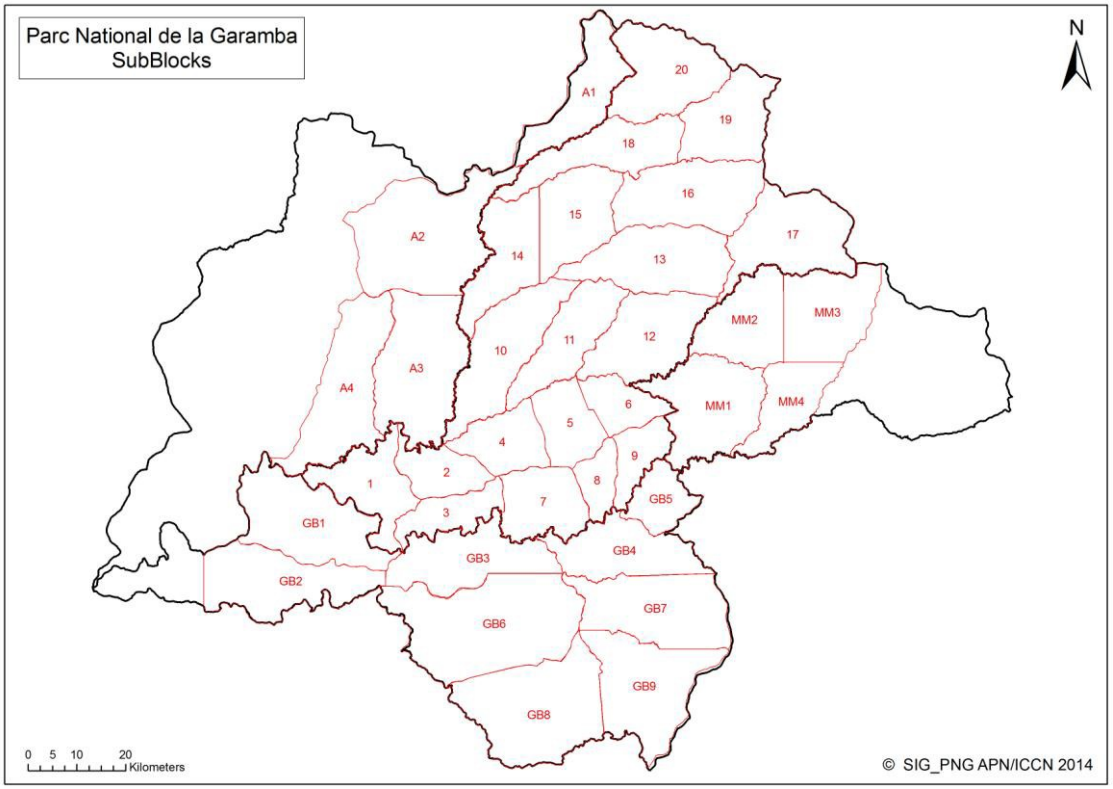
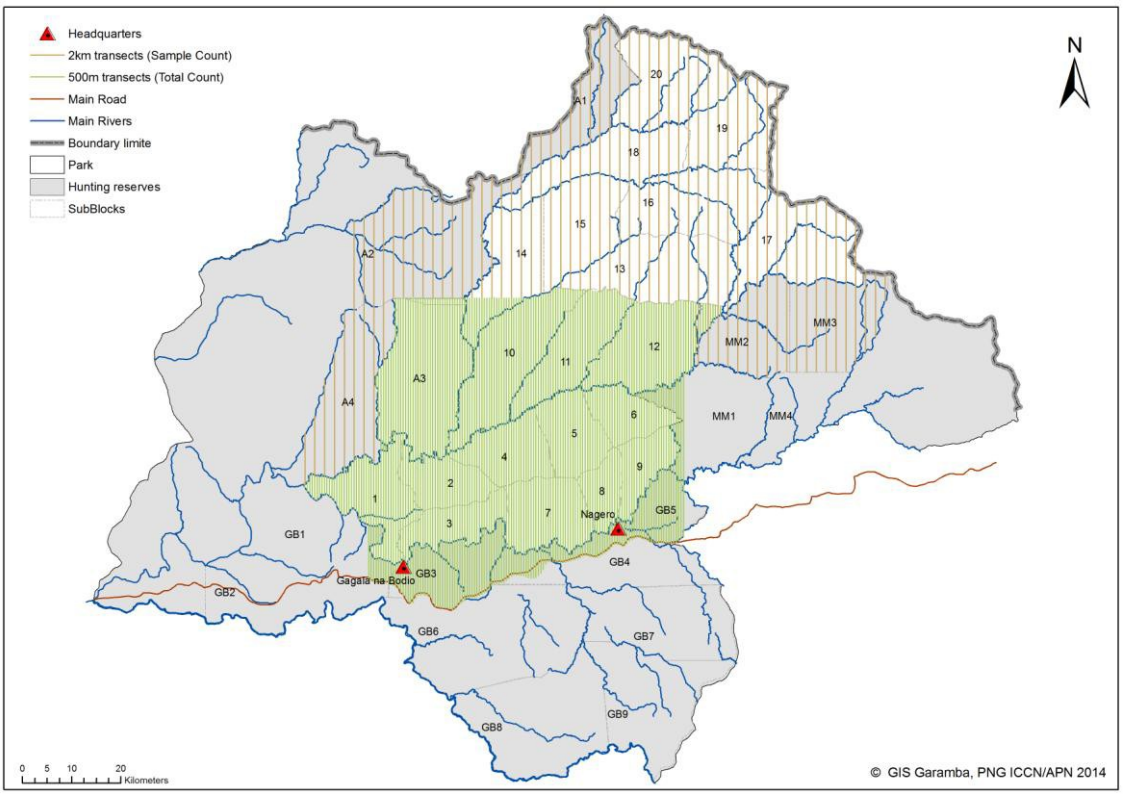


Fig 4: Map of the area surveyed in both counts



The areas not surveyed (part of the hunting reserves) include those characterised by dense canopy vegetation which made it difficult to see the animals from the plane.

The survey was timed to fall over the end of the dry season/beginning of the rainy season to maximize the quality of sightings facilitated by the fact that a large portion of the park had been burned and a green flush was evident in most parts. That period coincided with the end of March and early April.

The survey team focused their attention counting on elephant herds, but also recorded giraffe, buffalo, hippopotamus in water pools, hartebeest, waterbuck, kob, Roan antelope and carcasses. Human activities and signs of poachers and their camps were recorded to provide additional data for the law enforcement team. All sightings and observations were recorded on standard data sheets. (See Annex II)

The survey team comprised a pilot, a principle observer seated in the front (FSO), and two observers at the rear of the airplane (RSOs). The own project Cessna206 was used to fly parallel transects spaced 500m and 2km intervals, arranged in north-south orientation across the two survey blocks. The pilot navigated along the transects with the aid of route lines programmed into a Garmin GPSMAP 296 moving map GPS, and maintained an altitude of 106 m (350ft) above ground level with the aid of a radar altimeter.
Two test flights were done before the survey, and all the team were briefed prior to start to ensure all details and the protocol were clear. The two rear seat observed participated in the past aerial survey in 2012, and also are part of the daily aerial monitoring in the park. Pilot has the necessary certificate and lisence as the minimum of hours to perform the survey.

The team was on their guard out to make sure they didn't double count sightings of animals and herds which may have moved onto adjacent transect strips. Furthermore, using a moving map GPS where tracks are visible on the device, we were able to control and eliminate "inter-transect" double counts of herds.

Most of the 12 count blocks in the southern sector had been burned during the dry season with some isolated long grass areas remaining intact. Very little of the north areas and the hunting reserves had been burned and visibility in some patches was poor due to the high level of leaf cover on trees. Conditions varied but were generally good for counting. Only two mornings were hampered by mist and one afternoon flight was cancelled due to a storm.

In order to minimise the effects of undercounting large buffalo and elephant herds, a Nikon coolpix AW110 digital camera was used to photograph the larger herds (more than 10 individuals). An overlapping series of photographs were taken when more than one photograph was needed to visually capture a large herd. While visual estimates of numbers in herds were recorded during the course of flights, the number of animals in herds was later counted from the photographs taken, using a pen to cross off animals as they were tallied.

For each observation seen within a transect interval, the observer called out the species and the numbers. In the case of elephant, the herd type was also recorded (bull, herd or family group). A GPS (Etrex 20) was used to record the track log and wpt of every flight and to record all the observations. Data was downloaded and transcribed to an Excel document at the conclusion of every flight.

According to the standard methodology for strip transect sampling developed by Norton-Griffiths (1978), only animals that were observed within the interval were counted and recorded. Any animals outside the area delineated by the two attached poles, were not counted.

For the total count a single, stainless steel pole was attached to the aircraft, corresponding to the upper limit of 500 m for each of the left and right side observers, as a way of keeping track of where the plane was flying over and in order to count lost observations. This marker was set on the ground using standard calculations.

For the sample count, two wands were attached to the wing struts of the plane to delineate the 200m interval for recording observations at an altitude of 350ft. Additionally, a mark was put on the plane window to help observers keep their eyes at a consistent height to maintain the same sighting angle for each observation. This helped keep consistent interval widths for each observation.

Each interval width on each side of the plane was calibrated and confirmed prior to initiating the first survey by placing markers at measured distances (20m) on the ground and conducting fly over tests. Repeated flying, across these markers allowed observers to record the distances that coincided with the two wands, and photos were taken to verify the interval distances. Where necessary the wands were adjusted and a second session of calibration to provide a definitely 200m-wide strip at 350ft altitude. The aluminium wands were attached to the struts for the duration of the survey.

3.2 Data Analysis

Following the guidelines developed by Norton-Griffiths (1978), strip transect sampling, abundance and variance estimates were calculated from observation data collected in 400m wide intervals. We adjusted for altitude and used the traditional Jolly's Method II for unequal sized sampling units (Jolly 1969). The Jolly's Method II 'ratio method' is based on the calculation of the ratio between animals counted and area searched. The population estimate is based on the density of animals per sample unit (transect) rather than the number of animals per sample unit. (See Annex III)

Actual Strip width calculation: $W = w.H/h$

Where; W = Actual strip width
w = Nominal width (400m)
H = Actual Height
h = Nominal height (350ft or 107m)

The software ArcGIS version 9.3 was used to design all maps, including animal distribution, human activity and transects.

4 Results

4.1 Total Count

4.1.1 Survey results

This survey was conducted over a period of 10 days, from 23/03/2014 to 01/04/2014. Seventeen survey sessions were completed, 10 in the morning and seven in the afternoon. Session durations ranged from 02:05hrs to 04:40 hrs (with flyovers). The team flew 10,191km during a total of 59 hours (*See Annex IV Fig4 and Table 1*)

A total of 170 north/south parallel survey strips, with a spacing of 500m, were flown over an area of 3,581km2.These transects were followed precisely using a GPS, flown at approximately 350 feet (107m) above ground level, and at an average speed of 167 km /hour. The lengths of the 170 survey strips varied between 500m to 63km and the total length was 7,286km (*See Annex IV Table 1*).

4.1.2 Animal observations

Below is a table summarising the number of animals in each species for each of the sub-Blocks of the park.

At first glance we can detect differing abundances between some blocks which are better illustrated in the distribution analysis of each species.

Table 1: Table summarising the number of individuals counted for each species in each sub block for the total count in Garamba NP.

Total Count		Number indiv.							
Block nº	**Area (km2)**	**Elephant**	**Buffalo**	**Giraffe**	**Hippo**	**Hartebeest**	**Waterbuck**	**Kob**	**Roan**
1	257	50	334	12	30	45	103	359	3
2	164	393	342	0	10	26	110	360	0
3	155	27	409	0	14	30	57	351	0
4	194	92	1186	0	201	58	17	381	0
5	187	57	1347	0	179	65	19	86	0
6	142	0	279	7	7	71	10	91	0
7	231	24	918	0	139	69	105	520	1
8	101	36	636	0	112	28	25	70	0
9	131	477	541	8	26	25	86	221	0
10	372	0	272	0	20	120	84	535	0
11	265	32	316	0	102	55	69	250	1
12	333	0	230	0	17	49	102	231	8
MM1	73	3	6	4	0	11	46	46	0
GNB3/5	504	99	224	7	1	15	164	265	0
A3	472	428	109	4	2	31	123	94	0
Total	**3581**	**1718**	**7149**	**42**	**860**	**698**	**1120**	**3860**	**13**

4.1.2.1 Elephant

This year we counted 1,718 elephant, a density of 0,63 elephant/km2. The high density is illustrated in Blocks 2 (2.40 elephants/km²) and Blocks 9 (3.64 elephants/km²); here is where the largest herds were found. No elephants were seen in Blocks 6, 10, and 12.

Table 2: Number and density of elephant counted in each block for the total count of 2014.

Total Count		Elephant	
Block nº	**Area (km2)**	**Number**	**Density (ind/km2)**
1	257	50	0,19
2	164	393	2,40
3	155	27	0,17
4	194	92	0,47
5	187	57	0,30
6	142	0	0,00
7	231	24	0,10
8	101	36	0,36
9	131	477	3,64
10	372	0	0,00
11	265	32	0,12
12	333	0	0,00
MM1	73	3	0,04
GNB3/5	504	99	0,20
A3	472	428	0,91
Total	**3581**	**1718**	**0,63**

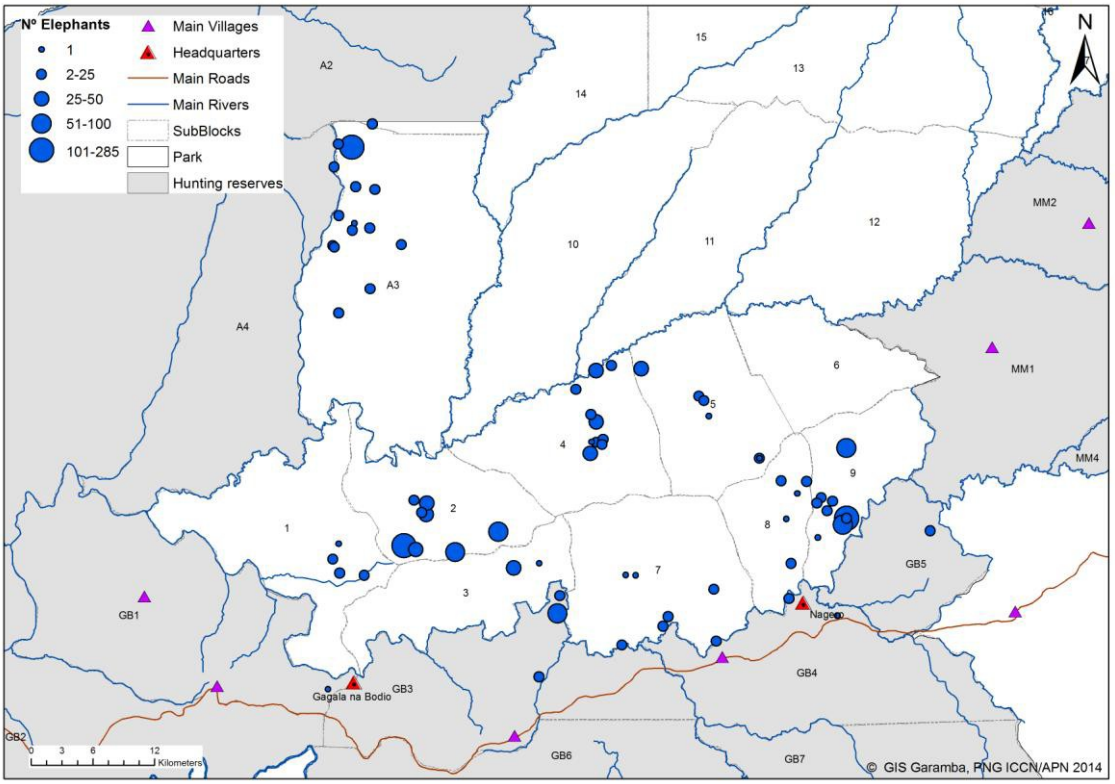
Three groups of more than 100 elephant were sighted. The first of 285 elephant was in Block 9, a second group of 104 elephant in Block 2 and a third large group of 282 elephant in Block A3 in the Azande Hunting Reserve. In addition, we also counted five groups of between 51 and 100 elephants, eight groups of 25 to 50 individuals, 47 groups of between two and 25 elephants and on 13 occasions, 13 individual elephant.

