

Aerial Census Report for Maputo Special Reserve, Futi Corridor & the Sanctuary Area  
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# AERIAL CENSUS REPORT FOR MAPUTO SPECIAL RESERVE SEPTEMBER 2016

C.C. Hanekom, District Ecologist, Ezemvelo KZN Wildlife, Tembe Elephant Park  
R. Cumbane, Head of Ecology Department, Ministério De Terra, Ambiente e Desenvolvimento Rural, Reserva Especial De Maputo

## 1. INTRODUCTION

The aerial census was undertaken towards the end of September 2016, and the overall aim was to determine the current status of some of the most abundant large herbivore species in Maputo Special Reserve. Some concern continues to prevail regarding the re-introduced species, and so it was important to undertake an aerial census in 2016 to determine the status of these populations, as well as to continue gathering long-term data regarding the species' trends. The census also provides information on the spatial distribution of the game populations, which in turn provides information on the habitat use of the species.

Although the count was initially planned for August, the count could only be undertaken towards the end of September (27-29 September). Despite some rain having been received in the area, the rainy season had not yet begun. However, due to early season warm temperatures the abundant leaf cover made observation of some species, such as nyala, difficult. It is critical that the aerial survey be undertaken earlier in the year in future.

This transect aerial census builds on those of the previous years, and will contribute to the understanding of long-term herbivore population trends. The methods used were the same as previous censuses. Two methods were used, namely (i) total area aerial count and (ii) transect distance sampling count.

The aerial census was undertaken by Vere van Heerden (pilot), Cathariné Hanekom (co-ordinator & recorder) and Leonard Muller, with Rodolfo Cumbane and Brian Neubert as observers.

The census was made possible through funding from the National Administration for Conservation Areas (ANAC) and the Peace Parks Foundation.

## 2. METHODS

### Aerial Census

#### a) *Total Aerial Count*

1. A helicopter containing four people (pilot & recorder in front, and two observer in back) was flown on pre-determined, parallel east-west orientated transects over the reserve, and with a north-south orientation over the Futi Corridor and Sanctuary areas. These transects are situated 1km apart and arranged systematically to cover the whole census area (Appendix 1).
2. The helicopter was flown at 90m (300ft) above the ground and at an air speed of approximately 30-40 knots. Transects were flown in the morning and afternoon for periods of up to a maximum of 3hrs at a time. This resulted in three survey sessions

per day. The hottest part of the day was avoided as far as possible, as animals tend to rest under shade in the heat of the day and consequently are more difficult to spot.

3. Devices were fitted to both sides of the helicopter which, when flying at a height of 90m, demarcated a distance of 500m on each side of the helicopter. All individuals of all herbivore species were recorded in the 1km wide belt.
4. Where large groups of species, such as elephant, hippo and wildebeest, were spotted, the helicopter deviated from the transect line, a total count was undertaken, the locality captured and then returned to continue the count from the point of departure.
5. All data were captured on a notebook computer using Cartalinx v1.2 (Clark Labs, Clark University, 1999) which, when connected to a GPS unit, allowed the simultaneous collection of flight path information, animal numbers (as way points) and the number of the transect being traversed.
6. Where the number of sightings and their distribution allowed, mapping of the distribution of species was done by importing the Cartalinx data into ArcGIS.

#### b) *Distance Sampling*

1. Data were collected for the distance sampling analyses at the same time as for the total count.
2. In order to enable Distance Sampling to be applied to the census results, counting bars were fitted to both sides of the helicopter which, when flying at a height of 90m, demarcated a distance of 500m on each side of the helicopter. The 500m was further divided into five sectors: 0-30m, 31-90m, 91-180m, 181-300m and 301-500m. This division differs from previous years and is based on the vegetation and thus associated visibility of game. Whenever an individual or group of individuals were observed they were recorded as occurring in one of the distance sectors.
3. Animal observations recorded during the aerial census were edited and then exported directly to Distance 6 from the Microsoft Access database constructed whilst entering the data using Cartalinx. Where the number of observations allowed, density along each transect and from this population size, was estimated using the statistical routines in distance 6 (Thomas *et.al.* 2001).
4. A statistically robust estimate can only be derived for species with approximately 60 sightings. Although species with observations as low as 30 can also be analysed with Distance, these estimates should not be considered reliable but rather considered as best estimates of population sizes for those species which have been under-sampled.

