Aerial wildlife count of the Parque Nacional da Gorongosa, Mozambique, October 2016

Approach, results and discussion

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November 2016

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Summary

- An aerial wildlife count of the Parque Nacional da Gorongosa was conducted between 18 and 31 October 2016.

- The focus was on the Rift Valley in the southern and central sector of the park. A total of 184 500 hectares was fully covered by means of a helicopter. Systematic, parallel strips that were 500 m wide were assessed. All large mammals observed were counted. All data, including geographical positions, were directly entered into a custom-made census programme. In addition to this count block, a distance of respectively 100 and 125 km of transect lines were flown on the western and eastern side of the core count area. This represents an additional coverage of 11 250 ha. Total coverage through the central counting block and these additional transect lines is 51.6% of the Park.

- A total of 78 627 herbivores of 19 species were counted (Table 1). These are actual counts, not estimates. This represents the absolute minimum number of large animals that occur in the park.

- Still more animals occur outside of the areas that were not counted. However, the counting block represents the area with the best habitat and the highest known densities of wildlife as clearly illustrated by the much lower density and diversity of animals recorded along the sample lines to the east and west.

Table 1: total number of herbivores counted in 2016 in the count block and additional sample lines.

Species	Total number counted
Blue wildebeest	363
Buffalo	696
Bushbuck	2 062
Bushpig	115
Common reedbuck	10 609
Duiker grey	61
Duiker red	22
Eland	118
Elephant*	567
Hartebeest	569
Hippo	440
Impala	4 721
Kudu	1 491
Nyala	1 320
Oribi	3 896
Sable	863
Warthog	5 400
Waterbuck**	45 280
Zebra***	34
	78 627

* 4 elephant added based on satellite collar data

** A total of 207 waterbuck were removed through live capture prior to the count and not included in this tally

** 15 held in the Sanctuary.

Summary - continued

- The previous two years have been very dry, in particular over the months of January and February. These dry conditions appear to have had a significant negative impact on several species (see page 5).

- The waterbuck have continued to increase and now number over 45 000 (Table 1). This represents a year-on-year increase of less than 15%. This is lower than previous annual increment rates. This either reflects a slowing down of the population as it nears ecological carrying capacity and/or it reflects the effects of the drought years on calf survival.

- Impala, kudu and nyala have increased substantially since 2014. Being predominantly browsers they are generally less affected by drought conditions.

- The sable population now number over 800 in the central part of the Park with several good herds being found in the miombo areas in the east.

- Elephant and buffalo numbers are up despite the drought conditions. The latter grew with decreased or less than expected increments. In the South African lowveld, calving percentages have been extremely low due to the prolonged drought conditions.

- Blue wildebeest have remained stagnant, a concern that was already identified in 2014.

Table 2: side-by-side comparison between the numbers of animals in the same counting block surveyed in 2014 and 2016.

Species	2014	2016	2016 as % of 2014
Blue wildebeest	361	363	100.6
Buffalo	670	696	103.9
Bushbuck	2 277	2 022	88.8
Bushpig	167	108	64.7
Common reedbuck	11 871	10 451	88.0
Duiker grey	61	49	80.3
Duiker red	26	21	80.8
Eland	105	94	89.5
Elephant	535	567	106.0
Hartebeest	613	562	91.7
Hippo	436	440	100.9
Impala	2 727	4 705	172.5
Kudu	1 200	1 466	122.2
Nyala	945	1 299	137.5
Oribi	4 485	3 884	86.6
Sable	757	810	107.0
Warthog	9 086	5 383	59.2
Waterbuck	34 482	44 948	130.4
Zebra	33	34	103.0
TOTAL	**70 837**	**77 902**	**110.0**

Summary - continued

- A group of smaller species including bushbuck, bushpig, common reedbuck, oribi and warthog have been substantially affected by the drought. These are mostly selective feeders requiring higher quality feed which may be reduced due to drought. Warthog in particular have declined in numbers. The latter species is typically the first to suffer from drought, but can also recover very quickly when conditions become favourable again.

- It has been noticeable how species such as buffalo have increased their range through the Park. Buffalo were observed for the first time as far north as Mucodza marsh, a distance of 54 km from their furthest south-eastern occurrence in the Park.

- Overall, a lower incidence of illegal activities was noted during the count. Whereas in 2014 a total of 4 freshly snared animals were encountered, only one (waterbuck) was observed during the 2016 count. Only one group of poachers was seen as against two groups observed in 2014. This decrease in the observed illegal activities would seem to reflect the good progress made in the recruitment and training of law enforcement personnel as well as in the improved tactics of deployment and organisation.

- Overall, the Park has weathered well the preceding drought years and the increased pressures of illegal hunting in a time of political turbulence. The recovery of the wildlife is progressing well.

- The 2016 count has re-affirmed the importance of these regular surveys. The aerial wildlife count using a helicopter is one of the most important and critical tools to evaluate the status of the recovery and the effectiveness of park management. It will be critically important to continue with regular counts.

1. Survey methodology

1.1. Flight observations and recording

The specific technique used was as follows:

- 4-seat Bell Jet Ranger helicopter with the pilot in the right front seat, data capture / observer in the left front seat and two observers in the back;
- For the sake of maximum visibility, all doors of the helicopter are removed during the actual count;
- Parallel strips of 500 m width are flown. This means that observers look for wildlife in a strip of 250 m wide on each side of the helicopter. Marker bars indicate the strip width to avoid looking too far from the helicopter;
- The helicopter is maintained at a constant height of 50 to 55 m (160 feet) above the ground. Airspeed is maintained at around 96 km/h (60 knots). When a large herd is observed (e.g. impala) the pilot circles around to enable an accurate count;
- All animals are individually counted. The presence of baboon troops was recorded but the number of individual baboons is not enumerated;
- A separate flight was made from the middle Vunduzi River downstream to the confluence of the Urema-Pungue rivers to focus on crocodiles and hippo in the river and Lake system ;
- A GPS-based system (Global Positioning System) is used for accurate navigation. A grid is generated on a notebook computer that is linked to the helicopter's GPS. Every 2 seconds a flight co-ordinate is downloaded onto the hard disc. When a sighting is made the position together with the species code and number is logged. The flight path and the observations are visible on screen. This enables the pilot to keep the helicopter on the pre-determined line and avoids the risk of areas not being covered or being covered twice. The position of the animals that have already been spotted is displayed on screen which assists in preventing double counting (Fig. 1);
- The observers in the back wear yellow goggles that reduce shadows and enhance contrast for better visibility and detection of the animals;
- Sessions lasting about two to three hours are flown. A short break is taken every hour to relieve observer fatigue. Two 3-hour or three 2-hour sessions can be flown in a single day depending on temperature and visibility.

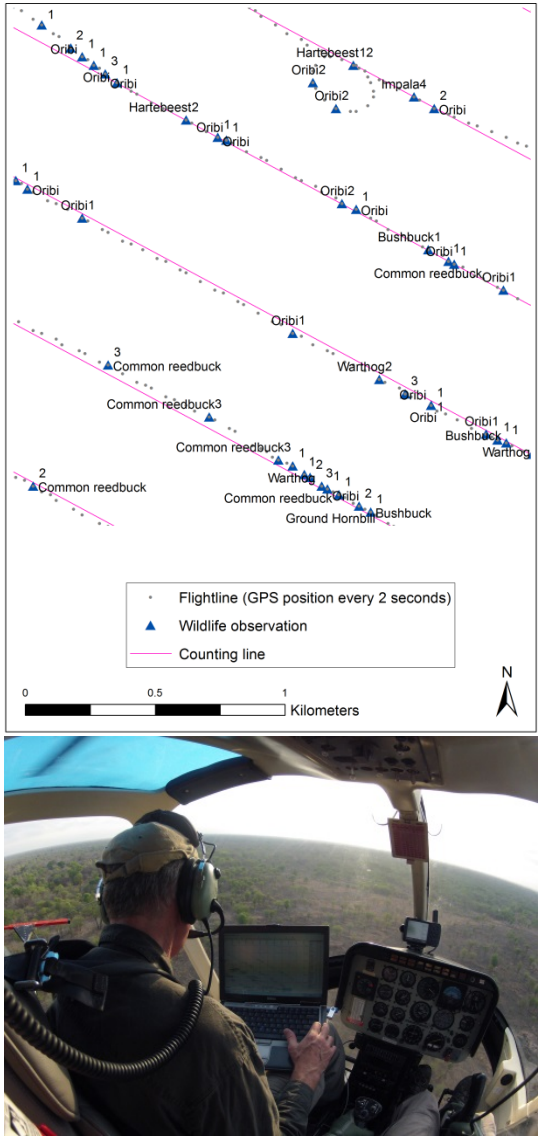

Fig. 1: Example of actual flight lines and observations during the 2016 aerial wildlife count.

1.2. Data handling

Following their on-board capture, the data were consolidated into an Excel spreadsheet and exported to an Access database. The 2016 data were amalgamated with the data from previous counts to facilitate analysis and general comparisons.

Each data point has the following information:

- Unique ID number
- Day
- Time
- Count day and count session
- Latitude / Longitude
- Transect line
- Species
- Number of animals.

The relational Access data base allows linking these individual observations with other species characteristics such as the average weight for each species that can be used for the calculation of stocking rates. The count data were also converted to shapefiles for use in ArcGis.

Id	Date	Time	Count_day	Session	Latitude	Longitude	Line2014	Species	Number
41113	10/24/2016	08:20:00 AM	6	16	-18.88860	34.39680	61	Waterbuck	28
41114	10/24/2016	08:20:21 AM	6	16	-18.88620	34.39570	61	Waterbuck	34
41115	10/24/2016	08:20:24 AM	6	16	-18.88570	34.39520	61	Warthog	5
41116	10/24/2016	08:20:26 AM	6	16	-18.88560	34.39500	61	Impala	1
41117	10/24/2016	08:20:27 AM	6	16	-18.88550	34.39490	61	Bushbuck	3
41118	10/24/2016	08:20:33 AM	6	16	-18.88490	34.39380	61	Waterbuck	2
41119	10/24/2016	08:20:35 AM	6	16	-18.88470	34.39340	61	Waterbuck	26
41120	10/24/2016	08:20:39 AM	6	16	-18.88440	34.39270	61	Common reedbuck	1
41121	10/24/2016	08:20:41 AM	6	16	-18.88430	34.39240	61	Waterbuck	3

2. Results

2.1. Survey statistics

A count block of 184 500 hectares was fully covered by means of a helicopter. In addition to this count block a distance of 100 and 125 km of transect lines were flown on the western and eastern side of the count block respectively (Fig. 2). Total coverage through the central counting block and the additional transect lines in the east and west was 51.6% of the Park.

