Aerial wildlife count of the Parque Nacional da Gorongosa, Mozambique, October 2018

Dr Marc Stalmans , Dr Mike Peel & Dominique Gonçalves

November 2018

Our milestones

- For the first time ever, more than 100 000 large animals were counted in Gorongosa National Park
- For the first time since the mid 1980's , the following numbers have been observed
    - More than 6 000 impala
    - More than 1 000 buffalo
    - More than 600 blue wildebeest
    - More than 500 hippo.

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Summary

- An aerial wildlife count of the Parque Nacional da Gorongosa was conducted between 16 October and 2 November 2018.

- The focus was on the Rift Valley in the southern and central sector of the Park. A total of 193 500 hectares was fully covered by means of a helicopter. Systematic, parallel strips that were 500 m wide (250 m either side of the flight line) were assessed. All large mammals observed were counted. In addition to this count block, a distance of respectively 195 and 205 km of transect lines were flown on the western and eastern side of the core count area. This represents an additional coverage of 20 000 ha. Total coverage was therefore 57.4% of the Park.

- A total of 100 409 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 of the central count block.

Table 1: total number of herbivores counted in 2018 in the count block and additional sample lines.

Species	Total number counted
Blue wildebeest	627
Buffalo	1 021
Bushbuck	1 787
Bushpig	203
Common reedbuck	10 821
Duiker grey	66
Duiker red	28
Eland	142
Elephant*	544
Hartebeest	647
Hippo	546
Impala	6 274
Kudu	2 105
Nyala	2 269
Oribi	4 027
Sable	968
Warthog	11 274
Waterbuck	57 016
Zebra**	44
	100 409

* Excludes a number of satellite-collared female elephants and their accompanying family units hidden in dense riverine forest (see section 3. Discussion)
** Includes an additional 5 zebra observed separately by Dr Rui Branco on 31 October 2018

Summary - continued

- The numbers in 2018 were higher than those recorded in 2016 for every single species, with the exception of elephant. A number of collared lead female elephants with their accompanying family units were hidden in the dense riverine fringe of the Pungue River at the time of the survey and hence were virtually undetectable.

- A total of 1 223 waterbuck, 146 reedbuck and 200 warthog were removed during the 2016 and 2017 season for the restocking of Zinave National Park and Maputo Special Reserve. This did however not materially affect the numbers on Gorongosa.

- The waterbuck have continued to increase and now number over 55 000 (Table 1). The buffalo numbers show good growth. For the first time since the start of the restoration process, more than 1 000 buffalo were counted. Impala, kudu and nyala have increased substantially since 2016. Whereas some concern was expressed in previous years about the blue wildebeest, their numbers have picked up significantly and more than 700 individuals were counted. The hippo population now exceeds 500 individuals. The warthog population that declined with some 40% during the 2015/2016 drought years has rebounded following the excellent rainfall and grazing condition experienced during the 2017-2018 season, highlighting the 'boom and bust' response of this species to environmental and subsequent rangeland conditions.

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

Species	2014	2016	2018
Blue wildebeest	361	363	587
Buffalo	670	696	960
Bushbuck	2 277	2 022	1 665
Bushpig	167	108	183
Common reedbuck	11 871	10 451	10 220
Duiker grey	61	49	42
Duiker red	26	21	21
Eland	105	94	117
Elephant	535	567	544
Hartebeest	613	562	578
Hippo	436	440	546
Impala	2 727	4 705	6 122
Kudu	1 200	1 466	1 928
Nyala	945	1 299	1 934
Oribi	4 485	3 884	3 958
Sable	757	810	805
Warthog	9 086	5 383	10 739
Waterbuck	34 482	44 948	55 351
Zebra	33	34	33
TOTAL	70 837	77 902	96 633

Summary - continued

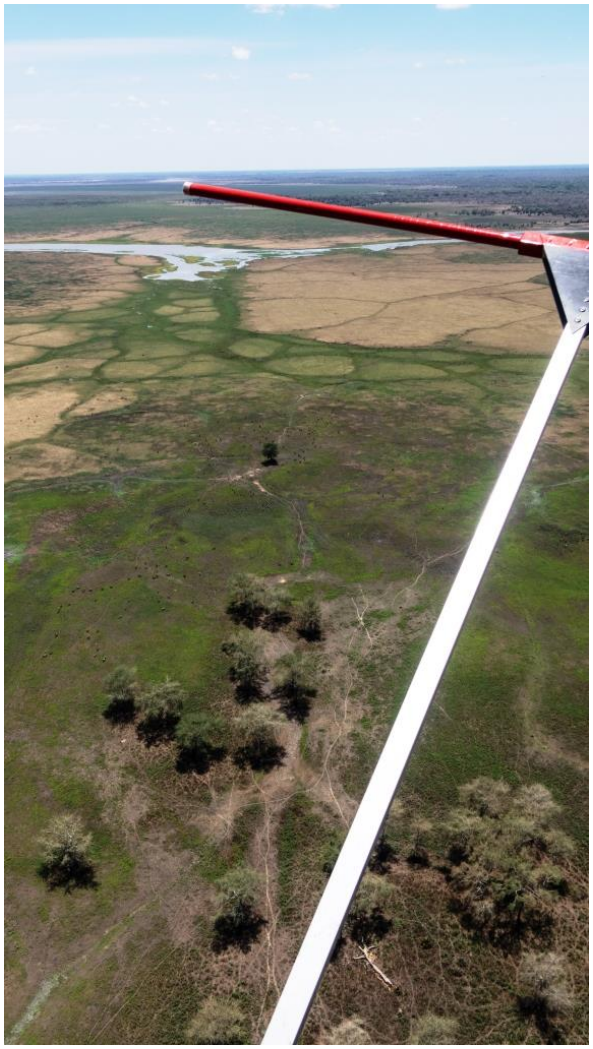
- More than 2 000 crocodiles were observed. The actual number of crocodiles in Gorongosa is much higher and a count during the winter months when more of them can be found out of the water is recommended.

- 219 baboon troops were counted.

- A total of 229 active nests of marabou storks were recorded. This must represent the single largest breeding population of Marabou stork in the SADC region.

- Not a single animal was found in a snare. In contrast, during the 2014 count, a total of 4 recently snared animals were encountered. In 2016, a single snared waterbuck was observed during the count. The positive results from 2018 confirm the effectiveness of the dedicated efforts by the Conservation staff in the field.

- The 2018 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. The aerial wildlife count is a vital M&E tool for the Park.



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. buffalo) 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 (Fig. 1). 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.

1.2. Photographs of waterbuck concentrations

The sheer density and numbers of waterbuck in the open terrain around Lake Urema made it impossible to count these animals individually from the helicopter. Photographs were taken of the largest concentrations. The photographs were linked to the satellite image. The number of waterbuck in each photograph or part of a photograph was enumerated. These numbers were linked to the satellite image and their spatial position was captured for use in the GIS environment (Fig. 2).

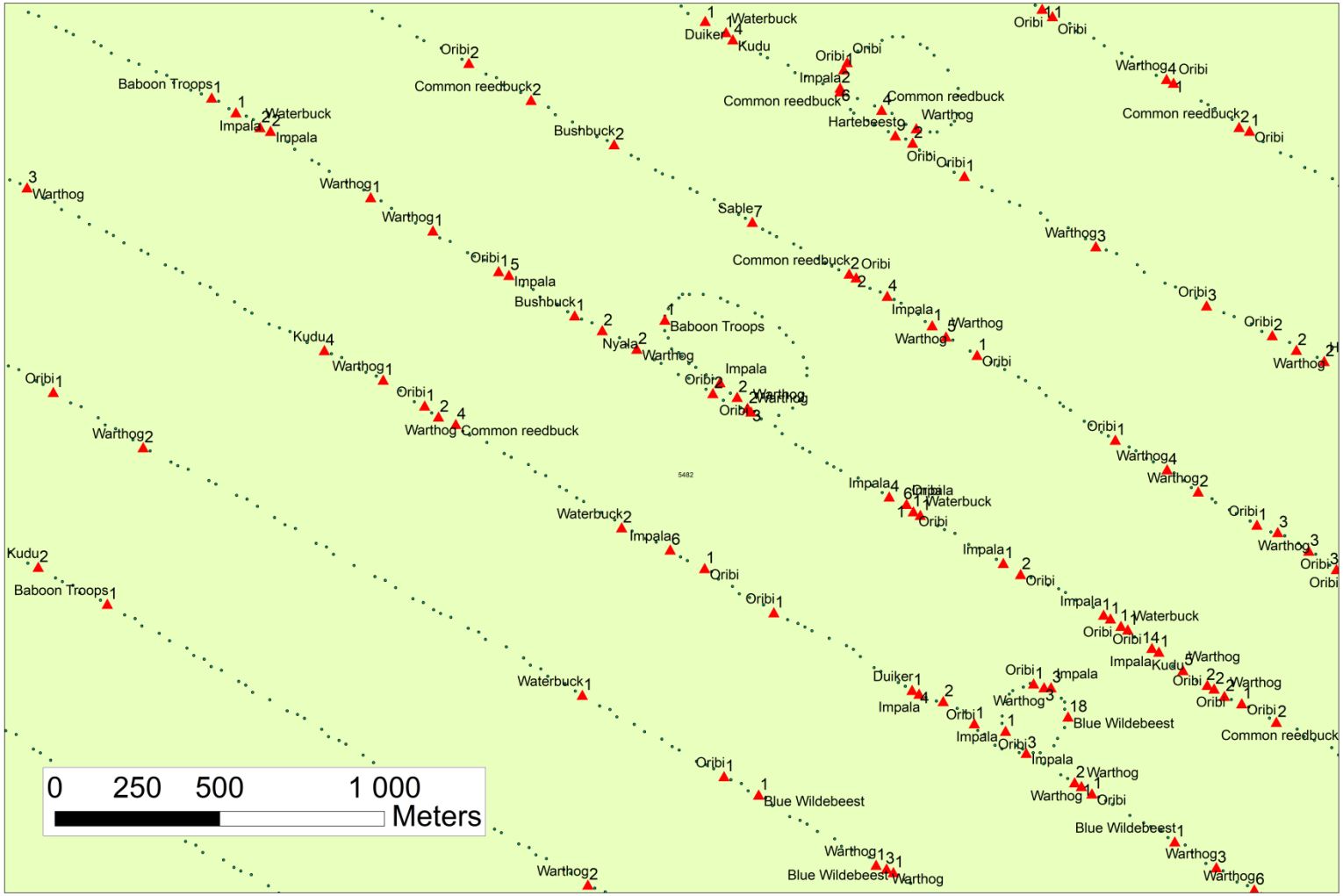


Fig. 1: Flight path and observations that are displayed on-screen during the counting. Lines are 500 m apart. Black points indicate GPS positions that are automatically downloaded every 2 seconds. Red triangles denote wildlife observations with species and number.