In the map we see how widely they are distributed. They are concentrated in the blocks of the southern sector

(Blocks 1-9), plus we discovered a group of 32 in Block 11, near the Garamba River, which is the only

recorded presence of elephant in the middle blocks spanning 10 to 12. We have also highlighted their presence in Block A3 in the Azande Hunting Reserve.

Fig 5: Distribution map of elephant for the total count in 2014.



Next table summarises the bull groups and the family groups counted.

Table 3: Number of groups and total of individuals for bull groups and family groups counted in the total count.

Elephant	N groups	Total indiv	% of total indv
Bull groups	24	61	3,55
Family groups	42	1585	92,26
Unkmown*	10	72	4,19
Total	76	1718	

*Unknown, is the category created for not identifeid groups, which all of them were small groups within 5 to 11 elephants.

Of the 76 groups of elephants found, more than half (42) were family groups, in which represents the 92% of the total elephants counted. To a lesser extent, a total of 24 bull groups were counted, representing a total of 3.55% of the elephants. Finally, 10 groups were not identified if they belonged to a family or bull group, they represent 4% of the total elephant population.

4.1.2.2 Giraffe

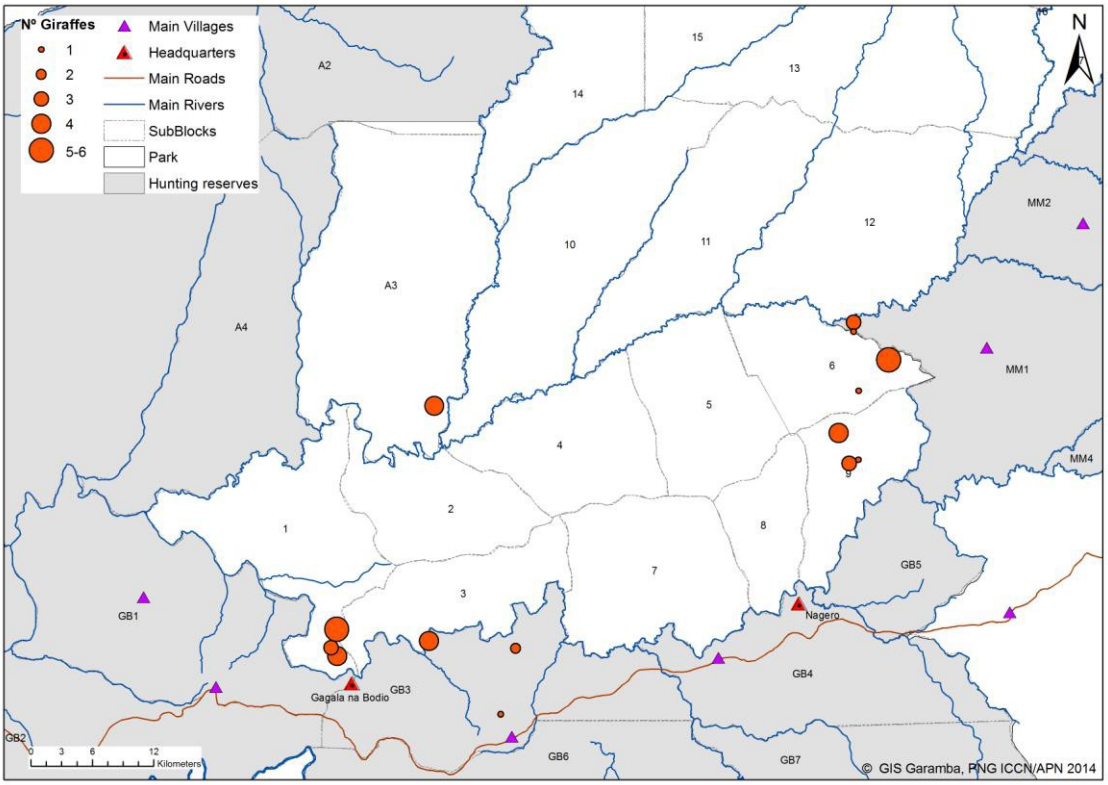
A total of 42 giraffe were seen during this survey, representing a density of 0,01 giraffe/km^2 . This population occurs broadly as four sub populations. One with seven individuals (0,01 giraffe/km^2) in the south of the Dungu River to the East of Gangala Na Bodio, another of about 12 (0,05 giraffe/km^2) in Block 1, the third group were four (0,01 giraffe per km^2) in the north of the Aka-Garamba River, and the last and most abundant group of 19 giraffe, were recorded moving between Blocks 6, 9 and Mondo Missa.

Table 4: Number and density of giraffes counted in each block for the total count of 2014.

Total Count		Giraffe	
Block nº	**Area (km2)**	**Number**	**Density (ind/km2)**
1	257	12	0,05
2	164	0	0,00
3	155	0	0,00
4	194	0	0,00
5	187	0	0,00
6	142	7	0,05
7	231	0	0,00
8	101	0	0,00
9	131	8	0,06
10	372	0	0,00
11	265	0	0,00
12	333	0	0,00
MM1	73	4	0,05
GNB3/5	504	7	0,01
A3	472	4	0,01
Total	**3581**	**42**	**0,01**

We can observe these groups in the distribution maps. These areas are mostly herbaceous savannah or very densely wooded savannah like that found in the hunting domains. This distribution is referenced since before the count in 2007.

Fig 6: Distribution map of giraffes for the total count in 2014.



4.1.2.3 Buffalo

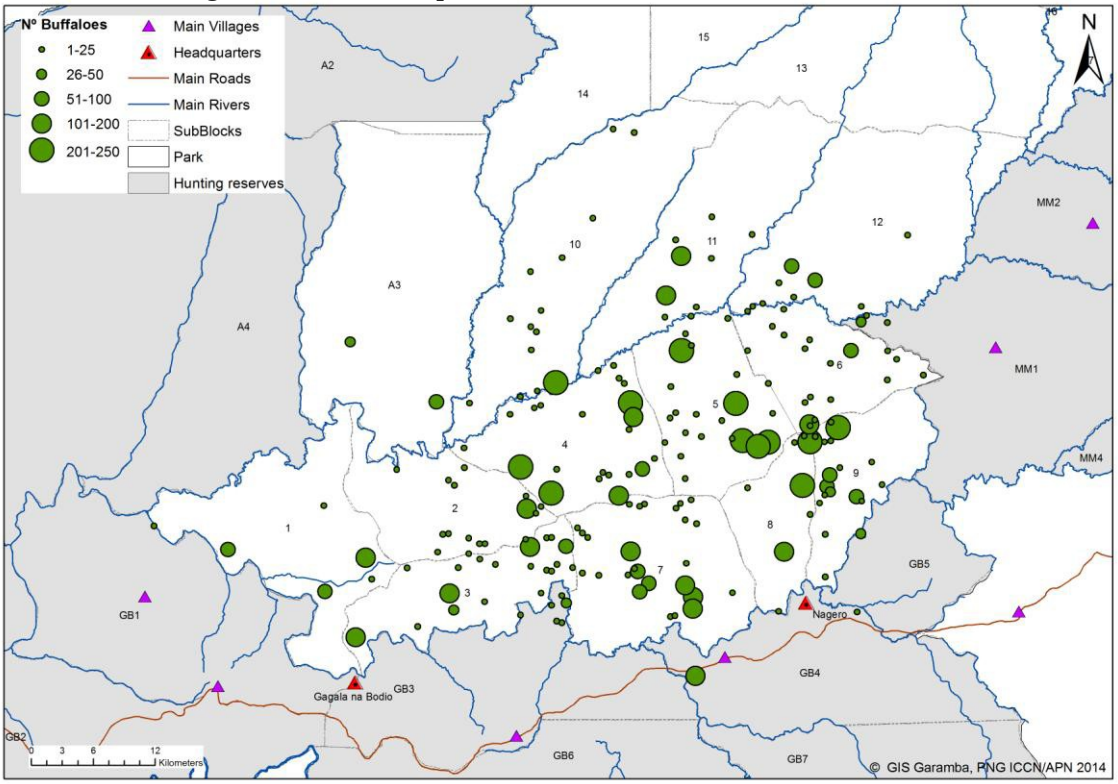
The number of buffalo recorded in this survey is 7,149, a density of 1,97 buffalo/km². We can see that they are present in almost all the blocks although the highest densities are in Block 4 (6,11 buffalo/km²), Block 5 (7,20 buffalo/km²) and Block 8 (6,30 buffalo/km²). They are less abundant in Blocks 1, 6, 10, 11, 12 and both hunting reserves.

Table 5: Number and density of buffalo counted in each block for the total count of 2014.

Total Count		Buffalo	
Block nº	**Area (km2)**	**Number**	**Density (ind/km2)**
1	257	334	1,30
2	164	342	2,09
3	155	409	2,64
4	194	1186	6,11
5	187	1347	7,20
6	142	279	1,96
7	231	918	3,97
8	101	636	6,30
9	131	541	4,13
10	372	272	0,73
11	265	316	1,19
12	333	230	0,69
MM1	73	6	0,08
GNB3/5	504	224	0,44
A3	472	109	0,23
Total	**3581**	**7149**	**1,98**

The buffalo were often concentrated in large groups of hundreds or, at the opposite end of the spectrum, in small groups with only a few individuals. In this count, there have been groups of up to 300 individuals, 12 groups of 200 individuals, 17 groups of 100 to 200, 14 groups of between 50 to 100 buffalo, seven groups of between 25 and 50, and finally 164 groups of one to 25 buffalo.

Fig 7: Distribution map of the buffalo for the total count in 2014.



4.1.2.4 Hippopotamus

For this survey we counted only the hippos present in water pools inside the park and not the populations present in the Dungu and Garamba rivers. (A specific census for hippos was undertaken prior to the start of this survey.). That latter survey was implemented with the Ultra Light Microlight and flew across the two rivers, counting and photographing all hippo groups. As a result of both initiatives - in the main rivers and in the pools - we have been able to determine the density of the population of this species. (*See* Mònico.M *2014. Hippopotamus count 2014*)

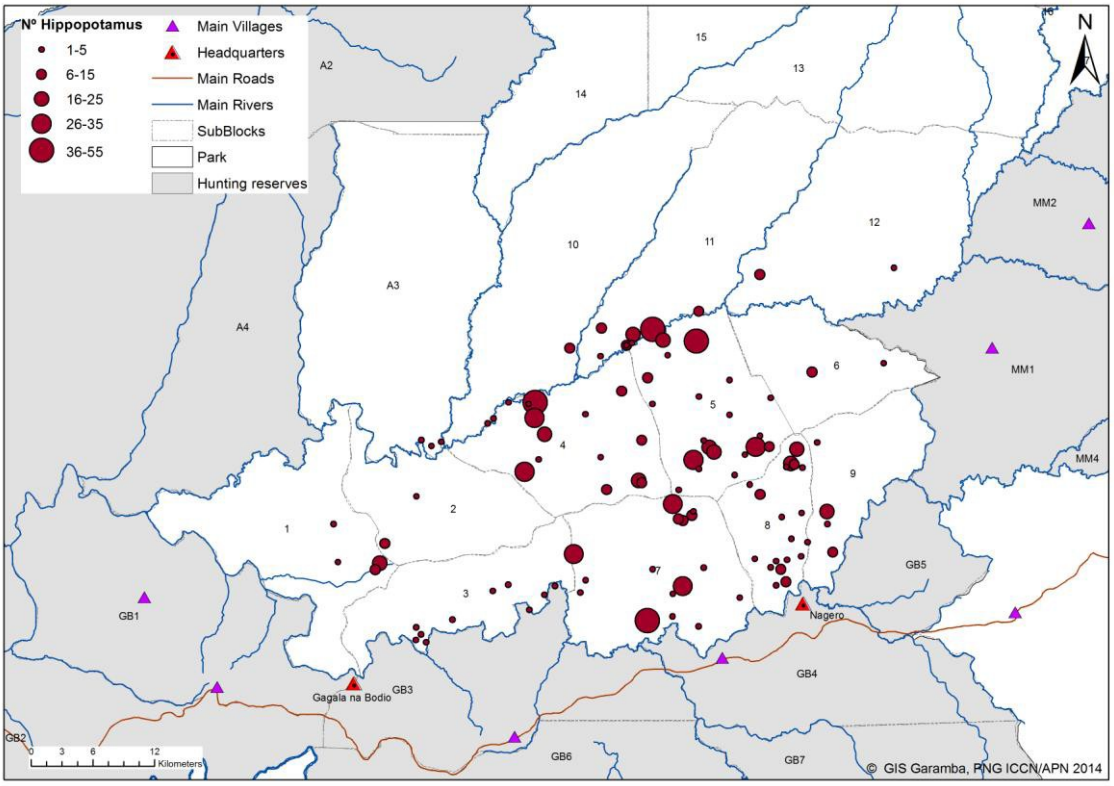
Here follow the results of the census. We counted 860 hippos in total in the water pools of the park, an equivalent density of 0,25 hippos/km². The most abundant densities are found in Block 4 (1,04indiv/km²), Block 5 (0,96indv/km²),Block 7 (0,6 indv/km²) and Block 8 (1,11indv/km²).

Table 6: Number and density of hippopotamus counted in each block for the total count of 2014.

Total Count		Hippopotamus	
Block nº	**Area (km2)**	**Number**	**Density (ind/km2)**
1	257	30	0,12
2	164	10	0,06
3	155	14	0,09
4	194	201	1,04
5	187	179	0,96
6	142	7	0,05
7	231	139	0,60
8	101	112	1,11
9	131	26	0,20
10	372	20	0,05
11	265	102	0,38
12	333	17	0,05
MM1	73	0	0,00
GNB3/5	504	1	0,00
A3	472	2	0,00
Total	**3581**	**860**	**0,25**

Our survey established that hippos in water pools tend to aggregate in relatively small groups, and that bigger groups are found in the rivers. There were five groups of between 26 and 55 individuals, three groups of 26 to 35 hippos, 11 groups of 16 to 25 hippos, 23 groups of between six and 15 hippos and 66 groups of one to five individuals.

