Parque Nacional de Banhine, Moçambique

Wildlife survey

December 2007

Technical report commissioned by *ACTF - MITUR*

Projecto Áreas de Conservação Transfronteira e
Desenvolvimento do Turismo (ACTFDT)
Ministério do Turismo
REPÚBLICA DE MOÇAMBIQUE
Enquiries: Dr Bartolomeu Soto

Service provider

International Conservation Services
Agricultural Research Council - Range & Forage Unit
Sunrise Aviation

Dr M Stalmans
PO Box 19139
NELSPRUIT 1200 South Africa
stalmans@ics-consulting.co.za

Contract number: UC-ACTF/029/07 - Grant number: TF 056038MOZ

Executive summary

A wildlife survey was undertaken during October-November 2007 of the Parque Nacional de Banhine as a follow-up from the survey undertaken during 2004. Balancing the requirements for objectivity, repeatability and affordability, a partial survey (sample count) was applied with a helicopter using the same survey blocks used in 2004. A Global Positioning System with pre-determined survey blocks and flight lines was used to accurately cover important habitats and landscapes. The position of wildlife that was observed was captured and integrated into the Geographic Information System for Banhine, thereby allowing adjustments that take into account the relative proportion of the different landscapes that were covered.

A total of 44,800 ha (or 448km^2) representing 7.8% of Banhine was covered by the 9 survey blocks. The survey technique that was used can be repeated as the survey blocks that were flown are spatially defined and incorporated into a GIS system.

Two blocks were counted three times in order to assess the replicability of the technique. The statistical analysis was limited to a few species only because of the very low number of sightings and low densities that tend to confuse the issue. Furthermore, the sample blocks are 'open' to the larger system and significant movement in and out of the blocks could be experienced. Nevertheless, the results indicate that CV factors of less than 0.2 (20%) can be attained with CV's as low as 4.5% for nyala and 15.45 for kudu. This would indicate that that the technique is robust at the block level. If the animals are present, they are likely to be picked up by the observer team and counted correctly. However, the replicates do not inform one as to whether the overall sampling percentage was sufficient.

The overall sampling intensity of 7.8% is relatively low. Sample counts in for example the Kruger National Park are based on 22% coverage. This means that one must be careful with the extrapolation of the results to the full Park. A higher sampling percentage is preferable. This has obviously significant financial implications.

The following numbers of wild animals were observed in the survey blocks:

Species	Number	
	2004	2007
Bushpig	50	46
Common reedbuck	67	83
Duiker	149	424
Impala	108	83
Kudu	129	205
Nyala	7	19
Oribi	39	194
Ostrich	84	144
Steenbuck	51	230
Warthog	25	13

The above does not include animals seen during the ferry flying from block to block. If one includes the ferry lines, this increases the absolute minimum number of animals that were present in the Park at the time of the survey to 93 reedbuck, 149 impala, 275 kudu, 221 oribi and 213 ostrich. It is difficult to reliably extrapolate these numbers across the Park because of low sampling intensities and the differences between habitats.

Nevertheless, it can be safely stated that a viable nucleus of bushpig, common reedbuck, grey duiker, impala, kudu, oribi, ostrich and steenbuck exists. In particular, ostrich appear to be doing very well. Banhine probably holds the best population of this species in the GLTP. Other large species such as the zebra, wildebeest etc that were still found in the Park in the early 1970's have since been exterminated.

Lower numbers have been recorded in 2007 compared to 2004 for common reedbuck, warthog and bushpig. These lower numbers can best be explained by the much drier conditions that most likely negatively impact these specific species. However, much higher numbers have been recorded during 2007 for the other species. Some of these increases cannot be explained by even optimal recruitment rates. The logical explanation is that distribution patterns appear to have shifted considerably in response to the drying out of the wetland.

The count blocks are open to the remainder of the Park and animals can thus drift in and out. The concern is that whilst changes can be explained in this manner, it is not very satisfactory. It implies that the sampling intensity is too low to adequately capture temporal changes.

As in 2004, an interesting, diverse suite of small carnivores such as African wild cat, serval, honey badger, mongooses and black-backed jackal were observed. The latter appears to be more abundant than in 2004, which can again be explained by the drier and more suitable conditions for this species.

A long barrier of mopane branches was detected in the central sector of the Park. This barrier has been used to herd wildlife through small openings where snares are put. This is an effective way to illegally hunt animals over a wide area. Packs of domestic hunting dogs were also observed. Old and more recent signs of illegal cutting of the prized chamfuti hardwood were observed in the western sector of the Park. The resource base of Banhine thus remains under serious pressure.

Current diversity and numbers are still very low compared to historic patterns and to what the habitats could support. The current impact from hunting (and possibly other human activities such as subsistence farming) is certainly keeping the wildlife recovery back. The recovery of many species such as zebra, wildebeest, sable and roan will only be possible through their physical re-introduction. A re-introduction strategy that makes use of a Sanctuario is recommended.

One will need to be careful in determining the boundaries of the Sanctuario. If there are such large temporal movements of the wildlife as assumed from the 2004/2007 surveys in response to the flooding and drying out of the wetland, care be exercised that a fence will not prevent influx to and dispersal from key resources.

The following is recommended to improve the value of the aerial survey:

- Aim for a higher coverage of the Park (15 to 20% at least);
- Include a larger area (of grassland and woodlands) around the wetland block to document the temporal movement of wildlife in response to wetter and drier phases of the wetland;
- Apply a shorter time interval between successive surveys (2 years maximum);
- Institute some form of ecological monitoring at ground level to supplement the aerial survey (sex- and age structure, relative densities in different habitats and seasonal change thereof).