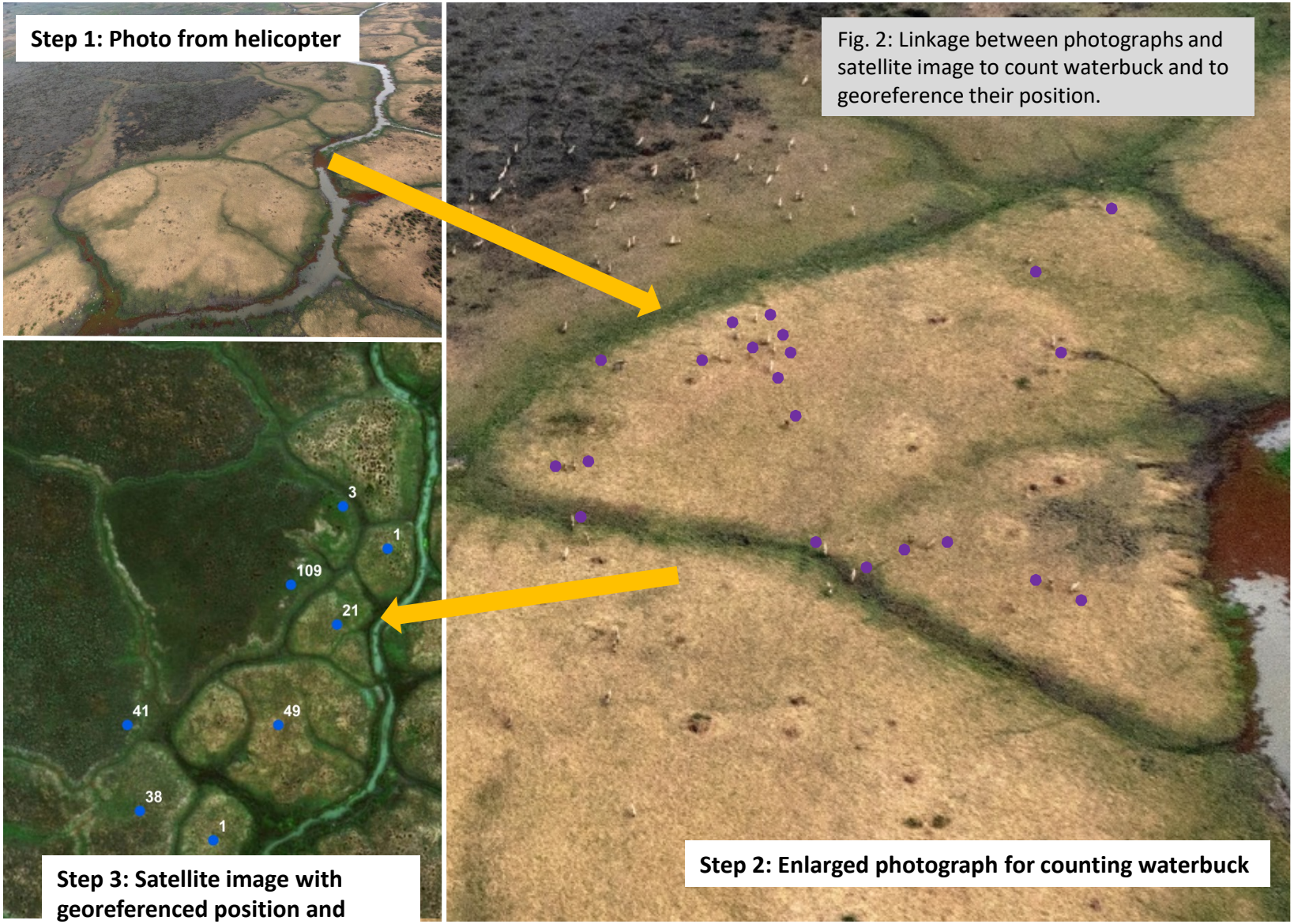


Fig. 2: Linkage between photographs and satellite image to count waterbuck and to georeference their position.

1.3. Data handling

The 2018 data were amalgamated with the data from previous counts (Stalmans et al. 2014, Stalmans & Peel 2016) into an Access database to facilitate analysis and general comparisons. Each data point has the following information (Table 3):

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

The relational 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 and habitat selection. The count data were also converted to shapefiles for use in ArcGis.

Table 3: Extract from the consolidated data for 2018

Id	Date	Time	Count_day	Session	Latitude	Longitude	Species	Number
2492	10/18/2018	10:20:39	3	8	-19.09680	34.53150	Buffalo	2
2493	10/18/2018	10:21:08	3	8	-19.10080	34.53820	Waterbuck	11
2494	10/18/2018	10:21:10	3	8	-19.10110	34.53870	Waterbuck	1
2495	10/18/2018	10:22:09	3	8	-19.09820	34.54310	Elephant	7
2496	10/18/2018	10:23:11	3	8	-19.10770	34.55170	Waterbuck	2
2497	10/18/2018	10:23:45	3	8	-19.11210	34.55980	Elephant	1
2498	10/18/2018	10:23:55	3	8	-19.11360	34.56240	Bushbuck	1
2499	10/18/2018	10:24:03	3	8	-19.11460	34.56430	Warthog	2
2500	10/18/2018	10:24:06	3	8	-19.11480	34.56520	Bushbuck	2

2. Results

2.1. Survey statistics

A count block of 193 500 hectares was fully covered by means of a helicopter. In addition to this count block a distance of 195 and 205 km of transect lines were flown on the western and eastern side of the count block respectively (Fig. 3). Total coverage through the central counting block and the additional transect lines in the east and west was 57.4% of the Park.

The total flying time for the survey was approximately 80 hours. The average area covered per flying hour was approximately 2400 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 ninth 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 fourth survey of Gorongosa. This was also the fourth count of Gorongosa for data recorder Dr Marc Stalmans. The remaining observer seat was occupied by Lukas Manaka (a very experienced counter from the Agricultural Research Council – his second survey of Gorongosa).

Flying and counting conditions varied with some very hot days being experienced (see Table 4). 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.

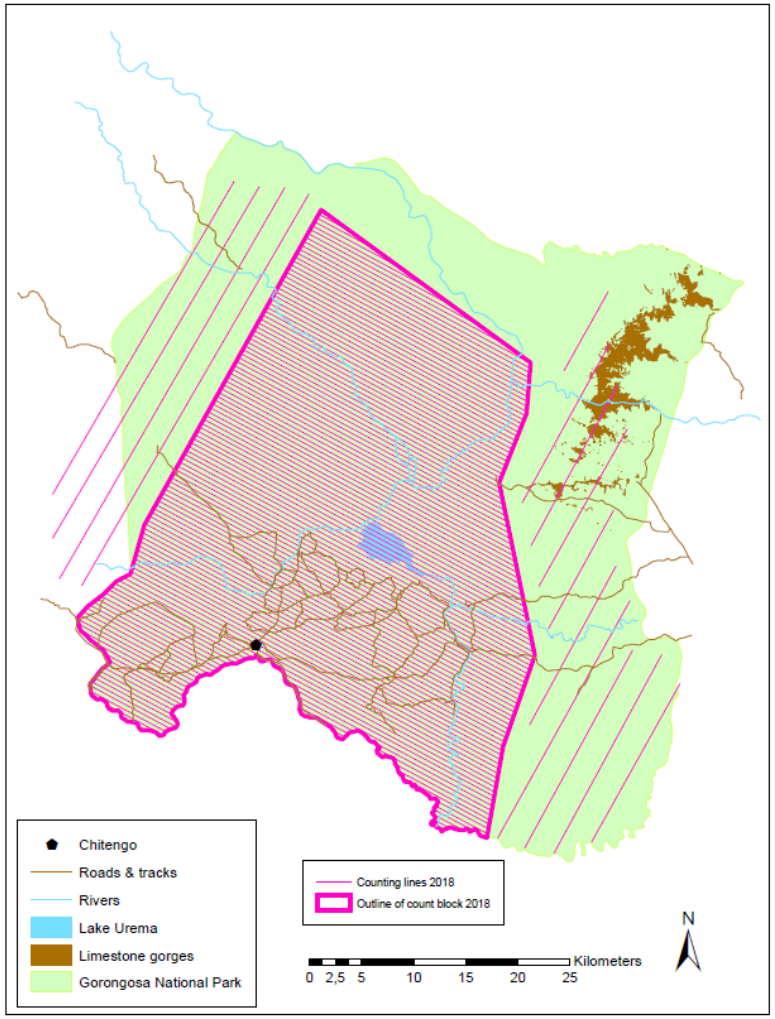


Fig. 3: Count block and additional sample lines covered by the 2018 aerial wildlife count.