Fig8: Distribution map of hippopotamus for the total count of 2014.



4.1.2.5 Hartebeest

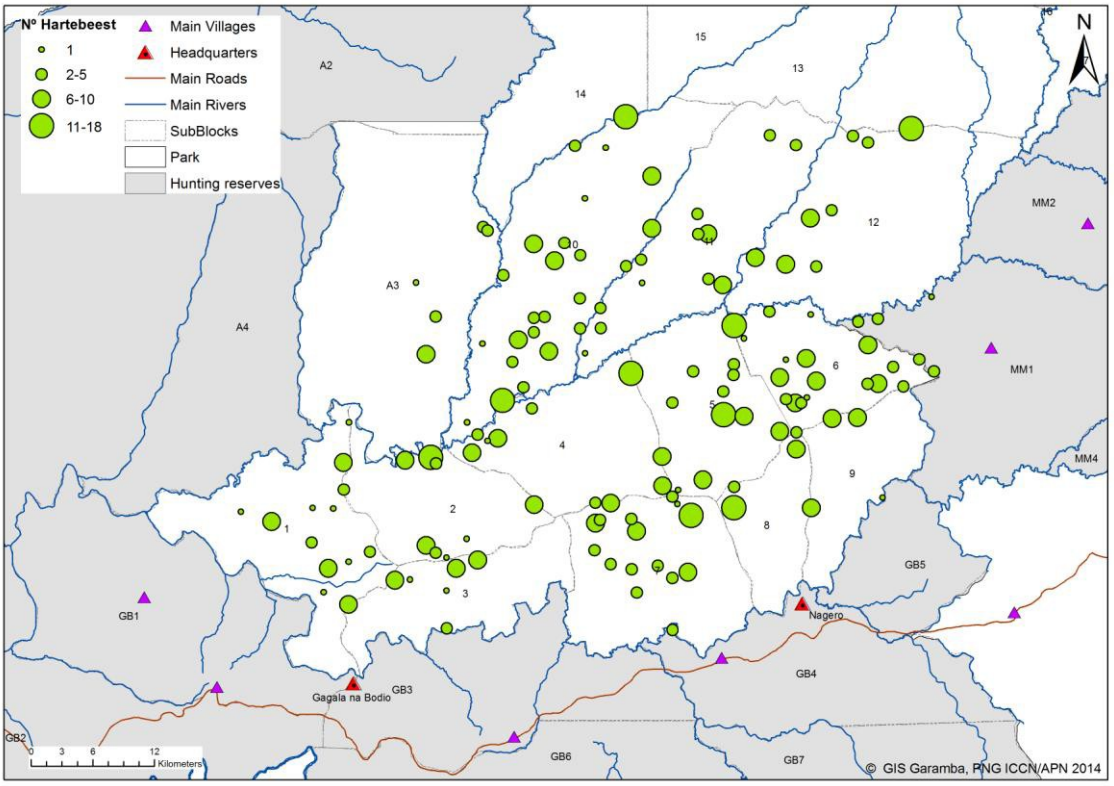
This year we counted 698 hartebeest, which is a density of 0.14 indiv/km2. We noted that the density of the species does not vary much between the blocks, except in the hunting reserves of Gangala Na Bodio (0,03indv/km²) and Azande (0,07indv/km²).

Table 7: Number and density of hartebeest counted in each block for the total count of 2014.

Total Count		Hartebeest	
Block n°	**Area (km2)**	**Number**	**Density (ind/km2)**
1	257	45	0,18
2	164	26	0,16
3	155	30	0,19
4	194	58	0,30
5	187	65	0,35
6	142	71	0,50
7	231	69	0,30
8	101	28	0,28
9	131	25	0,19
10	372	120	0,32
11	265	55	0,21
12	333	49	0,15
MM1	73	11	0,15
GNB3/5	504	15	0,03
A3	472	31	0,07
Total	**3581**	**698**	**0,14**

The distribution map verifies that hartebeest are present in all of the Blocks but that the groups are not very large. It was recorded that there are nine groups of between 11 and 18 hartebeest, 43 groups of six to 10, 63 groups of between two and five, and finally on 26 separate occasions we sighted a single individual.

Fig 9: Distribution map of hartebeest for the total count of 2014.



4.1.2.6 Waterbuck

In this census we counted 1,120 waterbuck, equivalent to a density of 0.23 individuals/km2. Overall we found the presence of waterbuck in all Blocks. The most abundant density is in Blocks 2 (0,67indiv/km2), 9 (0,66indiv/km2) and Mondo Missa(0,63indiv/km2). The lowest densities were in Blocks 4 (0,09indv/km2), 5 (0,10indv/km^2) and 6 (0,07indv/km2).

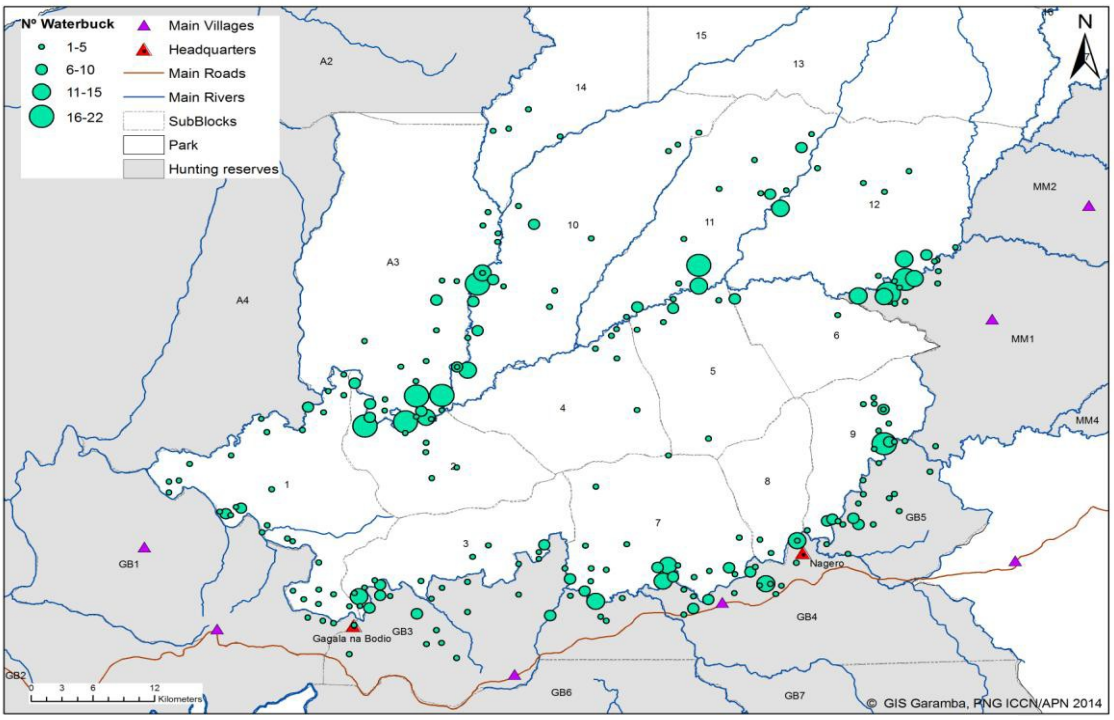
Table 8: Number and density of waterbucks counted in each block for the total count 2014

Total Count		Waterbuck	
Block nº	**Area (km2)**	**Number**	**Density (ind/km2)**
1	257	103	0,40
2	164	110	0,67
3	155	57	0,37
4	194	17	0,09
5	187	19	0,10
6	142	10	0,07
7	231	105	0,45
8	101	25	0,25
9	131	86	0,66
10	372	84	0,23
11	265	69	0,26
12	333	102	0,31
MM1	73	46	0,63
GNB3/5	504	164	0,33
A3	472	123	0,26
Total	**3581**	**1120**	**0,23**

The distribution of these antelopes is linked to water, as their name suggests, and as we see in the map below. Except for a few individuals, most groups were observed near the main Dungu and Garamba Rivers.

For this species, the size of the groups was not big: we found nine groups of 16 to 22 individuals, 14 of between 11 and 15, 41 groups of between six and 10 and finally the most abundant were 180 separate sightings of between one and five individuals.

Fig 10: Map distribution of waterbuck for the total count of 2014.



4.1.2.7 Kob

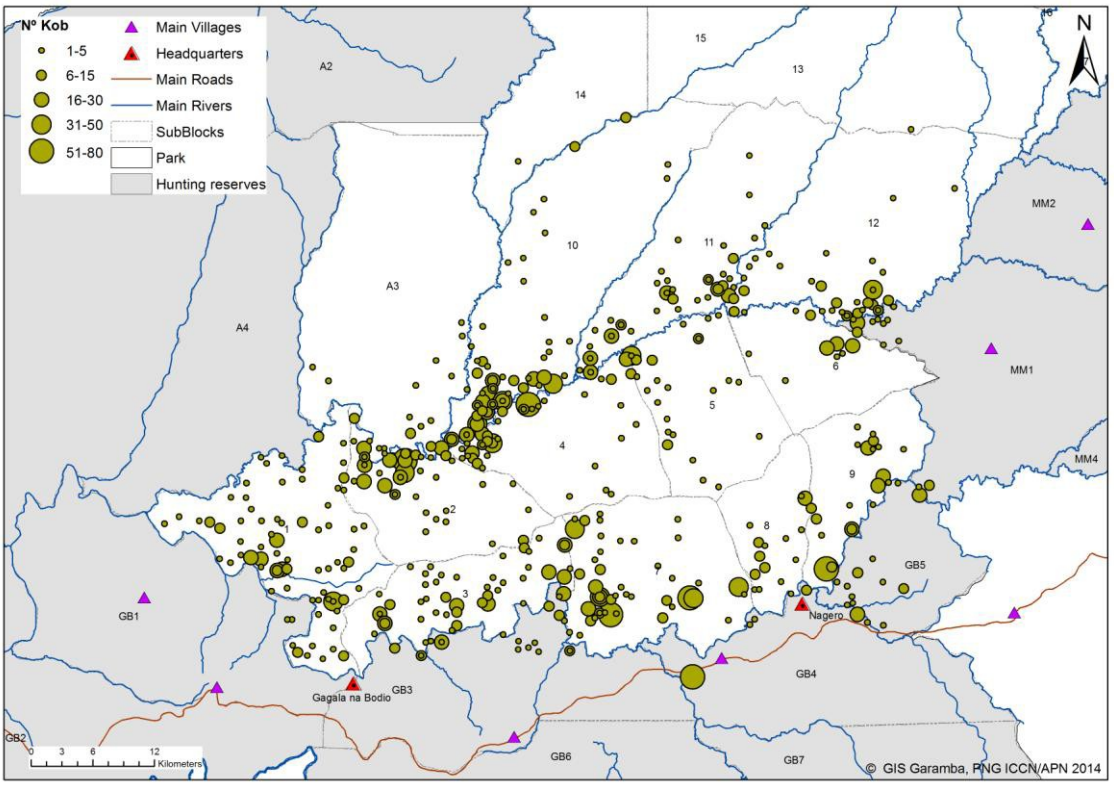
The number of kob counted totalled 3,860, representing a density of 0,74 kob/km². For this population, we found differences in densities between blocks, as there are blocks with 351 to 520 kob and others with only 46 or 70 animals.

Tablo 9: Number and density of kob counted in each block for the total count of 2014

Total Count		Kob	
Block nº	**Area (km²)**	**Number**	**Density (ind/km²)**
1	257	359	1,40
2	164	360	2,20
3	155	351	2,26
4	194	381	1,96
5	187	86	0,46
6	142	91	0,64
7	231	520	2,25
8	101	70	0,69
9	131	221	1,69
10	372	535	1,44
11	265	250	0,94
12	333	231	0,69
MM1	73	46	0,63
GNB3/5	504	265	0,53
A3	472	94	0,20
Total	**3581**	**3860**	**0,74**

Usually, this species tends to cluster in small groups around large watercourses. We reported on seven groups of between 51 to 80 kob, 12 groups of between 31 and 50 individuals, 57 groups of between 16 and 30 individuals, 111 sightings of groups ranging in size from six to 15 and finally on 344 occasions, groups of between one and five individuals.

Fig 11: Distribution map of kob for the total count in 2014



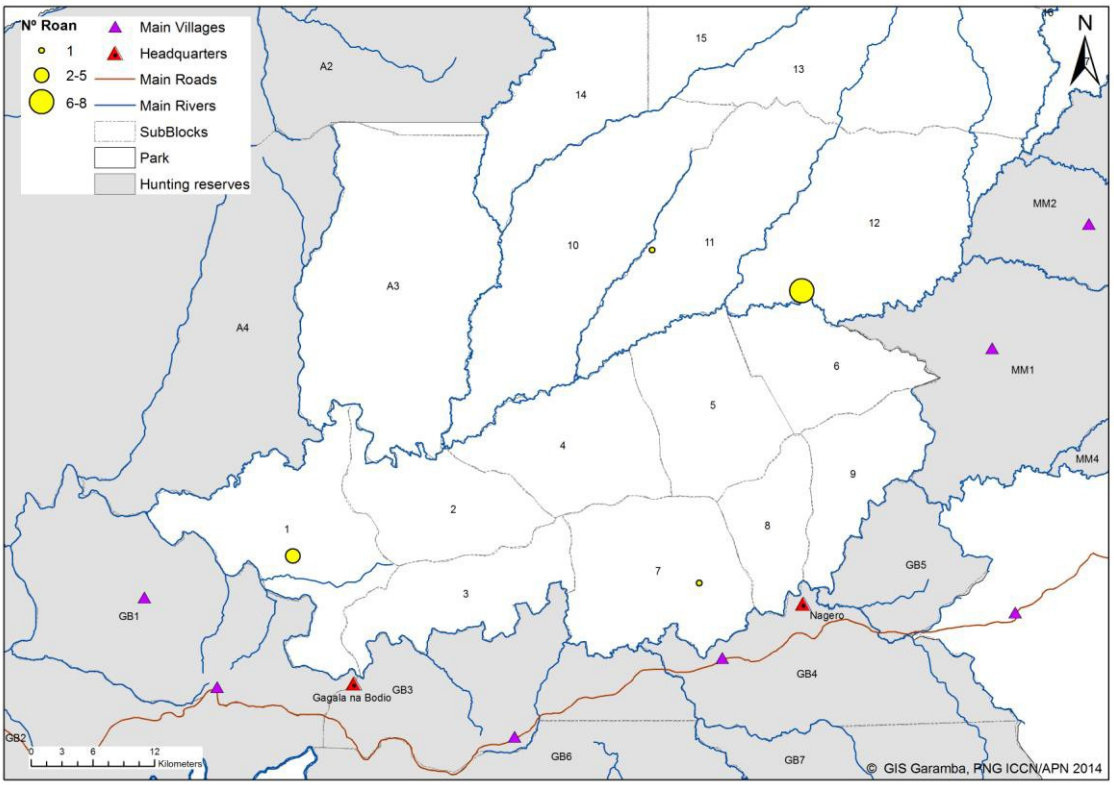
4.1.2.8 Roan antelope

For this species were counted 13 individuals, a density of 0.01 indiv/km2. As anticipated the population is limited to only four blocks, and in two we found only one individual (0,004indiv/km2). In Block 1 we recorded three (0.01 indiv/km2) and in Block 12, eight individuals (0.02 indv/km2).

