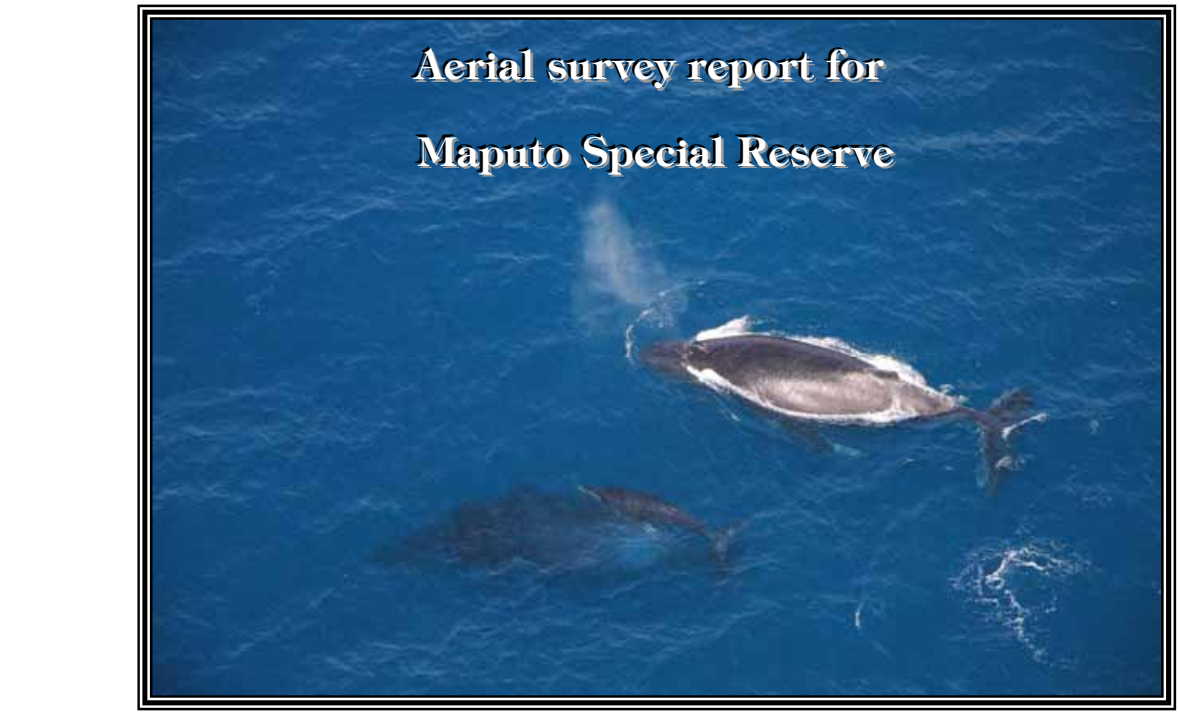
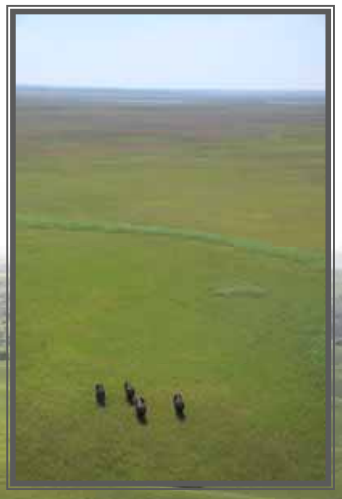
Aerial survey report for

Maputo Special Reserve





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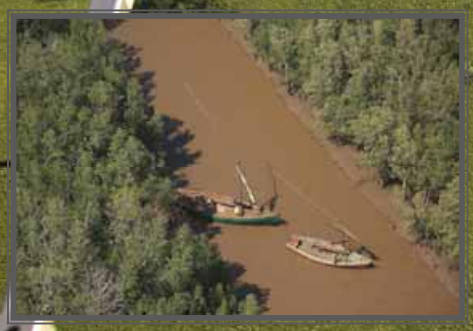

AERIAL SURVEY REPORT FOR MAPUTO SPECIAL RESERVE

NOVEMBER 2008

W. S. Matthews (Ezemvelo KwaZulu-Natal Wildlife, Tembe Elephant Park)

I. INTRODUCTION

This is the second comprehensive aerial census undertaken of large herbivores occurring in Maputo Special Reserve. The aerial census was undertaken during the end of October beginning of November 2008, although late in the season very little rain had fallen. The overall aim of the census was to derive current status of the most important large herbivore populations in Maputo Special Reserve, which could be useful in management decisions and would stand as a record of abundance for future trend analyses. In addition, the survey undertaken aims to record the spatial distribution of the most important herbivores with emphasis on the elephant population so as to gain a better understanding of their habitat relations, but also to gain an understanding of the relative abundance of these herbivores in the Maputo Special Reserve and part of the adjacent Futi Corridor.

This census builds on the recommendations of Matthews 2000. The methods used; were the same as those used in 2000, which were a refined and improved version of those used in 1994. Two methods were used to estimate numbers in each of the large herbivore populations. These were (i) total area aerial counts and (ii) transect distance sampling counts. Midday water hole counts for elephant were not undertaken this year.

The transect aerial census was undertaken by Glenton Combes (pilot), Wayne Matthews (co-ordinator and recorder) with Nick De Goede and Tristan Parsons (observers). Custodia Banze, Derek Potter, Oscar Osberg and Rickert van der Westhuizen helped with all field logistics.

The aerial census was made possible due to the generosity and support of Paul Tudor Jones of Tudor Investment Corporation in the USA. Thanks also go to Trish Parsons of Parsons Aviation for the co-ordination of the donation of the helicopter.

II. METHODS

Aerial Counts

a) Total Aerial Count

1. A helicopter containing four people (pilot and recorder (front) and two observers (back) was flown on pre-determined, parallel east west orientated transects situated 1 km apart and arranged systematically to cover the whole census area. (See appendix 2; Matthews & Momade 2006, for Transect specifics).
2. The helicopter was flown at 90 m (300 ft) above the ground and at an air speed of approximately 30 – 40 kts. Transects were flown morning and afternoon, for periods of up to a maximum of 3 hrs at a time, this resulted in three survey sessions as depicted in Figure 1. The hottest part of the day was avoided as far as possible, as animals tended to rest under shade in the heat of the day and as a consequence 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 large herbivore species were recorded in the 1 km wide belt.
4. Where large groups of elephant, hippo etc. was spotted, the helicopter deviated from the traverse line, a total count of the group 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 v 1.1 (Clark Labs, Clark University, 1999) which, when connected to the onboard GPS allowed the simultaneous collection of flight path information, animal numbers (as way points) and the number of the transect being traversed.