1. Background

The Government of Mozambique has received a Credit from the IDA, a Grant from Global Environment Facility and PHRD Grant from the Government of Japan, towards the costs of the Trans-frontier Conservation Areas and Tourism Development Project, which will be implemented during the period 2006-2012.

Focusing on the targeted area, the Project intends to improve the management effectiveness of protected areas (PAs) within the Limpopo TFCA, through improvement of the management capacity of the relevant management bodies in the Limpopo National Park, the Banhine National Park (BNP) and the Zinave National Park (ZNP). These three protected areas represent, with the Kruger National Park in South Africa and the Gonarezhou National Park in Zimbabwe, one of the major transfrontier conservation units (the Great Limpopo TFCA) in the whole continent, which offers a unique opportunity to achieve both valuable conservation goals and benefits to local populations.

It is largely recognized that the estimation (or real number if possible) of animals occurring within PAs is a valuable information to improve their management and conservation. Counting large and medium size animals becomes very efficient using aerial survey techniques. In this context, the Government of Mozambique, throughout the Ministry of Tourism (MITUR), has commissioned a survey to obtain reliable information on the abundance of large and medium size animals in the Parque Nacional de Banhine in order to improve the monitor and management of their populations.

The objective of the study was therefore to conduct an assessment of the wildlife resource of Banhine for the purpose of comparing the current situation to the results from the 2004 survey.

2. Methodology

2.1. General approach

The study had to take into account the technical criteria formulated by MITUR (see Appendix A) and repeat the methodology used in the 2004 survey (Stalmans 2004).

Furthermore, the survey had to fit the criteria of objectivity, repeatability and affordability. A pre-determined quantitative method is required in terms of objectivity. Given the large size of the Park (approximately 6,000 km^2), the lack of an extensive road network and the generally flat topography without vantage points, some form of aerial survey represented the only realistic approach. The criteria for repeatability requires a spatially-explicit assessment whereby a follow-up survey can be undertaken on the same area(s). Given the low expected densities of wildlife and the fact that some of the most important species are small-bodied (e.g. oribi) a helicopter was preferred to a fixed-wing aircraft. The high cost of flying required the adoption of a sampling approach rather than a full count.

A landscape map is available for Banhine (Stalmans 2003 and Stalmans & Wishart 2005). A total of 9 count blocks were defined in 2004 in such a way as to cover the different landscapes and geographical parts of Banhine within the available budget for flying hours (Fig. 1). The largest block covers the wetland area whilst the other 8 blocks are each 4,000 ha (40 km^2) in size.