Table 10: Number and density of Roan antelope counted in each block for the total count of 2014.

Total Count		Roan	
Block n°	**Area (km²)**	**Number**	**Density (ind/km²)**
1	257	3	0,01
2	164	0	0,00
3	155	0	0,00
4	194	0	0,00
5	187	0	0,00
6	142	0	0,00
7	231	1	0,004
8	101	0	0,00
9	131	0	0,00
10	372	0	0,00
11	265	1	0,004
12	333	8	0,02
MM1	73	0	0,00
GNB3/5	504	0	0,00
A3	472	0	0,00
Total	**3581**	**13**	**0,01**

Fig 12: Distribution map of Roan antelope for the total count of 2014.



4.1.3 Carcasses

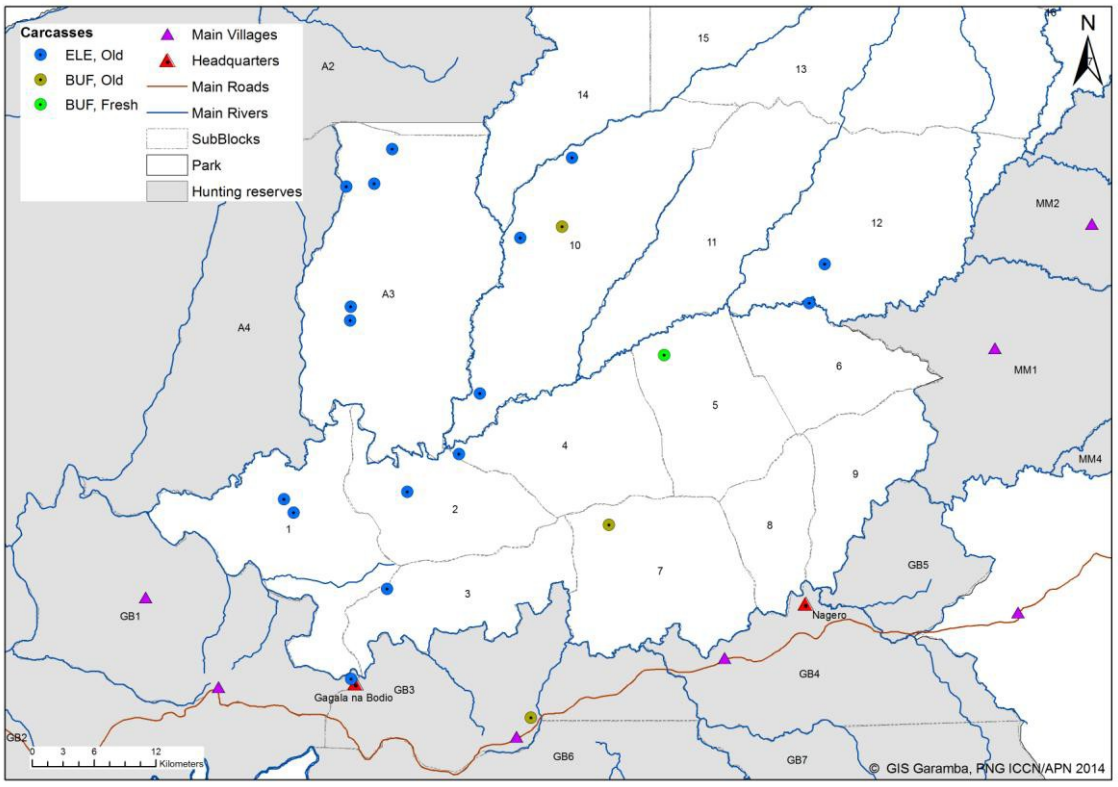
A total of 16 old (CAT3) and very old (CAT4) elephant carcasses were found (as described in Douglas-Hamilton (1996)). Three old (CAT3) buffalo carcasses and one fresh (CAT1) buffalo carcass were also found.

Table 11: Number of carcasses counted in each block for the total count of 2014.

Total Count		Carcasses			
Block n°	**Area (km2)**	**ELE-C**	**Density (indv/km²)**	**BUF-C**	**Density (indv/km²)**
1	257	3	0,012	0	0,000
2	164	1	0,006	0	0,000
3	155	0	0,000	0	0,000
4	194	1	0,005	0	0,000
5	187	0	0,000	1	0,005
6	142	1	0,007	0	0,000
7	231	0	0,000	1	0,004
8	101	0	0,000	0	0,000
9	131	0	0,000	0	0,000
10	372	3	0,008	1	0,003
11	265	0	0,000	0	0,000
12	333	1	0,003	0	0,000
MM1	73	0	0,000	0	0,000
GNB3/5	504	1	0,002	1	0,002
A3	472	5	0,011	0	0,000
Total	**3581**	**16**	**0.004**	**4**	**0.001**

As illustrated in the distribution map, the majority of the elephant carcasses were found in the western part of the park in Block A3 (0,011 carcasses/km^2), Block 1 (0,012carcasses/km^2), Block 2 (0,006carcasses/km^2) and Block 10 (0,008carcasses/km^2).

Fig 13: Map distribution of carcasses found for the total count of 2014



These are the carcass classification done by Douglas-Hamilton (1996), and from which we based our classification and the carcass ratio calculation:

1. Fresh carcasses (CAT1) have intact bodies with a rounded appearance, vultures are usually present and there is a pool of putrefied fluid surrounding the body. This category applies to carcasses thought to be less than 3 weeks old.

2. Recent carcasses (CAT2) generally have skin present with the skeleton still intact, and are distinguished by the presence of a rot patch. This category applies to carcasses that are 3 weeks to1 year old.

3. Old carcasses (CAT3) are bones only where the rot patch has disappeared. This category applies to carcasses older than 1 year.

4. Very old elephant carcasses (CAT4) are bones only. This category applies to carcasses older than 3 years.

The carcass ratio provides an index of elephant mortality and is an expression of all elephant carcasses as a percentage of all elephants (i.e. live plus dead). We have considered carcass ratios in two different ways (Table 12), as used by Dunham (2008):

1. The traditional all-carcass ratio (sensu Douglas-Hamilton and Burril (1991) represents the mortality rate during an unknown period prior to the survey, and it reveals a general recent trend, but not necessarily the current trend, this is a percentage expression of [all carcasses/(live + all carcasses)], and

2. Considering fresh and recent carcasses independently, a better index of recent elephant mortality can be obtained. The category 1+2 carcass ratio relates to elephant mortality in the survey year, and this is a percentage expression of [category 1+2 carcasses/(live + cat. 1+2 carcasses)

Table 12: Number of elephants and buffaloes and the carcasses in the surveyed area

Survey 2014	Total live	Total dead (CAT 1-4)	Recent dead (CAT 1+2)	Known Poached	Carcass ratio (%)	Recent carcass ratio (%)
Elephant	1718	16	0		0,98	0
Buffalo	7149	4	1		0,06	0,01

4.1.4 Human activity

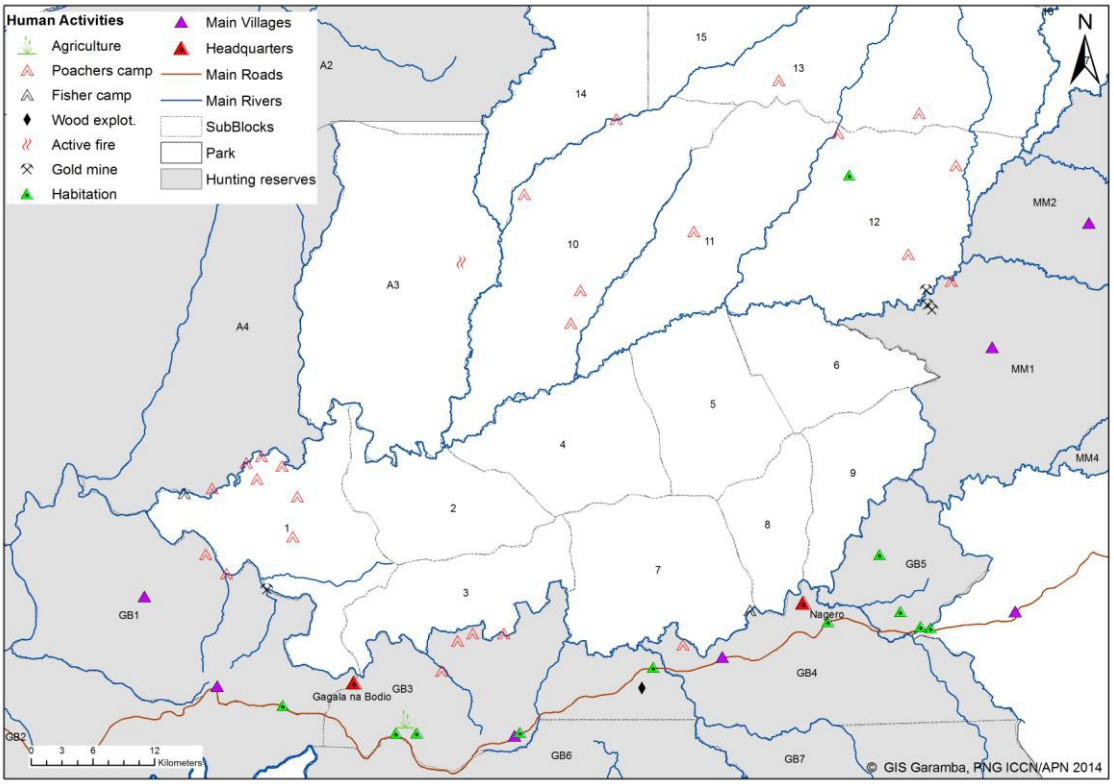
For this count, 47 indicators of human activities were recorded. Of these, 27 were directly related to poaching. We found 26 poacher camps of which 20 were old (three with meat-smoking racks), five were recent camps (two with meat-smoking racks) and one was occupied (smoke was observed). As visible on the map, all were located in Blocks 10, 11, 12, A3 and 1.

There were also three fishing camps, two in the Dungu River and one in the Aka-Garamba River.

In the hunting reserves of Mondo Missa and Gangala Na Bodio, evidence was found of illegal mining (four cases) and illegal logging (three cases).

When it came to human settlements (HAB), 11 observations featured, although six could have been affiliated to small, nearby villages.

Fig 14: Map distribution of human activity observed for the total count of 2014



4.2 Sample Count

4.2.1 Survey results

This survey took place over four days, from 03/04/2013 to 07/04/2014. Four morning sessions were conducted in durations ranging from 04:34hrs to 05:29hrs. The team flew 3,075km in a total of 20 hours. (*See Annex V Fig 5 and Table 2*)

A total of 60 north/south parallel survey strips were surveyed spaced in 2km intervals, with a wide strip of 207m each side of the aircraft. In total, they covered an area of 4,118km2. These exact transects were followed precisely using a GPS and flown at an average altitude of 362,26 ft (VAR 771,15) above ground level. The average speed was 167 km /hour. The lengths of the 60 survey strips varied between 5,56km to 65km and the total length was 2,263km (*See Annex V Table 2*)

4.2.2 Animal observation

Only elephant, buffalo, hartebeest, waterbuck and kob were observed for the count. In general, we must mention that their abundance was very small and the number of recordings per sample / transect also very low. Estimations done from low numbers of observations are not accurate and comes with big variances that makes difficult to observe statistical differences between them. For example, in Table 13, for buffalo only one group of 32 individuals was found in the A4 block, or for elephants only three groups were found. The estimates were calculated for each population in the sampled area. We estimated 206 elephant, 129 buffalo, 231 hartebeest, 279 waterbuck and 166 kob.

Next table summarizes the number of individuals counted in each of the sub-blocks and the densities calculated.

Table 13: Number of individuals counted and density calculated for each sub-block for the sample count 2014.

Block	area (km2)	Elephant		Buffalo		Hartebeest		Waterbuck		Kob	
		N	Density	N	Density	N	Density	N	Density	N	Density
13	373	0	0	0	0	50	0,13	1	0,00	15	0,04
14	283	0	0	0	0	4	0,01	2	0,01	0	0,00
15	286	0	0	0	0	7	0,02	0	0	4	0,01
16	376	0	0	0	0	3	0,01	7	0,02	1	0,00
17	375	0	0	0	0	0	0,0	0	0	0	0
18	293	0	0	0	0	0	0,0	13	0,04	0	0
19	273	0	0	0	0	5	0,02	0	0	0	0
20	353	0	0	0	0	0	0	2	0,01	0	0
MM2	280	0	0	0	0	0	0	27	0,10	3	0,01
MM3	325	0	0	0	0	0	0	0	0	3	0,01
A2	598	0	0	0	0	0	0	11	0,02	12	0,02
A4	431	51	0,12	32	0,07	0	0	7	0,02	3	0,01
	4247	51	0,01	32	0,01	69	0,02	70	0,02	41	0,01

N (Number of individuals counted in each transect), **Density** (individuals/km2)

Here below are the estimates calculated for each population for all the sampled area. The ideal should be calculate the estimates by sub-blocks due the low density of observations but because all the transects are present in more than one stratum (sub-blocks) it's difficult to calculate the estimates for each sub-blocks.

Table 14: Estimates for the species observed in the sample count for 2014.

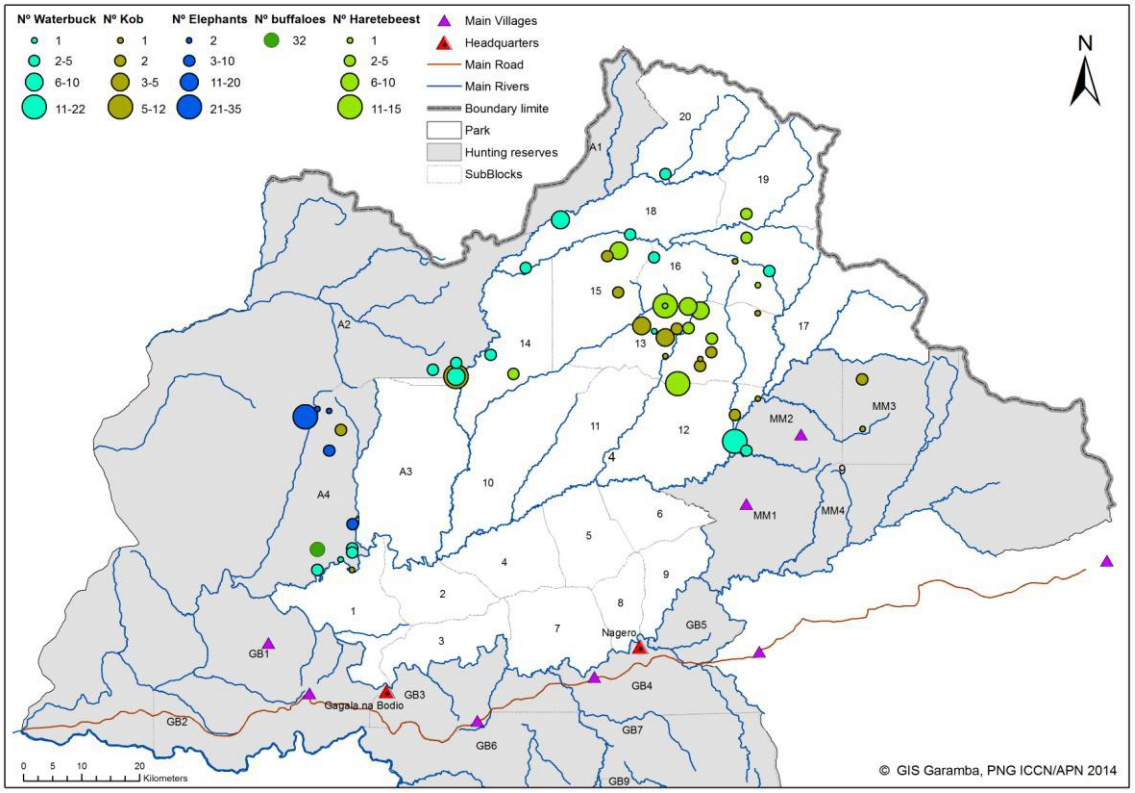
Specie	Scientific name	Individuals observed (n)	Population Estimate ($\hat{Y}$)	Standard Error (SE ($\hat{Y}$))	Density (anim/Km²)	95% CI	CI as % of population estimate
Elephant	*Loxodonta africana*	51	206	4819,49	0,05	9638,98	4673,28
Buffalo	*Syncerus caffer*	32	129	3599,94	0,03	7199,88	5563,35
Hartebeest	*Alcelaphus buselaphus*	69	231	1081,42	0,06	2162,84	938,23
Waterbuck	*Kobus ellipsiprymus*	70	279	1775,26	0,07	3550,52	1272,34
Kob	*Kobus kob*	41	166	582,55	0,04	1165,10	702,65

Table 15: Number of individuals counted for each species and number of groups in the sample count for 2014.