### 3. RESULTS

#### Aerial Counts

The complete aerial survey of the entire reserve (79 594ha), the Futi Corridor (3 120ha) and the Sanctuary area (8 000ha), took two and a half days (13.4hrs) to complete (Table ). This was done in three (one to three) sessions per day, so as to allow for re-fuelling and avoidance of the hot midday periods.

The first counting day was warm with good visibility, while the remaining two days experienced light drizzle and average visibility, which also reduced the contrast. Due to the development of leaf cover, game visibility was fair to poor in the sand forest covered areas, as is evidenced by the sightings of the browser species such as nyala.

Table 1. Aerial survey flight sessions, 2016.

Day	Session	Start	End	Hrs
1	1	08:10	10:29	2.2
	2	11:20	13:28	2.1
	3	14:55	16:47	1.5
2	4	07:25	10:11	2.5
	5	11:00	13:11	2.1
	6	14:34	15:22	0.5
3	7	09:20	10:41	1.2
	8	11:15	12:48	1.3
				13.4

a) *Total Aerial Count and Distance Analysis*

With respect to distance sampling, grey duiker, elephant, hippo, nyala, red duiker, wildebeest and zebra had sightings of more than 20 observations. However, only reedbuck had more than 60 observations, with red duiker having over 50 sightings. However, as hippo, nyala and zebra each had almost, and just over, 30 sightings, these were also analysed using Distance (Table 2). Elephant were also analysed using Distance, as an attempt to estimate the total elephant population in MSR, in the absence of monitoring. The 2016 count produced some of the highest number of elephant observations to date.

Table 2. Large herbivore population estimates from Distance sampling, 2016.

Species	Distance sampling estimates for 2016	
	Estimate	95% CV
Bushbuck	255	197 – 329 / 12.9%
Duiker, Grey	257	184 – 359 / 16.1%
Duiker, Red	405	296 – 555 / 15.8%
Elephant	1323*	901 – 1942 / 19.4%
Hippo	2161*	1070 – 4364 / 36.2%
Nyala	422*	281 – 634 / 20.3%
Reedbuck, Common	2611	1887 – 3611 / 16.3%
Wildebeest, Blue	2153*	1305 – 3550 / 25%
Zebra	2182*	1230 – 3873 / 29.1%

\*Unreliable estimate

The number of groups and the total number of animals counted in Maputo Special Reserve, the Futi corridor and the Sanctuary Area for 2016 and past information is summarised in Table 6. The distribution of sightings for the larger, abundant and more significant species is presented in Figures 2 – 7.

## Best Estimate of Numbers

Acceptable estimates for 7 species (Table 3) was achieved. For most species the counts were similar or slightly up from that of the past few years, and a more consistent trend can be observed from 2006 to present (Table 4).

Table 3. The final large herbivore population estimates for 2016.

Estimation method: 1 – Known group; 2 – Total Area Count; 3 – Distance Sample; 4 – Introduction Based Growth Estimate; 5 – Field Ranger Encounter Rates; 6 – informed Guess;  
\* - Unknown.

Species	Total Count	Distance Sample	Final Estimate
Buffalo	-	-	3 <sup>1</sup>
Bushbuck	19	197 – 329 / 12.9%	255 <sup>3</sup>
Bushpig	6		50 <sup>6</sup>
Crocodile	26		*
Duiker, Grey	22	184 – 359 / 16.1%	257 <sup>3</sup>
Duiker, Red	53	296 – 555 / 15.8%	405 <sup>3</sup>
Elephant	286	901 – 1942 / 19.4%	400 <sup>2,5</sup>
Giraffe	28		28 <sup>2</sup>
Hippo	219	1070 – 4364 / 36.2%	750 <sup>6</sup>
Impala	162		200 <sup>4</sup>
Jackal, Side-striped	1		*
Kudu	33		135 <sup>4</sup>
Nyala	41	281 – 634 / 20.3%	230 <sup>4</sup>
Reedbuck, Common	873	1887 – 3611 / 16.3%	2611 <sup>3</sup>
Rhino, White	-	-	-
Serval	1		*
Steenbok	2		*
Suni	-		*
Warthog	17		100 <sup>4</sup>
Waterbuck	2		10 <sup>1</sup>
Wildebeest, Blue	351	1305 – 3550 / 25%	351 <sup>2,4</sup>
Zebra	446	1230 – 3873 / 29.1%	446 <sup>2,4</sup>

The count for nyala was considerably lower than the 2015 count, which bears testimony to the fact that the effectiveness of the leaf flush plays a significant role in visibility of browse species. This same pattern was evident in the 2014 count.