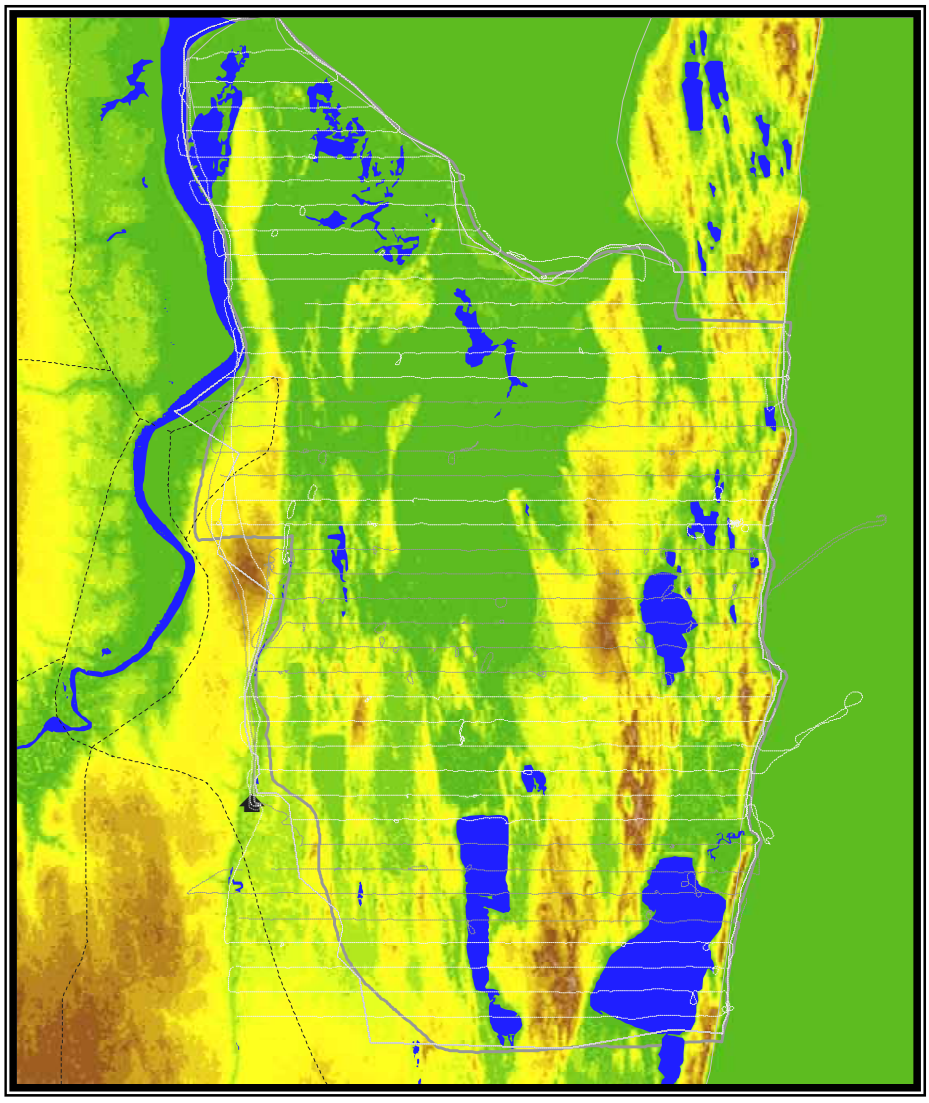

Figure 1. Census flight path based on the defined transects for the game census. Each flight session is depicted in alternating colours, starting in the north.

6. Plotting of distributions by species was done by importing the Cartalinx data into Arcview, these in cases where the number of sightings and their distribution allowed visualisation.

b) Distance Sampling

1. Data were collected for the distance sampling analysis at the same time as for the total count.
2. Devices were fitted to both sides of the helicopter which, when flying at a height of 90m, demarcated distance classes on each side of the traverse (transect) line with the following intervals: 0 – 90 m, 91 – 200 m, 201 – 350 m and 351 – 500 m. 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 5 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 5 release 2 (Thomas *et al.* 2001).

4. A statistically robust estimate can only be derived for species within the region of 60 sightings. Although species having as low as 30 observations were analysed with Distance, these estimates should not be considered reliable (in most instances, the confidence intervals indicate this), but rather as best estimates of population size in species that have been under sampled.

III. RESULTS

Aerial Counts

The complete aerial survey of the entire reserve (79 594 ha) and the southern portion of the Futi (3 120 ha) linking with the Park, took three days (17 hours) to complete, as per sessions set out in Table 1. This was done in four – (one – three sessions per day), so as to allow for refuelling, rain and resting out the hot midday periods. One day had rain in morning only allowing an afternoon session, thus resulting in three session on final day.

Table 1. Aerial survey flight sessions.

Session *(start time)*	**Time (hrs)**
day 1 – 1 *(6.30 –10:44am)*	4
day 1 – 2 *(11 – 1.42pm)*	2.5
day 1 – 3 *(3.30 – 5.14pm)*	2
day 2 – 1 *(3.30 – 5.28pm) * rain*	2
day 3 – 1 *(6.30 – 9.26am)*	3
day 3 – 2 *(10.15 –12.22pm)*	2
day 3 – 3 *(3.30 – 4.52pm)*	1.5

Conditions during the census were good. The weather was dominated by partly cloudy, generally calm (one afternoon had very strong winds over coast), warm to hot conditions, with rain on one day. The woody plant leaf flush was only partially developed, as no meaningful rains had yet fallen in the Maputo Special Reserve area, and game visibility conditions were fair to good.

a) Total Aerial Count and Distance Analysis

The total number of groups and animals counted for each species during the census is shown in Table 6. The final estimate of each species is given in Table 3. The distribution of sightings for the larger abundant and more significant species is presented in Appendix 1. With respect to distance sampling, bushpig, bushbuck, reedbuck, red duiker and grey duiker had reasonable or close to 60 or more sightings, and could therefore be analysed reasonable reliably with distance (Table 2). The number of groups and the total number of animals physically counted in Maputo Special Reserve for 2008 and past info is summarised in Table 4.

b) Midday Waterhole Counts of Elephants

No midday water hole counts were undertaken this year, as emphasis was placed on completing all transects.

Best Estimate of Numbers

Acceptable estimates (Table 3) for 6 species namely; elephant, reedbuck, hippo and to some degree red duiker, grey duiker and bushpig. For most, species counts were similar or slightly down on the 2006 count, and confirmation was made of particular species still being present in the reserve, such as waterbuck and kudu.

Table 2. Large herbivore population estimates from distance sampling, 2008. *(* unreliable)*

Species	Aerial Distance sampling estimates for 2008	
	Est.	95% C
Bushbuck	79	*47–133 / 26.6 %*
Bushpig	204	*127–341 / 25.2 %*
Elephant	n/a	
Grey Duiker	112	*74–169 / 20.7 %*
Hippo	n/a	
Kudu	*	
Nyala	*	
Red Duiker	375	*263–532 / 17.6 %*
Reedbuck	1156	*822–1365 / 12.6 %*
Side st jackal	*	
Steenbok	*	
Suni	*	
Waterbuck	*	

For Distance sampling; for most species, the numbers of sightings for a single repetition were way below or marginal for a confident result, but some were analysed so as to have some indication of possible population sizes. Sample based estimates were made for five species namely, reedbuck, red duiker, grey duiker, bushbuck and bushpig. The final estimate used was based on the number of observations, best confidence levels, taking into consideration observer fatigue for the different repetitions sessions and transect data sets confidence levels.

Table 3. Final estimates for 2008.
Estimation Method: 1 – Known Group, 2 – Total Area Count, 3 – Distance Sample, 4 – Informed Guess 5–Field ranger encounter rates. *(* unreliable) (# D. Potter pers. Comm.)*

	Total Count	Distance Sample	*Final Estimate*
Bushbuck	33	*47–133 / 26.6 %*	79 [2,3*]
Buffalo#	-		7 [1]
Bushpig	78	*127–341 / 25.2 %*	204 [2,3]
Elephant	348		330-350 [2,4]
Grey Duiker	37	*74–169 / 20.7 %*	112 [2,3*]
Hippo	140		140 [2]
Kudu	2		10 [4*]
Nyala	8		100 [4*]
Red Duiker	122	*263–532 / 17.6 %*	375 [2,3]
Reedbuck	824	*822–1365 / 12.6 %*	1156 [2,3]
Side st jackal	3		-*
Steenbok	13		-*
Suni	3		-*
Waterbuck	3		-*

The population size of reedbuck was estimated at 1156 from a sample of 459 sightings, this is the most abundant species in the reserve. The population was distributed throughout most of the reserve with most sightings in the more open central areas (Figure 5). As reedbuck are found in the more open areas, the statistical analysis result could be biased and the total count could be quite reliable. This result is very similar to the 2006 result.