The total flying time for the survey was 79 hours. The average area covered per flying hour was 2 330 hectares. This would vary from day to day depending on distance from the base (longer or shorter ferry time), density of the animals and nature of the vegetation cover and structure.

This was pilot Mike Pingo's eight helicopter wildlife count of Gorongosa. Observer Dr Mike Peel from the Agricultural Research Council is very experienced with wildlife counts in South Africa. This was his third survey of Gorongosa. This was also the third count of Gorongosa for data recorder Dr Marc Stalmans. The remaining observer seat was mainly occupied by Lukas Manaka (a very experienced counter from the Agricultural Research Council).

Flying and counting conditions varied with some very hot days being experienced (see Table 3). The counting sessions were adjusted in order to avoid the hottest time of the day when animals would tend to remain under the shade which made their detection more difficult.

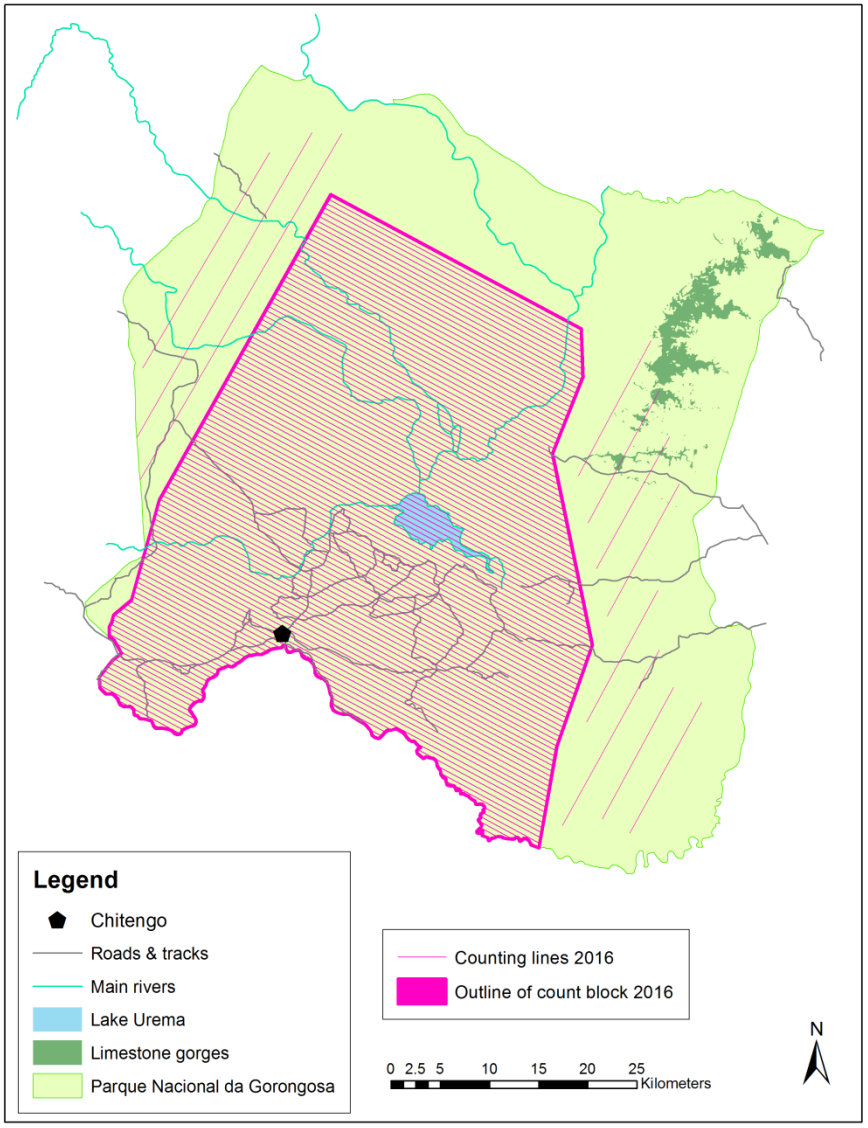

Fig. 2: Count block and additional sample lines covered by the 2016 aerial wildlife count.

Table 3: Counting conditions during the 2016 aerial wildlife survey.

Date	Session	Cloud cover (1 to 8 scale)	Visibility	Temp. ºC	Team
18/10	1	6	Poor (P)-P-Moderate (M)	26-27	Marc Stalmans (MS); Mike Pingo (MP) Mike Peel (MP); Gregory Pingo (GP)
18/10	2	8(blustery)	M-P-P-M-P-P	29	MS; MP MP; GP Jason Denlinger (part)
18/10	3	8(high hazy)	M-M-G-M-P-P	30-29	MS; MP MP; GP
19/10	1	8(high)	P-P-P-M	26-28	MS; MP MP; GP
19/10	2	7-3	M	29-31	MS; MP MP; GP
19/10	3	6-0	M-G-M-G-G	30-28	MS; MP MP; GP
20/10	1	0-2	G-E-G-M	22-25	MS; MP MP; GP
20/10	2	0	G	28-33	MS; MP MP; GP
20/10	3	O(hazy)	M	33-28	MS; MP MP; GP
21/10	1	8(high)	P	23-25	MS; MP MP; Lukas Manaka (LM)
21/10	2	0	G	27-32	MS; MP MP; LM
21/10	3	0	G-M-P (last half hour smoke)	36-30	MS; MP MP; LM
22/10	1	0	E	22-27	MS; MP MP; LM
22/10	2	0	G	30-36	MS; MP MP; LM
22/10	3	0	G	38-39	MS; MP MP; LM
24/10	1	6-4	P-P-P-M	24-28	MS; MP MP; LM
24/10	2	0	G	30-37	MS; MP MP; LM
24/10	3	2-4(hazy-fires)	G	39	MS; MP MP; LM
25/10	1	8-4	P	23-27	MS; MP MP; LM
25/10	2	0	G(lake)-M(woodland)	32(lake)-37(woodland)	MS; MP MP; LM
25/10	3	3	G	35	MS; MP MP; LM
26/10	1	8-6	P-P-P-P-M	25-28	MS; MP MP; LM
26/10	2	1	G	30-35	MS; MP

Table 3 (continued): Counting conditions during the 2016 aerial wildlife survey.

Date	Session	Cloud cover (1 to 8 scale)	Visibility	Temp. ºC	Team
					MP; LM
26/10	3	0	G	35-34	MS; MP MP; LM
27/10	1	8-6	P-P-P-P-M	23-28	MS; MP MP; LM
27/10	2	3-4	G-M-M-G-P	37-35	MS; MP MP; LM
28/10	1	6-2	M	26-31	MS; MP MP; LM
28/10	2	0	G	35-37	MS; MP MP; LM
30/10	1	0	E-G	25-30	MS; MP MP; LM
30/10	2	1	G	38	MS; MP MP; LM
30/10	3(buffalo)	0(v hot)	G	40-39	MS; MP MP; LM
31/10	1(river)	0	G	25-28	MS; MP MP; LM
31/10	2	0	G	34-37	MS; MP MP; LM

2.2. Animal numbers recorded

A total of 78 627 herbivores of 19 species were counted (Table 4). These are actual counts, not estimates. This represents the absolute minimum number of large animals that occur in the park given that only 51.6% of the Park was counted.

These records were amalgamated in the database together with the data from the previous counts. The 2016 count generated 17 432 individual observations. At present, the database holds 52 324 individual observations from 14 wildlife counts since 1969.

More animals still occur outside the block that was counted in 2014/2016, but no estimates were made. However, the count block represents the area with the best habitat and the highest known densities of wildlife and is therefore likely to hold the bulk of most species as clearly illustrated by the much lower density and diversity of animals recorded along the sample lines to the east and west (see section 3.2.).

Table 4: total number of herbivores counted in 2016 in the count block and additional sample lines.

Species	Total number counted
Blue wildebeest	363
Buffalo	696
Bushbuck	2 062
Bushpig	115
Common reedbuck	10 609
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** A total of 207 waterbuck were removed through live capture prior to the count and not included in this tally

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2.3. Spatial distribution patterns

The distribution of the different species across the count block indicates a general preference for the floodplain area[1] and along the perennial rivers such as Vunduzi, Mucombeze and Urema Rivers. (Fig. 3).

Certain species are strongly associated with the floodplain (e.g. waterbuck and common reedbuck – Fig. 4 & 5), others with the floodplain-woodland interface (elephant and buffalo Fig. 6 & 7), and others still with the woodlands (sable antelope, Lichtenstein hartebeest, kudu, nyala and impala – Fig. 8 to 12). The distribution of wildebeest, zebra, warthog and oribi is illustrated in Fig. 13 to 16. Hippo and crocodile are, as expected, strongly associated with Lake Urema and the perennial rivers and pans (Fig. 17 & 18).