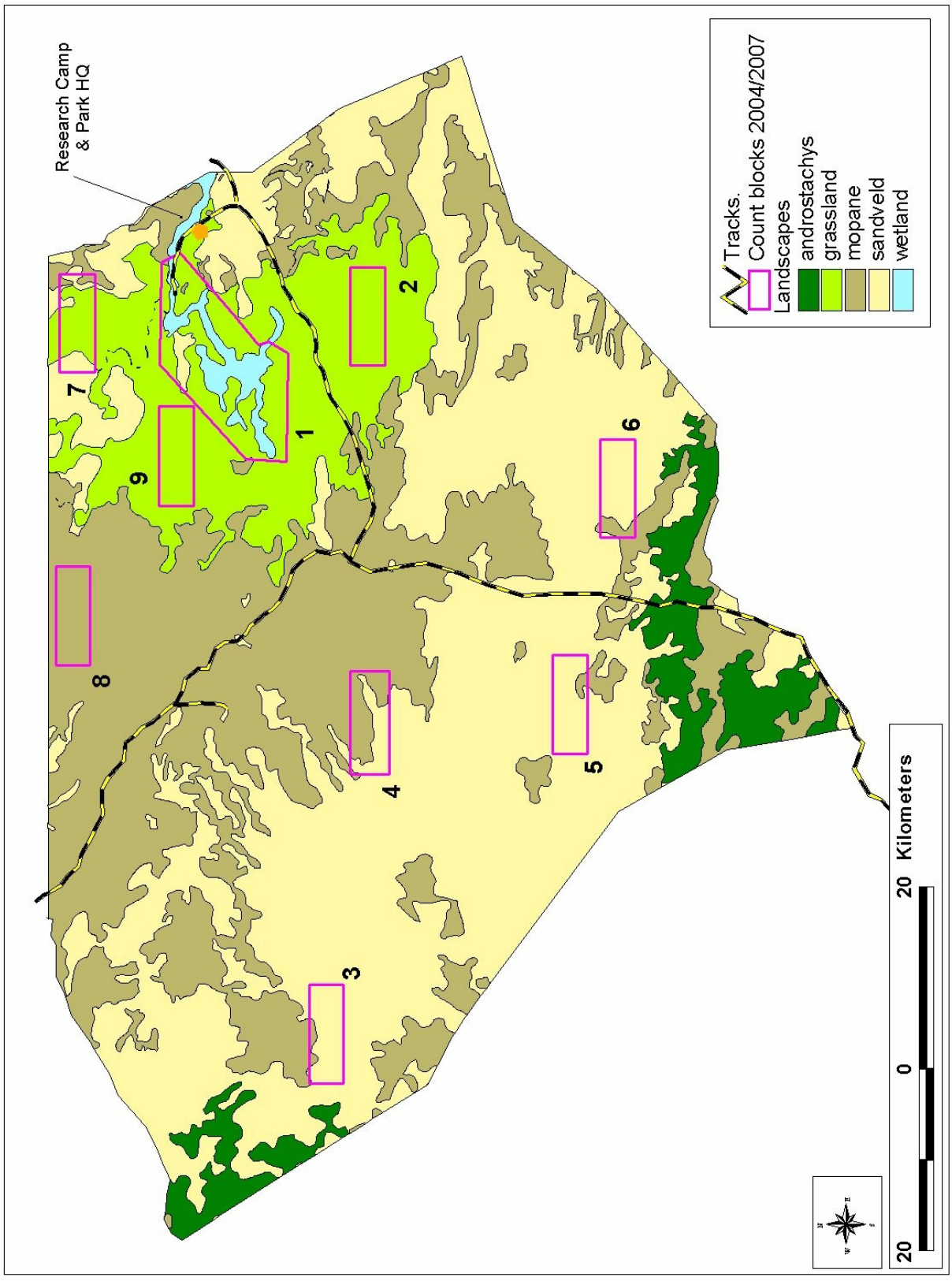

Fig. 1. Count blocks for the sample count of the Parque Nacional de Banhine during 2007. The same blocks were used as in 2004.

2.2. Survey technique

The specific equipment and technique are as follows (Fig. 2):

- 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 close or too far from the helicopter;
- The helicopter is maintained at a constant height of 50 to 55 (160 feet) above the ground. Airspeed is maintained at around 96 km/h (60 knots). Where a large herd is observed (eg impala) the pilot circles to enable an accurate count;
- 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. As a sighting is made the position together with the species code and number is stored. 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 on screen of the animals already spotted assists in preventing double counting or under counting;
- An east-west grid was flown;
- All observers wore yellow goggles that reduce shadows and enhance contrast for better visibility and detection of the animals (see Table 1 for weather conditions during the 2007 survey);
- A total of 9 blocks were counted giving a total coverage of 7.8% of the Park;
- Two of the blocks (part of 1 and all of 4) were flown three times in order to analyze replicate samples to evaluate the robustness of the count technique.

The survey was flown by pilot Mr Mike Pingo (Sunrise Aviation) with navigator/observer Dr Marc Stalmans (International Conservation Services) and observers Dr Mike Peel, Mr John Peel and Mr Andre Jacobs (Range and Forage Institute of the Agricultural Research Council). The warden of Banhine, Snr Eurico Agostinho accompanied the survey crew for the count of the wetland block. Mr Erroll Pieterse, Technical Advisor from the African Wildlife Foundation, assisted with a large part of the survey including the replicates.

The survey was undertaken from 30 October till November 2007.

The research camp near Pio Cabral was used as the logistics basis. Park staff assisted with refuelling.