The population of hippo was estimated at 140 made up of 29 groups, which were spread between the different water bodies (Figure 8). Lake Piti having the highest number followed by Lake Xingute. The hippo's population estimate is down compared to the 1972 figure of 272 and now down compared to 2006 result of 179 (in 32 groups).

The red duiker population is estimated at 375, this was determined from 115 observations, this is the second most abundant species in the Reserve. The distribution of red duiker is spread throughout the southern western portion of the park with concentrations in the south western section, including areas outside the reserve, going into the Futi (Figure 4). There is a noted scarcity in the northern sections of the park. Note; with small antelope (eg. suni, red & grey duiker), this type of result can be expected – the true population size could be much larger.

The grey duiker population is estimated as 112, this was determined from 36 observations, although this estimate is felt is unreliable. The distribution of grey duiker seems to be spread throughout most of the park with concentrations in the central grassland and more open woodland areas (Figure 3).

The bushpig population is estimated at 204, this was determined from 33 observations, the fourth most abundant species in the reserve. The distribution of bushpig shows no clear pattern and seems to be spread more consistently in the central areas of the Reserve (Figure 7).

The population estimated of nyala could not be estimated reliable as only 6 sightings were made totalling 8 animals, this was less than the 2006 result. The number could be much higher considering the thick canopy cover of the habitat within which the nyala were sighted and experience from Tembe Elephant Park's counts. The distribution of nyala seems to be concentrated in the south western corner, the area linking to the Futi corridor (Figure 2).

The population estimated of bushbuck was 79, but this estimated should not be considered reliable, 28 sightings were made, totalling 33 animals. The number could be higher considering the thick vegetation habitat within which the bushbuck was found. The distribution of bushbuck seems to be concentrated in the southern central areas of reserve as well as the area linking to the Futi corridor, including a fair amount of sightings been made outside the Reserve in the linking Futi area (Figure 9).

The population estimates for kudu, steenbok, suni and waterbuck is considered not reliable. What can be said for these species (except for suni), is that they are present, but in quite low numbers. Suni is different in that it could be occurring in relatively high numbers but the ability for the aerial survey technique to detect them in thick canopy cover is very difficult. This happens to be the preferred habitat for suni eg. Sand Forest. Suni sighting this year were down compared to 2006, with no sighting be made in the sand forest this year. The distribution of the species of low encounter rate is shown in Figure 2, and these species seems to be distributed more in the south western areas.

Elephant Numbers

Table 4. Elephant sightings per survey sessions.

Session *(start time)*	**sightings**	**number**
day 1 – 1 *(6.30 –10:44am)*	-	0
day 1 – 2 *(11 – 1.42pm)*	1	4
day 1 – 3 *(3.30 – 5.14pm)*	8	142
day 2 – 1 *(3.30 – 5.28pm)* * *rain*	12	130
day 3 – 1 *(6.30 – 9.26am)*	4	63
day 3 – 2 *(10.15 –12.22pm)*	5	29
day 3 – 3 *(3.30 – 4.52pm)*	-	0

The total number of elephant counted during all transect counts was 368, (see Table 6), although this number includes repeat groups. After excluding any possible repeats the total number was estimated at **348** elephant. This was one of the highest numbers of elephant encountered during a survey of the reserve. The number of elephant counted in each session is shown in table 4. It is interesting to note that the sessions' transects which covered the central areas, which happened to be afternoons of the day

(3.30 – 5.55pm), alone yielded 272 elephant (this did include repeat groups). Most of the animals were seen were found in the reed beds or near Muzi system centred in the Reserve (see Figures 14 & 15). The bulls were fairly widely distributed over Maputo Special Reserve while the family groups on a whole were found closer to water, (Figures 14 & 15). This is very similar to what has been the case with the Tembe Elephant Park aerial transects surveys (Matthews 2005a).

It is the opinion of the author that a high proportion of all the family units were encountered during the census (Table 5), and that the total number of animals in family units is approximately 319. The number of free roaming bulls seen was 29 but it is quite possible that animals were missed or were included in the counts of the family group; this is supported by Morley & Van Aarde (2002) who says, the aerial surveys as done in Tembe Elephant Park constantly underestimate the true size of the population. Based on this, it could mean that the population size for elephant in Maputo Elephant Reserve could be between **330 – 350** animals, based on minimum count and a percentage error.

Current estimates compared to past estimates (Table 5) seem to show a stable to increasing population. This is substantiated by the number of infants encountered during this years survey (Table 5). Currently from Morley *et al.* 2002 based on their demographic estimates, the population in the Maputo Elephant Reserve was found to be increasing at 2.28% per annum. This is below the average growth rate figures (7-10%) as calculated over a sweep of reserves for elephant by Slotow *et al.* 2005.

Four new elephant carcasses were found (See Figure 10), no tusks were to be seen with these carcasses.

Elephant Population Structure[1]

The number of different family units (groups) observed was 15. It is quite possible that this is in the right region for the number of family units in Maputo Elephant Reserve, Tello 1972 estimated the number of family units at 14. The number of animals recorded in family groups during the 2008 survey, was 319 compared to only 29 free roaming bulls. It is quite possible that a few adult free roaming bulls were included in the count of the family groups, but these would be very few as effort was made to distinguish and exclude them. If we assume that 2/3 of the number of animals in family units are sexually mature females, this would give 212 adult females. This gives an approx sex ratio of 1 male to 7 females (1:5 if half are adult females). This is quite different to the ratios found in Tembe Elephant Park of 1 male to 1.2 females. Morley *et al.* 2002 also found this bias towards free roaming adult bulls in Tembe Elephant Park, although not to this extent.

[1] Survey use of the following terms: young referred to animals born in the last year and up to two years; Sub adults & unclassified, any animal older than three years but not of adult size. Free Roaming Bulls, those males that are not attached to a family group.

Table 5. Summary of population estimates of elephant for Maputo Special Reserve based on information extracted from published and unpublished papers and reports. (Source of info [1]- Van Aarde *et al.* 2004; [2]- Morley & Fairall 2002; [3]- Ntumi & Van Aarde 1999; [4]- De Boer *et al.* 2000; [5]- Ostrosky & Matthews 1995; [6]- Klingelhoeffer 1987; [7]- Tello 1973; 2006 data based on systematic flight grids as described by Matthews, 1994 & 2000). [% - refers to percentage of the total population composition].

Count	Total	Free roaming Bulls	Family group Total	Young (<1-2 yrs)	Family group adults & Unclassified	Family groups
2008 (transects – Helic.)	348	29	319	44	275	15
%		8%	90%	13%	79%	
Past counts						
Count	Total	Free roaming Bulls	Family group Total	Young (<1-4 yrs)	Family group adults & Unclassified	Family groups
2006 (transects – Helic.)	329	33	296	42	254	18
2004 (transects-MicroL)[1]	81	4	77	18	59	-
2002 (transects-MicroL)[2]	141	31	110	25	85	6
1999 (transects-Helic.)[3]	205	19	186	11	175	-
1998 (count-Helicopter)[4]	180	-	-	-	-	-
1995 ((count-Helicopter)[5]	150	-	-	-	-	-
1979 (Educated guess)[6]	80	-	-	-	-	-
1972 (Educated guess)[6]	269	-	-	-	-	-
1970 (ground survey)[7]	350	27	323	5	318	14

Table 6. Summary of large herbivore counts (minimum number) for Maputo Special Reserve, 1972, 1995, 2006 & 2008. 2008 count based on systematic flight grids as described. (*large crocodiles; estimated at greater than 3m in length).
[√ – recorded as present although not quantified]