[1] Floodplain landscape as defined by Stalmans & Beilfuss (2008)

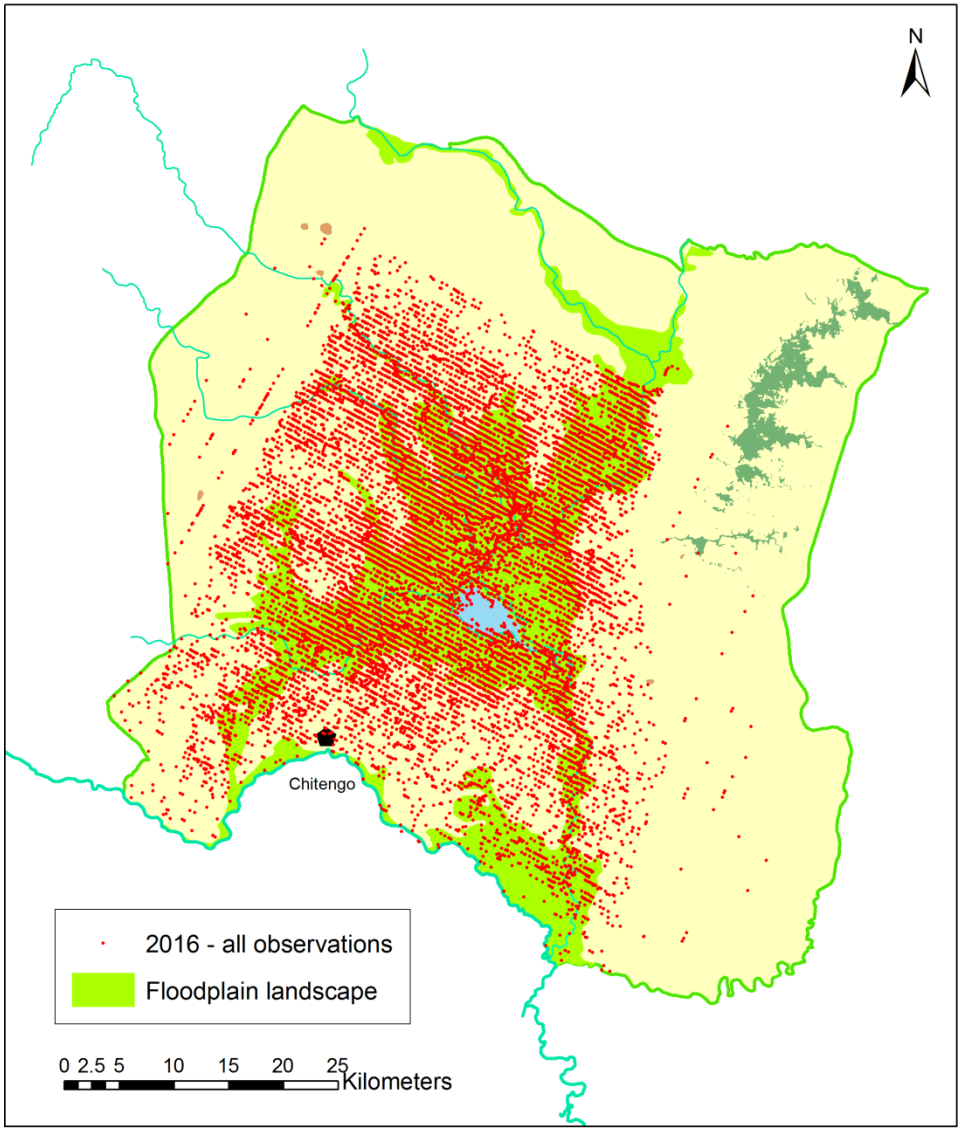

Fig. 3: Spatial distribution of all observations during the 2016 aerial wildlife count.

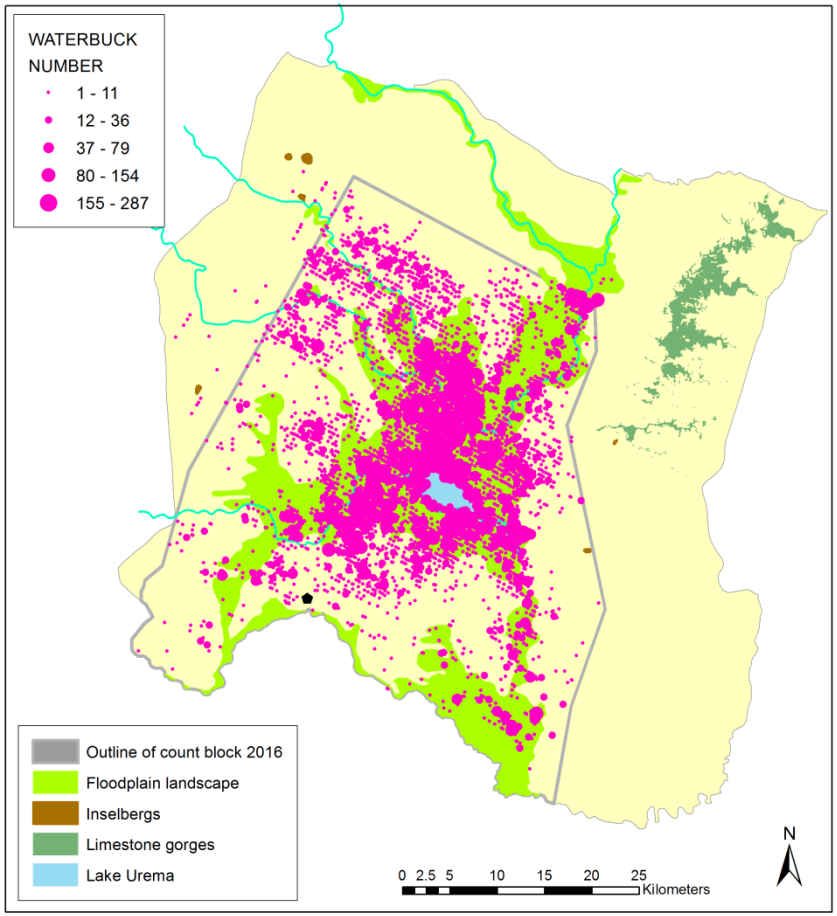

Fig. 4: Spatial distribution of waterbuck during the 2016 aerial wildlife count.

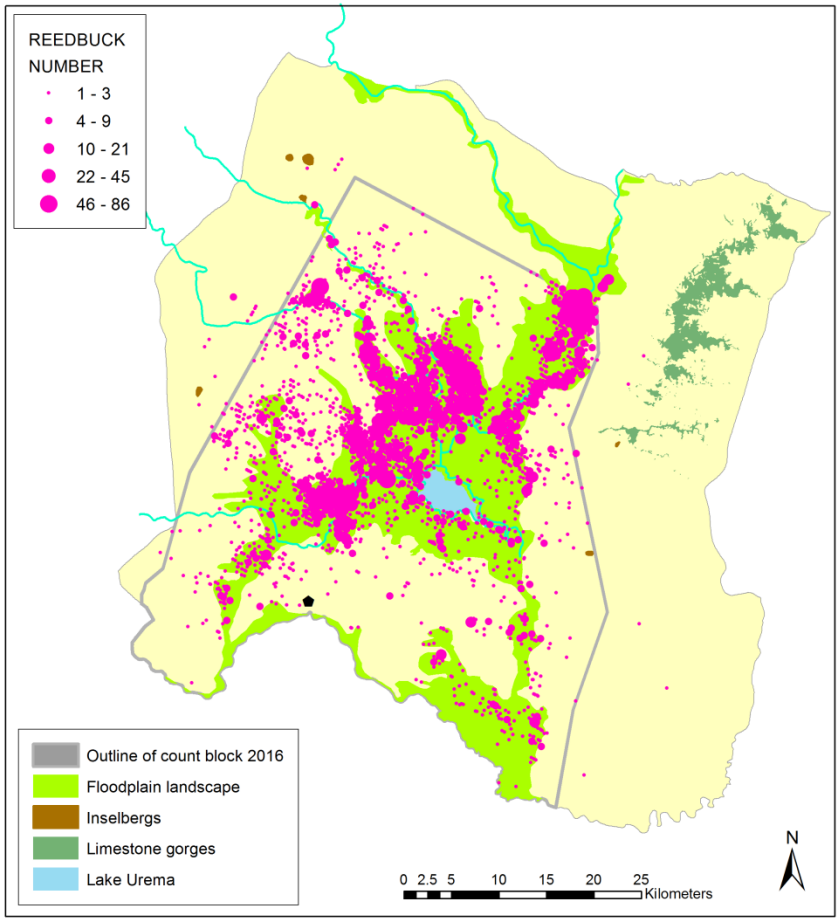

Fig. 5: Spatial distribution of common reedbuck during the 2016 aerial wildlife count.

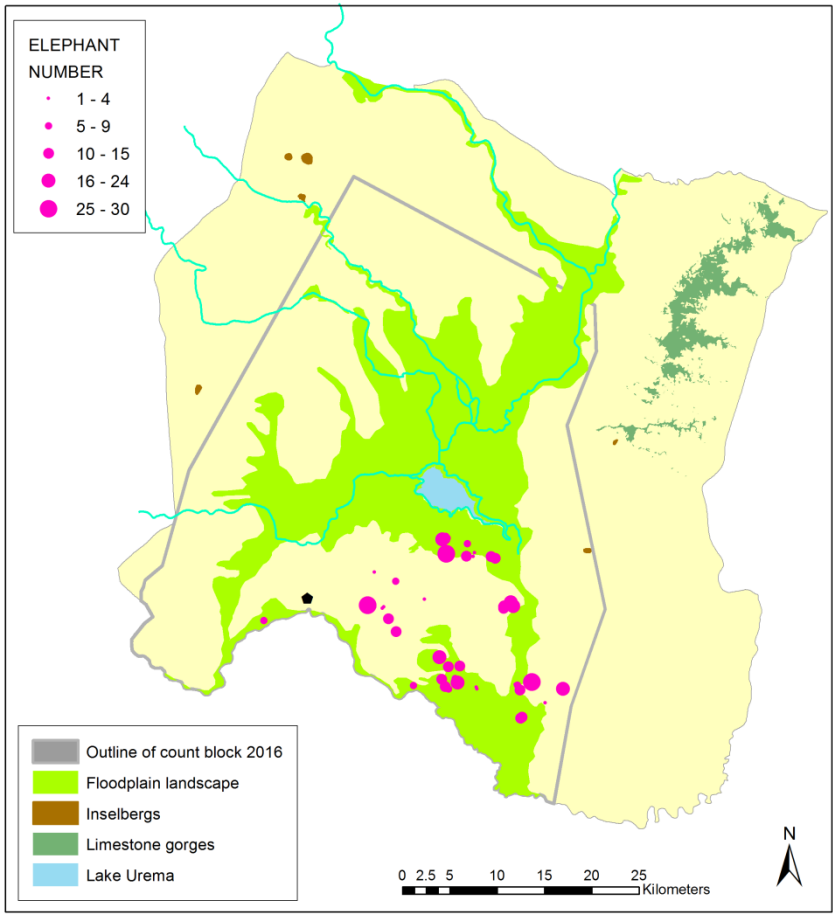

Fig. 6: Spatial distribution of elephant during the 2016 aerial wildlife count.