Table 4: Counting conditions during the 2018 aerial wildlife survey.

Date	Session	Cloud cover (0 to 8 scale)	Visibility	Temp. ºC	Team
16/10	1	6–5 (high)	Good (g), Moderate-Moderate (m-m), Poor (p) g-m-m-p	26-30	Marc Stalmans (MS); Mike Pingo (MP); Mike Peel (MP); Moloko Manaka (MM); Bryan Pingo (BP)
16/10	2	3–1	g (bit hazy)	32-36	MS; MP; MP; MM; BP
16/10	3	8	p – very poor (vp) (v smoky)	36	MS; MP; MP; MM; BP
17/10	1	4	m-g-m-g-g	28-32	MS; MP; MP; MM; Dominique Gonçalves (DG)
17/10	2	4-2	g	28-32	MS; MP; MP; MM; DG (last part session)
17/10	3	2-4	g (smoky end)	39	MS; MP; MP; MM; DG
18/10	1	8	m-g-g (v high; smoky end)	25-28	MS; MP; MP; MM; DG
18/10	2	8	g-m-m-m (v high; smoky end)	30-35	MS; MP; MP; MM; DG (first part)
18/10	3	8	m-p-p-p-vp (v high; smoky end)	28	MS; MP; MP; MM; DG (first part)
19/10	1	8	p (heavy cloud cover)	27-28	MS; MP; MP; MM; DG
20/10	1	8	p-p-m-m (heavy cloud cover)	26-27	MS; MP; MP; MM; DG
20/10	2	5-4	m-g-m-g	32-34	MS; MP; MP; MM; DG
22/10	1	1	Excellent (e)	20-23	MS; MP; MP; MM
22/10	2	2	g	25-28	MS; MP; MP; MM
26/10	1	4	m-g-g	23-26	MS; MP; MP; MM
26/10	2	2-0	g	29-33	MS; MP; MP; MM
26/10	3	0	g-g-m (smoky later)	35-34	MS; MP; MP; MM
27/10	1	8-5-2	p-m-g	23-27	MS; MP; MP; MM
27/10	2	3	g (west)-m-p (east)	30-32	MS; MP; MP; MM
27/10	3	0	g	34	MS; MP; MP; MM

Table 4 (continued): Counting conditions during the 2018 aerial wildlife survey.

Date	Session	Cloud cover (0 to 8 scale)	Visibility	Temp. ºC	Team
28/10	1	0-2	e-e-e-g	23-27	MS; MP; MP; MM
28/10	2	2	g	23-27	MS; MP; MP; MM; DG
28/10	3	0	g (light haze)	34	MS; MP; MP; MM; DG
29/10	1	3-1	m-g-g-g (hazy)	23-25	MS; MP; MP; MM;
29/10	2	0	g-m-g-g-g	30-32	MS; MP; MP; MM;
30/10	1	0	m (high hazy)-g-g-g	23-27	MS; MP; MP; MM
30/10	2	0	g	30-35	MS; MP; MP; MM
30/10	3	0	g	36	MS; MP; MP; MM
31/10	1	0	g	23-27	MS; MP; MP; MM; Jason Denlinger
31/10	2	0	g	30-36	MS; MP; MP; MM
31/10	3	0	g (hazy later)	40-39	MS; MP; MP; MM; Ivan Jooste
01/11	1	8 (high)	g (hazy)	23-26	MS; MP; MP; MM; DG
01/11	2 (River)	3-0	g	29-34	MS; MP; MP; MM; Brett Kuxhausen
01/11	3	0	g (hazy later)	32-34	MS; MP; MP; MM
02/11	1	8	p	27	MS; MP; MP; MM; DG (first part)

2.2. Animal numbers recorded

A total of 100 409 herbivores of 19 species were counted (Table 5). These are actual counts, not estimates. This represents the absolute minimum number of large animals that occur in the park given that only 57.4% of the Park was counted.

In addition, more than 2 000 crocodiles were observed. The actual number of crocodiles in Gorongosa is much higher and a count during the winter months when more of them can be found outside of the water is recommended. A total of 245 baboon troops were also recorded.

The 2018 count generated 21 415 individual observations. These records were amalgamated in the database together with the data from the previous counts. At present, the database holds more than 70 000 individual observations from 15 wildlife counts since 1969.

More animals still occur outside the block that was counted in 2014/2016/2018, 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 5: total number of herbivores counted in 2018 in the count block and additional sample lines.

Species	Total number counted
Blue wildebeest	627
Buffalo	1 021
Bushbuck	1 787
Bushpig	203
Common reedbuck	10 821
Duiker grey	66
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Kudu	2 105
Nyala	2 269
Oribi	4 027
Sable	968
Warthog	11 274
Waterbuck	57 016
Zebra	44
	100 409

2.3. Spatial distribution patterns

The distribution of the different species across the count block indicates a general preference for the floodplain grasslands[1] and the areas along the perennial rivers such as Vunduzi, Mucombeze and Urema Rivers. (Fig. 4).

Certain species are strongly associated with the floodplain (e.g. waterbuck and common reedbuck – Fig. 5 & 6), others with the floodplain-woodland interface (elephant and buffalo Fig. 7 & 8), and others still with the woodlands (sable antelope, Lichtenstein hartebeest, kudu, nyala and impala – Fig. 9 to 13). The distribution of wildebeest, zebra, warthog and oribi is illustrated in Fig. 14 to 17. Hippo and crocodile are, as expected, strongly associated with Lake Urema and the perennial rivers and pans (Fig. 18 & 19).

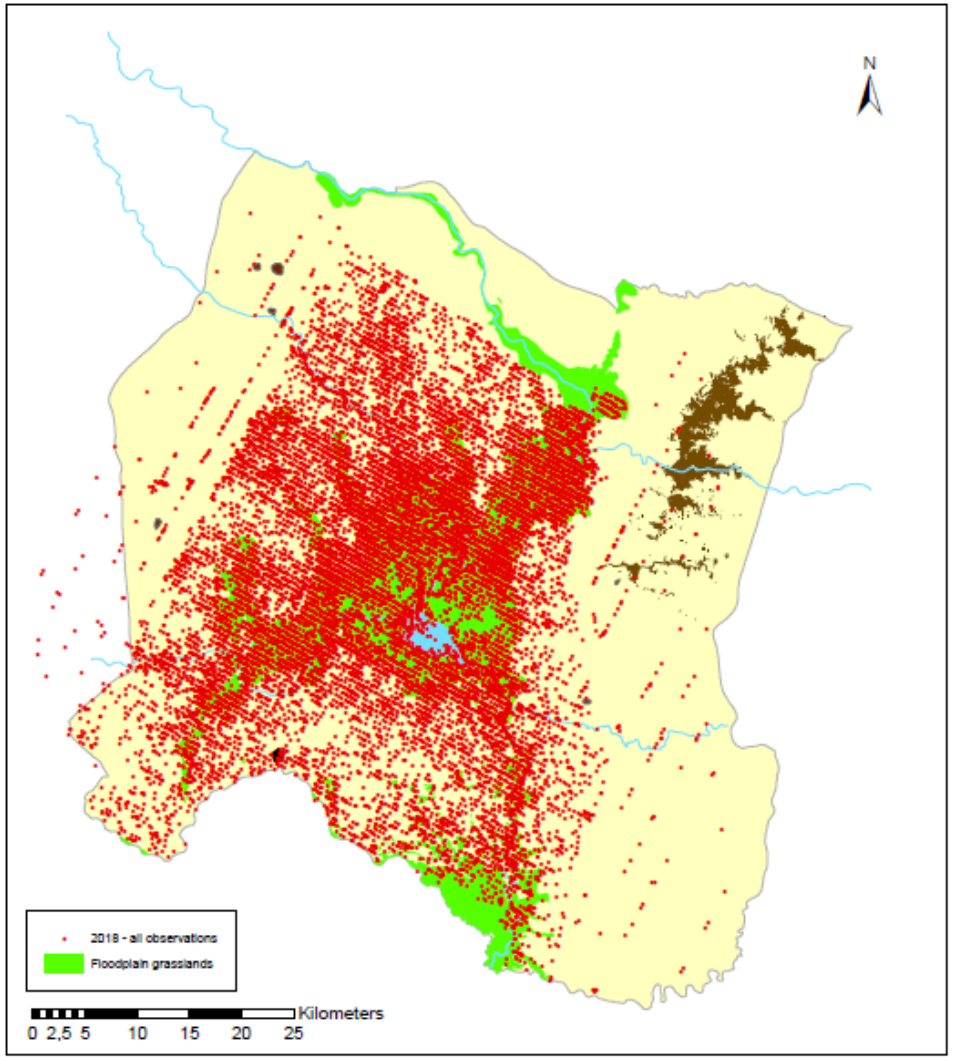

Fig. 4: Spatial distribution of all observations during the 2018 aerial wildlife count.