Animal Obsv.	Total	#Groups
Elephant	51	5
Buffle	32	1
Hartebeest	69	11
Waterbuck	70	17
Kob	41	18

In the distribution map we can see that observations of hartebeest and kob were concentrated in Blocks 13, 15 and 16, with the greatest abundance in Block 13. Waterbuck were present in Blocks 12, 18 and A2, always close to sources of water. All elephant observations took place in Block A4, also the site for the observation of a herd of 32 buffalo.

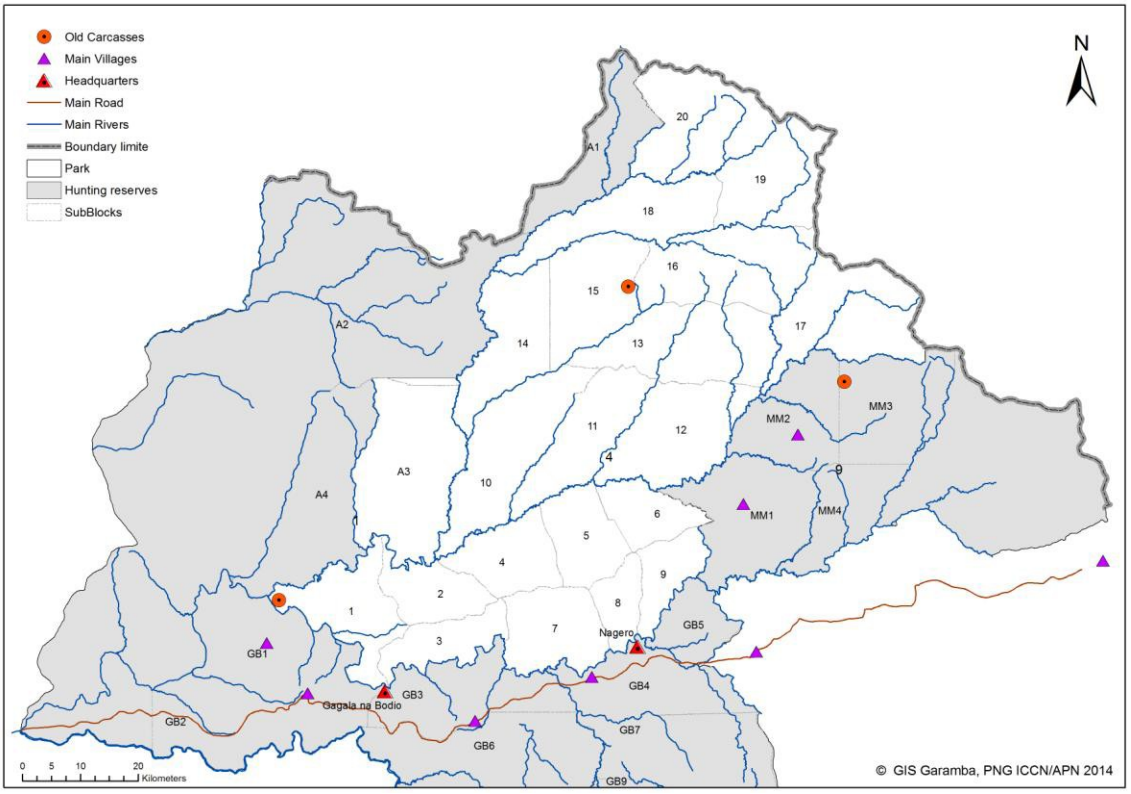
Fig 15: Distribution map for all the species observations for the sample count of 2014.



4.2.3 Carcasses

In total we saw three old elephant carcasses (CAT3) in Blocks 15, MM3 and A4.

Fig 16: Distribution map for all the carcasses observed for the sample count of 2014.



4.2.4 Human activity

In total there were 41 indicators of human activities, of which 29 were direct evidence of poaching activities, eight involved mining and three were human settlements. No cattle or domestic livestock was recorded.

Table 16: Number of human activities counted for each species and number of times for sample (N) in the sample count for 2014.

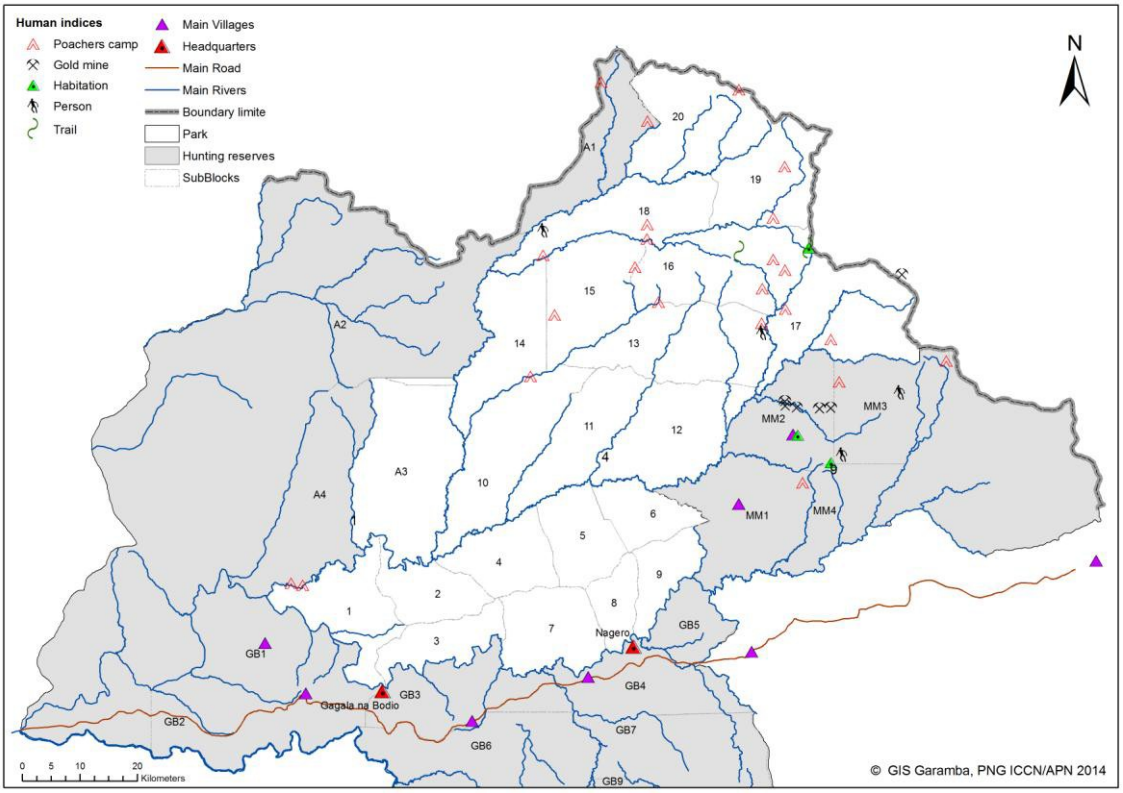
Human activities	Total	N
Poacher camp	23	23
Fisherman camp		
Gold mines	8	8
Logging		
Agriculture		
Settlement	1	1
Village	2	2
Poachers	7	4
Fire		

Of the 29 poaching indicators, 23 were of camps/huts, of which 16 were old bases, 2 were recent and 5 actually occupied. Six had racks for smoking poached meat. Two active path were detected and on four occasions we saw poachers, in groups of two.

As per the distribution map, evidence of mining and human settlements were concentrated in the hunting reserve of Mondo Missa. We know that there are two small villages in the area called Tekadje and Gbere, where residents are involved in illegal gold mining.

Most of the poaching camps were inside the park next to a large river. Several were close to the border with South Sudan.

Fig 17: Distribution map of human activities observed for the sample count of 2014.



5 Discussion

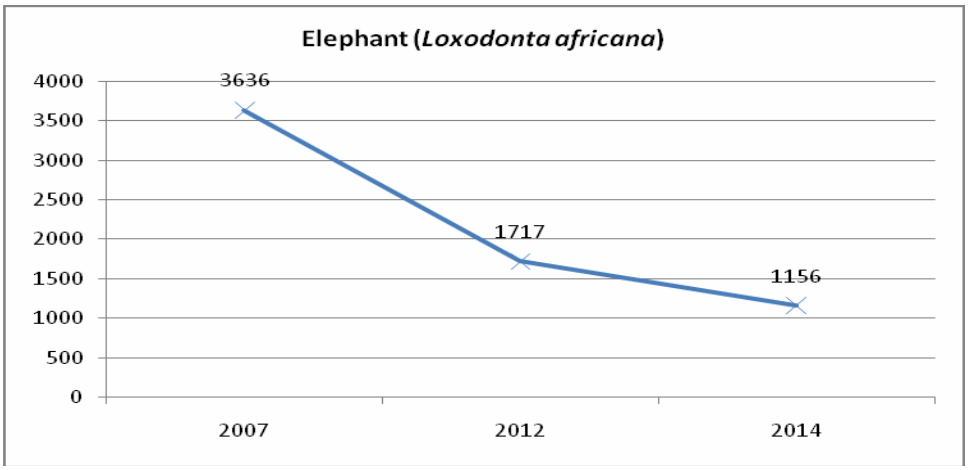
Below we have compared the results with the surveys conducted in April 2007 and April 2012. Altought, there were some differences in the total sampled area, with the census of 2007. The blocks10, 11 and 12 are not the same surface, even seems yes, they are smaller (See Appendix I, Fig 1 and Fig 2). Because of that we have compared the results from the Blocks of the south of the park (Blocks 1 to 9).

5.1 Elephant population

Garamba is well known for its large elephant herds that aggregate in large numbers at the beginning of the rainy season. Unfortunately, Garamba is also is known to suffer heavy poaching pressure, exacerbated by the presence of several rebel groups in the region. The park was home to 22,000 elephants in 1978 compared to the current figure of less than 2,000, a decline attributable to the ongoing poaching of the species.

This year we counted 1,718 elephants and estimated 206 in the northern part of the park. By comparing only Blocks 1 to 9, the population has declined by 68 percent compared to the 2007 count, and by 33 percent compared to the 2012 dry season count.

Fig 18: Elephant trend by the last three total counts in Garamba National Park.

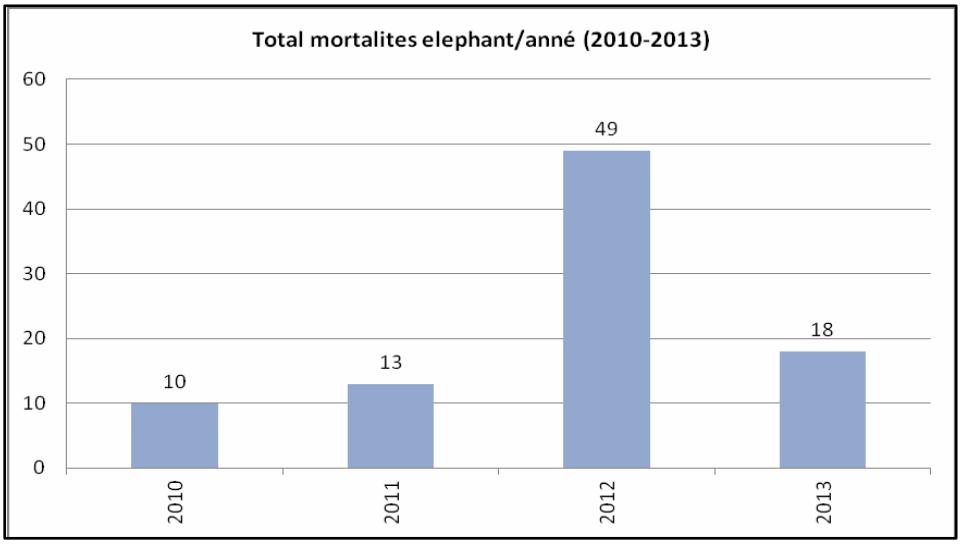


From all the elephant counted, 92 per cent of the population were found in family groups, and all of them presented a healthy structure of adults, medium sized youngsters and even a very small calfs, which is a positive indicator even the treats the population is facing.

The high poaching pressure is directly linked to the demand for ivory. There are several groups involved: There is strong poaching pressure emanating from South Sudan, in which poachers enter the park by the north, north-east, and up to the southern sector of the park. There is also strong pressure from the local population and elements from the country's military, the FARDC, who provide local communities with weapons. These communities know the terrain and location of elephants and other species killed for the illegal bush meat trade. Armed groups like the Lord's Resistance Army (LRA) are another factor. They are present in the Azande Hunting Reserve and conduct raids in small groups to kill elephants. It is know that they trade ivory to finance the purchase of weapons and ammunition. There is also growing evidence that the illegal trade in natural resources, such as ivory, maintains armed groups in countries devastated by war, such as the DRC. In fact, close to 20,000 elephants are killed each year in conflict-ravaged countries (site Web UN)

Below is a graph of carcasses found from 2010 to 2013(the remnants of poaching), before raw data wasn't available. In 2010 the number of carcasses discovered totalled 13, there were 49 in 2012 and 18 in 2013. In 2012, 22 elephants were killed by helicopter in just one day.

Fig 19: Elephant mortalities from 2010 to 2013 in Garamba National Park.



The elephants poached in 2012 represented 2,45 percent of the total population counted.

The distribution observed in the maps for this count and for the 2012 count showed that all groups of elephants were concentrated in the southern sector of the park, probably because they felt safe there. This has been reported previously and we can assume that the southward movement is a result of poaching activity. In examining the bush and tree cover, we observed that the bush regeneration in the north of the park was very apparent and in some places tree canopy cover was 80 percent plus we noticed that bush and tree cover was increasing in the south-east, all a consequence of the absence of elephants.