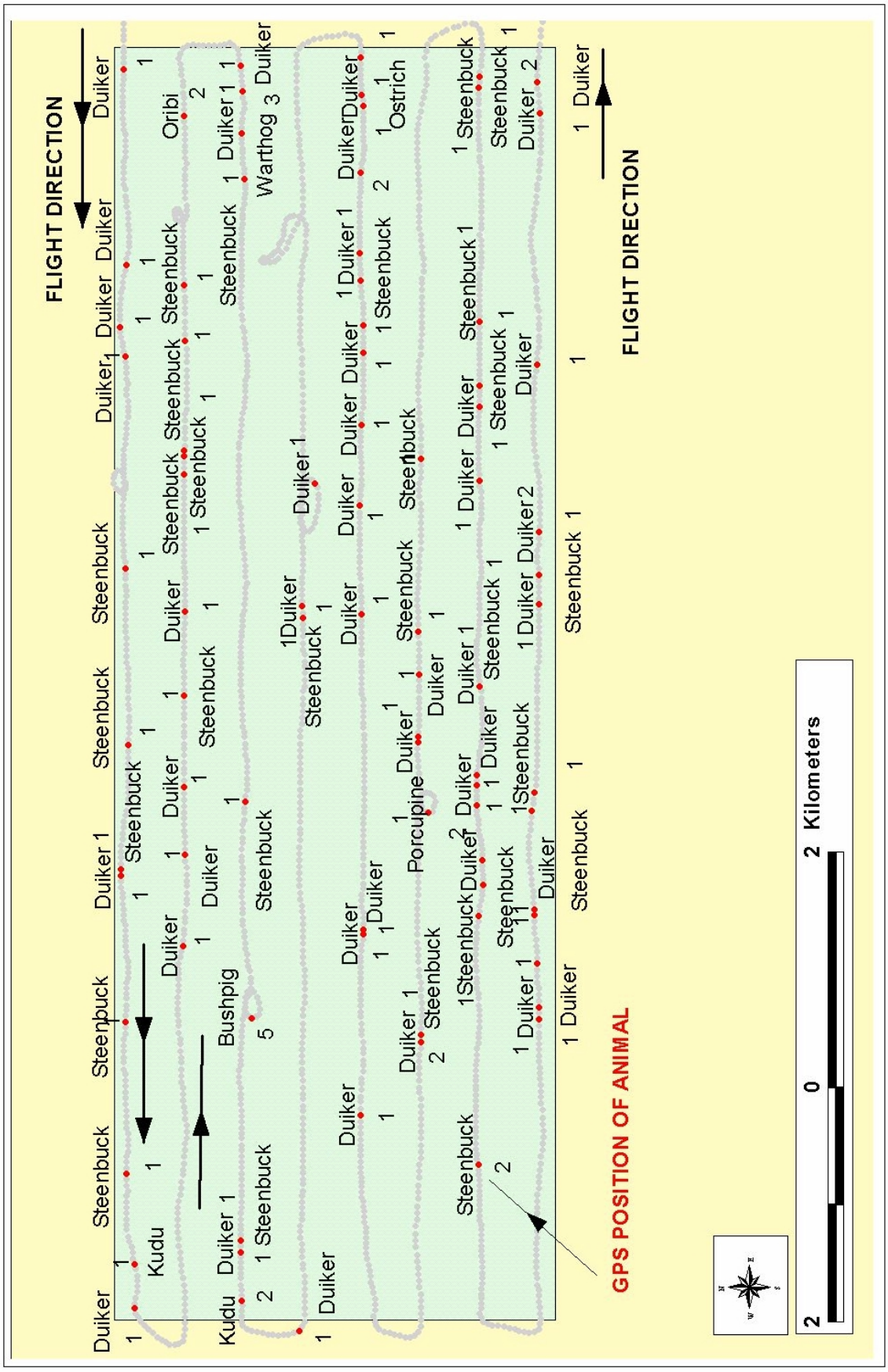

Fig. 2: Count block with flight lines and GPS position and number of animals observed (illustrated for count block 8 – flight 29 October 2007).

Table 1: Weather conditions during 2007 survey of Banhine.

Date	Block	Cloud cover	Light	Light score (lower = better)	Tempera-ture ºC	Midpoint score ºC	Comment
30/10	1	0/8	Excellent	1	20-25	22.5	sunny
30/10	2	4/8	Moderate	3	25-30	27.5	high cloud
31/10	3	8/8	Poor-Moderate	3.5	20-25	22.5	mid-high cloud
31/10	4	8/8	Poor	4	25-30	27.5	low-moderate cloud
1/11	5	5/8	Good	2	30-35	32.5	high cloud
1/11	6	5/8	Good	3	30-35	32.5	high cloud
31/10	7	8/8	Moderate	3	25-30	27.5	high cloud
29/10	8	0/8	Excellent	1	25-30	27.5	sunny
1/11	9	7/8	Moderate	3	20-25	22.5	high cloud
1/11	4	6/8	Moderate-good	2.5	25-30	27.5	high cloud
2/11	1	0/8	Excellent	1	20-25	22.5	sunny
2/11	1	1/8	Excellent-good	1.5	20-25	22.5	sunny
2/11	4	1/8	Excellent	1	25-30	27.5	high cloud

2.3. Data analysis

The GPS positions of the flight lines as well as the GPS positions of the wildlife that was observed were integrated into the GIS information for Banhine. Each observation point was linked to a specific landscape. This information makes it possible to analyse wildlife presence and numbers in relation to specific landscapes and the Park in general. Care was taken to relate all figures and extrapolations to the proportional representation of the landscapes as mapped for Banhine and as covered during the survey. An ArcGis shapefile is thus available and the individual observations are also consolidated in an ACCESS database. This database and the GIS already held the results from the 2004 counts. It is thus possible to analyse differences between the 2 surveys.

No sophisticated statistical analysis was undertaken. This is mainly because many of the assumptions required for such analysis were violated. This relates in particular to the requirement for the wildlife to be uniformly and independently distributed throughout the survey region in relation to randomly placed sample lines (Buckland *et al*. 2001). This is definitely not the case for Banhine.

Furthermore, efficiency of the statistical analysis may be poor if wildlife density is highly variable as a function of habitat type. This does also apply to Banhine. In order to improve the efficiency of the technique it is necessary that areas with marked variation in densities should either be sampled with appropriate variation in technique or at least be subjected to data analysis that considers those variations. The areas must however remain large enough to provide the minimum number of observations that are required by the much-used program DISTANCE to conduct analysis. Some 60 to 80 observations per species are required. Low wildlife densities on Banhine precluded attaining this number of observations for most species (Table 2).

Furthermore, the effective number of sightings is lower than indicated in Table 2. As the animals were sexed, there are often two sightings (male and female) for only one group of animals. This applies in particular to kudu.

Only the duiker and steenbuck have a high number of sightings. These are species for which there is relatively little concern to have very accurate numbers given their wide distribution and self-regulatory densities.

Table 2: Number of sightings for the wildlife observed in the 9 count blocks.

Species	Sightings
Bushpig	11
Common reedbuck	41
Duiker	367
Impala	9
Kudu	76
Nyala	10
Oribi	83
Ostrich	46
Steenbuck	193
Warthog	2

A conservative, commonsense approach was taken to infer possible numbers and distribution patterns of wildlife throughout Banhine. The raw data however remain available for more sophisticated analysis and comparison with the results of surveys that may be undertaken in the future.

3. Results

3.1. Area covered

The total area covered by the blocks was 44,800 ha (or 448 km^2) which represents 7.8% of the Park (Fig. 1). The blocks each have a different make-up in terms of landscape composition (Table 3).

Table 3: Landscapes of the 9 count blocks for Banhine.

Count blocks	Dominant landscape	Other landscapes
1	Wetland	Grassland / Sandveld
2	Grassland	Mopane
3	Sandveld	Mopane
4	Mopane	Sandveld
5	Sandveld	Mopane
6	Sandveld	Mopane
7	Grassland	Mopane / Sandveld
8	Mopane	
9	Grassland	

The wetland and grassland landscapes are proportionally much better covered than the mopane and sandveld landscapes (Table 4). It is important to understand that the 'habitat' that was covered has changed much in appearance and suitability for different species of animals as the wetland has dried up. This is illustrated visually in Fig. 3.