Species	Tello report - 1972	Hutton report - 1995	Aerial Census – 2006		Aerial Census – 2008	
			No. Groups	No. Counted	No. Groups	No. Counted
Buffalo	-	-	-	-	*0*	0
Bushbuck	•	•	*25*	**30**	*28*	**33**
Bushpig	•	•	*38*	**102**	*33*	**78**
C Reedbuck	•	22	*463*	**797**	*459*	**824**
Cheetah	•	0	*0*	**0**	-	**-**
Elephant	350	•	*32*	**329**	*30*	**368**
Grey Duiker	•	12	*38*	**40**	*36*	**37**
Hippo	272	5	*32*	**179**	*29*	**140**
Kudu	-	-	*1*	**6**	*1*	**2**
Leopard	•	•	-	**-**	-	**-**
Nyala	•	1	*15*	**47**	*6*	**8**
Red Duiker	•	14	*105*	**113**	*115*	**122**
Serval	•	-	-	**-**	-	**-**
Side st jackal	•	-	*2*	**4**	*3*	**3**
Steenbuck	•	1	*3*	**3**	*10*	**13**
Suni	•	5	*7*	**7**	*3*	**3**
Warthog	-	-	-	**-**	-	**-**
Waterbuck	-	-	*1*	**4**	*1*	**3**
White rhino	40	-	*0*	**0**	-	**-**
Crocodile*	•	1	*11*	**24**	*23*	**42**

IV. Human Activity

The surveyed area of Maputo Special Reserve still contains many people with various signs of human activity. Most of the human activity was in the north east section of the reserve (Appendix 1, Figure 13). The majority of human activity encountered in the survey area was in the form of homesteads and cultivation (Table 7). A total of **388** active homesteads were counted. Based on the work of Els *et al*. 2002 which gives an average of 5 people per homestead an estimate of the number of people living inside the reserve could be as high as 1 940 people. This is higher than the 2006 result. It must be assumed that most of these people will be subsistence farmers and consequently making use (harvesting) of the reserves' natural resources (Els *et al*. 2002).

Quite a few livestock were counted which included many goats; which in both cases was substantially more than was the case in 2006, in both cases have double or nearly doubled. This continues to be a concern if game management is given priority, as the species mix within Maputo Special Reserve will have veterinary implications, especially as part of the bigger Transfrontier area which links to South Africa.

Table 7. Current human activity recorded during survey. * cultivation recorded separately to homestead;- thus would include 2006 homestead with cultivation) (*nc – not counted*)

Human activity	2006		2008	
	Count	No. units	Count	No. units
Homestead	*33*	122	*106*	388
Homestead with cultivation	*23*	160	*nc*	*nc*
Total Homesteads	***56***	**282**	***106***	**388**
Cultivation	*26*	30	*64**	191*
Goats	*16*	387	*32*	623
Cattle	*4*	119	*14*	277
Forest clearing (tree felling)	*1*	1	*nc*	*nc*
Reed harvesting	*3*	3	*nc*	*nc*

Other human activities encountered in the survey area include fishing and the construction of large fish Kraals in the tidal areas of Maputo Bay.

V. Conclusions

Census conditions were on the whole very good. The two methods employed namely total area counts and distance based sample estimates, produced generally satisfactory population estimates. For most, species counts were similar to what was counted in 2006.

Current elephant estimates compared to past estimate seem to show a stable to increasing populations, although this needs to be treated with caution.

The species found to be the most abundant in Maputo Special Reserve are reedbuck, elephant, hippo, red duiker and bushpig.

The comparison of the elephant population structure between Maputo Special Reserve and Tembe Elephant Park is quite different with Family units dominating in Maputo Special Reserve while free roaming bulls dominate in Tembe Elephant Park.

Domestic live stock and goat numbers have substantially increased from the results of the 2008 survey. The veterinary implications of this needs to be investigated, if the reserve is to be managed with game, especially in light of the Transfrontier initiatives with South Africa.

The slower speed that we flew in the helicopter had a positive impact on the sightings, although there is a time cost involved.

VI. Recommendations

It was felt that the 2008 census effort was a success following on the approach used in Tembe Elephant Park (Matthews 2000), although some recommendations can be made and should be incorporated into the following census programme.

1. When possible the large herbivore population census for Maputo Special Reserve should continue to be undertaken using the methods described here and reported upon.
2. The next census should be conducted between the end of September and up to the middle of November, vegetation flush pending, with the same equipment and software used in the past census, using the same sample transect lines. However, in order to improve the precision of the sample estimates, at least 60 sightings of each target species should tried to be obtained.
3. Try to complete census at a flight speed of around 30kts, making sure though that flying is not done during hot midday periods and that all transects can be completed before nightfall.
4. In case of the centre section of the reserve, as far as possible these areas are covered towards the middle to afternoon of the day – so as to increase the probability of finding the elephant in the reed bed areas or near water sources.
5. Graphical analyses of the trends of the more important species should continue to be undertaken.
6. Other counts to be undertaken to supplement counts for smaller herbivores, such as suni.

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Appendix 1. Distributions of sightings of the most prominent large herbivores seen during the November 2008 census. (The symbol size is an indication of group size).

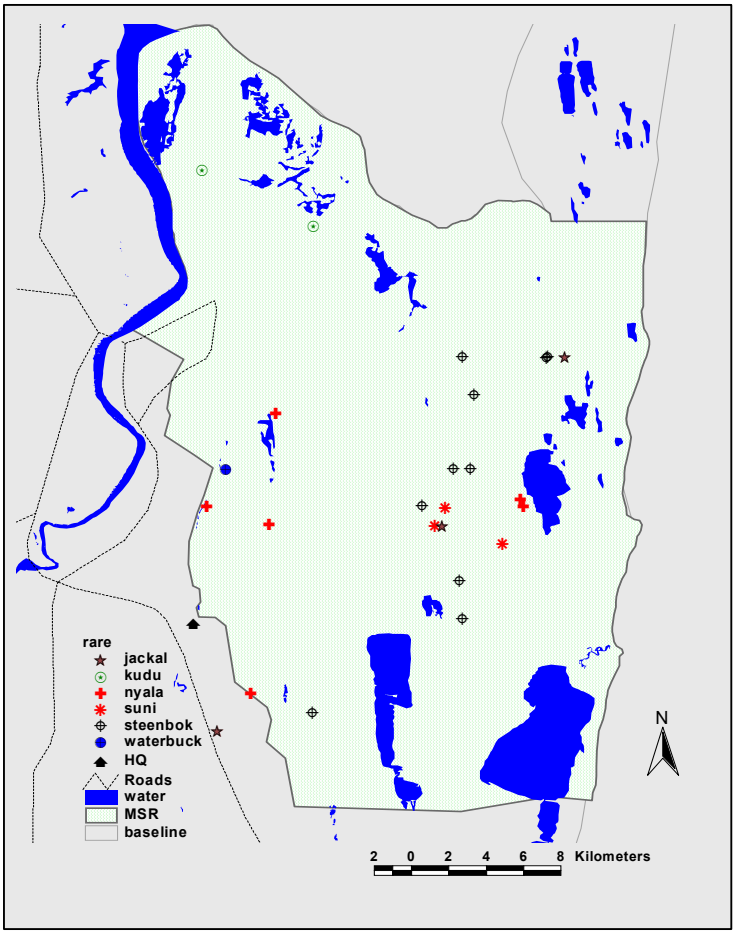

Figure 2. Distribution of the few sightings of suni, side-striped jackal, steenbok, kudu, waterbuck and nyala.