Courtesy of data from the GPS / VHF collars fitted to elephants, we know that they do undertake small-distance migrations during the year. Through the collars we are kept abreast of their use of different habitats in the park including when they move towards the north and towards the hunting reserves, and consequently the dangers they are exposed to due to high levels of poaching in those areas. (472 elephants were counted in Azande.)

5.2 Giraffe population

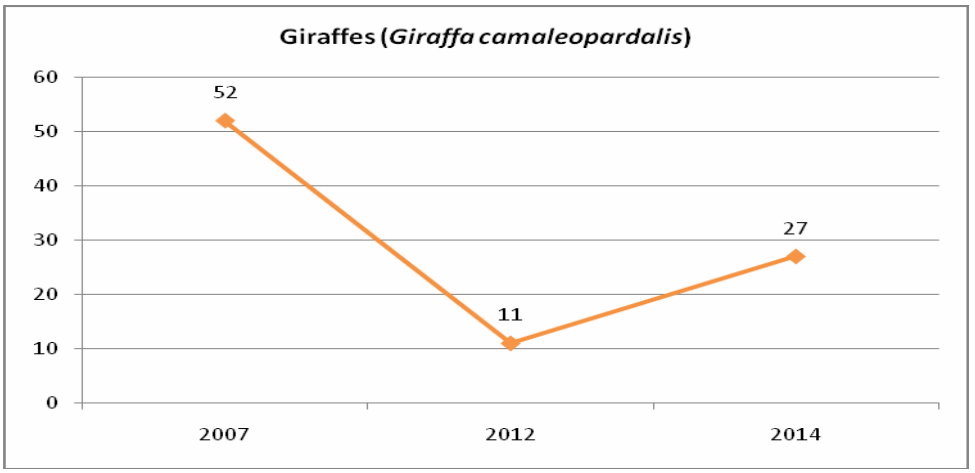
The giraffe population in Garamba is the only population of the species in the country. It is classified as endangered by the IUCN Red List Categories. This species, together with the extinct northern white rhino, was the main reason for the creation of the park in 1938 and for its proclaimed World Heritage Status in 1981. (Hillman Smith et al. 1995)

It has always been believed that Garamba's giraffe are a subspecies but recent genetic studies show they are the Kordofan subspecies (*G.c. antiquorum*), the same species found in Cameroon and Chad.

Although the giraffe population has always been relatively low, their numbers have plummeted to a few individuals over the decades. Some 345 giraffes were estimated to occur in the park in 1993. This number decreased to 81 reported giraffe in 2007 and during the most recent aerial count this year we found 42 giraffe. In the census conducted in 2012 it is assumed that not all giraffe present were counted, as there would probably have been some outside the area of study.

If we compare only the southern sectors of the park (Blocks 1 to 9) we can discern a drop of 48 percent in giraffe numbers, compared to the count in 2007.

Fig 20: Giraffe trend by the last four total counts in Garamba National Park.



The park has faced many challenges over the years and poaching activity has been always present. We know that local poachers do not kill giraffe but that South Sudanese poachers do.

At present, giraffe are concentrated in the southern part of the park, between the Garamba and Dungu Rivers. The principal groups are west and east from the southern sector, the latter group in a higher concentration.

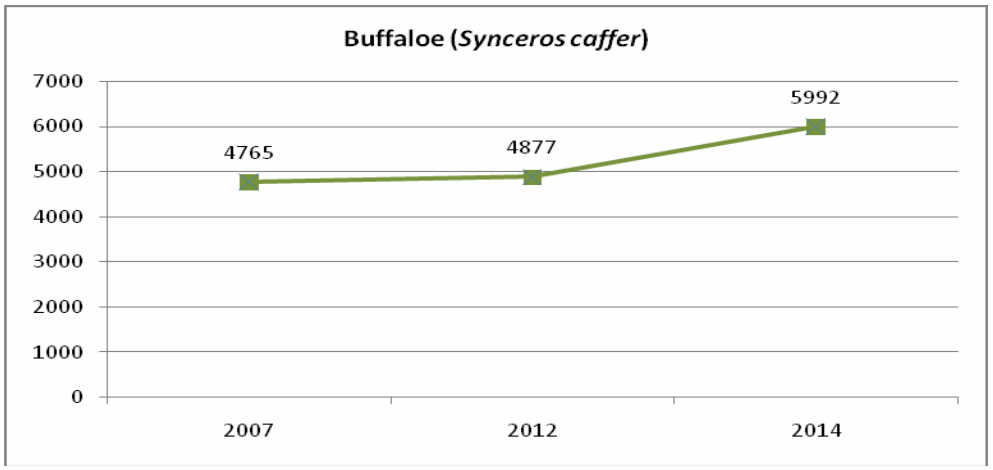
Due their low numbers and as a protective measure, in 2012 we decided to attach GPS collars to some giraffe to monitor their movements and in order to learn more about their ecology. Five giraffe were collared and the measure began providing important information. Three of the collared giraffe were poached by the Sudanese.

We can confirm that the population is currently at a critically low number and we need to devise an action strategy to protect and try to increase their numbers.

5.3 Buffalo population

Buffalo are the most numerous large mammals. The number of buffalo has increased this year by 26 percent and by 23 percent compared to the dry season counts in 2007 and 2012.

Fig 21: Buffalo trend by the last three total counts in Garamba National Park.



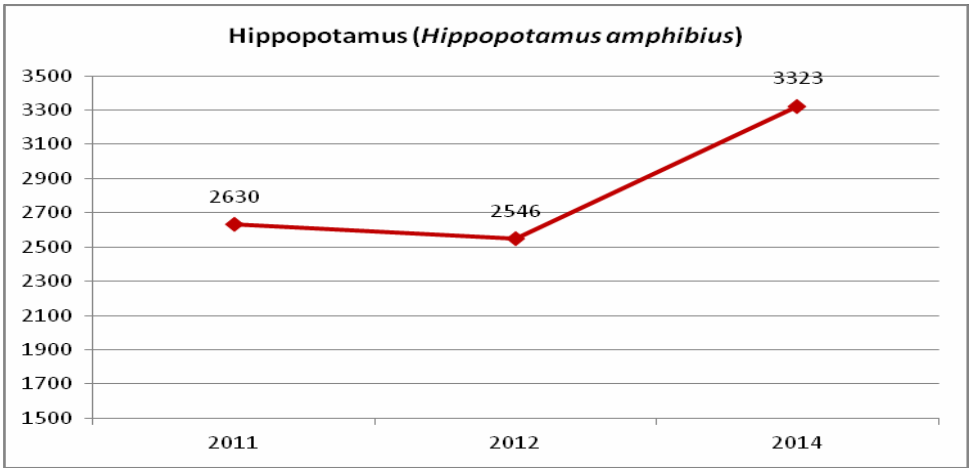
The distribution map shows that buffalo have responded to the poaching pressure from the north of the park because all the big herd concentrations are in the southern sector of the park. Some smaller groups or solitary males are in the hunting reserves. No buffalo were found in the north.

5.4 Hippopotamus population

A report has been complied for the specific hippo count that was undertaken earlier this year, along with the data provided by this count for the hippo recorded in water pools in the park. For a better understanding and analysis see the report.(*See* Mònico.M *2014*. *Hippopotamus count Mars 2014*)

However, if we compare the results of the counted number of hippo in the water pools in 2012 (740 hippo) with the number found this year (848 hippo), we can see that the number has increased by 16 percent. Moreover we can compare the total results of the specific count conducted in 2011 and 2014, with 2630 and 3323 hippo recorded respectively, resulting in a population increase of 26 percent.

Fig 22: Hippopotamus trend by the last three specific counts in Garamba National



Hippopotamus populations are concentrated mostly in the Dungu and Garamba Rivers. The highest proportion is in the Dungu River, and the largest groups near the Nagero station. The hippo found within the park are in permanent ponds and account for 22 percent of the total population.

Hippopotamus has long been the preferred species of bushmeat poachers because of their availability in the rivers that form the boundaries of the park.

5.5 Antelope population

When it comes to hartebeest, waterbuck, and kob we can only compare the results from the last count in 2012 because they were not counted in 2007. We also need to be mindful that we are comparing only the results of the southern sector (Blocks 1-9).

The hartebeest population has increased by 57 percent compared to two years ago. They are distributed throughout the park, except in the thickly wooded zone. They tend to be sedentary and their preferred habitat is the ridges of the savanna grasslands.

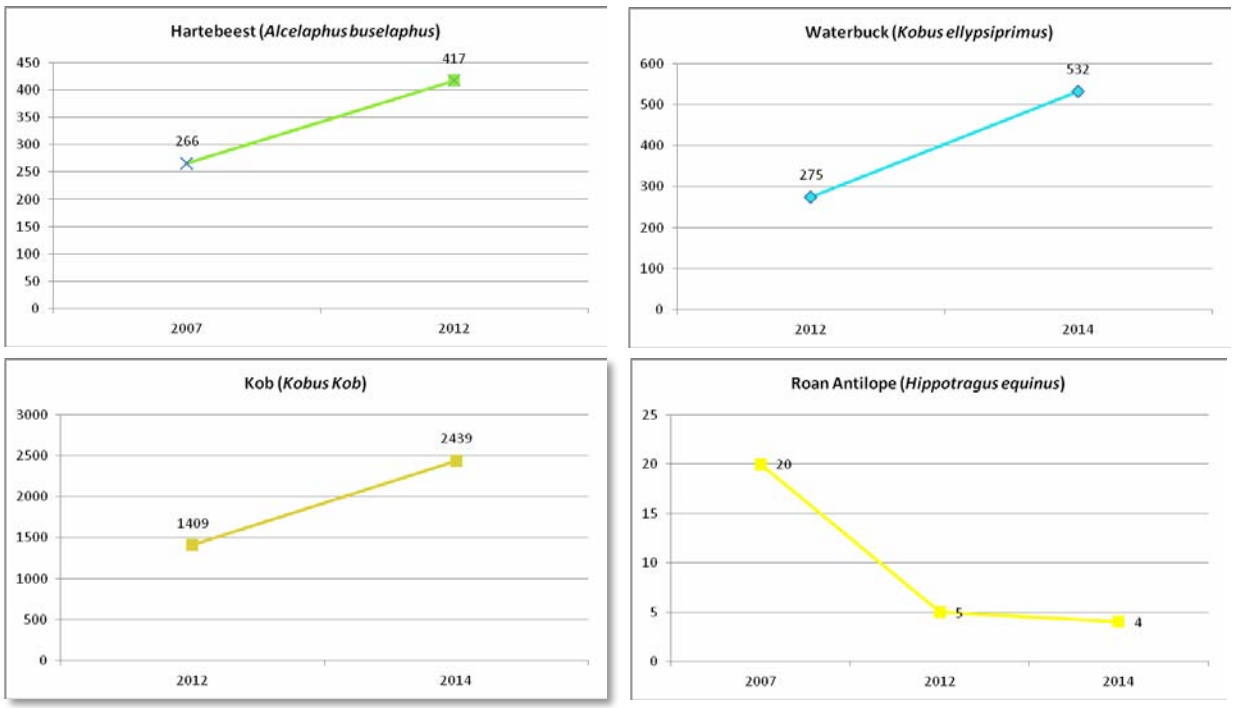
Kob have increased by 73 percent compared to 2012. They are distributed mainly in the southern sector but are also present in limited numbers in the north and in the hunting reserves. Kob tend to show a certain

affinity for areas where the grass is shorter all year, for example near the Naululoko/Eleti confluence, and Willibadi 2 confluence.

Waterbuck are widely distributed throughout the park, principally in the southern sector and in the hunting reserves with access to water sources that are connected to the Dungu and Garamba Rivers. Their numbers have increased by 94 percent since 2012.

Roan antelope are represented in the park by a very small population, which has decreased by 20 percent since 2012 and by 80 percent since 2007. It would appear that this species is not selectively poached, and that they are rarely reported as poached, at least in the southern sector of the park. The likelihood exists that they could be poached in the north and in the hunting reserves.

Fig 23: Trend by the last three total counts in Garamba National Park for the Hartebeest, Waterbucks, Kob and Roan antelope.



5.6 Human activity

Eighty-nine signs of human activity were recorded in the two counts, of which 63 percent were directly related to poaching. Most of the activity was in the form of poachers camps, generally located in the northern area, north-east, and near a river. Illegal mining represents 14 percent of human activity and takes place in the Monda Missa Hunting Reserve; timber exploitation represents some 3.3 percent and was occurring in the Gangala Na Bodio Hunting Reserve. Human occupation constitutes 16 percent of "human activity" and is interpreted as meaning a small hut with some agriculture, mostly located near a neighbouring village.

The poachers camps are temporary shelters or merely meat-smoking set-ups, built near the site of a kill in order to smoke poached meat and would only be occupied for one or two days.

Active, illegal gold mining and logging are also taking place in the reserves. Mines were observed in the Mondo Missa Hunting Reserve but it is known that much of the illegal mining activity centres on Sambia, in the south of Gangala Na Bodio. This is also an area of potential poaching activity.

6 Conclusion

A repeat of the total survey is recommended every two years, (using the same methodology, observers, sampling intensity and area covered) in order to investigate population trend.

Ground counts in the hunting reserve are required to gain knowledge about the number of elephants located there.

We need to amend the methodology of sample counting, and tests for blocks, in order to get an accurate estimate. This completed survey has however informed us on the status of wildlife and provided evidence of poaching levels and treats in Garamba. We propose a more extensive study. Estimates are inflated because they are based in small number of observations, providing too few samples for robust estimates. Also, because they were calculated for all the sampled area and not for each sub-blocks, which will give accurate estimates.
Because all the transects are present in more than one stratum (sub-blocks) it's difficult to calculate the estimates for each sub-blocks, which will give better estimates. This error we can modify for the next survey, and have better estimations.

It is clear that the northern sector of the park has been a major site for poaching over several decades. This has been substantiated by irrefutable census data, the high levels of human activity, and virtually zero existence of wildlife.

The elephant is the species that has, and is, suffering a steady decline year after year as a result of massive poaching pressure. Intensive monitoring is required to protect this population. Due the sophisticated level of poaching, continue with aerial monitoring of the population, more GPS collars deployed to more elephant groups, and special anti-poaching rangers, could be methods that helps maintain the elephant population in Garamba.

The status of the giraffe population is critical. We need to take immediate action if we are to avert their demise. Measures to protect giraffe could be extended to the Roan antelope. Different measures could be, build a fence to enclose them and assure their protection, or a less invasive method could be a special monitoring ranger following the group.

The populations of buffalo, hippopotamus, hartebeest, kob and waterbuck can be said to be developing although they could be suffering indirect pressure from poachers whose primary intention is to hunt elephant because they are species that can also be hunted as food.

The meat poaching and ivory poaching activities of the past decades are reflected in the distribution of all species that are concentrated in the southern sector of the park.

It is important for the future of the park and its wildlife that sufficient resources are allocated to the park and that political engagement is mobilised in order to stop elephant poaching from all fronts, and at all levels.

7 Bibliography

Amube Ndey J. (2007). Rapport de coomptage aérien du secteur sud du Parc National de la Garamba. Du 08 au 16 Avril 2007-07-27. ICCN et African Parks.