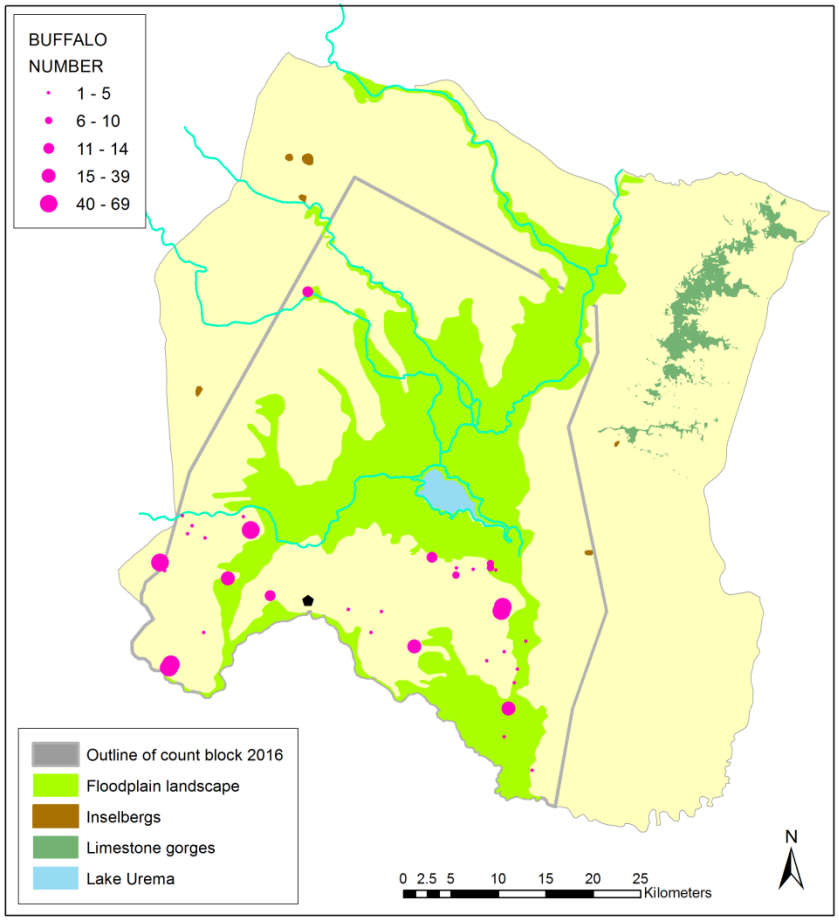

Fig. 7: Spatial distribution of buffalo during the 2016 aerial wildlife count.

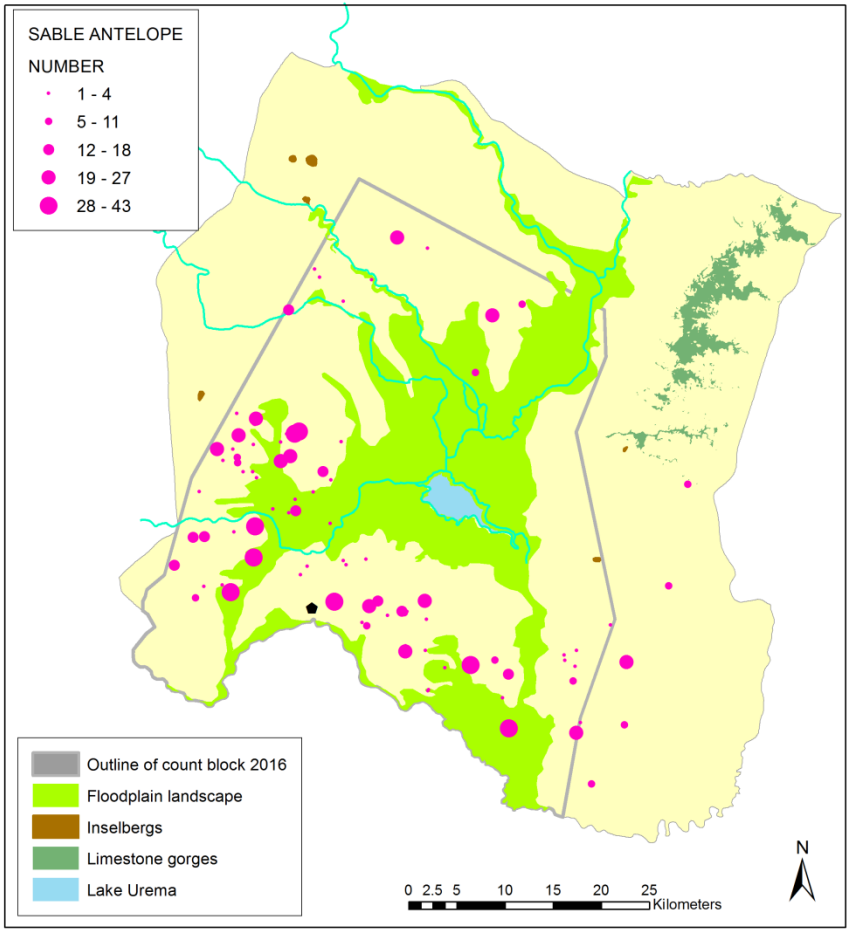

Fig. 8: Spatial distribution of sable antelope during the 2016 aerial wildlife count.

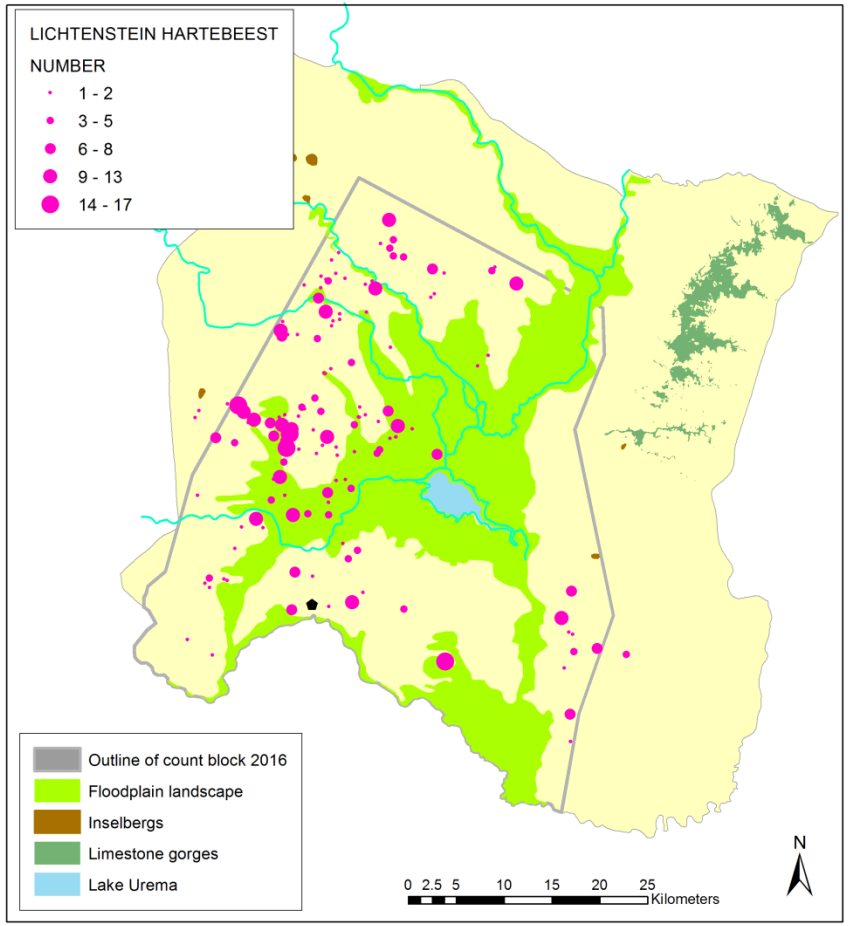

Fig. 9: Spatial distribution of Lichtenstein hartebeest during the 2016 aerial wildlife count.

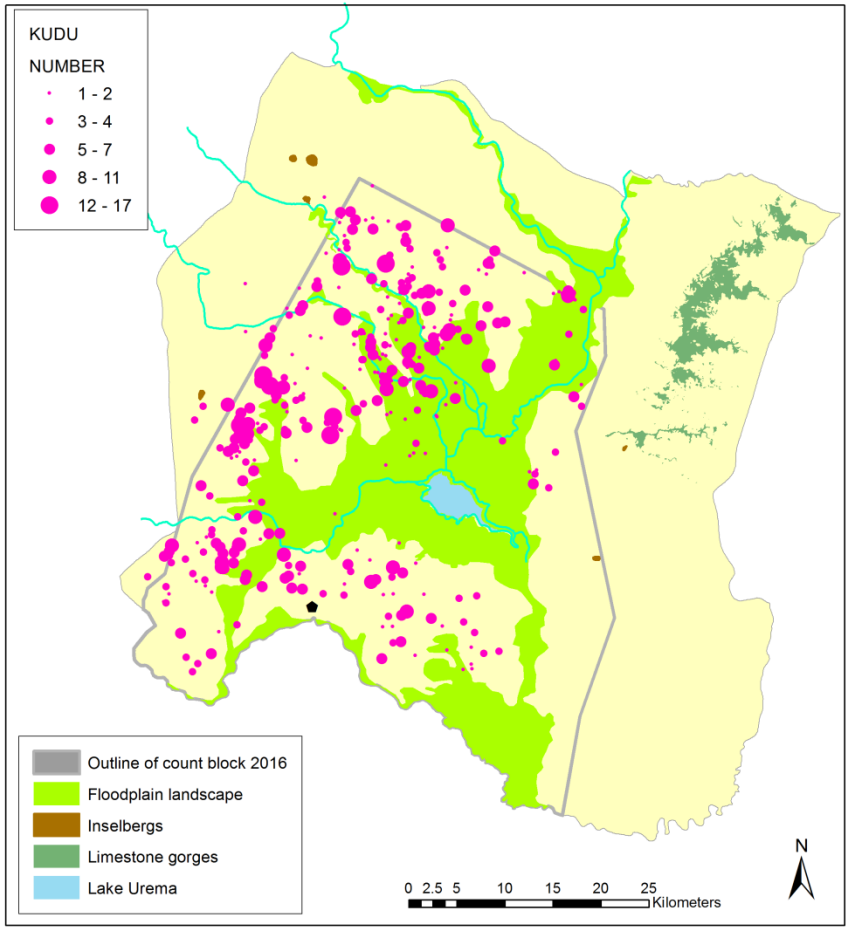

Fig. 10: Spatial distribution of kudu during the 2016 aerial wildlife count.