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

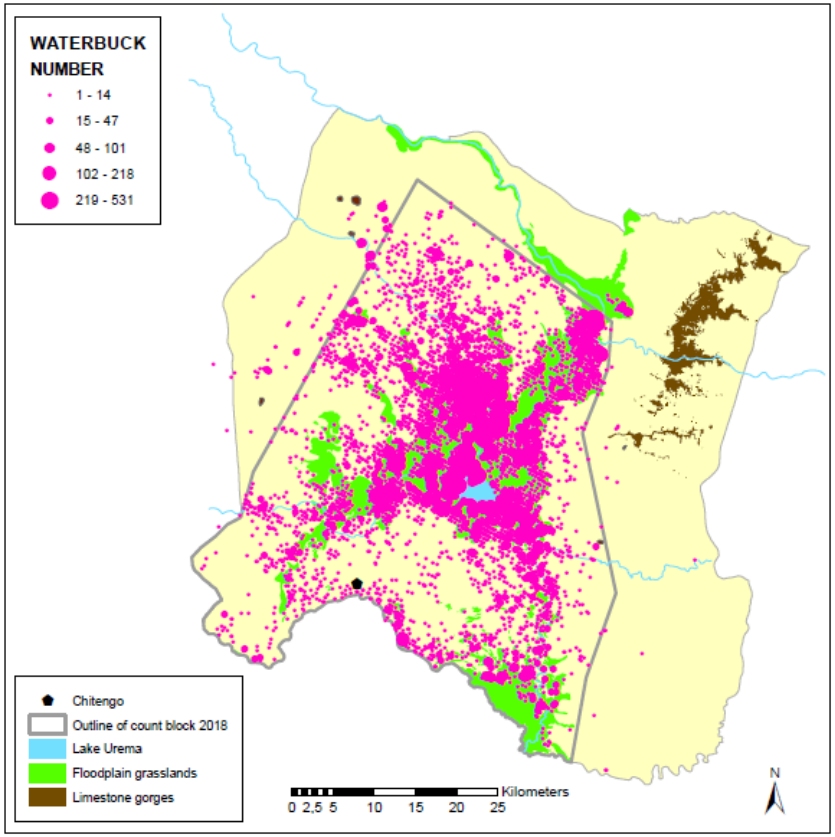

Fig. 5: Spatial distribution of waterbuck during the 2018 aerial wildlife count.

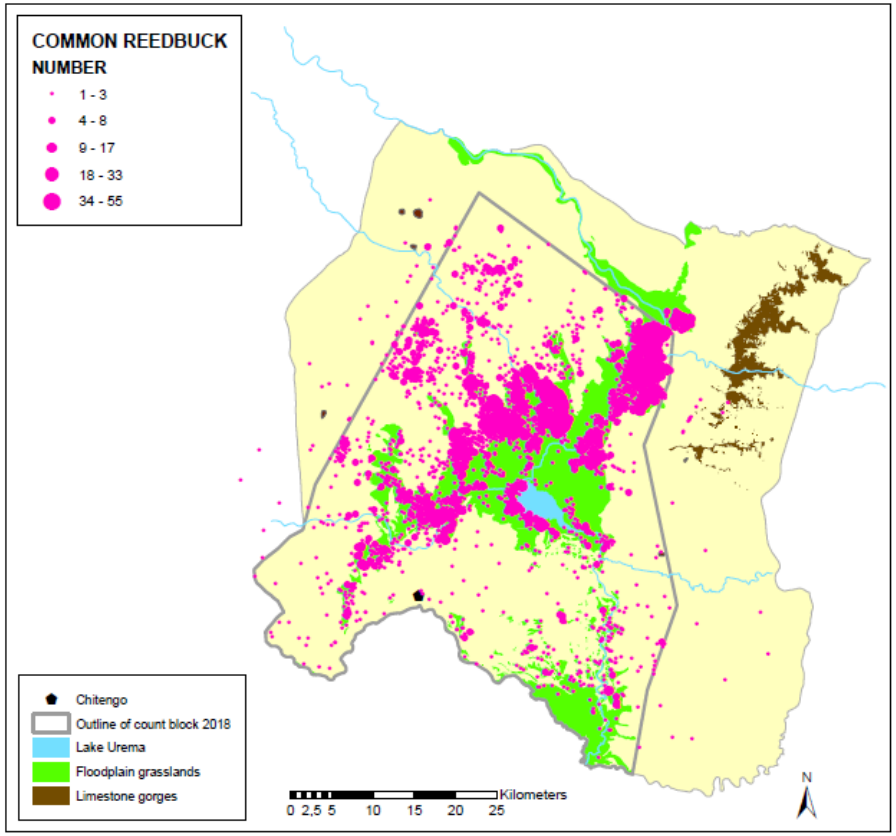

Fig. 6: Spatial distribution of common reedbuck during the 2018 aerial wildlife count.

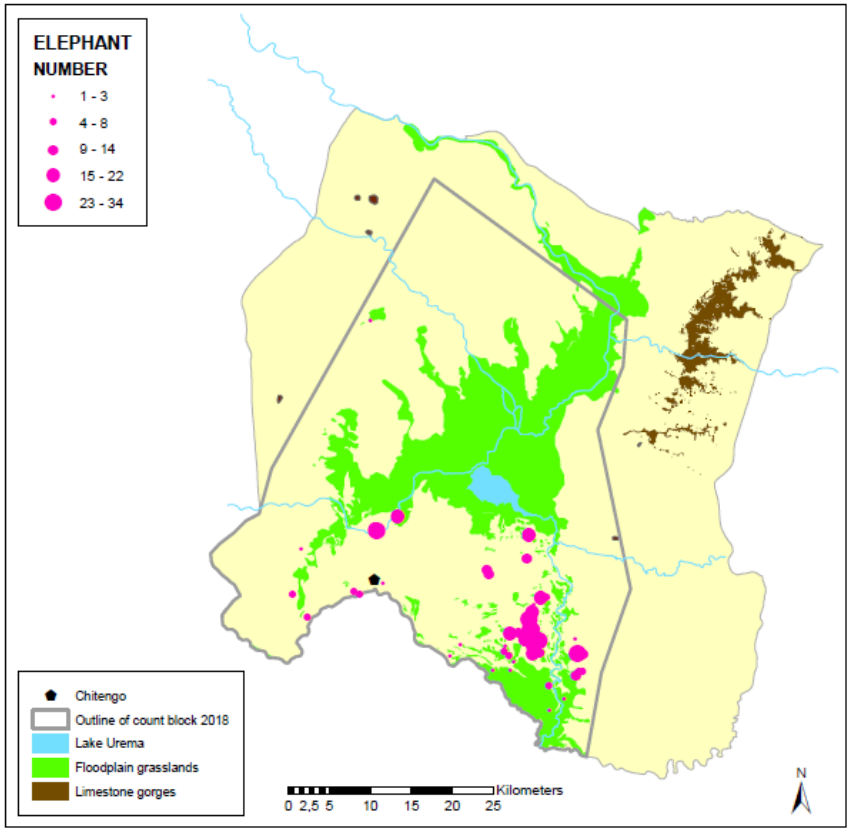

Fig. 7: Spatial distribution of elephant during the 2018 aerial wildlife count.

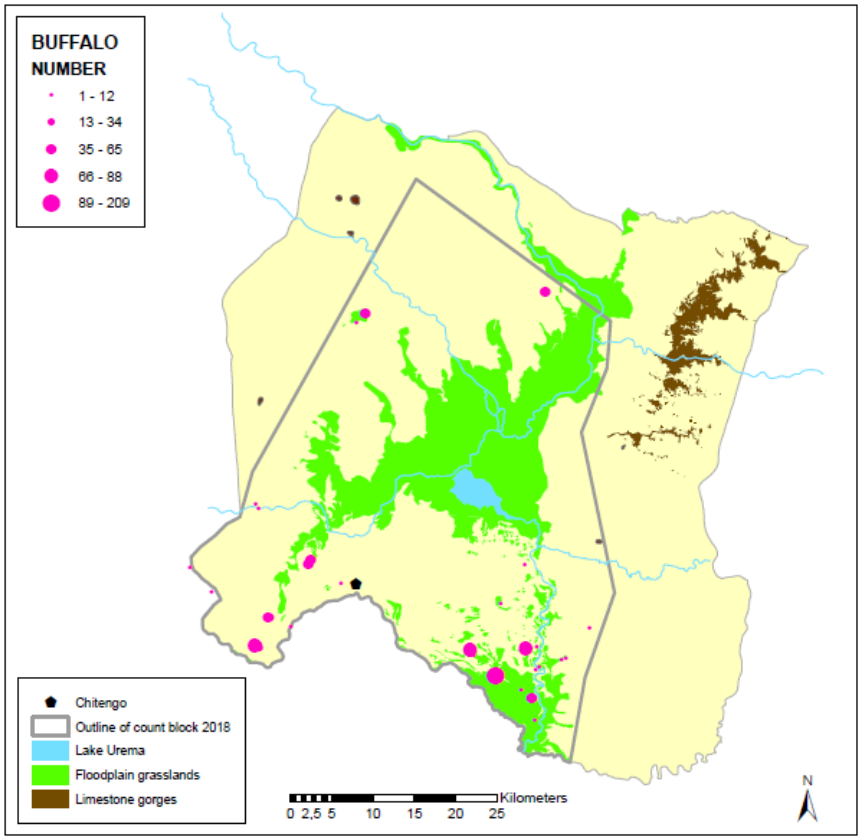

Fig. 8: Spatial distribution of buffalo during the 2018 aerial wildlife count.