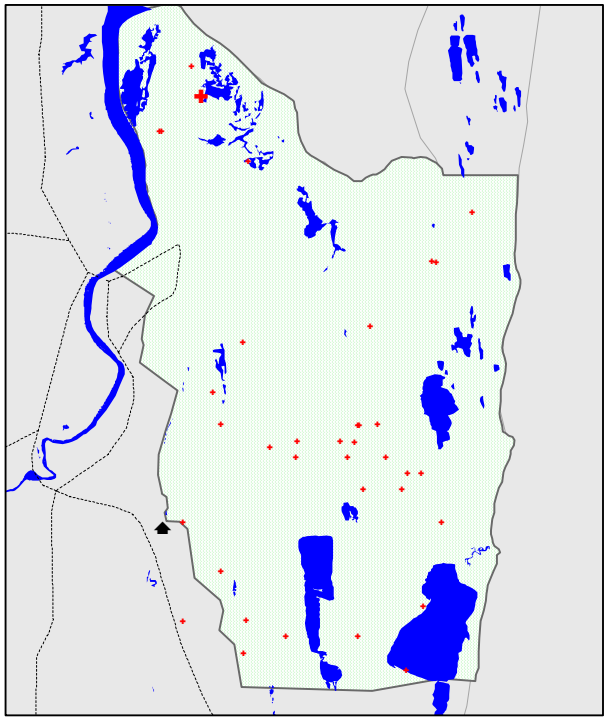

Figure 3. Distribution and group sizes of grey duiker

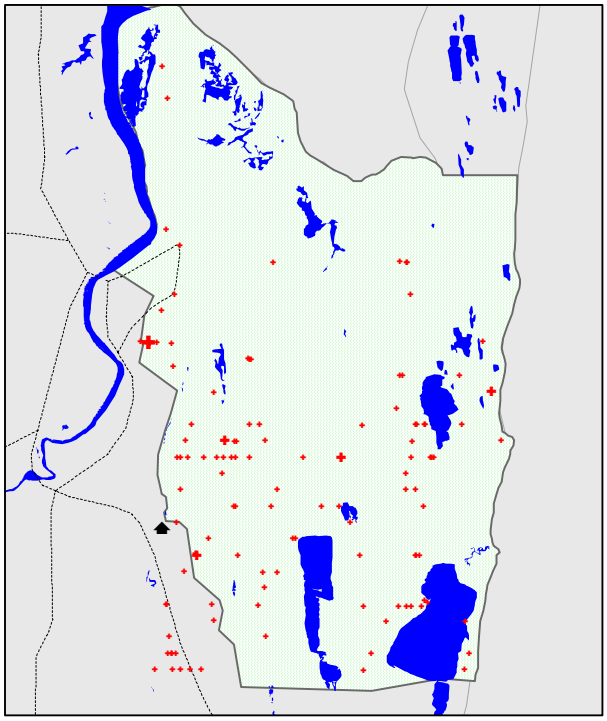

Figure. 4. Distribution and group sizes of red duiker

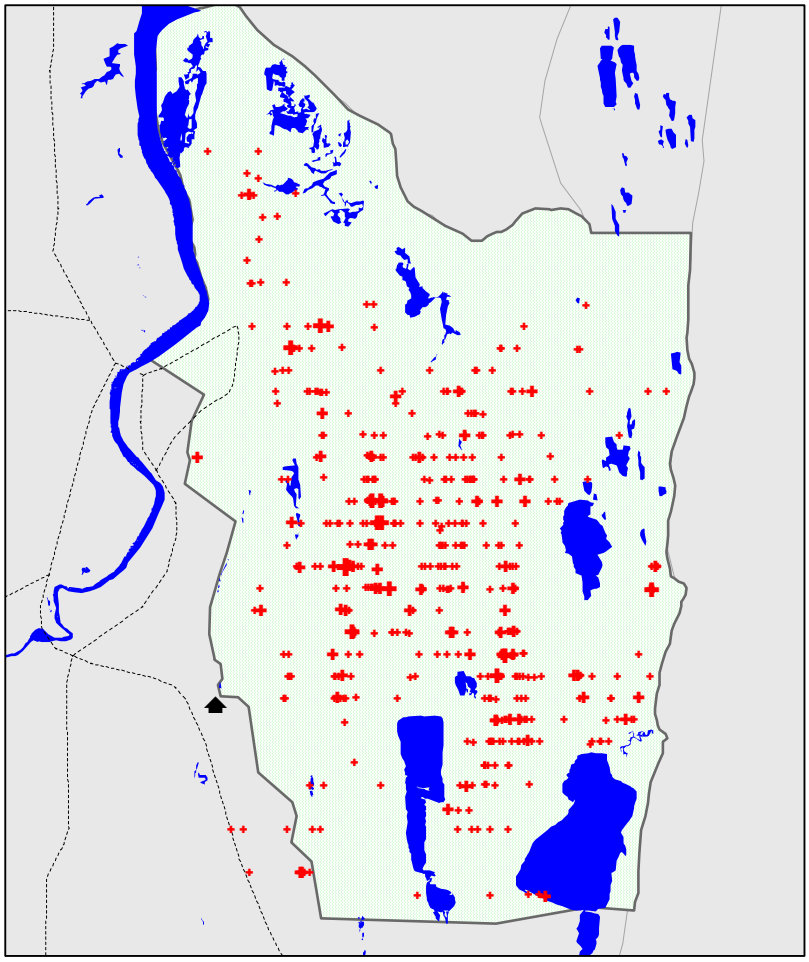

Figure 5. Distribution and group sizes of reedbuck

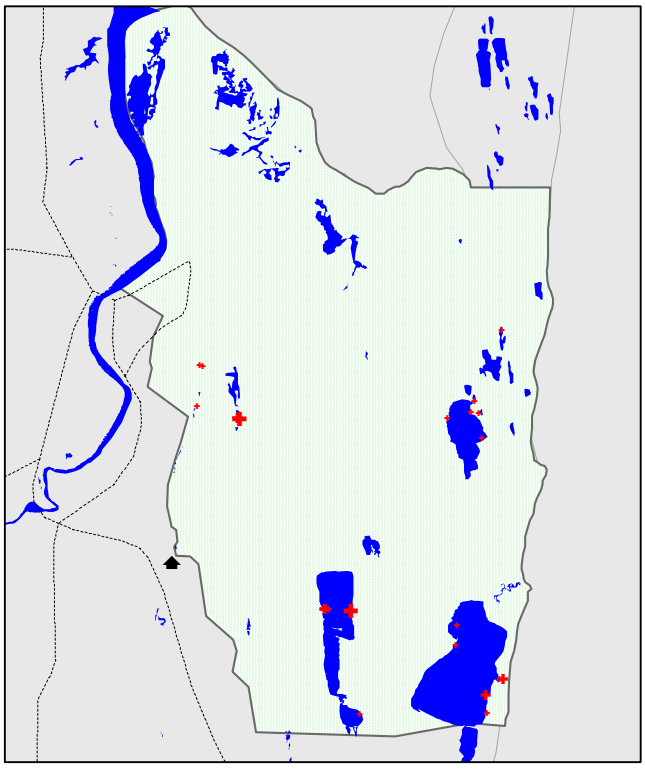

Figure 6. Distribution and groups of crocodiles