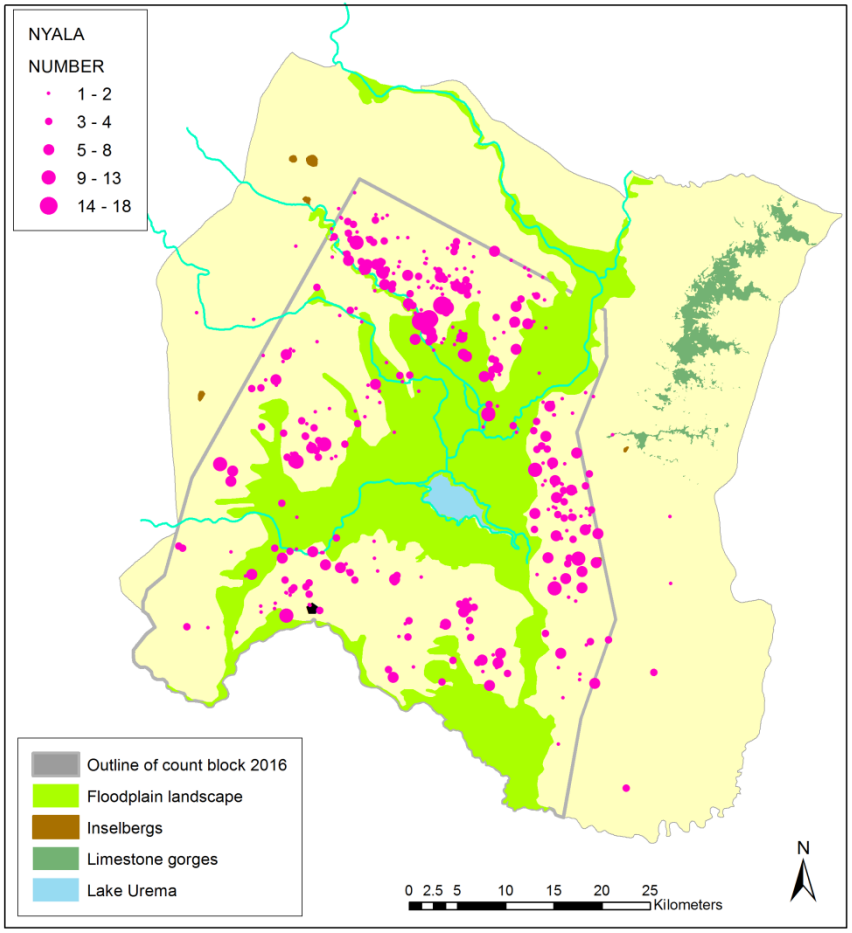

Fig. 11: Spatial distribution of nyala during the 2016 aerial wildlife count.

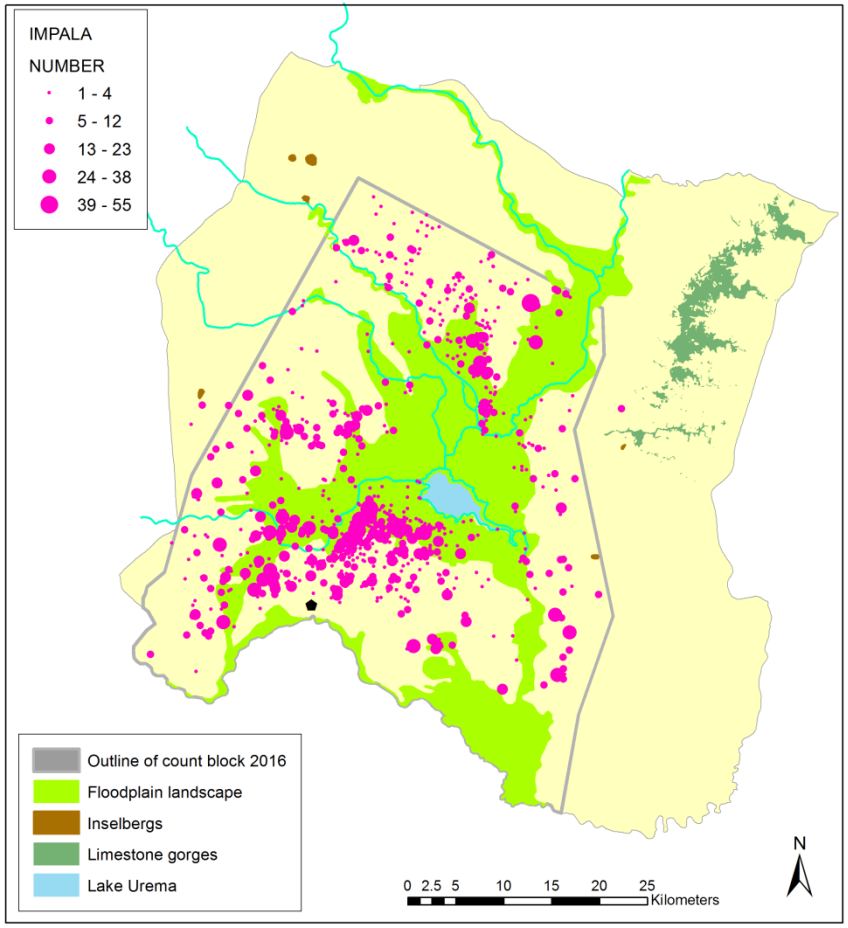

Fig. 12: Spatial distribution of impala during the 2016 aerial wildlife count.

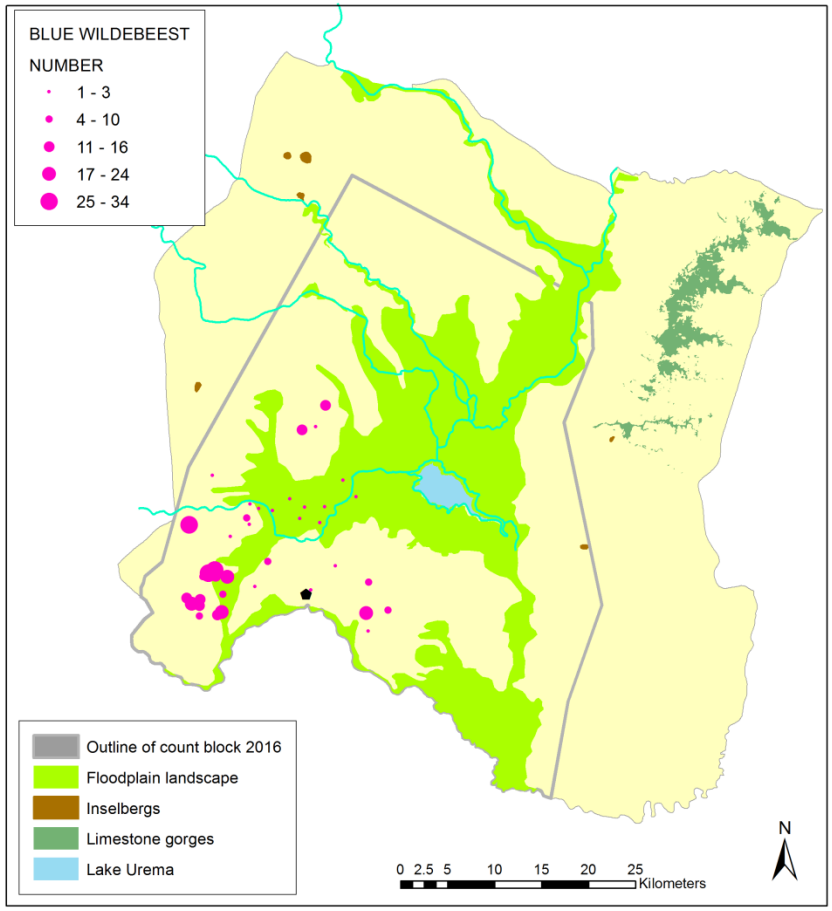

Fig. 13: Spatial distribution of blue wildebeest during the 2016 aerial wildlife count.

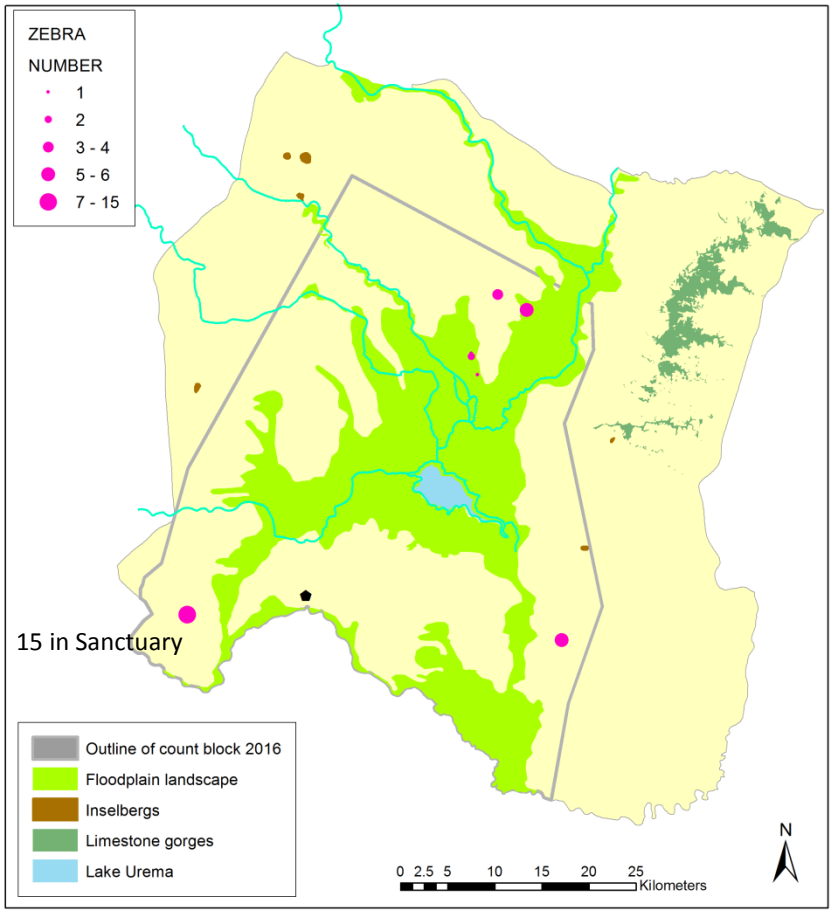

Fig. 14: Spatial distribution of zebra during the 2016 aerial wildlife count.