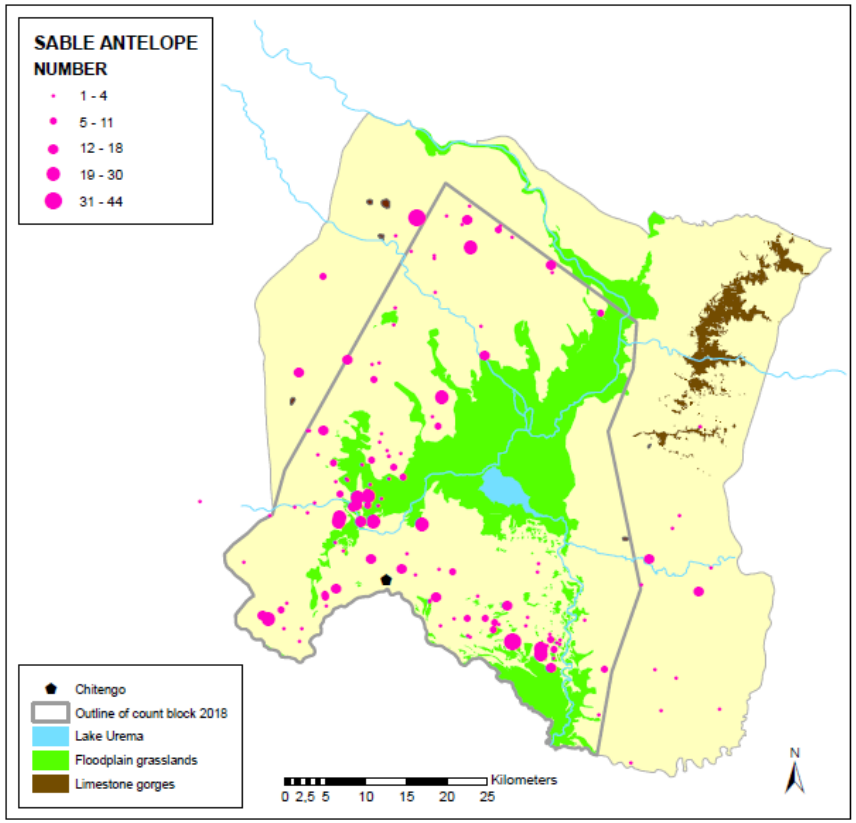

Fig. 9: Spatial distribution of sable antelope during the 2018 aerial wildlife count.

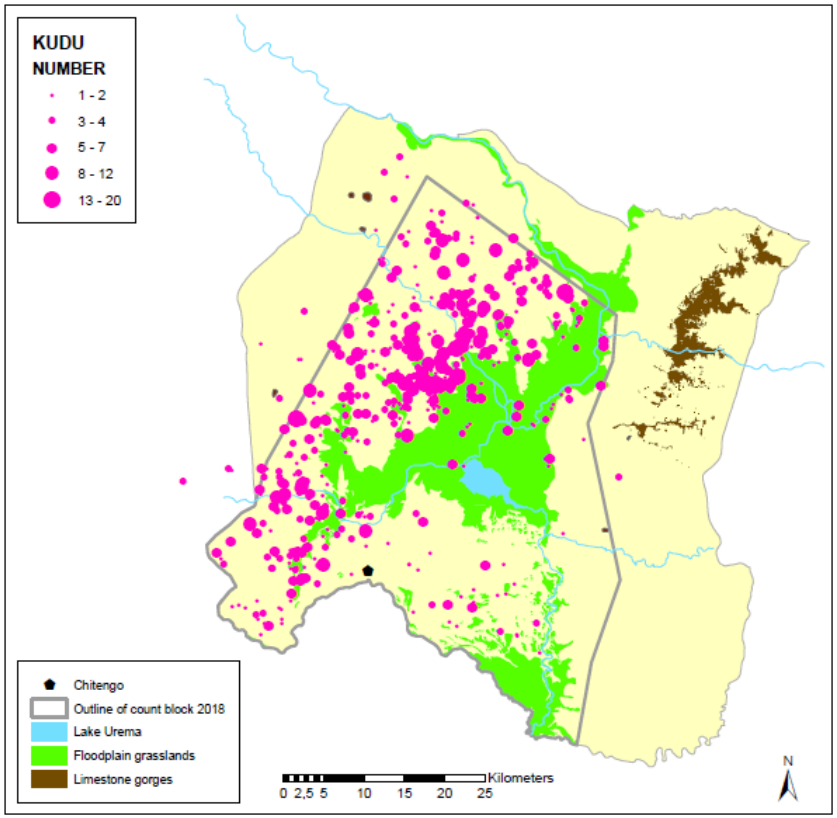

Fig. 10: Spatial distribution of kudu during the 2018 aerial wildlife count.

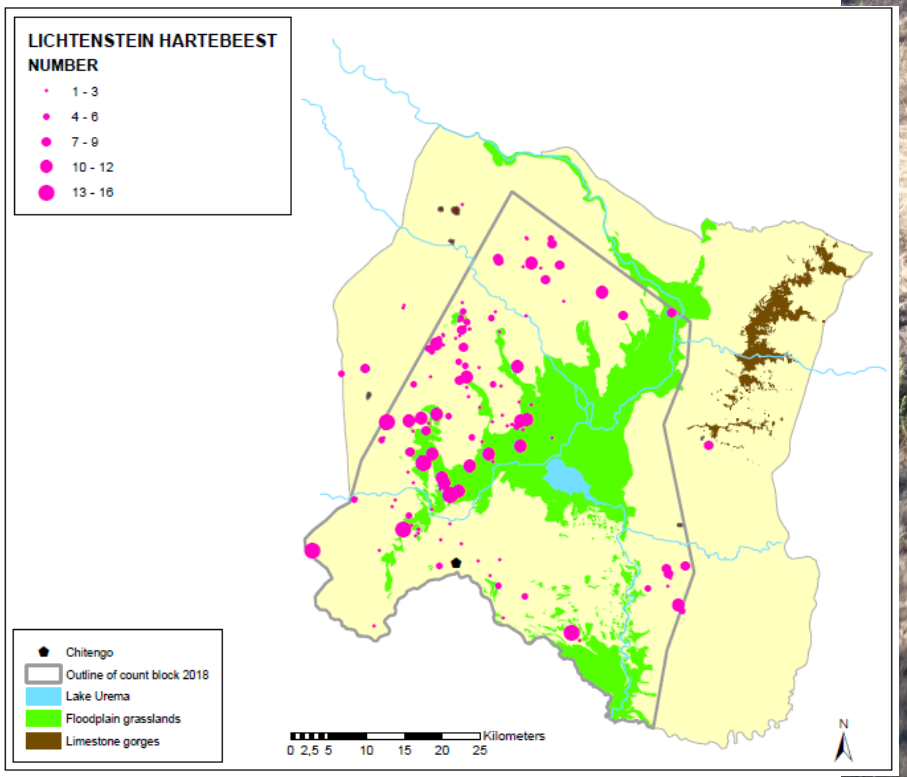

Fig. 11: Spatial distribution of Lichtenstein hartebeest during the 2018 aerial wildlife count.

A “white” Lichtenstein hartebeest observed during the 2018 aerial wildlife count.

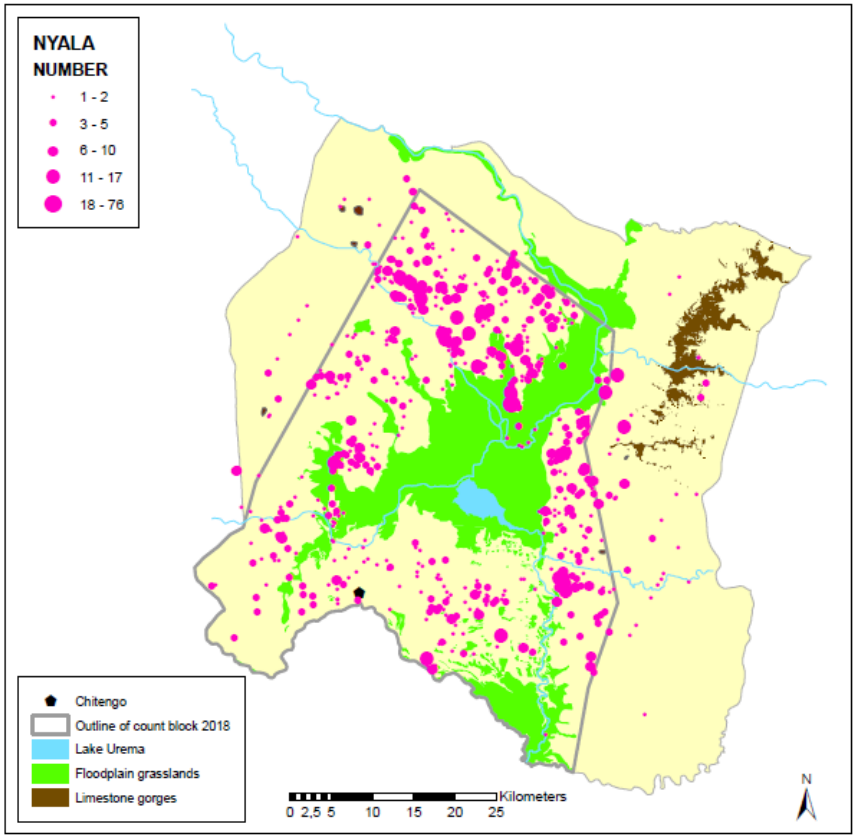

Fig. 12: Spatial distribution of nyala during the 2018 aerial wildlife count.