Of particular interest was the sighting of the waterbuck again in the 2016 count, despite the fact that only 3 individuals were seen. According to field observations they appear to be doing well. Some species have seen significant increases during the 2016 aerial census, which can be ascribed to the earlier timing of the count as well as the continued northwards dispersal of some of the re-introduced species. The increase of some species, such as impala, blue wildebeest and zebra, since introduction was also noticeable. A summary of the re-introductions to date is detailed in table 5.

Reedbuck remain the most abundant species in the reserve, with a total of 873 individuals having been counted in 2016 (Figure 2). Blue Wildebeest and Zebra have increased significantly from 276 to 351, and from 303 to 446 respectively, and have begun to move slightly further afield from their introduction areas (Figures 3&4). Kudu have again shown a slight increase in sightings, while giraffe sightings increased slightly from 21 individuals in 2015 to 28 individuals in 2016.

Since the 2006 aerial census the hippo population has shown a consistent increase. However, in 2016 the count decreased from 268 counted in 42 groups in 2015 to 219 counted in 29 groups in 2016 spread between the different water bodies (Figure 5). This decrease can presumably be ascribed to the low water levels due to the continued drought, and the supposition that many hippo have moved out of the park to alternative water bodies. This can be borne out in the fact that the hippo count in Ndumo Game Reserve, which is linked to Maputo Special Reserve via the Usuthu/Rio Maputo river, has seen a dramatic increase in hippo numbers in their 2016 count.

The total count of red duiker has decreased from 96 in 2015 to 53 in 2016 (Figure 6), while the grey duiker has decreased slightly from the total count of 24 in 2015 to 22 in 2016. Again, red duiker is a forest species making visibility under the leaf flush difficult.

The total count for bushpig has shown a marked decrease over time, and has again dropped from 24 in 2015 to 6 in 2016. Bushbuck have remained mostly unchanged over the past number of years, but did decrease from 23 in 2015 to 19 in 2016.

Sightings for species such as steenbok and suni remain low, with only 2 sightings of steenbok being made and none of suni. A group of 3 female buffalo are regularly being sighted by the reserve staff, but were unfortunately not seen during the aerial census.

The 2015 total count for impala showed a dramatic increase from all previous counts, with 162 being counted in 2016.

From these counts it is evident that the re-introduced populations are steadily increasing and flourishing (Table 5). It is well-known that re-introduced species often take some time to show marked increases in number and to start showing natural dispersal patterns within the landscape (Table 8).

Table 5. Summary of game re-introduced to MSR to date – although planned, there were no introductions for 2016.

Species	2010		2011		2012		2013		2015		2016		TOTAL	
	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual
Giraffe	20	0	20	0	20	8	12	12	40	0	0	0	60	20
Impala	40	22	40	0	40	74	80	75	125	0	500	0	120	171
Kudu	40	0	80	0	80	84	30	26	90	0	200	0	200	110
Nyala	80	20	80	0	80	74	80	72	74	0	700	0	240	166
Warthog	40	9	40	0	40	33	50	48	30	0	0	0	120	90
Waterbuck	40	0	40	0	40	0	0	0	120	0	200	0	120	0
Wildebeest, Blue	60	0	100	0	100	0	100	73	187	127	200	0	260	200
Zebra	200	3	100	24	200	159	100	88	226	97	600	0	500	371
Total	520	54	500	24	600	432	452	394	892	224	2400	0	1620	904

The total number of elephants counted in the 2016 survey was 286, which is one of the highest counts since the 2006 count. This can largely be ascribed to the fact that with the drought the herds are probably fragmenting into smaller groups than previously seen, making the counting of individual groups more accurate. Only one herd was counted outside the reserve, to the west of the Futi corridor (Figure 7). In order to obtain better estimates of the population, it is suggested that collars be deployed based on geographical location, as this will provide valuable information regarding movement and landscape use, as well as population estimates within an unknown population. It is evident from the sightings per survey session, as detailed below, that the majority of elephant sightings were made from mid-morning into the afternoons, during the hotter times of the day (Table 6).