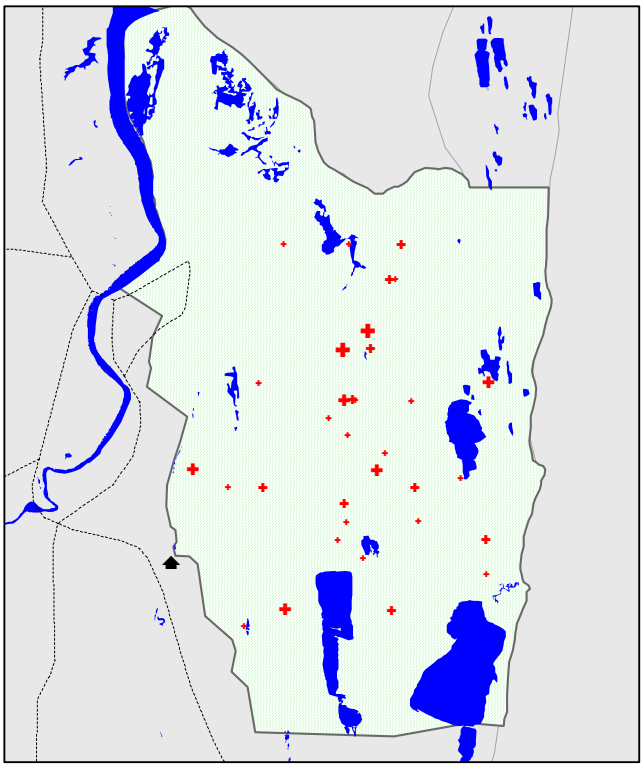

Figure 7. Distribution and group sizes of Bushpig

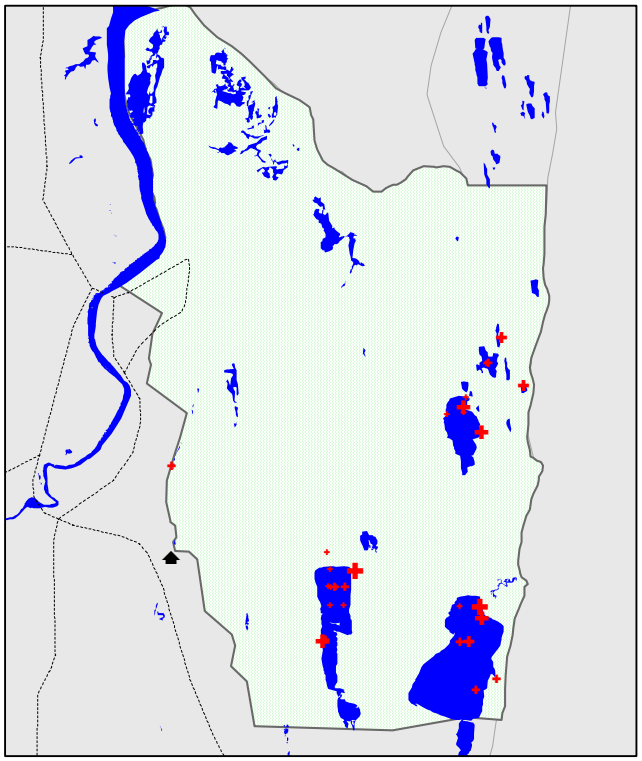

Figure. 8. Distribution and group sizes of hippo

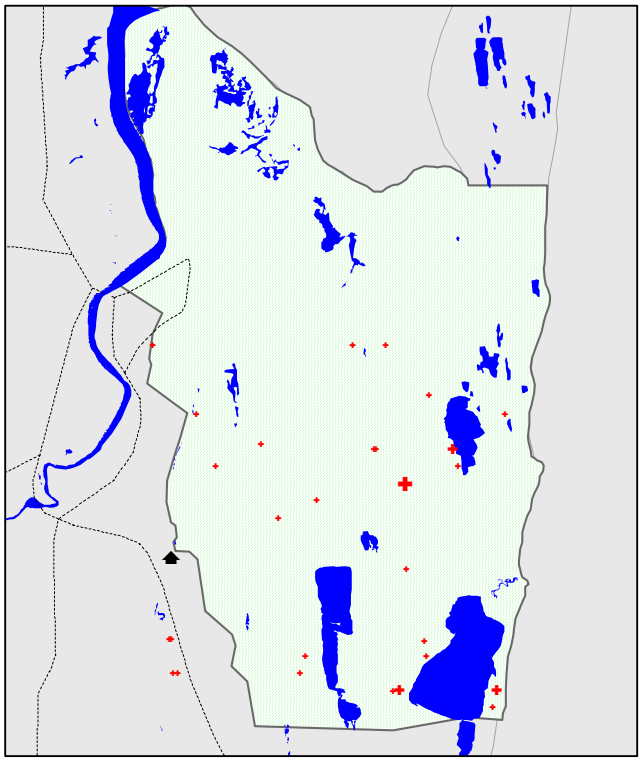

Figure. 9. Distribution and group sizes of bushbuck

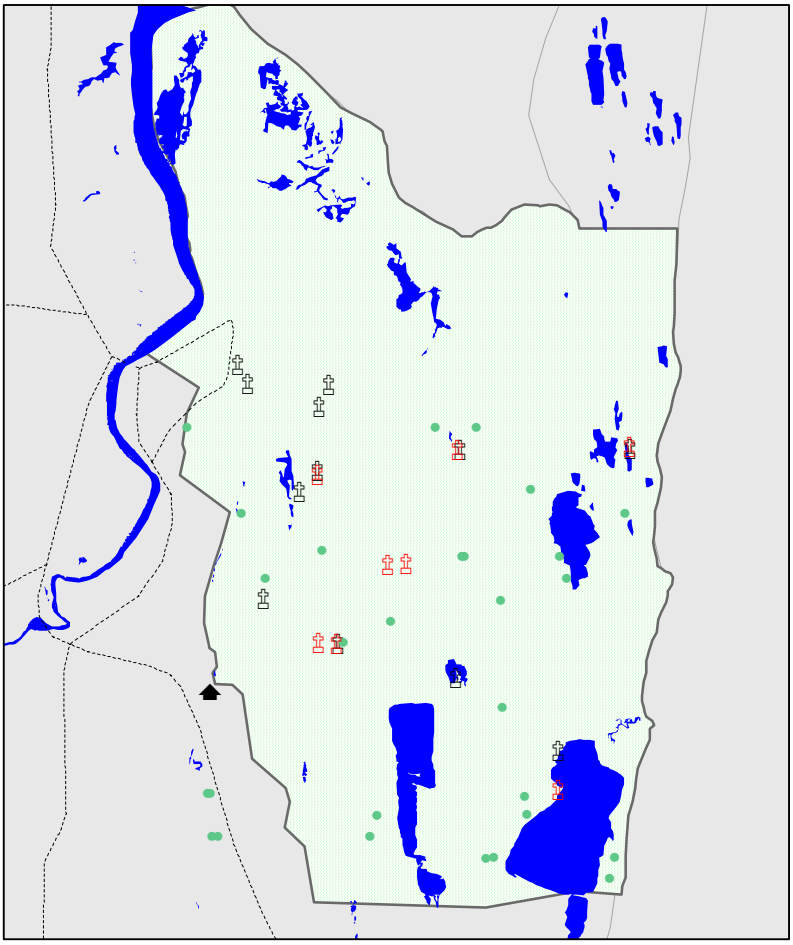

Figure. 10. Distribution of old elephant carcasses (*Black – 2006; Red – 2008*).