These changes have important implications. The original landscape map (Stalmans 2003) was drawn up based on the 2002-2003 conditions. The 'wetland' landscape was still very obvious during the 2004 survey. However, in 2007, the 'wetland' landscape has essentially changed to a 'grassland' landscape. This means that the 2004 and 2007 surveys, although based on the same coverage and same counting blocks, do not necessarily cover the same habitat. This confuses and complicates comparisons between the two surveys.

Table 4: Coverage of the dominant landscapes of Banhine by the count blocks.

Landscape	Proportion of Park	Area covered by survey blocks (ha)	Proportion of landscape covered by survey
Wetland	1.10%	5,237	79.50%
Grassland	13.60%	21,718	25.50%
Sandveld	46.70%	14,033	4.80%
Mopane	33.90%	7,640	3.60%

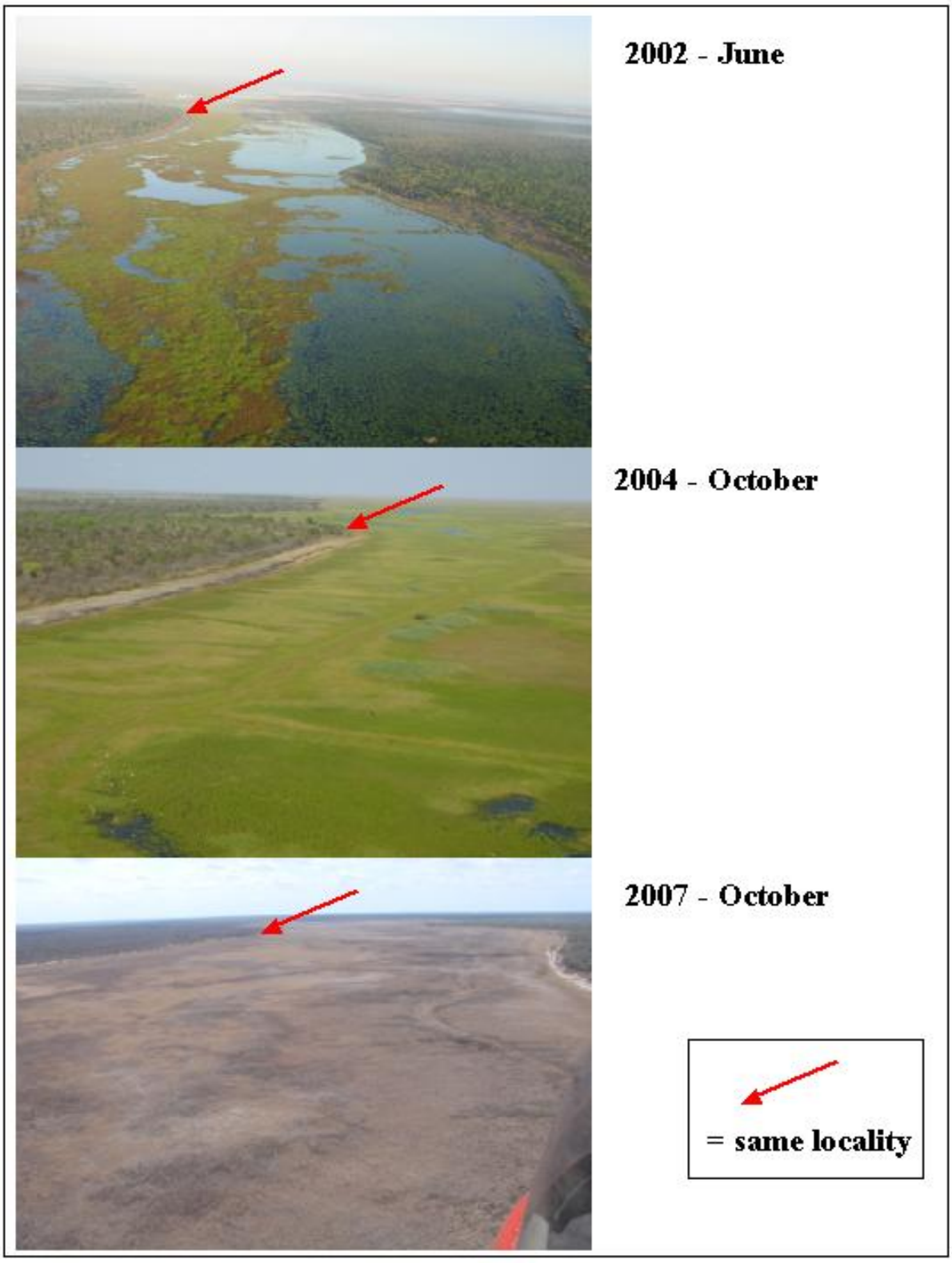

Fig. 3: Change in appearance of the ‘wetland’ habitat from 2002 to 2007.

3.2. Species observed

With regard to the ungulates, the same suite of species was observed during 2007 as in 2004 (Table 5). The only exception was the lone buffalo recorded in 2004. The distribution of these species follows the same pattern across the blocks with only some minor differences between 2004 and 2007. Warthog was much more widely distributed during 2004. The restricted distribution (and lower numbers) during 2007 reflects the adverse drier conditions for this species.