Table 6. Elephant sightings per survey session.

Session	No of Groups	Number Counted
Day 1 – 1 (08:10 - 10:29)	0	0
Day 1 – 2 (11:20 – 13:28)	4	12
Day 1 – 3 (14:55 – 16:47)	8	76
Day 2 – 1 (07:25 – 10:11)	3	10
Day 2 – 2 (11:00 – 13:11)	8	87
Day 2 – 3 (14:34 – 15:22)	5	32
Day 3 – 1 (09:20 – 10:41)	5	66
Day 3 – 1 (11:15 – 12:48)	1	2

#### 4. HUMAN ACTIVITY

Many homesteads still remain occupied within Maputo Special Reserve, and signs of human impact are evident in the form of agricultural plots, gillnets in the pans and the continued maintenance of fish and crab kraals in the tidal areas of Maputo Bay.

A total of 6 gill nets were recorded in the 2016 count compared to 1 in the 2015 count. However, the nets were visibly new and had thus obviously recently been purchased.

The numbers of cattle in Maputo Special Reserve have increased significantly from 513 counted in 2015 to 611 in 2016, while goat numbers have decreased from 397 in 2015 to 278 in 2016 (Table 7). However, if additional game are to be introduced and so as to avoid increased human wildlife conflict, the number of cattle and goats need to be substantially reduced and the homestead relocation programme accelerated. Three domestic dogs in two groups were also recorded during the count, and they were not accompanied by their owners.

Table 7. Current human activity impacts recorded during the survey.

Species / Activity	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cattle	50	119	277	149			585	513	611
Domestic dogs									3
Goats		387	623	466			259	397	278
Gill nets				1			6	1	6

The high cattle numbers and continued human agricultural activity in the protected area also results in the uncontrolled burning of vast tracts of grasslands for grazing for domestic stock.

This uncontrolled burning also damages the sand forest patches found within this mosaic, the impact of which may be irreversible in the long term. The areas burnt in 2016 were again extensive, and with the continued drought in southern Africa, this may have serious consequences in the medium to long term. Fortunately the current stocking levels are still below carrying capacity.

## 5. CONCLUSIONS

Overall, the aerial census conditions were acceptable during the 2016 count but not optimum. The total area counts produced generally satisfactory population estimates, with most species' counts being similar or having increased from previous counts.

Current elephant estimates are higher than most previous estimates, but these results need to be treated cautiously. It is perhaps time that more specific elephant counts and monitoring be applied to the elephant population. Given man power limitations, gps logger collars are suggested as useful tools with which to locate the herds and some free roaming bulls. These data is able to easily be downloaded by the reserve staff and will also give valuable insight into which areas are used by the elephants, as well as how their movement patterns may change once the area is completely fenced. In this way areas of possible future conflict or fence-breaking may be predicted or detected early so as to avoid damage to infrastructure and possible human wildlife conflict.

As expected, the species found to be the most abundant are hippo, reedbuck, elephant, grey duiker, red duiker, blue wildebeest and zebra, while giraffe populations are increasing steadily. The continued presence of waterbuck was confirmed with the count of 3 individuals, while field staff continue to record the presence of 3 female buffalo which unfortunately were not recorded during the count.

From the distribution patterns of the game populations, it is suggested that any future re-introductions be focused further north within the protected area. Most re-introduced populations remain concentrated in the south of the reserve, although they are now beginning to disperse further north and eastwards from their initial release locations.

Of significance is the sharp increase in cattle numbers present in the reserve and continued high goat numbers, which is possibly being exacerbated by the continued drought in the area. These numbers are unsustainable in the long term given the objectives for the reserve and must be reduced with the aim of eventually removing them altogether. It is time for the human population resettlement programme to be accelerated. However, this is a difficult programme and must be dealt with in a sensitive manner.