Burril A., Kaliski K. & Douglas-Hamilton I. (1984). Aerocount, aerial survey analysis program manual Typescript.

Casado N., 2012. Aerial animal census 2012, ICCN/APN, Parc National de la Garamba : Département de Recherche et monitoring.

Craig, G.C. 2012. Monitoring the Illegal Killing of Elephants: Aerial Survey Standards for the MIKE Programme. Version 2.0. CITES MIKE programme, Nairobi.

Emslie R.H., Reid C. And Tello J. (2006). Report on the different target species counted and evidence of poaching recorded during aerial and ground surveys undertaken in southern Garamba National Park and adjoining Domain de Chasse Gangala na Bodio, DRC. 17-20 March 2006. African Parks Foundation, ICCN, IUCN, SSC, African Rhino Specialist Group and UNESCO.

Hillman Smith K., Atalia M., Likango M., Smith F., Amube Ndey J. & Panziama G. (1995). General aerial count 1995 and evaluation of the status and trends of the ecosystem. PNG and DC

Markéta A., 2010. Le suivi écologique des éléphants (Loxodonta africana) dans le Parc National de la Garamba au moyen des colliers télémétriques, Département de Recherche et monitoring, Rapport technique 1, Mise en place les colliers, suivi et les résultats préliminaires.

Norton-Griffiths, M. (1978). Counting animals. African Wildlife Foundation, Kenya.

PAASE Management team (2014) Aerial Survey Standards and Guidelines for the Pan African Aerial Survey of Elephants 2014. January 2014.

Petri Viljoen (2010). Aerial Wildlife Survey Octobre 2010. Bangweulu Wetlands Zambia

Potgieter D., N´gakoutou E.B., Djimet B., Lamoureaux S. (2010). Dry season aerial total count. Zakouma National Park, Chad. 11-15 March 2010.

Reid C.A. (2007) Aerial survey Garamba National Park. Democratic Republic of Congo. 08-16 April 2007. ICCN, African Parks, UNESCO and EU.

Schapira P., Antoninova M. (2011). Garamba National Park Hippopotamus Survey 2011 (Preliminary Rapport). African Parks, ICCN.

Smith K., Smith F., Atalia M., Likango M., Watkin J., de Merode E., Amube Ndey J., Kobode E. (1993). Recensement General/General aerial count. May 1993. WWF, IUCN, UNESCO

Songhurst A. & Chase M. (2010) Elephant Survey July 2010. Eastern Okavango Panhandle, Botswana (NG11,NG12 and NG13). Okavango Elephant and People Research Project & Elephants Without Borders

http://pfbc-cbfp.org/news_en/items/UN-enen.html

8 Annex

Annex I

Fig 1: Map of the flights for the total count in 2012.

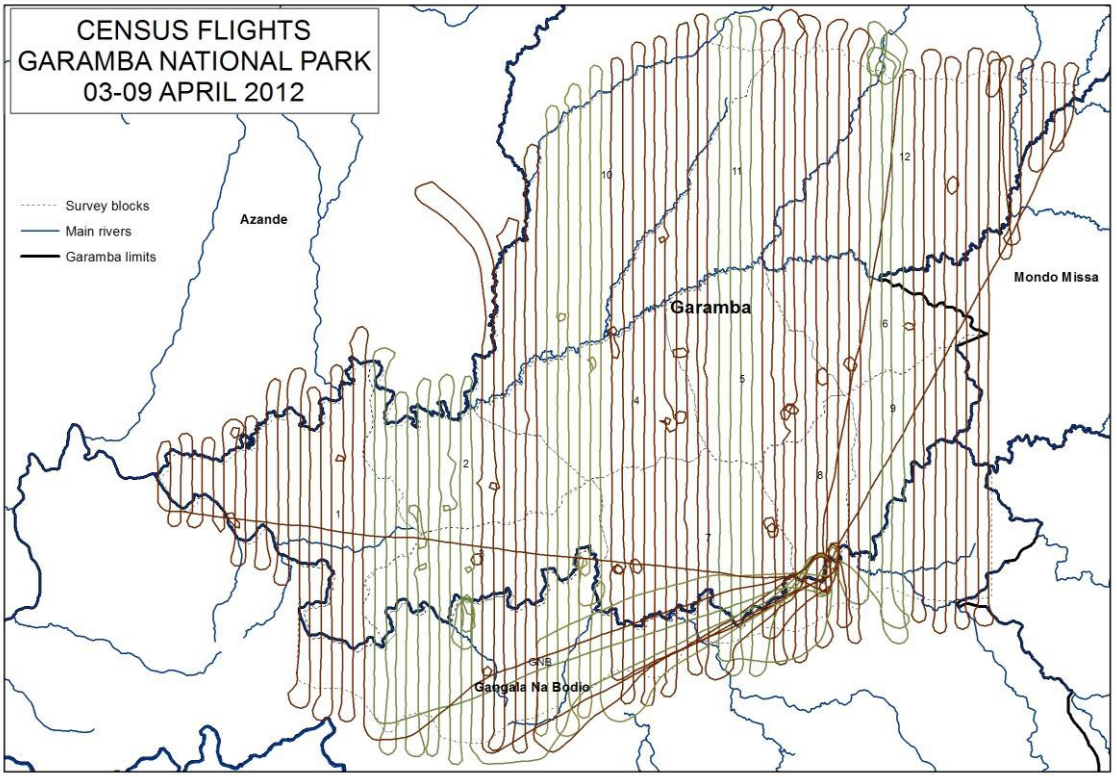
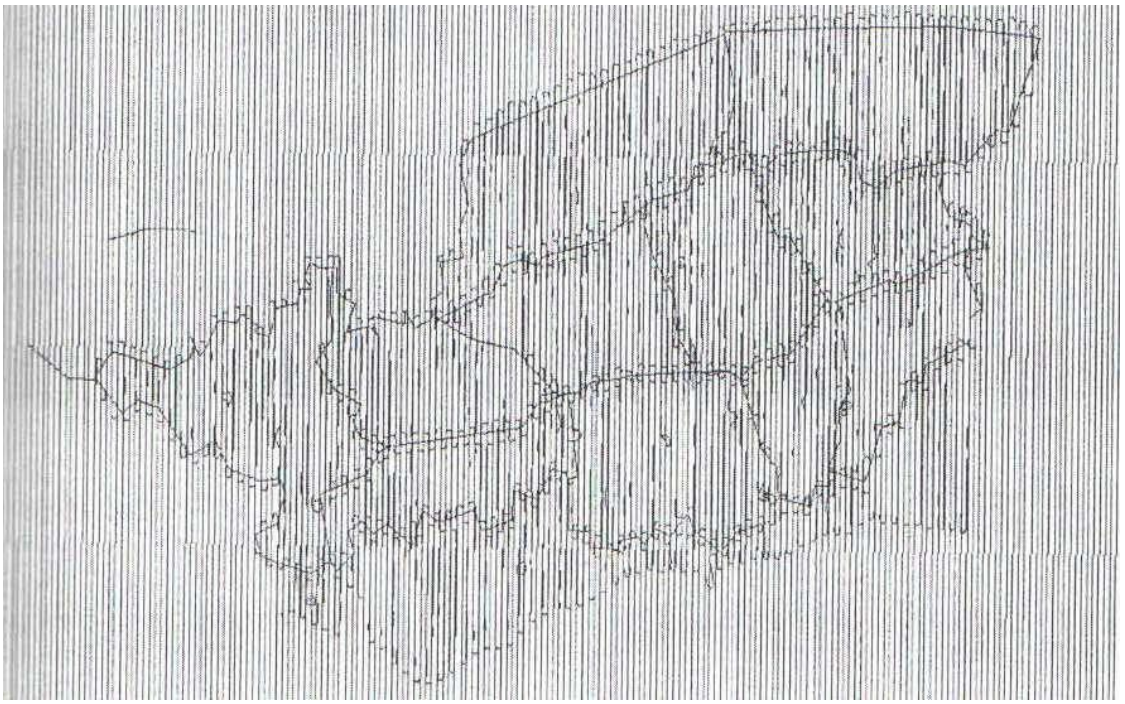


Fig 2: Map of the flights for the total count in 2007.



Annex II

Fig 3: Data sheet used to record all the observations and flight information.

RECENSEMENT AERIENNE 2014 GNP/APN-ICCN

Date		AM		Flight No/Page	
Pilot		PM		Transect	
Recorder		Take off		Start	
Left obs.		Landing		End	
Right obs.		Total		TOTAL	

Tr	Alt	s/st	Side	Wpt	spp/obs	vis	photos	ph.c	age	NOTE

EXPL:

Tr	Transect number
s/st	Start and Stop time of each transect (each transect start at new sheet)
spp/obs	Species, carcass or indices observation
vis	Visual estimates of each group numbers
photos	Photo number
ph.c	Number of individuals counted from the photographs
age	Age of carcass or indices
WPT	Waypoint number

Key species direct observations:

- Elephant ELE*
- Giraffe GIR
- Buffalo BUF
- Roan antelope ROA
- Hippopotamus HIP
- Kob KOB
- Waterbuck WAT
- Bubal BUB **Elephant in family group or bull group*

Carcasses

- Elephant ELE-C*
- Giraffe GIR-C
- Buffalo BUF-C **Remark whether tusks present in carcass*

Human activity:

- Poacher's camp CP
- Fisherman's camp CF
- Habitation (village, huts) HAB
- Fields/agriculture AGR
- Tree cutting/logging LOG
- Gold mines GM

Annex III

Jolly'sMethodII:

N = the number of sample units in the population

n = the number of sample units in the sample

Z = the area of the Census Zone

z = the area of any one sample unit

y = the number of animals counted in that unit

$\hat{R}$ = the ratio of animals counted to area searched = $\Sigma y / \Sigma z$

s_y^2= the variance between animals counted in all the units

$= 1 / n\text{-}1 * \{\Sigma y^2 – [(\Sigma y)^2 /n]\}$

s_z^2= the variance between the area of all sample units

$= 1 / n\text{-}1 * \{\Sigma z^2 – [(\Sigma z)^2 /n]\}$

s_{zy}= the covariance between the animals counted and the area of each sample unit

$= 1 / n\text{-}1 * \{\Sigma z * y – [((\Sigma z) * (\Sigma y)) /n]\}$

Population Total: $\hat{Y} = Z.R$

Population Variance: $\text{Var}(\hat{Y}) = \{[N(N-n)] /n\} * (s_y^2 – 2* \hat{R}* s_{zy}+ \hat{R}^2* s_z^2)$

Population Standard Error: $SE(\hat{Y}) = \sqrt{[\text{Var}(\hat{Y})]}$

95% confidence limits of $\hat{Y}$ $+/- t*SE(\hat{Y})$ (where t is for n-1 degrees of freedom

Annex IV

Fig 4: Map of the transects surveyed for the total count in the southern-middle of the park (sub blocks 1-12) and part of the hunting reserves (sub blocks A3, GNB3, GNB4, GNB5)

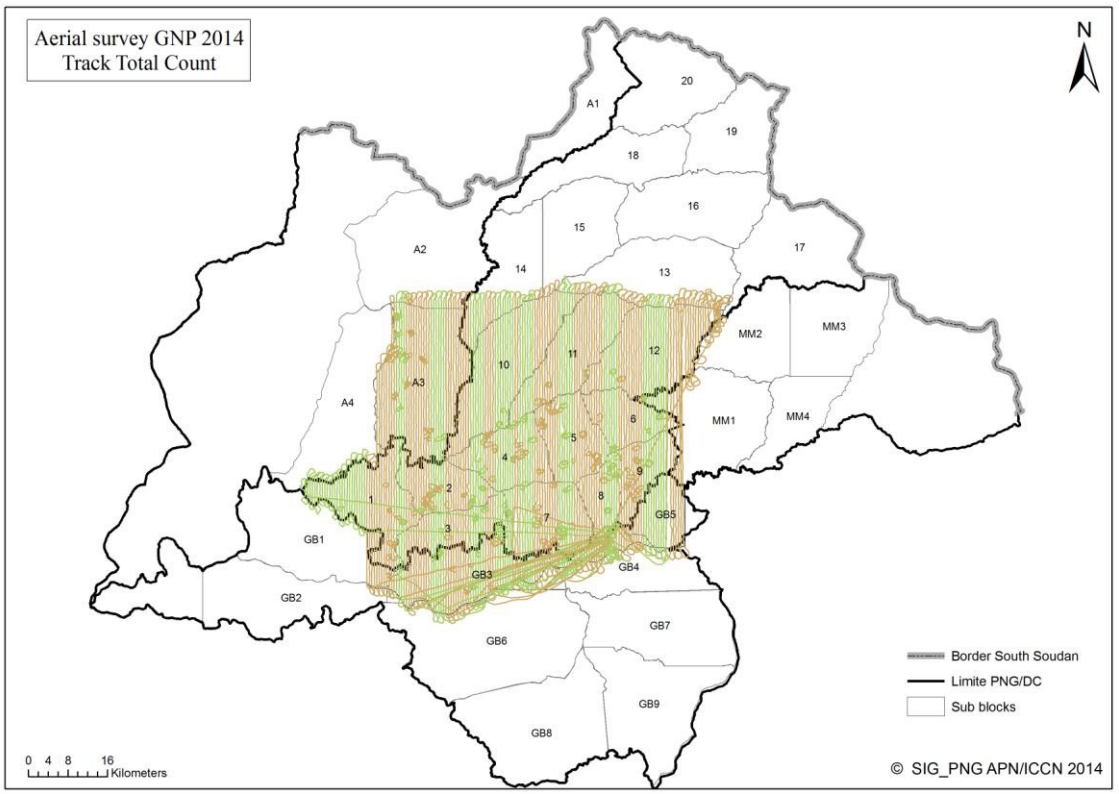


Table 1 : Flying schedule and distances from the total count.