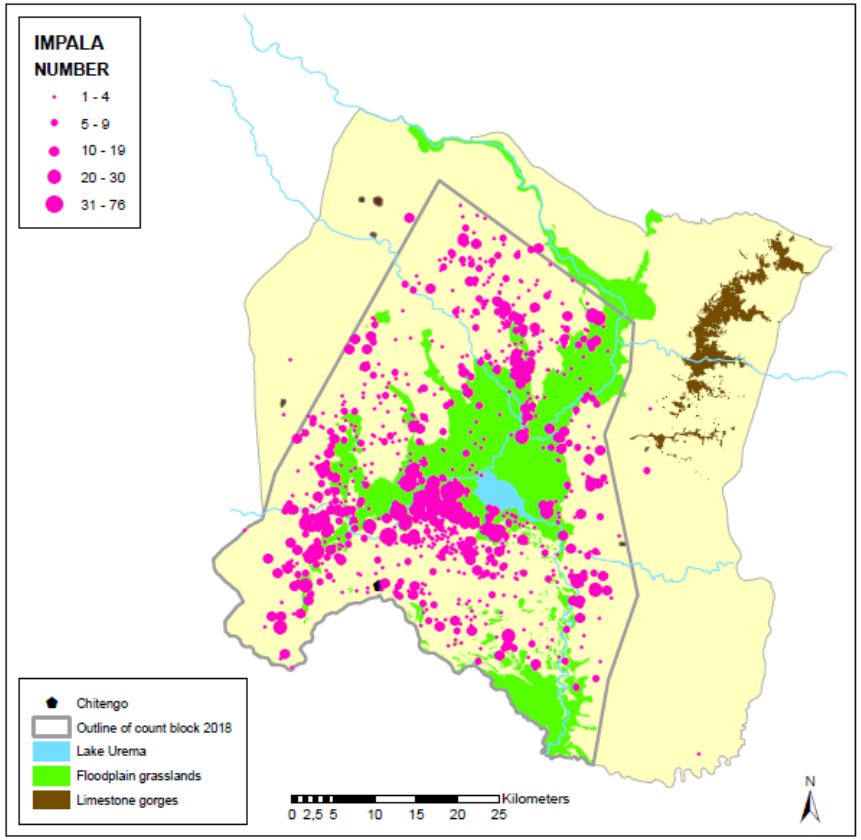

Fig. 13: Spatial distribution of impala during the 2018 aerial wildlife count.

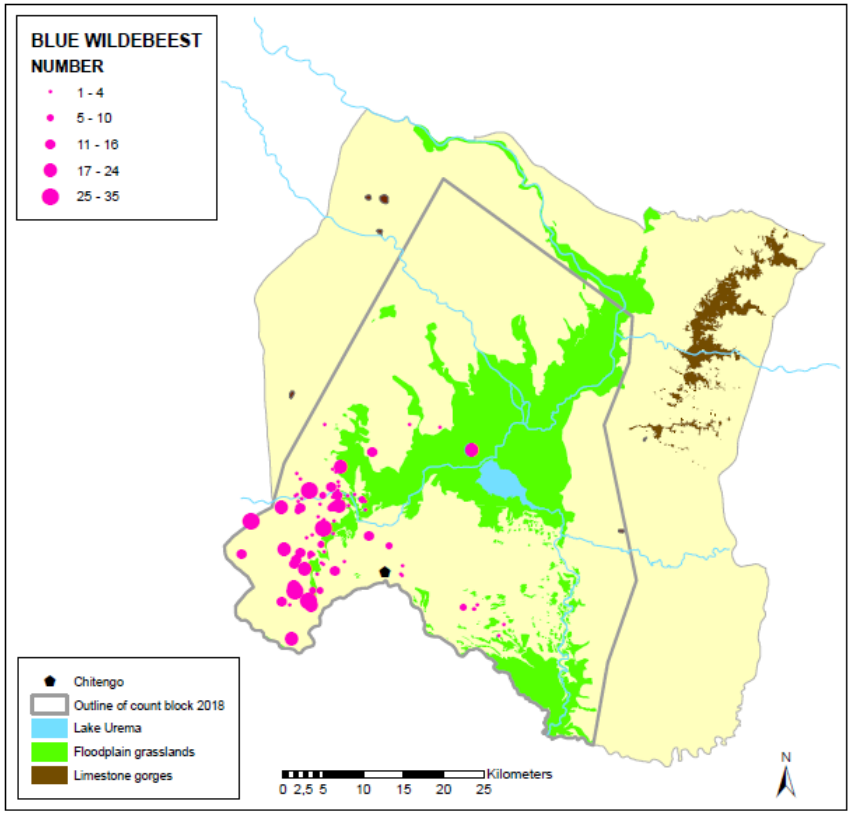

Fig. 14: Spatial distribution of blue wildebeest during the 2018 aerial wildlife count.

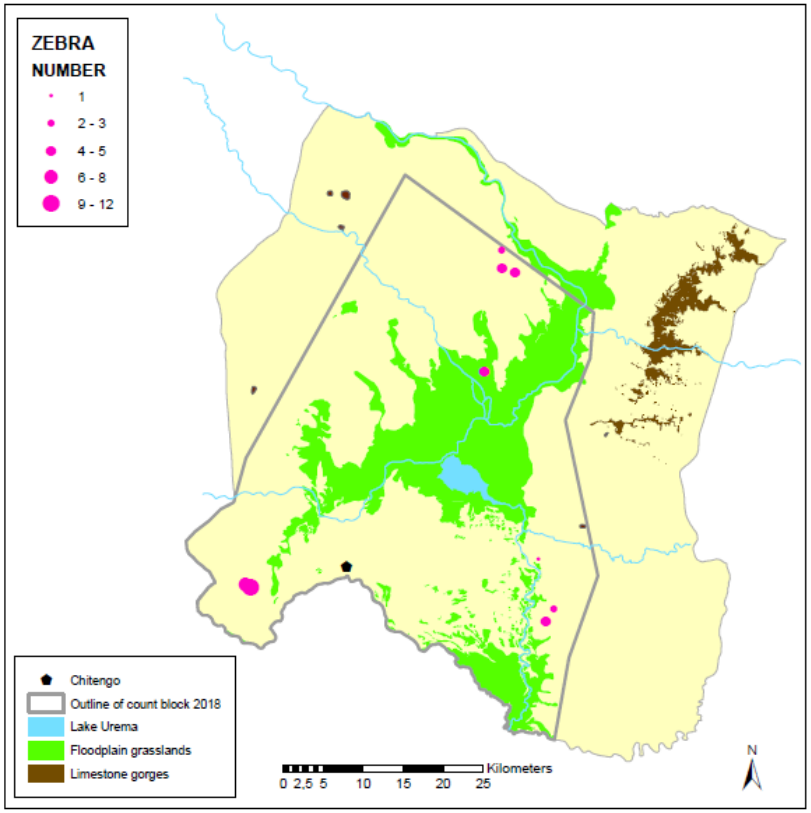

Fig. 15: Spatial distribution of zebra during the 2018 aerial wildlife count.

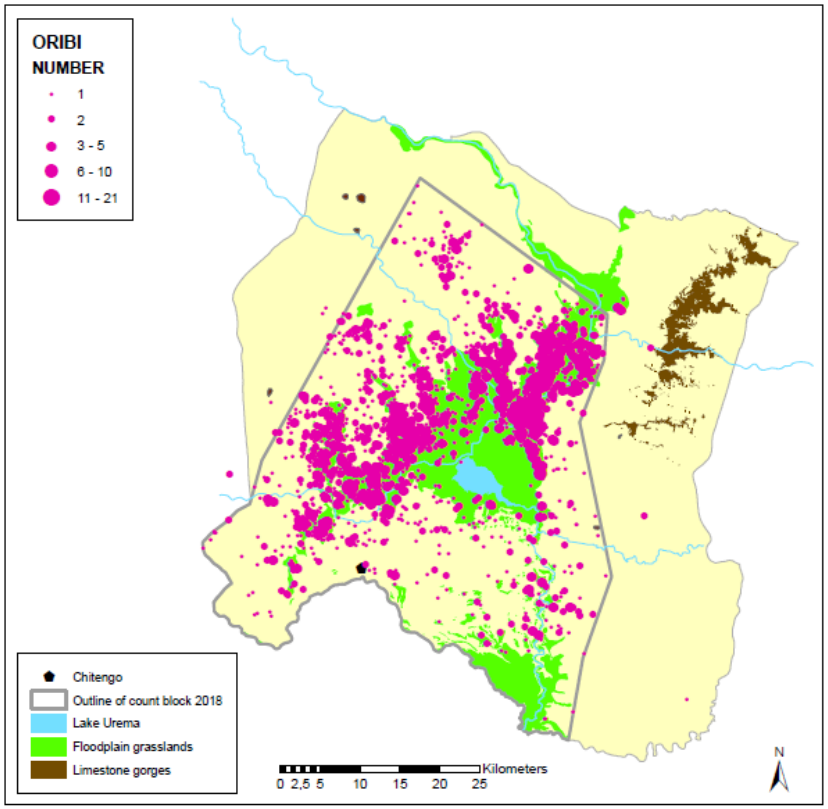

Fig. 16: Spatial distribution of oribi during the 2018 aerial wildlife count.