Wattled crane and saddle bill stork were not observed in this survey. Their absence is not unexpected given the very dry conditions. However, species that are more typical of arid conditions are now more prominent. Several Kori bustard were observed.

As in 2004, an interesting variety of small carnivores were observed. Black-backed jackal was much more widespread, probably in response to the drier conditions that suit this species. Porcupines remain common and have been observed in virtually every single block.

English, Portugese and scientific names for the wildlife species are given in Appendix B.

Table 5: Animal species encountered during the 2004 (**04**) and 2007 (**07**) surveys.

Species	Survey block									
	1	2	3	4	5	6	7	8	9	Ferry lines
Buffalo										04
Bushpig	04/07			07		07	04	07	04	04/07
Common reedbuck	04/07	07							04	04/07
Duiker	04/07	04/07	04/07	04/07	04/07	04/07	04/07	04/07	04/07	04/07
Impala	04/07		07				07		04/07	04/07
Kudu	04/07		04/07	04/07	04/07	04/07	04/07	04/07		04/07
Nyala				04/07						04/07
Oribi	04/07	04/07					04	07	04/07	04/07
Ostrich	04/07	04/07	07		07	04/07	04/07	07	07	04/07
Steenbuck	04/07	04/07	04/07	04/07	04/07	04/07	04/07	04/07	04/07	04/07
Warthog	04/07		04	04	04	07		04/07	04	04
Baboon troop	07					07				04/07
Vervet monkey troop				04/07						
Ground Hornbill	04/07		04	04/07	04/07	04/07				04/07
Kori bustard	07	07							07	
Saddlebill stork	04					04				04
Secretary bird										07
Wattled crane	04									
African wild cat	07	04		07				04	07	
Blackbacked jackal	07		07			07	07	04		07
Civet	07		07							
Honey badger	04							04	04/07	07
Large-spotted genet	04									04
Porcupine	04/07	04	04/07	04/07	04/07	04/07	07	04/07	04	04/07
Serval	04/07									
Spotted hyena	04									
Cattle	04/07	07								04/07
Goat	04/07	07								04/07

3.3. Numbers observed

A total of 1,843 ostriches and wild ungulates were recorded in the blocks and ferry lines (Table 6). This represents the absolute minimum number of animals that must be present in Banhine. The actual number is higher as only a proportion of the Park was surveyed. The ostrich count excludes chicks. A total of 60 chicks and young birds were counted.

Table 6: Wildlife and livestock numbers observed during the 2007 survey of Banhine.

	Survey block									Ferry	
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**line**	**Total**
Bushpig	28			4		9		5		9	**55**
Common reedbuck	81	2								10	**93**
Duiker	111	18	45	82	43	39	36	44	6	106	**530**
Impala	78		2				2		1	66	**149**
Kudu	16		28	32	45	75	7	3		70	**276**
Nyala				19						4	**23**
Oribi	174	11						2	7	27	**221**
Ostrich	71	1	2		6	5	42	1	16	69	**213**
Steenbuck	91	14	7	28	10	18	16	41	9	43	**273**
Warthog	8					2		3			**13**
Ground Hornbill	3			4	3	2				14	**26**
Baboon Troops	3					1				1	**5**
Vervet monkey troop				1							**1**
African wild cat	2			1					1		**4**
Blackbacked jackal	4		1			1	1			3	**10**
Honey badger									1	1	**2**
Porcupine	2		1	5	1	1	1	1		3	**14**
Serval	1										**1**
Cattle	53	28								60	**141**
Goat	117	45								189	**351**

3.4. Population structure

A helicopter is not a very suitable 'platform' for the determination of population structure (sex and age). Unless one spends a lot of time circling (which is expensive), most species cannot readily be sexed from the air. Generally, aerial surveys are very good at determining total numbers whereas ground observations are very good for accurate sex- and age classification. Only a few species were thus sexed during the 2007 aerial survey (Table 7). The ratios all indicate healthy and productive populations.

Table 7: Sex ratio of selected species as recorded during the 2007 survey of Banhine.

Species	Female %	Male %	F/M ratio
Kudu	77.0	23.0	3.3
Nyala	64.9	35.1	1.8
Impala	79.3	20.7	3.8
Reedbuck	65.5	34.5	1.9
Ostrich	61.3	38.7	1.6

Note: 'females' may include young animals which can not yet be differentiated

3.5. Replicates

Blocks 1 and 4 were each flown three times and species and numbers were recorded using the method described in section 2.2. The analysis of variation was limited to those instances where there were sufficiently large numbers of the larger species (Table 8).

Table 8: Determination of the coefficient of variation in replicate blocks 1 and 4.

Block 1 - grassland 4000ha open system

Number of animals				BSD	Mean	CV
	Rep 1	**Rep 2**	**Rep3**			
Oribi	51	72	53	9.39	58.67	16.01
Reedbuck	35	29	17	7.53	27.00	27.89

Block 4 - sandveld & mopane woodland 4000ha open system

Number of animals				BSD	Mean	CV
	Rep 1	**Rep 2**	**Rep3**			
Kudu	22	30	32	4.32	28.00	15.43
Nyala	17	19	18	0.81	18.00	4.50

Note: BSD = Bootstrapped Standard Deviation

These CV's can be compared to the range of CV's recorded in mixed Bushveld in South Africa: 2.92 to 70.9% for impala and 0 to 54.2% for kudu. Replicate counts of the total area of the Pilanesberg and Madikwe Game Reserves yielded CV's of 6.4 and 7.82% for impala and 22 and 14.4% for kudu respectively.