Date	Day time	Flight	Take off	Start	Stop	Landing	Time to Go	Time to Back	Total time	Time surveying	Distance (km)	Speed (km/h)
23/03/2014	M	1	06:59:07	07:29:37	10:49:08	10:54:56	00:30:30	00:05:48	03:55:49	03:19:31	732,72	
24/03/2014	M	2	08:18:51	08:25:32	11:58:40	12:02:07	00:06:41	00:03:27	03:43:16	03:33:08	601,95	162
25/03/2014	M	3	08:49:11	08:52:11	12:39:31	12:41:24	00:03:00	00:01:53	03:52:13	03:47:20	631,77	163
25/03/2014	A	4	15:27:32	15:33:25	17:51:15	17:54:06	00:05:53	00:02:51	02:26:34	02:17:50	412,87	168
26/03/2014	M	5	06:39:27	06:43:13	11:11:37	11:15:12	00:03:46	00:03:35	04:35:45	04:28:24	782,61	169
26/03/2014	A	6	15:10:55	15:16:21	17:36:37	17:50:02	00:05:26	00:13:25	02:39:07	02:20:16	471,57	176
27/03/2014	M	7	06:41:17	06:47:53	11:06:21	11:14:08	00:06:36	00:07:47	04:32:51	04:18:28	742,48	164
27/03/2014	A	8	15:11:12	15:18:40	17:45:40	17:45:53	00:07:28	00:00:13	02:34:41	02:27:00	434,32	165
28/03/2014	M	9	08:24:01	08:32:18	11:46:21	11:56:52	00:08:17	00:10:31	03:32:51	03:14:03	813,37	167
28/03/2014	A	10	15:10:37	15:20:51	17:06:31	17:16:20	00:10:14	00:09:49	02:05:43	01:45:40	354,65	168
29/03/2014	M	11	09:43:42	09:51:20	12:31:57	12:45:20	00:07:38	00:13:23	03:01:38	02:40:37	500	165
30/03/2014	M	12	06:31:43	06:43:07	10:58:03	11:11:46	00:11:24	00:13:43	04:40:03	04:14:56	774,56	164
30/03/2014	A	13	15:08:36	15:22:06	17:56:35	18:08:40	00:13:30	00:12:05	03:00:04	02:34:29	526,57	173
31/03/2014	M	14	06:33:51	06:49:28	11:31:23	11:45:37	00:15:37	00:14:14	05:11:46	04:41:55	851,68	163
31/03/2014	A	15	15:17:26	15:32:18	17:25:31	17:40:04	00:14:52	00:14:33	02:22:38	01:53:13	412,66	167
01/04/2014	M	16	06:38:09	06:54:03	10:34:35	10:54:43	00:15:54	00:20:08	04:16:34	03:40:32	721,24	166
01/04/2014	A	17	15:14:21	15:31:12	17:14:02	17:41:36	00:16:51	00:27:34	02:27:15	01:42:50	426,7	170
TOTAL		**17 flights**					**3:03:37**	**2:54:59**	**58:58:48**	**53:00:12**	**10191,72**	**166,875**

Annex V

Fig 4: Map of the transects surveyed for the sample count in the northern part of the park (sub blocks 13-20) and part of hunting reserves (sub blocks A2, A4, MM2, MM3)

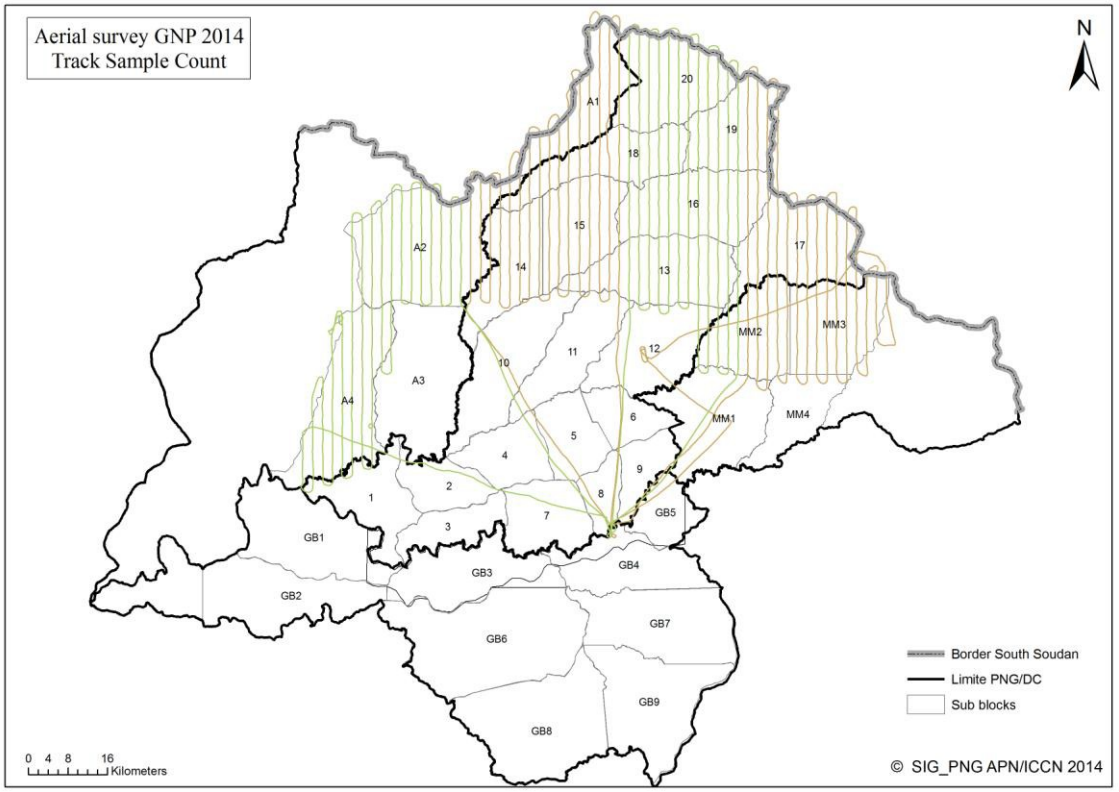


Table 2: Flying schedule and distances from the sample count.

Date	Day time	Flight	Take off	Start	Stop	Landing	Time to Go	Time to Back	Total time	Time surveying	Distance (km)	Speed (km/h)
03/04/2014	M	18	06:01:47	06:55:11	10:41:15	11:26:48	00:53:24	00:45:33	05:25:01	03:46:04	794,9	178
04/04/2014	M	19	06:39:44	06:54:15	11:23:48	12:09:23	00:14:31	00:45:35	05:29:39	04:29:33	832,21	176
06/04/2014	M	20	06:48:52	07:02:36	11:06:01	11:48:17	00:13:44	00:42:16	04:59:25	04:03:25	762,21	177
07/04/2014	M	21	06:48:28	07:05:51	10:44:53	11:22:49	00:17:23	00:37:56	04:34:21	03:39:02	686,61	172
4 Days		**4 Flights**					**1:39:02**	**2:51:20**	**20:28:26**	**15:58:04**	**3075,93**	**175,75**

Annex VI

Table 3: Survey parameters for the total count and the sample count.

Survey parameters	Garamba_TC	Garamba_SC
Survey dates	23/03 to 01/04 2014	03/04 to 07/04 2014
Survey area	12400km2	12400km2
Survey area locality	3º-4ºN 29ºE	3º-4ºN 29ºE
Survey aircraft	Cessna 206	Cessna 206
Survey crew		
Pilot	Guy Couture	Guy Couture
FSO	Marina Mònico	Marina Mònico
LSO	Mambo Marindo	Mambo Marindo
RSO	Fiston Padrini	Fiston Padrini
Survey strip spacing	500m	2km
Survey height (AGL)		
Targeted survey height	350 ft (106m)	350 ft (106m)
Recoded survey height - average		362,26ft (m)
Survey strips		
Number strips	170	60
Survey strip length	7286 km (500m-63km)	2263km (6km-65km)
Sample trip width		
Target sample strip width	500 (150m+150m)	400m (200m+200m)
Calculated average sample strip width		372m (179m+193m)
Area sampled		
Theoretical area sampled	3581km2 (29%)	4118km2 (33%)
Calculated area sampled	3581km2	1018km2 (25%)
Average survey ground speed		167km/h
Survey sessions		
Number of survey sessions	17	4
Sessions duration	02:05hrs to 04:40hrs	04:34hrs to 05:29 hrs
Distance total	10191km	3075km
Total Hours	58	20

Table 4: Area surveyed by each count vs the total of the area.

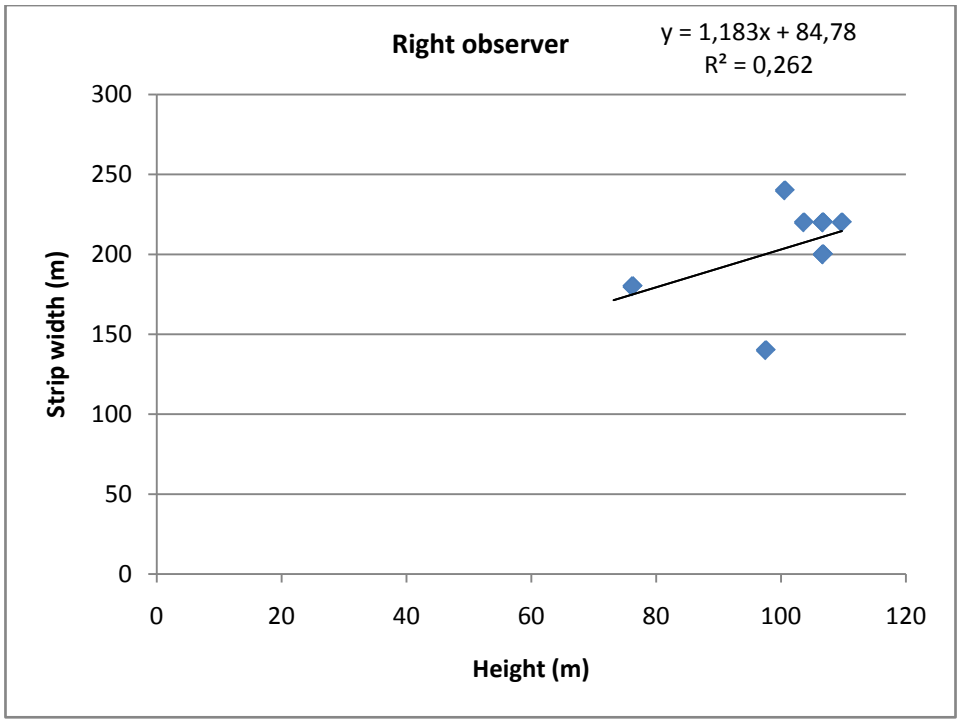
	Total area surveyed (km2)	% Total area Park+HR (12400km2)
TC	3581	28,88
SC	4118	33,21
Total	7699	62,09
not surveyed	4701	37,91

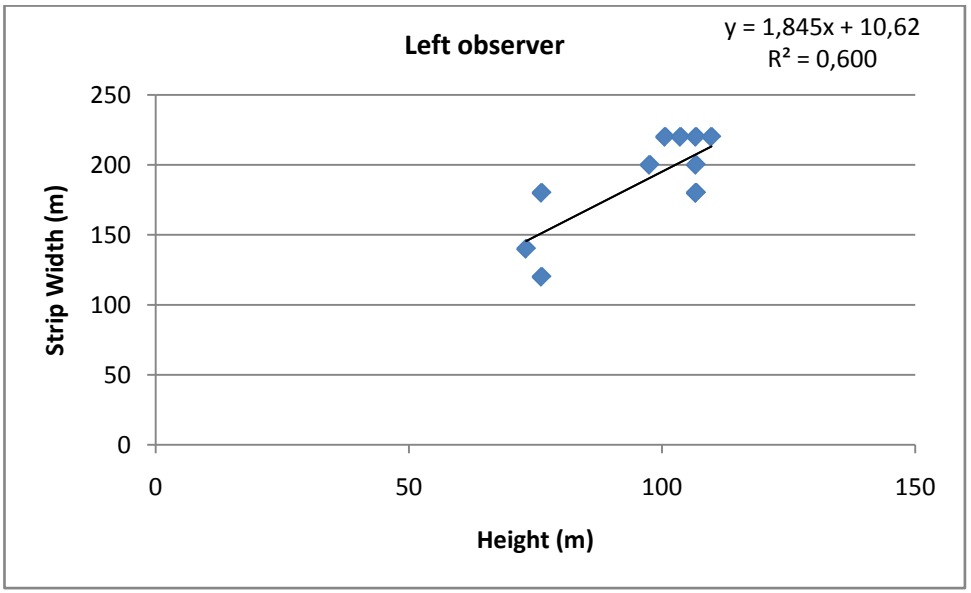
Table 5:Area for each of the sub-blocks

Block nº	Area (km2)
1	254
2	164
3	147
4	188
5	183
6	155
7	227
8	97
9	123
10	371
11	264
12	335
13	373
14	283
15	286
16	376
17	375
18	293
19	273
20	353
MM1	73
MM2	280
MM3	325
A2	598
A3	489
A4	431

Annex VII

Fig 5: Calibration results for the right and left rear seat observers.





	Left	Right	Total
Strip width	179,33	192,96	372,29

Annex VIII

Table 5: Average ground speed and search rate per flight for the total count 2014.

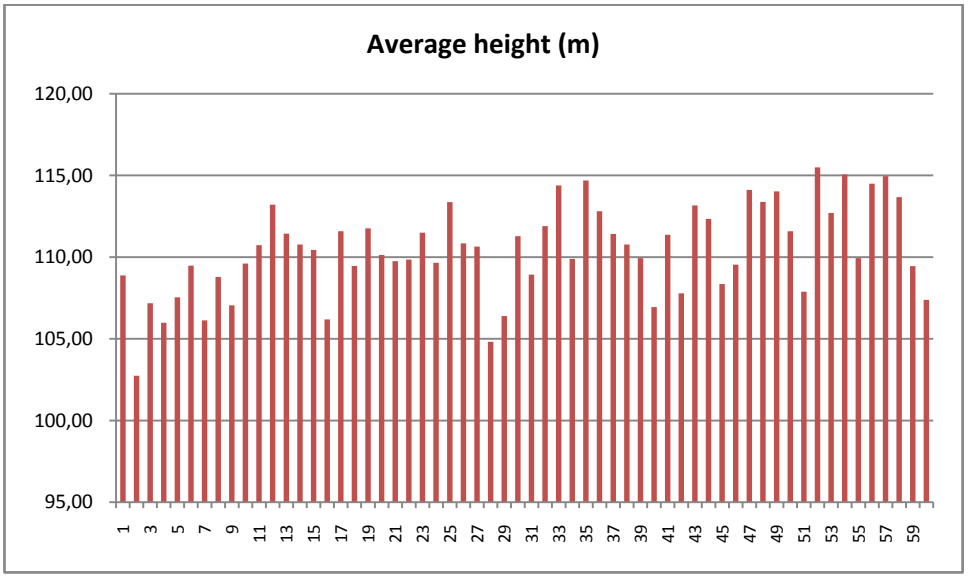
	Date	Day time	Flight	Avg Speed (km/h)	Search rate (km2/min)
Total Count	2014/03/23	M	1		
	2014/03/24	M	2	162	0,27
	2014/03/25	M	3	163	0,27
	2014/03/25	A	4	168	0,28
	2014/03/26	M	5	169	0,28
	2014/03/26	A	6	176	0,29
	2014/03/27	M	7	164	0,27
	2014/03/27	A	8	165	0,28
	2014/03/28	M	9	167	0,28
	2014/03/28	A	10	168	0,28
	2014/03/29	M	11	165	0,28
	2014/03/30	M	12	164	0,27
	2014/03/30	A	13	173	0,29
	2014/03/31	M	14	163	0,27
	2014/03/31	A	15	167	0,28
	2014/04/01	M	16	166	0,28
	2014/04/01	A	17	170	0,28
TOTAL	**10 Days**		**17 Flights**	**166,875**	**0,28**

Table 6: Average ground speed and search rate per flight for the sample count 2014.

	Date	Day time	Flight	Avg Speed (km/h)	Search rate (km2/min)
Sample count	2014/04/03	M	18	178	0,30
	2014/04/04	M	19	176	0,29
	2014/04/06	M	20	177	0,30
	2014/04/07	M	21	172	0,29
TOTAL	**4 Days**		**4 Flights**	**175,75**	**0,29**

Annex IX

Fig 6: Histogram for the average heigh (m) for the sample count 2014.



	height (ft)	height (m)
average	362,20	110,43
VAR	84,00	7,81
DESVEST	9,16	2,79