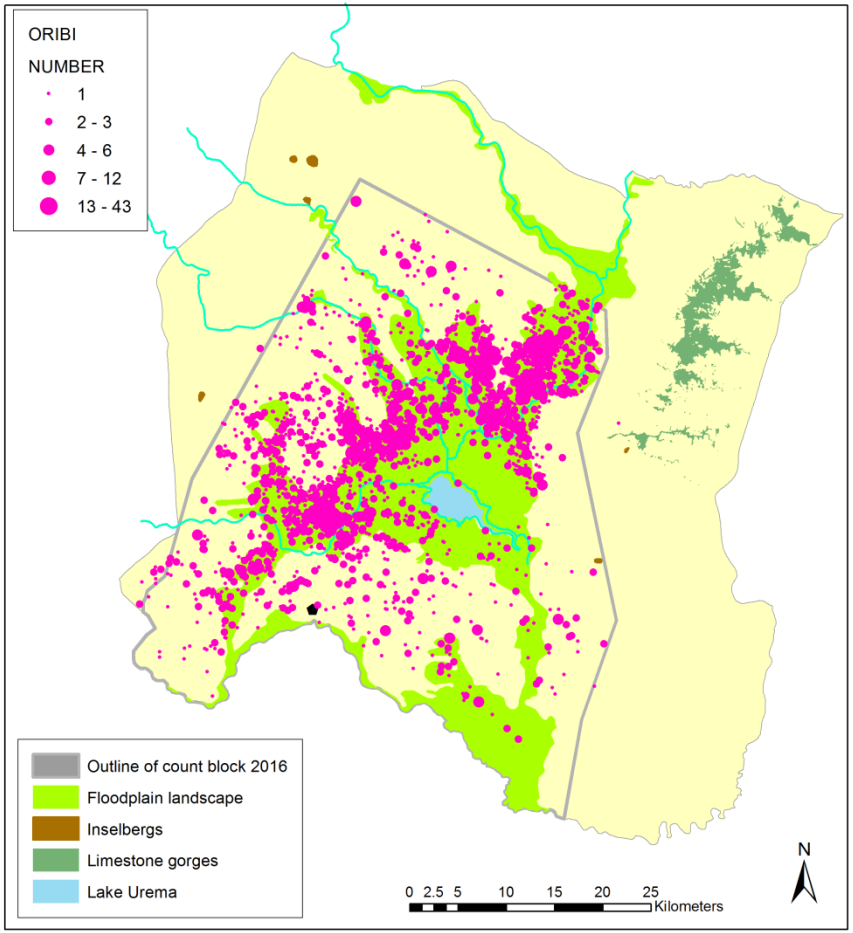

Fig. 15: Spatial distribution of oribi during the 2016 aerial wildlife count.

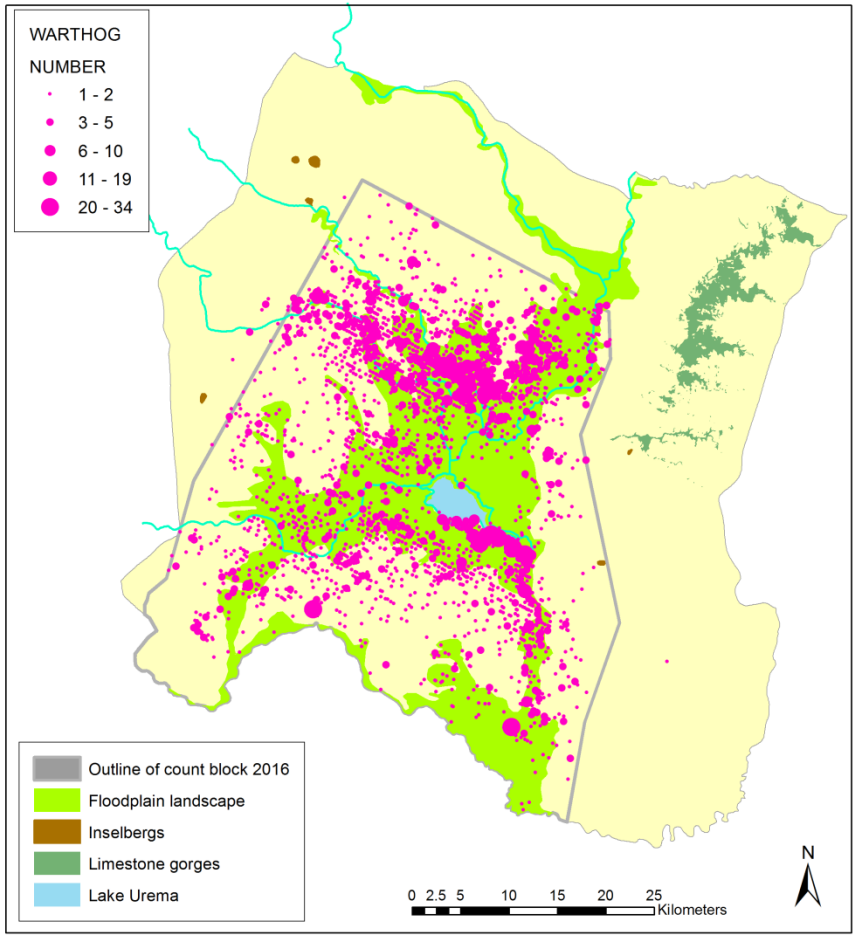

Fig. 16: Spatial distribution of warthog during the 2016 aerial wildlife count.

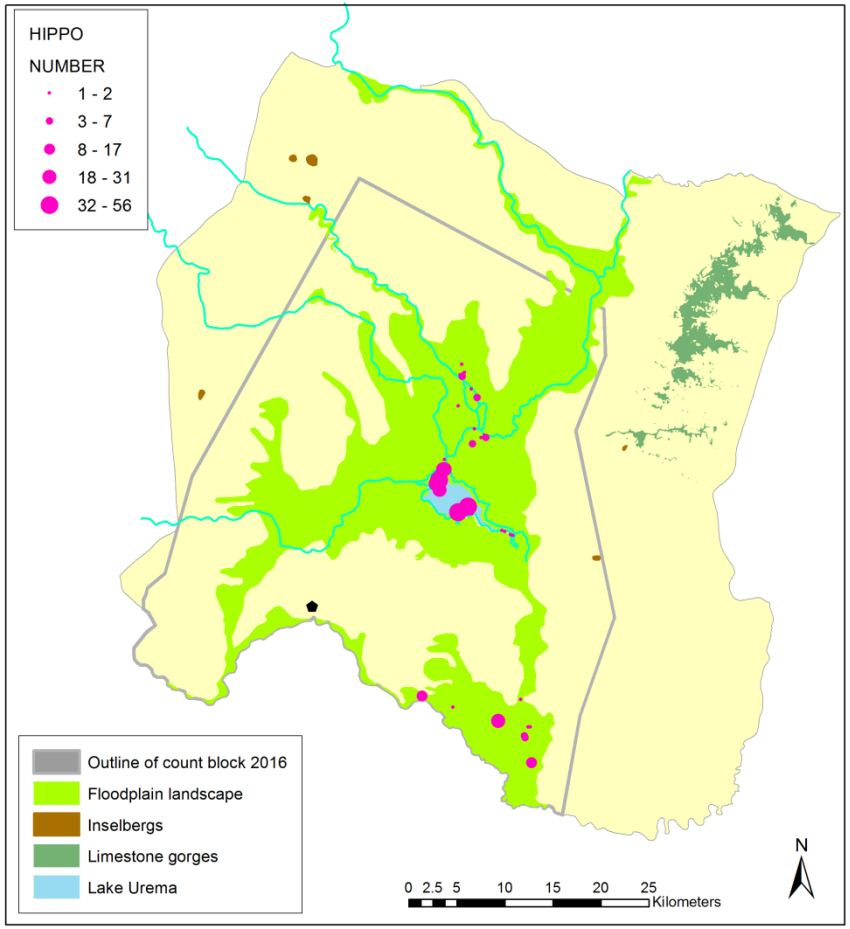

Fig. 17: Spatial distribution of hippo during the 2016 aerial wildlife count.

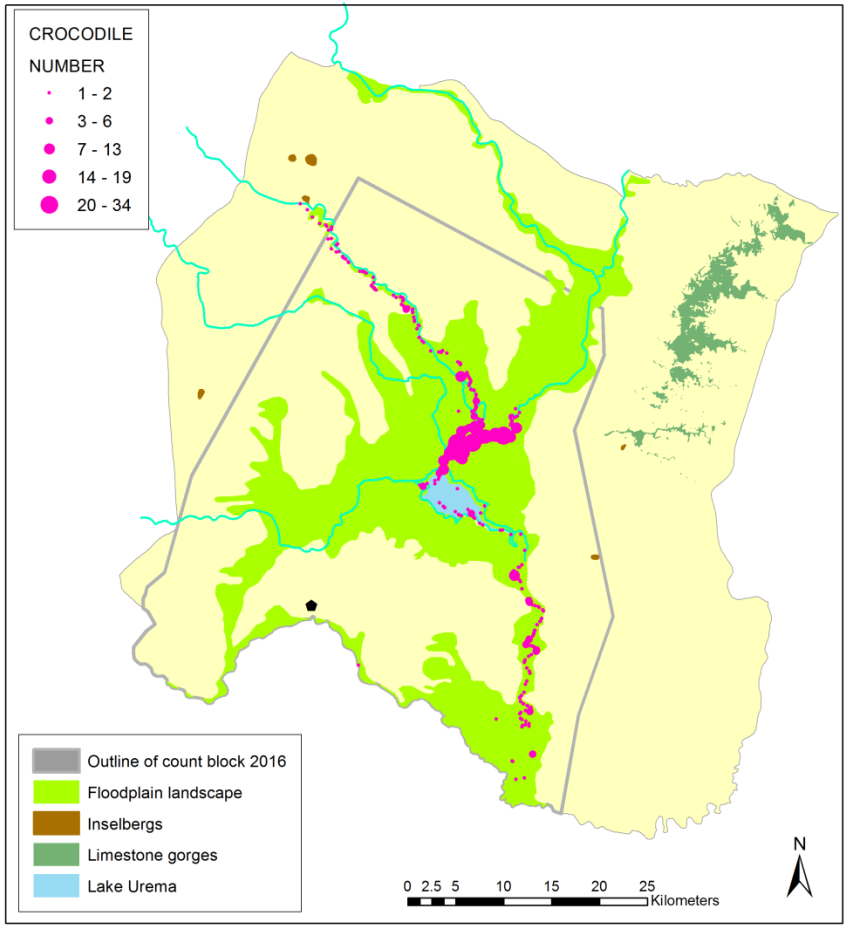

Fig. 18: Spatial distribution of crocodile during the 2016 aerial wildlife count.