Although the results for Banhine fit well within the CV range recorded in South Africa, the CV for reedbuck in block 1 compare relatively poorly with the Pilanesberg and Madikwe results. These poor results are easily explained (Dr Brian Reilly, Adjunct Associate Professor, Department of Fisheries, Wildlife & Conservation Biology, University of Minnesota, USA, pers. comm. 2007).

When replicates counts are conduced on a sample area in order to estimate precision, these replications are done with the following assumptions:

- Wildlife is stationary and non-mobile and will therefore be encountered in the same place during each replication;
- Wildlife is homogenously and non-randomly distributed over the sample area;
- Wildlife occurs in high densities.

All three of these assumptions are violated in the case of Banhine. The sample blocks are relatively small at 4,000 ha each. This means that animals can easily enter and exit the block and make a big difference in count over a small time period. This was observed with the oribi in block 1. The second replicate yielded the highest number of oribi as the animals were out in the open grassland in the middle of the block in the early morning. As temperatures increased with the third replicate, there was a significant movement into the shade of the adjoining woodland, some of which fell outside of the survey block.

However, where animals have been relatively stationary, the observers did pick them up in each replicate. The nyala count in block 4 is a good case in point. Although this species frequents relatively closed woodland, a very small CV of 4.5 was obtained in that block.

Although the data are very limited in nature, it would indicate that the aerial survey technique that was used is capable of repeatedly recording the same herds in the same area.

A CV factor of 20% means that any change of less than 20% in a population from one survey to the next survey could be either real but could also purely be the result of random chance.

It is also important to understand that the calculation of CV factors for the replicate blocks is not related at all to the possible variation of wildlife densities across the different parts of Banhine. In this instance, the CV is a metric purely related to the blocks and to the internal precision of the count.

4. Discussion of numbers and distribution

4.1. Landscape and area preferences

Wildlife species and their numbers are generally unevenly distributed across Banhine. The largest number of ungulates (excluding duiker and steenbuck) were generally observed in the area around the (now dry) wetland.

Generally, the same distribution pattern applies for 2007 as that recorded in 2004.

Kudu are now even found in the middle of the 'wetland' which is now totally dry (Fig. 4).

As in 2004, the only survey block where nyala were observed as block 4 (Fig. 5). Additional nyala were observed along the ferry lines outside of block 4 in the same general area. In 2004, nyala were also observed along one of the ferry lines in the south.

Similarly to 2004, the stronghold of impala is around the wetland area close to the Park Headquarters. A few individuals occur very far from water in the west sector of the Park (Fig. 6).

Ostrich prefer the grasslands around the wetland landscape. Significant numbers occur in the south, but only a few individuals were observed in the west (Fig. 7).

The oribi are almost totally confined to the wetland and grassland landscapes (Fig. 8). However, they were observed moving into the shade of the adjoining woodland habitats later in the day when the temperatures soared.

Reedbuck were even more concentrated into the wetland habitat in 2007 (Fig. 9).