## 6. RECOMMENDATIONS

From the results obtained, it was felt that the 2016 aerial census effort was a success, although some recommendations can be made and should be incorporated into the following census programme:

- 1) When possible the game population census for Maputo Special Reserve, the Futi corridor and Sanctuary area should continue to be undertaken using the methods described here and reported upon.
- 2) The next census should be conducted between the beginning of August and end of September, prior to the rainy season and thus prior to the vegetation flushing. The



same equipment and software should be used. The use of a larger helicopter, such as a Long-Ranger or Squirrel must be investigated so that more observers can be accommodated in the helicopter and thus training of staff can be facilitated. The additional cost of a larger helicopter must be taken into account.

- 3) Ensure that the census is completed at a flight speed of 30kts, and that flying is not done during the hotter midday periods and are completed prior to nightfall.
- 4) In the case of the centre of the reserve, as far as possible these areas should be covered towards the middle to afternoon of the day. This will increase the probability of locating the elephant in the reed bed areas or near the water bodies.
- 5) Graphical analyses of the trends of the more important species should continue to be undertaken.
- 6) Additional counts to be undertaken to supplement counts for smaller species, such as suni, or these may be conducted in the form of research projects to compile base line surveys.

## 7. REFERENCES

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Figure 1. The census flight path based on the defined transects, covering the MSR, Futi Corridor and Sanctuary areas.



Figure 2. The distribution of reedbeek in Maputo Special Reserve, 2016.

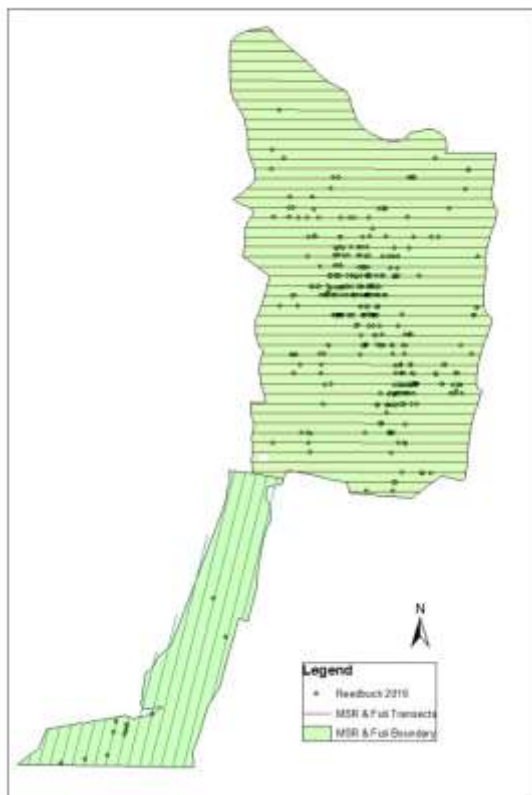


Figure 3. The distribution of blue wildebeest in Maputo Special Reserve, 2016.



Figure 4. The distribution of Zebra in Maputo Reserve, 2016.



Figure 5. The distribution of Hippo in Maputo Special Reserve, 2016.



Figure 6. The distribution of Red Duker in Maputo Special Reserve, 2016.

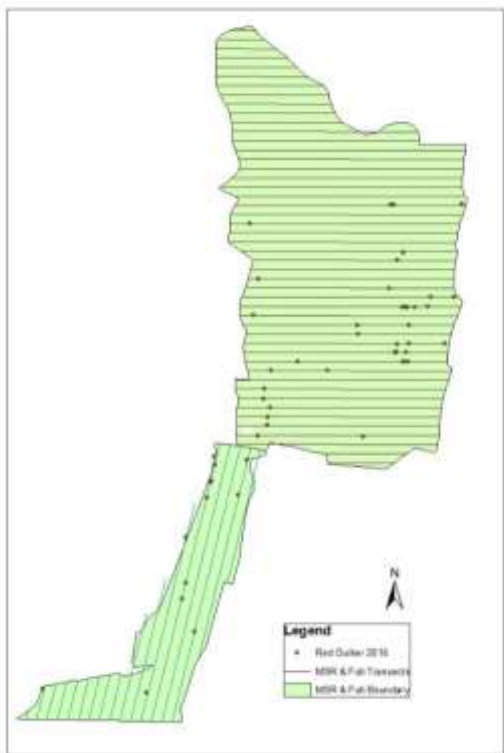


Figure 7. The distribution of Elephant in Maputo Reserve, 2016.



Table 4. Total count estimates for large herbivores in MSR, up to and including 2016.