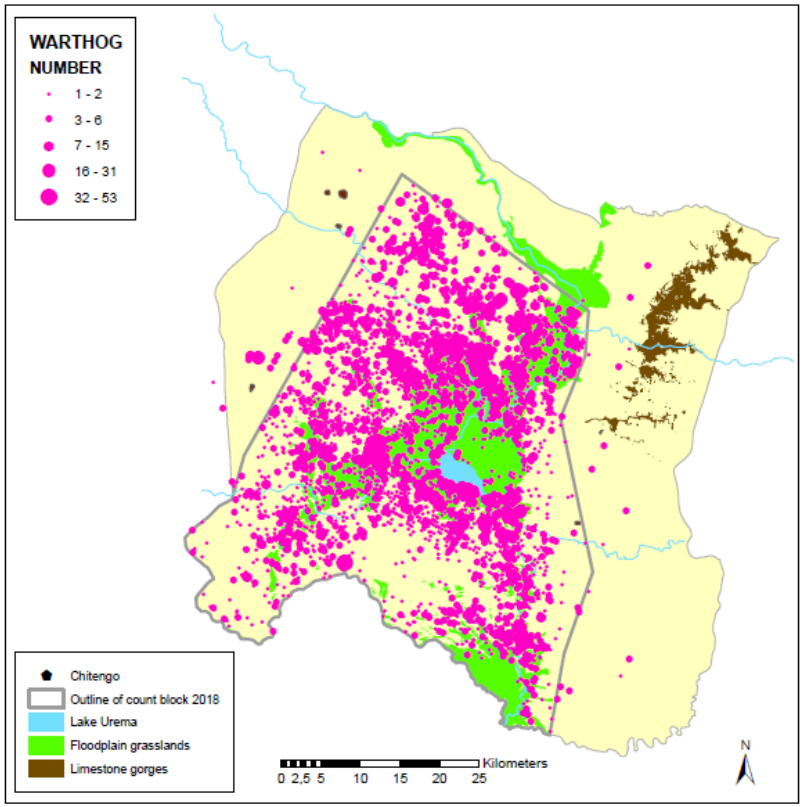

Fig. 17: Spatial distribution of warthog during the 2018 aerial wildlife count.

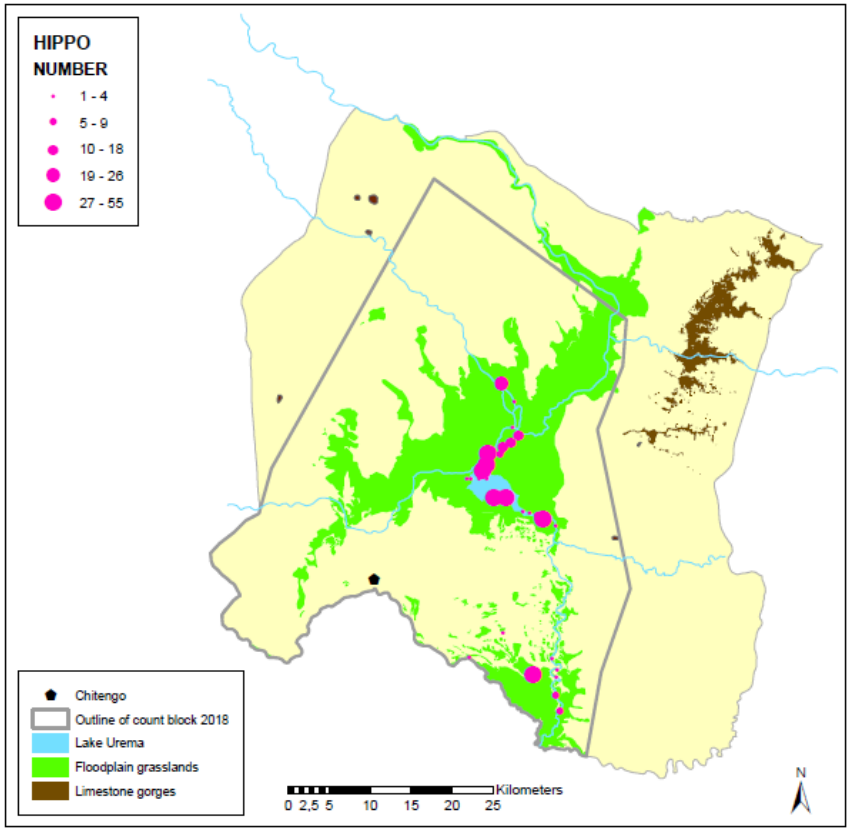

Fig. 18: Spatial distribution of hippo during the 2018 aerial wildlife count.

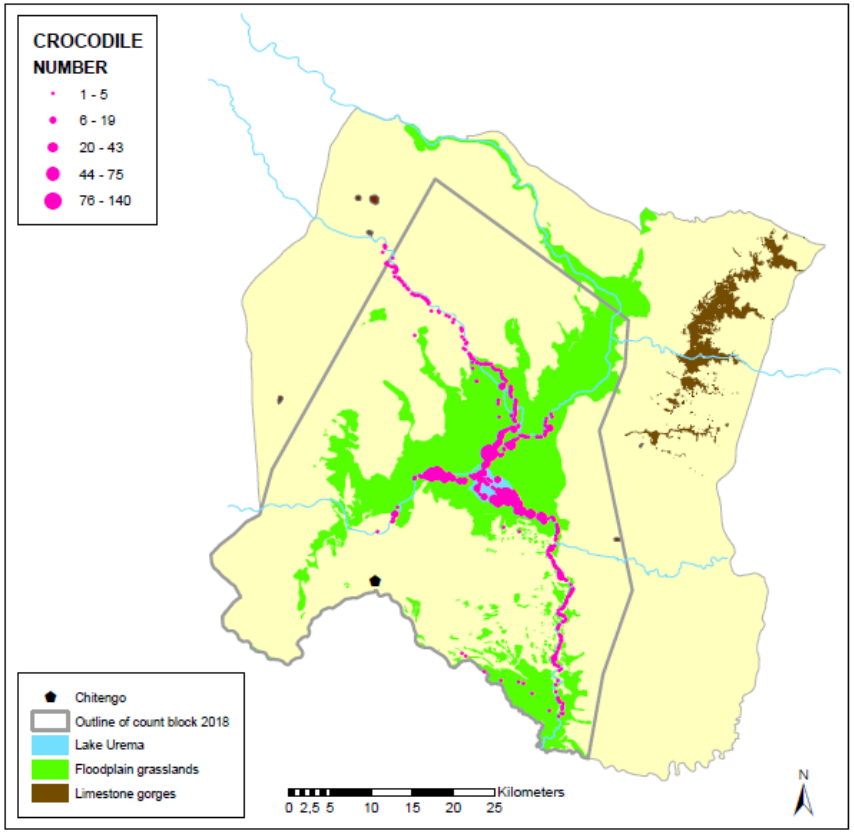

Fig. 19: Spatial distribution of crocodile during the 2018 aerial wildlife count.

2.4. Wildlife biomass

These animal numbers translate into an average biomass of 9 600 kg per km^2. This is similar to the average biomass recorded pre-war with the difference that species such as kudu, nyala, impala, reedbuck and warthog were not counted in those days. Waterbuck represents 63.3% of the total animal biomass.

2.5. Illegal activities

Not a single animal was found in a snare. In contrast, during the 2014 count, a total of 4 recently snared animals were encountered. In 2016, a single snared waterbuck was observed during the count. The positive results from 2018 confirm the effectiveness of the dedicated efforts by the Conservation staff in the field.

2.6. Additional species observations

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 188 Ground hornbills (182 in 2016), 90 Grey Crowned Cranes (119 in 2016) and 36 Saddle-bill storks (43 in 2016) were observed.

A total of 17 active nests of White-backed vultures, 8 active nests of White-headed vultures, 1 nest of Hooded vulture and 1 of Lappet-faced vulture were georeferenced (Fig. 20).

A total of 229 active nests of marabou storks were recorded. This must represent the single largest breeding population of Marabou stork in the SADC region (Fig. 20).

A Pel's fishing owl was observed along the Vunduzi River.

A total of 219 baboon troops (225 troops in 2016) were recorded. This information will be useful to the ongoing primatology research project. Five troops of samango monkeys were observed as well.

Although not a good tool to census lions, the helicopter count did yield records of use to the Lion Project. A rare sighting of a Side-striped jackal was also made.