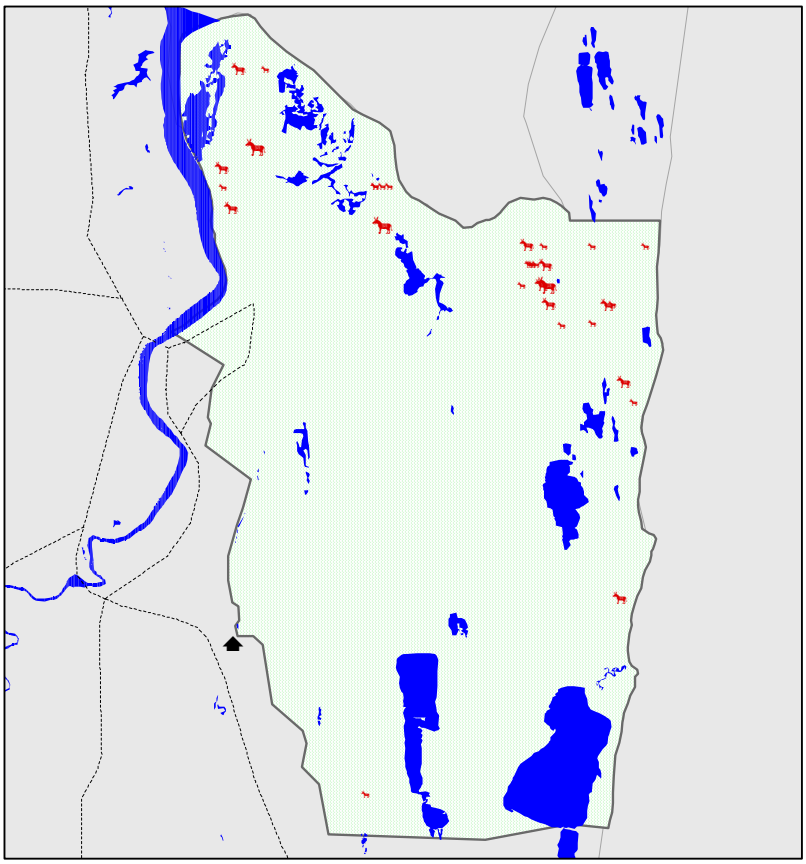

Figure. 11. Distribution and group sizes of goats.

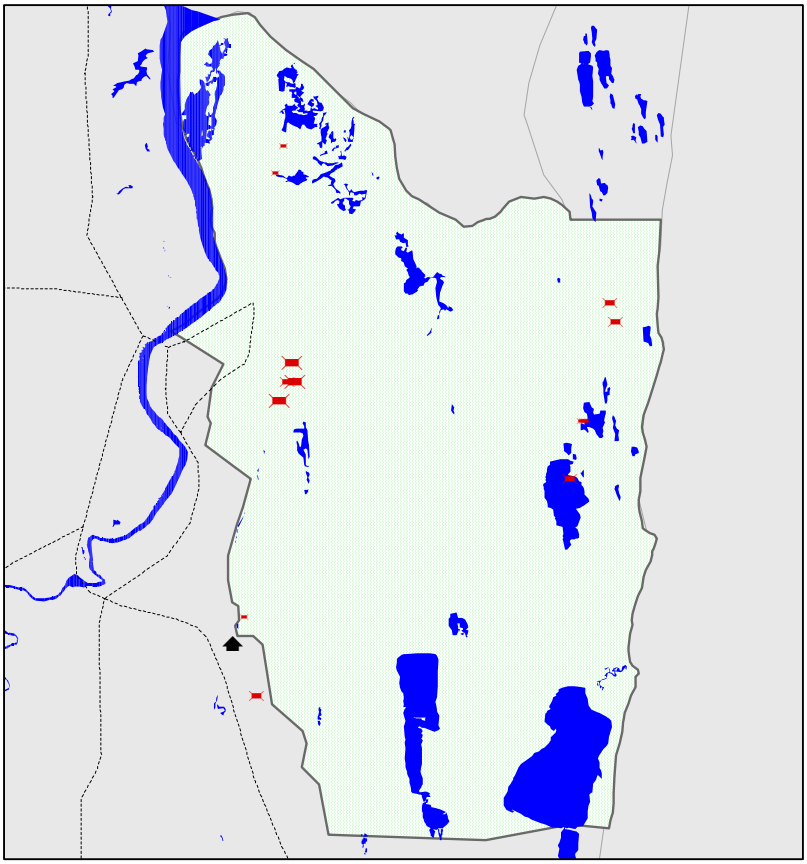

Figure. 12. Distribution and group sizes of cattle.

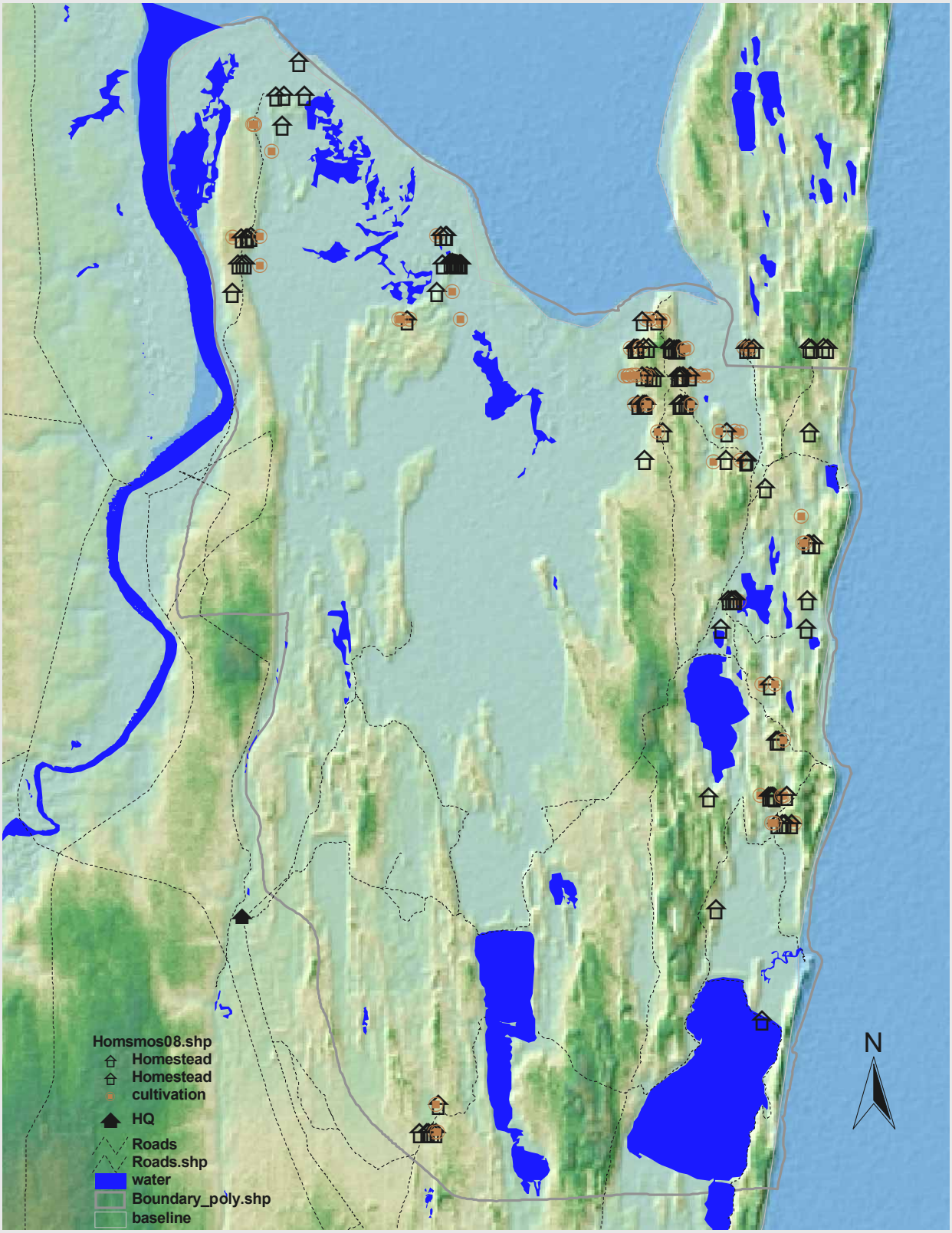

Figure 13. Distribution human activities from transect aerial survey, November 2008.