Species	1972 Tello	1995 Hatton	2005 Aerial Census Helicopter	2006 Aerial Census Helicopter	2008 Aerial Census Helicopter	2011 Aerial Census Helicopter	2012 Aerial Census Helicopter	2013 Aerial Census Bathawk	2014 Aerial Census Helicopter	2015 Aerial Census Helicopter		2016 Aerial Census Helicopter	
										No. Groups	No. Counted	No. Groups	No. Counted
Buffalo													
Bushbuck			18	30	33	8	27	30	23	21	23	17	19
Bushpig			8	102	78	9	33	39	27	7	24	3	6
Crocodile		1		24	42	23	41	19		13	29	20	26
Duiker, Grey		12	12	40	37	21	22	12	42	21	29	21	22
Duiker, Red		14	37	113	122	28	50	33	50	86	96	51	53
Elephant	350	150	9	329	368	228	264	288	239 (In-147, Out- 92)	25	172	34	286 (Plus 14 outside)
Giraffe							1	9	35	2	21	3	28
Hippo	272	5	4	179	140	196	168	185	181	42	268	29	219
Impala							52	33	51	3	40	5	162
Jackal, Side-striped				4	3				2			1	1
Kudu				6	2	3	15	3	26	6	31	10	33
Nyala		1	2	47	8	18	80	87	8	41	89	25	41
Reedbuck, Common		22		797	824	309	598	355	499	378	819	386	873
Rhino, White	40												
Serval											1		
Steenbok		1		3	13	3	8	10	5			2	2
Suni		5	10	7	3								
Warthog								2	19	8	16	8	17
Waterbuck				4	3				7	3	10	1	2
Wildebeest, Blue								62	126	16	276	25	351
Zebra						24	177	115	270	37	303	37	446

Table 8. Total game introductions to date with anticipated growth rates.

SPECIES	2010				2011				2012				2013				2014				2015				2016			TOTAL			2016 Census					
	Actual Intro	Growth	Intro Growth	Pop Est	Actual Intro	Growth	Intro Growth	Pop Est	Actual Intro	Growth	Intro Growth	Pop Est	Actual Intro	Growth	Intro Growth	Pop Est	Actual Intro	Growth	Intro Growth	Pop Est	Actual Intro	Growth	Intro Growth	Pop Est	Actual Intro	Growth	Pop Est	Actual Intro	Growth	Pop Est		Total Actual Intro	Growth	Total Est Pop - intro based		
Giraffe	0	12.8	0	0	0	12.8	0	0	8	12.8	9	9	12	12.8	14	23	0	12.8	0	32	0	12.8	0	32	0	12.8	0	32	0	12.8	0	32	20	12.8	23	28
Impala	22	25.6	28	28	0	25.6	0	28	74	25.6	93	121	75	25.6	94	215	0	25.6	0	215	0	25.6	0	215	0	25.6	0	215	0	25.6	0	215	171	25.6	215	162
Kudu	0	22.6	0	0	0	22.6	0	0	84	22.6	103	103	26	22.6	32	135	0	22.6	0	135	0	22.6	0	135	0	22.6	0	135	110	22.6	135	33				
Nyala	20	37.9	28	28	0	37.9	0	28	74	37.9	102	130	72	37.9	99	229	0	37.9	0	229	0	37.9	0	229	0	37.9	0	229	0	37.9	0	229	166	37.9	229	41
Waterbuck	0	17.6	0	0	0	17.6	0	0	0	17.6	0	0	0	17.6	0	0	0	17.6	0	0	0	17.6	0	0	0	17.6	0	0	0	17.6	0	0	0	17.6	0	2
Warthog	9	17.3	11	11	0	17.3	0	11	33	17.3	39	50	48	17.3	56	106	0	17.3	0	106	0	17.3	0	106	0	17.3	0	106	0	17.3	0	106	90	17.3	106	17
Blue Wildebeest	0	13.9	0	0	0	13.9	0	0	0	13.9	0	0	73	13.9	83	83	0	13.9	0	83	127	13.9	145	228	0	13.9	0	228	0	13.9	0	228	200	13.9	228	351
Zebra	3	8.5	3	3	24	8.5	26	29	159	8.5	173	202	88	8.5	95	297	0	8.5	0	297	97	8.5	105	403	0	8.5	0	403	0	8.5	0	403	371	8.5	403	446