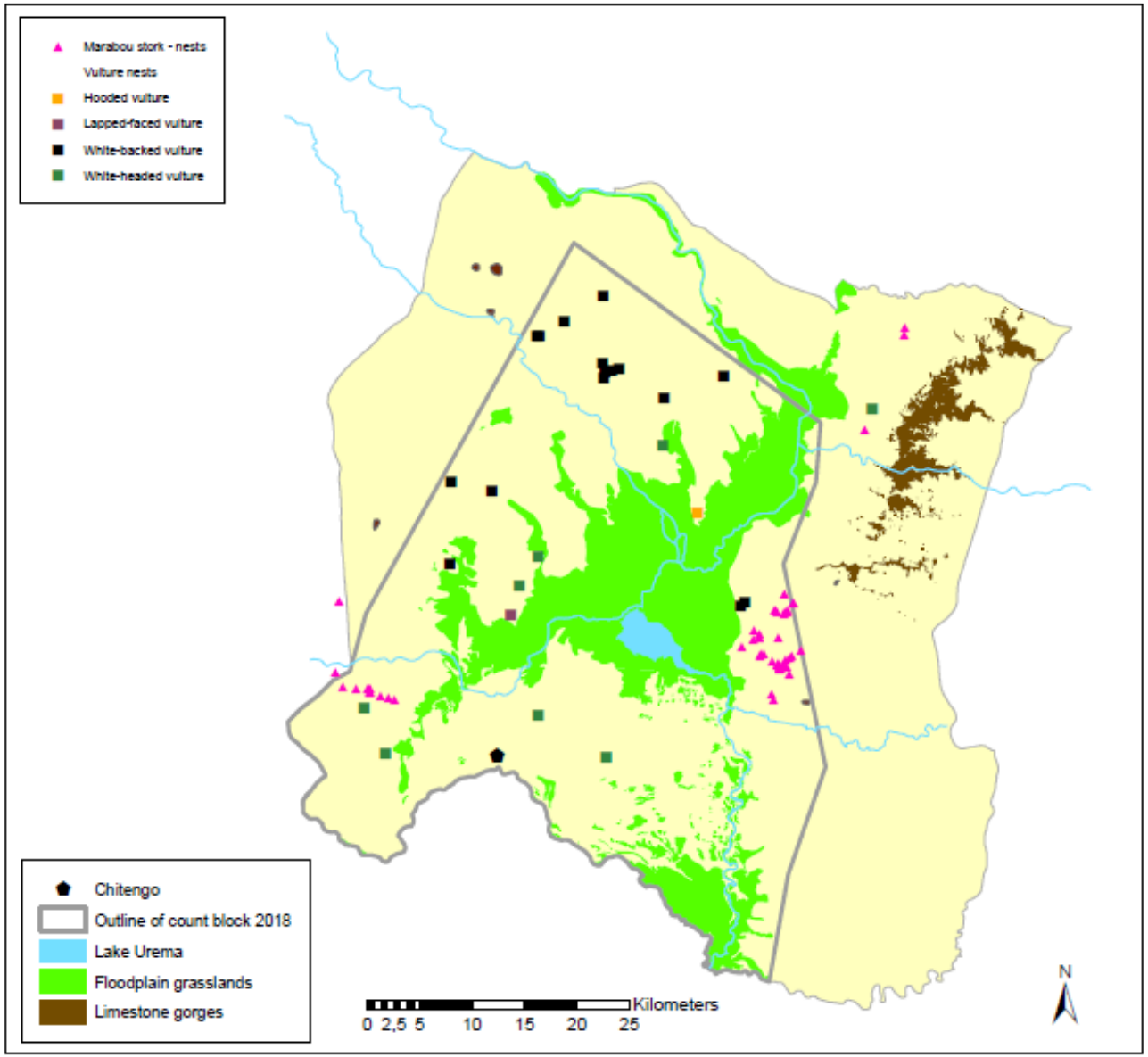

Fig. 20: Distribution of nests of vultures and of marabou storks observed during the 2018 aerial wildlife survey.

3. Discussion - general & individual species trends

The 2017-2018 season has been excellent for herbivores from a rainfall and vegetation perspective (Fig. 21).

The 2018 results are compared to those for 2014 and 2016 for the same counting block (Table 6). Overall, the number of herbivores has been steadily increasing. The results are now discussed on a species- by-species basis.

One of the most obvious, albeit not unexpected outcomes, has been the recovery of the warthog population. This species declined with some 40% between the 2014 and 2016 counts as a result of the harsh drought conditions in 2015 and 2016. Warthog are known for their "boom-and-bust" cycles in response to improving or deteriorating grazing conditions.

The waterbuck have continued to increase and now number over 50 000 (Table 6).

The buffalo numbers show good growth. For the first time since the start of the restoration process, more than 1000 buffalo were counted.

The hippo population now exceeds 500 individuals.

Impala, kudu and nyala have increased substantially since 2016.

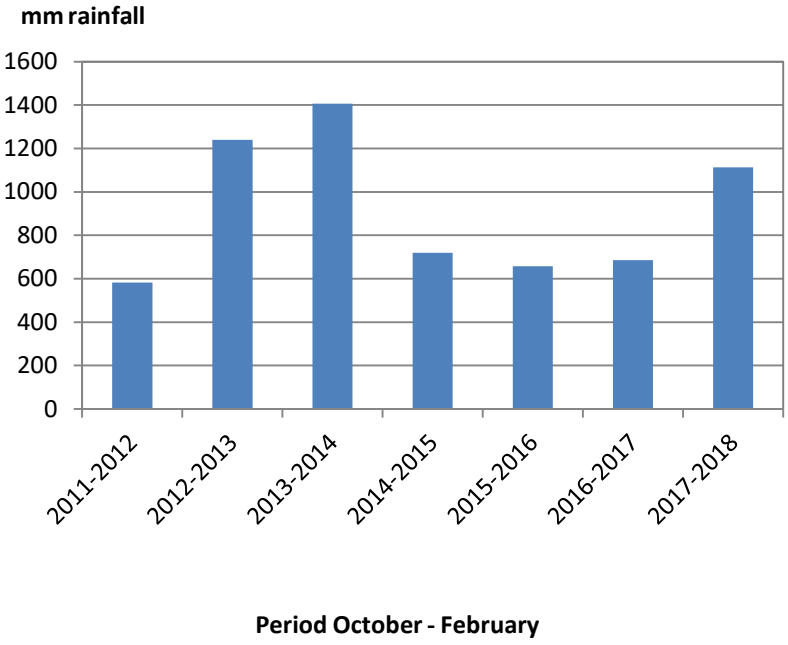

Fig. 21: Rainfall received for the period October till February over the past 7 years (note that these are not annual totals, but reflect the rainfall across the critical calving season).

Whereas some concern was expressed in previous years about the blue wildebeest, their numbers have picked up significantly and more than 600 individuals were counted. It is suspected that some groups were missed in 2016, either being under heavy tree canopy or being lured outside of the counting block by resprouting grass on burnt areas.

A total of 544 elephants were counted which is lower than the figure recorded on 2016. However, 6 out of the 12 collared lead females and their families were not observed. Movement data and GPS positions of these collared females during the count period show that they were using the Dingue-Dingue area along the Púngué River on the southern border of the Park. This area is characterized by dense riverine vegetation (*Piliostigma thonningii – Borassus aethiopium* Closed Woodland/Dry Forest community – see Stalmans & Beilfuss 2008) in which an elephant herd can easily disappear.

Elephants are social and matriarchal animals that live in family units that are often quite large. A family unit is composed by adult female or females and calves with coordination and affiliative behaviour and high frequency of association over time (Moss & Poole 1983). The collared matriarch or lead female is with the family unit guiding them through the landscape.

Table 6: side-by-side comparison between the numbers of animals in the same counting block surveyed in 2014, 2016 and 2018.

Species	2014	2016	2018
Blue wildebeest	361	363	587
Buffalo	670	696	960
Bushbuck	2 277	2 022	1 665
Bushpig	167	108	183
Common reedbuck	11 871	10 451	10 220
Duiker grey	61	49	42
Duiker red	26	21	21
Eland	105	94	117
Elephant	535	567	544
Hartebeest	613	562	578
Hippo	436	440	546
Impala	2 727	4 705	6 122
Kudu	1 200	1 466	1 928
Nyala	945	1 299	1 934
Oribi	4 485	3 884	3 958
Sable	757	810	805
Warthog	9 086	5 383	10 739
Waterbuck	34 482	44 948	55 351
Zebra	33	34	33
TOTAL	**70 837**	**77 902**	**96 633**

It is unlikely for matriarchs or lead females to be without their family unit. A total of 114 elephants make up the six family units that were not observed (Table 7).

There is therefore a high likelihood that the actual elephant population numbers more than 650 animals (544 counted + 114 based on collar and movement data = 658 elephants). No recent carcasses were observed during the count. Mortality records in 2017 and 2018 were 4 and 5 individuals respectively. One of the recorded mortalities was due to Human-Elephant Conflict, two resulted from confirmed cases of illegal hunting, and six of unknown causes.

A total of 19 small calves, younger than 1 years old, were observed during the count. By all accounts, the elephant population appears healthy and growing. Previous population estimations that were done using individual identification, trail camera monitoring and a ratio of 2.4 immatures to each adult female (Poole and Granli 2017) resulted in an estimate of 825 individuals.

In conclusion, Gorongosa has a healthy growing elephant population with small losses only. However, the concentration of several family units in the dense vegetation along the Púngué River (as confirmed through satellite collar positions) led to a substantial undercount.

Table 7: Lead females collar ID and number of elephants in the family units that were not observed during the aerial count as they were located in the dense riverine forest along the Pungue river.

Collar Number	Collared lead female	Number of elephants in the family unit
AWT - 14439	Megan	20
AWT - 14438	Dora	15
AWT 14435	Anne	10
AWT 14436	Julianne	9
2983	Gf61	40
2981	Iphigenia	20
	Total	**114**

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 sampling lines flown (Table 8).

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 potentially higher pressure from illegal hunting closer to the Park boundaries.

Table 8: Wildlife densities (as animals per km^2) across the western, central and eastern parts of Gorongosa National Park

Species	Western (miombo)	Rift	Eastern miombo
Bushbuck	0.26	0.89	0.12
Common reedbuck	0.40	5.42	0.29
Duiker grey	0.12	0.02	0.06
Impala	0.02	3.22	0.11
Kudu	0.23	1.05	0.04
Nyala	0.45	1.07	0.57
Warthog	1.05	5.70	0.31
Waterbuck	3.48	29.06	0.15
Sable	0.31	0.44	0.24
Hartebeest	0.17	0.32	0.09

4. Conclusion

In conclusion, the 2018 aerial wildlife count was highly successful.

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

Several milestones were recorded including a total of more than 100 000 animals with more than 1 000 buffalo.

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. The aerial wildlife count is a vital M&E tool for the Park.

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