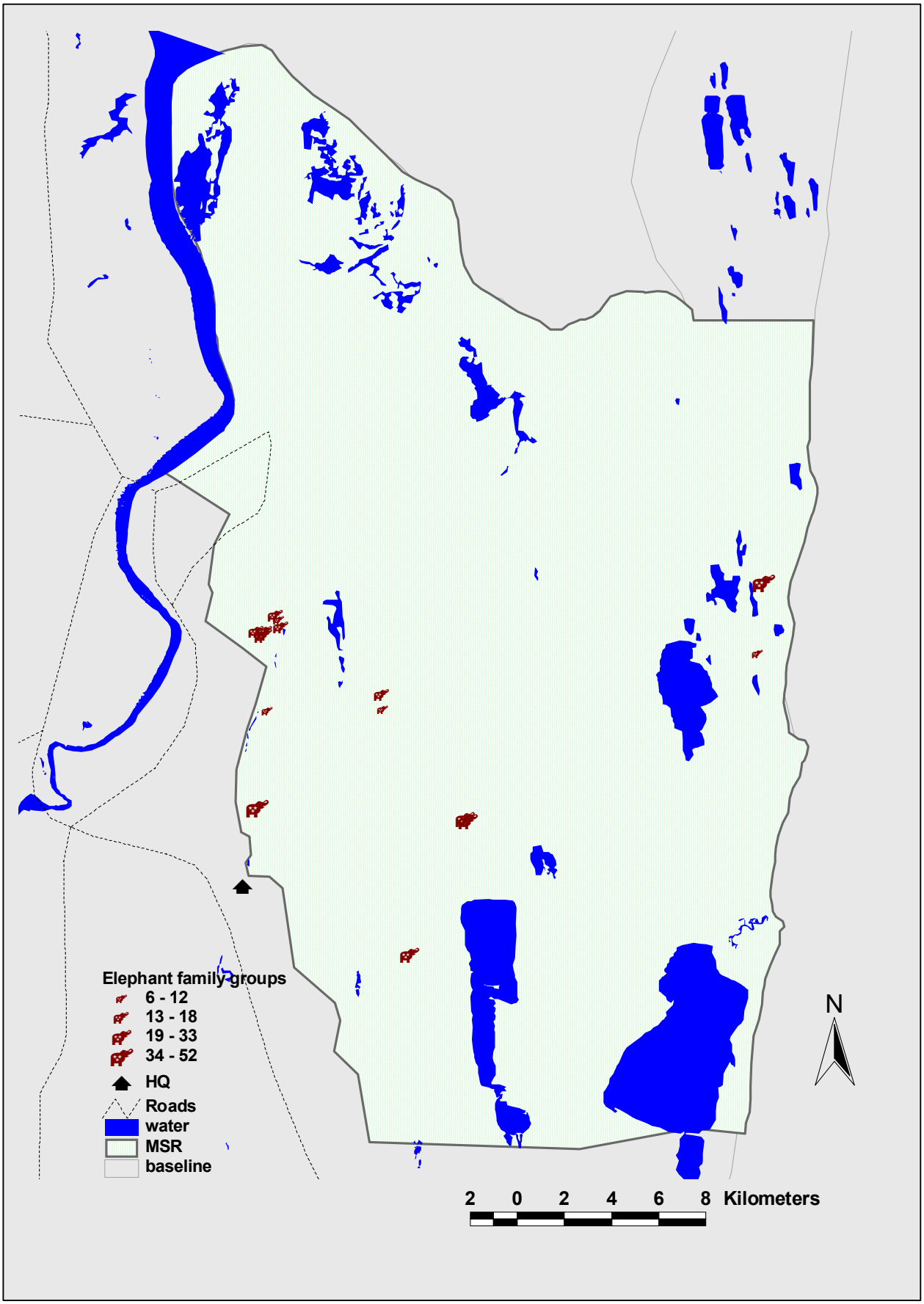

Figure 14. Distribution and group sizes of elephant family units [numbers – juveniles] from transect counts for the November 2008 census.

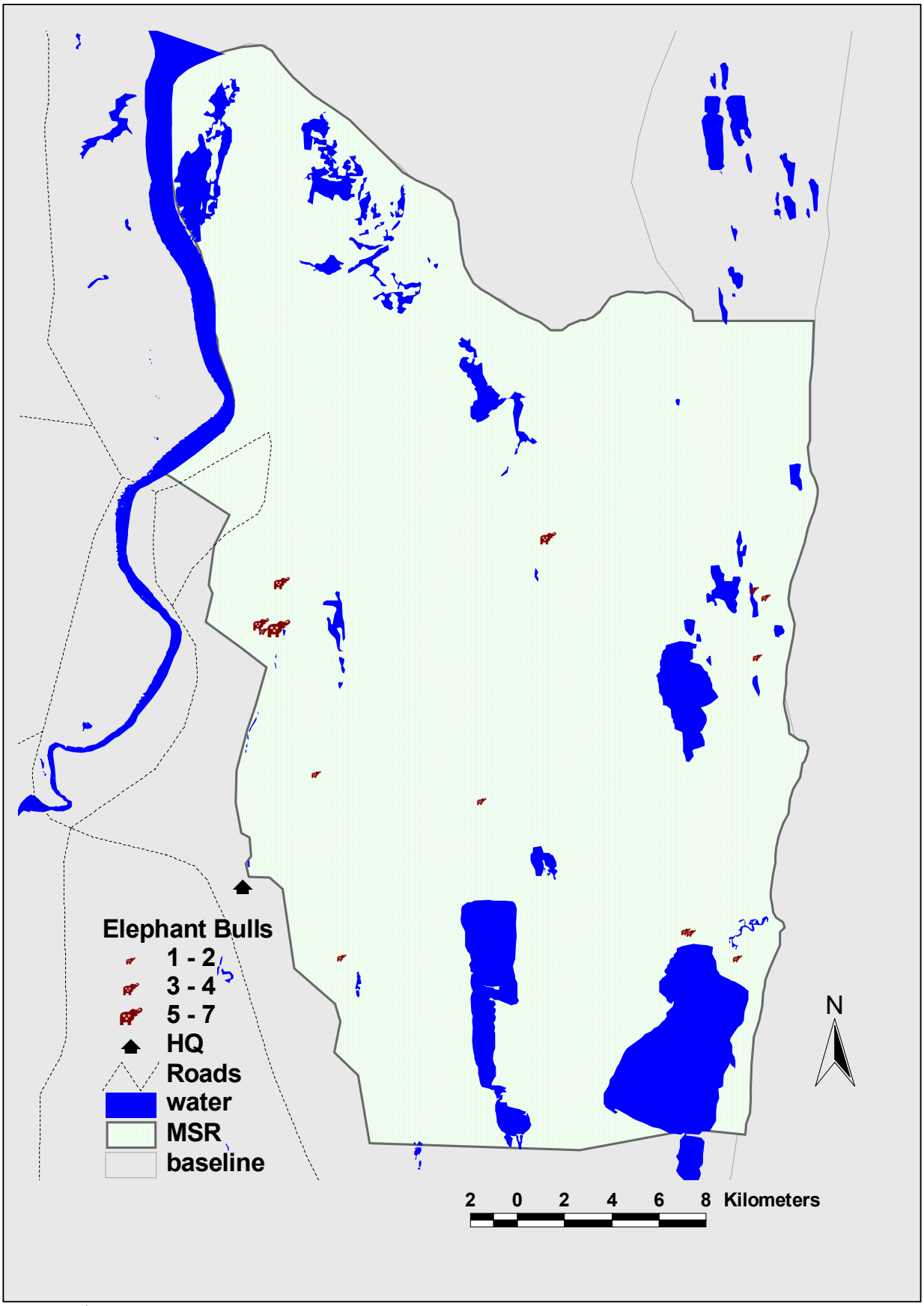

Figure 15. Distribution and group sizes of elephant bull units from transect counts for the November 2008 census.