2.4. Wildlife biomass

The distribution of animal weight is plotted across the landscape (Fig. 19). The highest animal biomass is found in the floodplain around and north of Lake Urema.

This translates to an average of 8 027 kg of biomass per km² which equates the conservative carrying capacity of 8 000 kg per km² calculated by Stalmans (2006) and Stalmans & Beilfuss (2008). This is 16% up from the average stocking of 6 913 kg per km² calculated following the 2014 count.

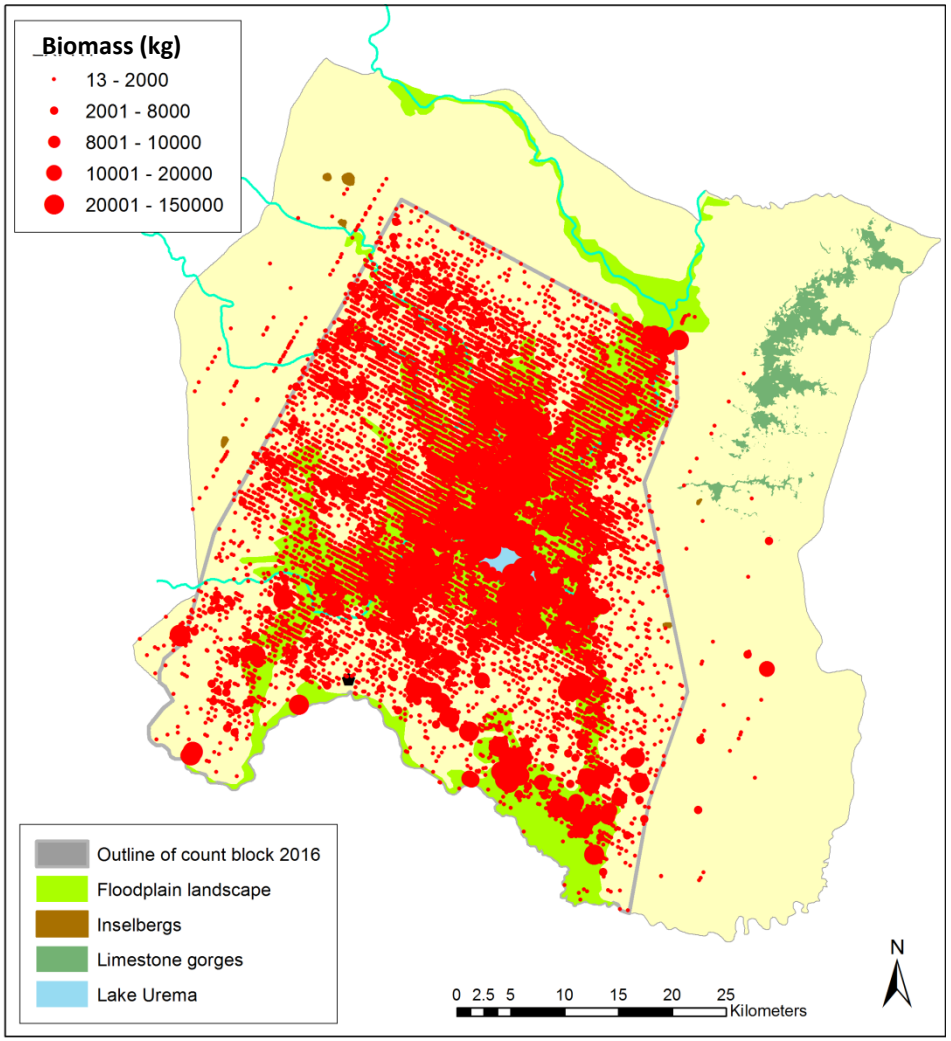

Fig. 19: Wildlife biomass across the landscape.

2.5. Additional species records

The presence of Crowned cranes, Saddle-bill storks and Ground hornbills were recorded during the aerial survey. These large birds are generally under some pressure in southern Africa. A total of respectively 182 Ground hornbills, 119 Grey Crowned Cranes and 43 Saddle-bill storks were observed.

A total of 225 baboon troops were recorded. This information will be useful to the ongoing primatology research project.

Although not a good tool to census lions, the helicopter count did yield records of lions not yet know to the Lion Project. Two young cubs were observed for the first time whilst one adult lioness is likely also new.

A total of 9 active nests of White-headed vultures , 1 nest of Hooded vulture and 7 nests of White-backed vultures were GPS'ed (Fig. 20). All three of these species are listed as Critically Endangered.

Two Pel's fishing owls were observed along the Vunduzi River.

Lastly, a total of 86 active nests of Marabou storks were GPS'ed. There is apparently only one other breeding locality of this species known in Mozambique.

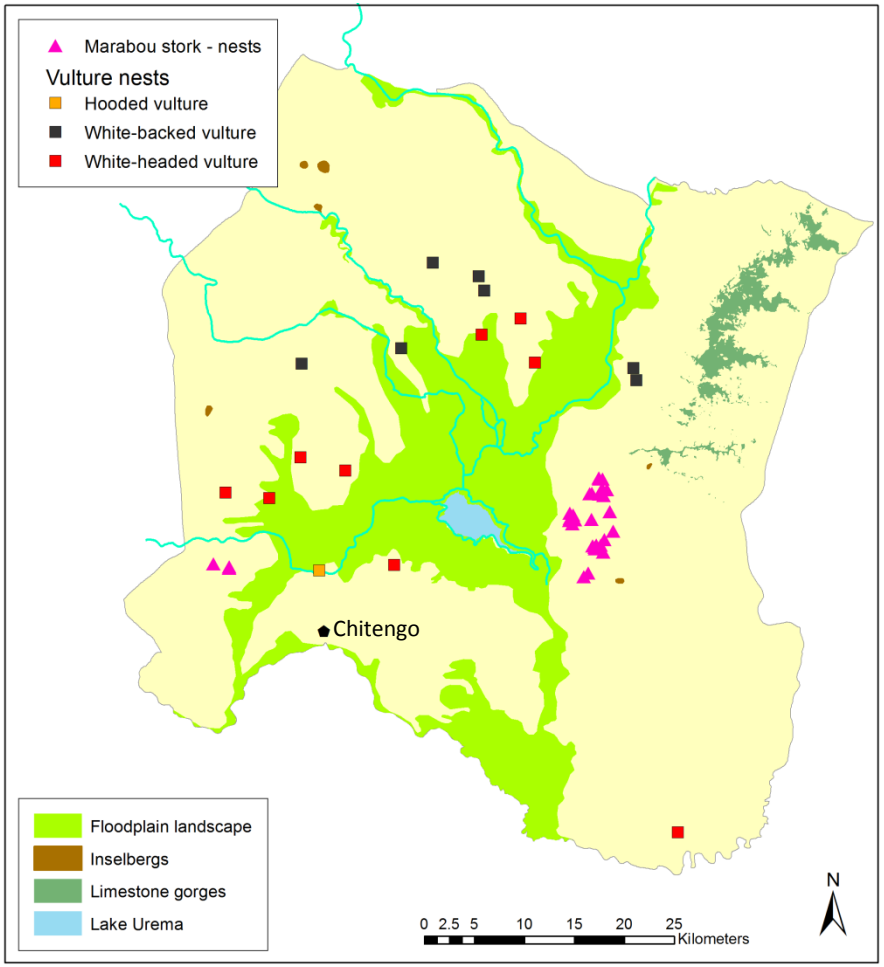

Fig. 20: Distribution of nests of vultures and of marabou storks observed during the 2016 aerial wildlife survey.

2.6. Illegal activities

During the count, signs of illegal activities were recorded.

Overall, a lower incidence of illegal activities were noted during this count. Whereas in 2014 a total of 4 freshly snared animals were encountered, only one (waterbuck) was observed during the 2016 count. It was released from the snare but its ultimate fate is unknown.

Only one group of poachers was seen as against two groups observed in 2014. The poachers fled and left behind two bundles of smoked bushmeat. As it was in a remote area, which precluded transporting the meat back to Chitengo, these bundles were incinerated (Fig. 22).

This decrease in the observed illegal activities would seem to reflect the good progress made in the recruitment and training of law enforcement personnel as well as in the improved tactics of deployment and organisation.

Fig. 21: Intercepted bundles of smoked bushmeat that were subsequently incinerated.

3. Discussion

3.1. Context with regard to the drought

Much of southern Africa has been in the grip of a profound drought over the last 2 years. Gorongosa has not been an exception. The critical period for vegetation growth, calving and calf survival extends from October till the end of February.

The total rainfall received during the past two growing seasons has been dramatically lower than that measured the two years before (Fig. 22). During October 2014-2015 the rainfall was only 51% of that measured for the same period in 2013-2014. In 2015-2016, the figure was even lower with only 26% of the equivalent amount received in 2013-2014.

The low rainfall has resulted in a generally much reduced grass production (Fig. 23). These dry conditions with reduced availability of grazing can have a significant negative impact on several wildlife species.

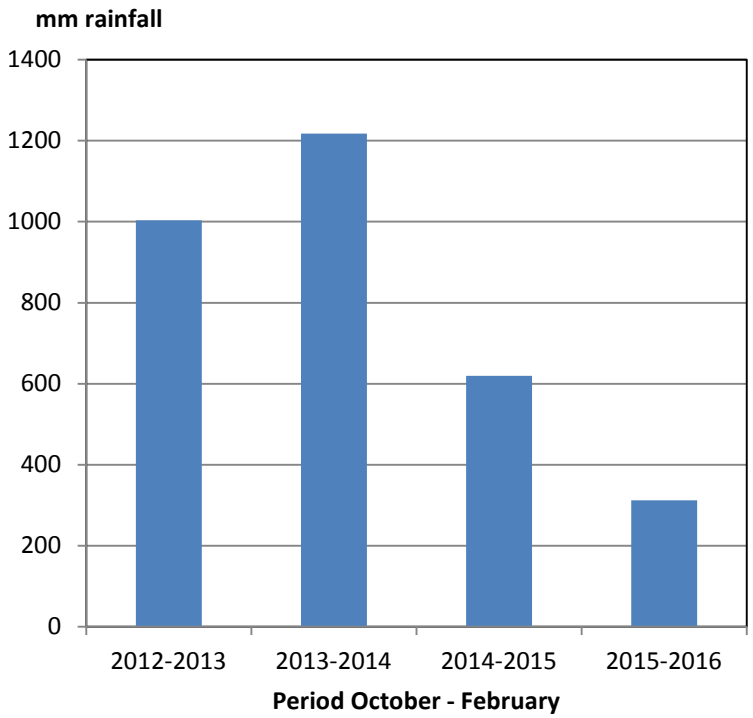

Fig. 22: Rainfall received for the period October till February over the past 4 years (note that these are not annual totals, but reflect the rainfall across the critical calving season).

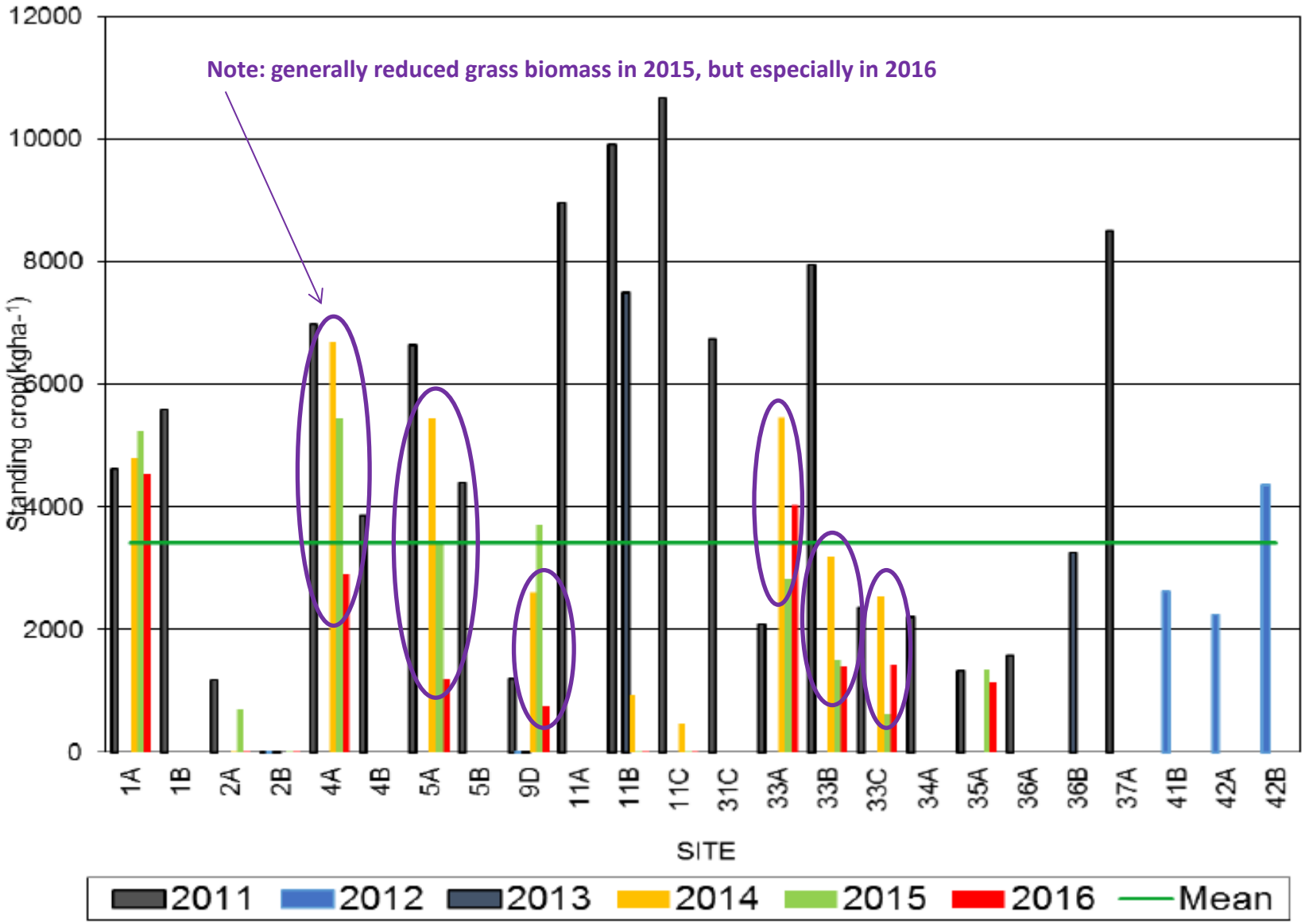

Fig. 23: Standing grass biomass (kg/ha) in the Rift Valley Alluvial Fan landscape for a number of fixed monitoring transects (Peel 2016).

3.2. Side-by-side comparison with 2014

The 2016 results are compared to those for 2014 for the same counting block (Table 5). Overall, the number of herbivores rose with 10% or more than 7 000 animals.

The results are now discussed on a species-by-species basis.

Table 5: side-by-side comparison between the numbers of animals in the same counting block surveyed in 2014 and 2016

Species	2014	2016	2016 as % of 2014
Blue wildebeest	361	363	100.6
Buffalo	670	696	103.9
Bushbuck	2 277	2 022	88.8
Bushpig	167	108	64.7
Common reedbuck	11 871	10 451	88.0
Duiker grey	61	49	80.3
Duiker red	26	21	80.8
Eland	105	94	89.5
Elephant	535	567	106.0
Hartebeest	613	562	91.7
Hippo	436	440	100.9
Impala	2 727	4 705	172.5
Kudu	1 200	1 466	122.2
Nyala	945	1 299	137.5
Oribi	4 485	3 884	86.6
Sable	757	810	107.0
Warthog	9 086	5 383	59.2
Waterbuck	34 482	44 948	130.4
Zebra	33	34	103.0
TOTAL	**70 837**	**77 902**	**110.0**

- The waterbuck have continued to increase in numbers to over 45 000 (Table 1). This represents a year-on-year increase of less than 15%. This is lower than previous annual increment rates. This either reflects a slowing down of the population as it nears ecological carrying capacity and/or it reflects the effects of the drought years on calf survival.

Anecdotally, during the capture of waterbuck earlier in October for relocation to Zinave National Park and Maputo Special Reserve, it was observed that the waterbuck in the woodlands appeared to be in better physical condition than those on the floodplain. At the time of the count, the proportion of the waterbuck population found inside the woodlands has increased substantially since 2014 (Fig. 24). This probably reflects the higher availability of resources found at present within the woodlands.

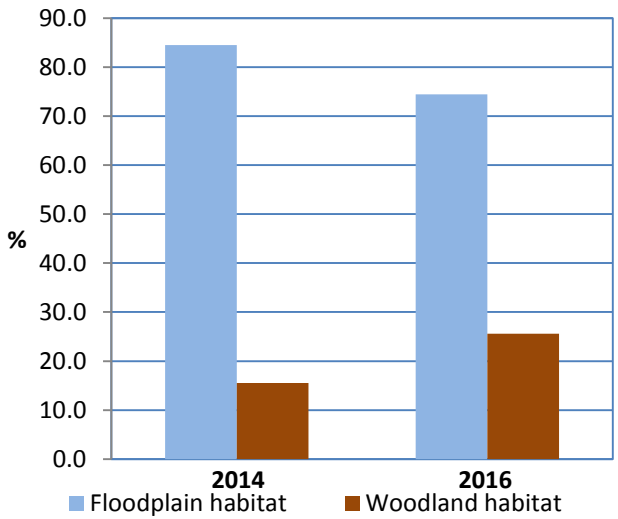

Fig. 24: Shift in habitat occupation by waterbuck from 2014 to 2016.

- Impala, kudu and nyala have increased substantially since 2014. Being predominantly browsers they are generally less affected by drought conditions.

- The sable population now number over 800 in the central part of the Park with several good herds being found in the miombo areas in the east and west.

- Elephant and buffalo numbers are up despite the drought conditions.

- Blue wildebeest have remained stagnant, a concern that was already identified in 2014.

- A group of smaller species including bushbuck, bushpig, common reedbuck, oribi and warthog have been substantially affected by the drought. These are selective feeders requiring higher quality feed which may be reduced due to drought. Warthog in particular have declined in numbers. This species is typically the first to suffer from drought, but can also recover very quickly when conditions become favourable again

- It has been noticeable how species such as buffalo have increased their range through the Park. Buffalo were observed for the first time as far north as Mucodza marsh, a distance of 54 km from their furthest south-eastern occurrence in the Park (Fig. 7).

- Still more animals occur outside of the areas of the central counting block. However, densities of most species are much lower to the east and west as measured through the (limited) sampling lines flown (Table 6).

The difference is often an order of magnitude or more in wildlife densities. This is a reflection of the more infertile habitat on the eastern and western rim of the Rift Valley. However it more than likely also reflects the still incomplete nature of the restoration and the expected higher pressure from illegal hunting closer to the Park boundaries.

Sable antelope do well in the eastern miombo. A total of 53 sable in 5 herds were observed along the few sample lines flown. Sable tend to do well in a low-competition environment. to A herd of 24 eland were also observed in the east.

Interestingly enough, no waterbuck were observed at all to the east of the counting block. A low density of waterbuck was recorded in the west.

Grey duikers are occurring at higher densities in the west and east which conforms with their known habitat preferences.

Table 6: Wildlife densities (as animals per km^2) across the western, central and eastern parts of Gorongosa National Park

Species	Western sample lines	Central countblock	Eastern sample lines
Bushbuck	0.32	1.10	0.19
Common reedbuck	0.58	5.66	0.08
Duiker grey	0.10	0.03	0.06
Impala	0.14	2.55	0.14
Kudu	0.26	0.79	0.00
Nyala	0.10	0.70	0.21
Warthog	0.20	2.92	0.35
Waterbuck	1.48	24.36	0.00

4. Conclusion

In conclusion, the 2016 aerial wildlife count was successful.

This was the second block count that covered 100% of the central, and most important, part of the Gorongosa National Park.

Overall, the Park has weathered well the preceding drought years and the increased pressures of illegal hunting in a time of political turbulence. The recovery of the wildlife is progressing well.

The aerial wildlife count using a helicopter is one of the most important and critical tools to evaluate the status of the recovery and the effectiveness of park management. It will be critically important to continue with regular counts. The aerial wildlife count is a vital M&E tool for the Park.

5. References

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