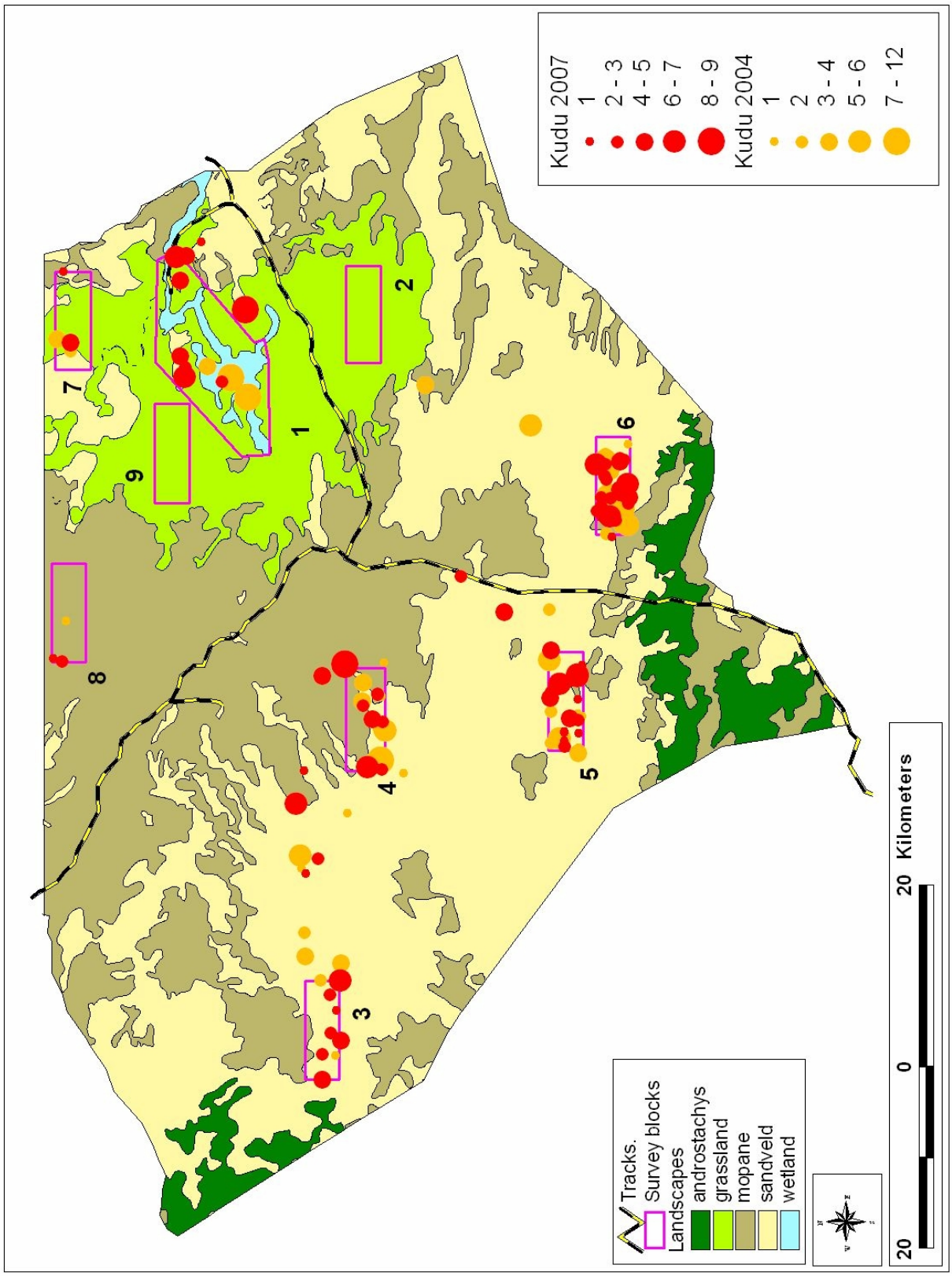

Fig. 4: Distribution of kudu during the 2004 and 2007 surveys of Banhine.

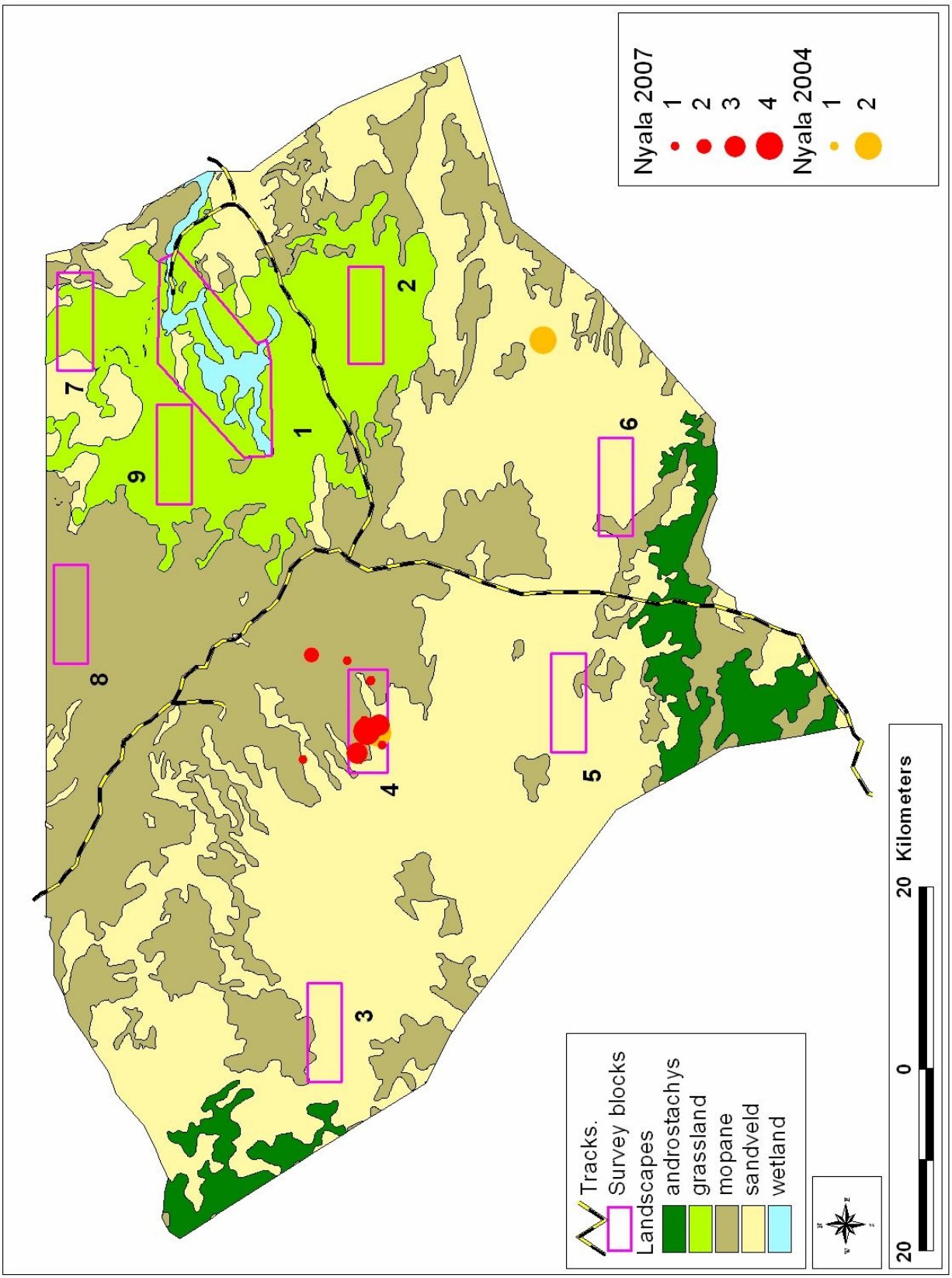

Fig. 5: Distribution of nyala during the 2004 and 2007 surveys of Banhine.

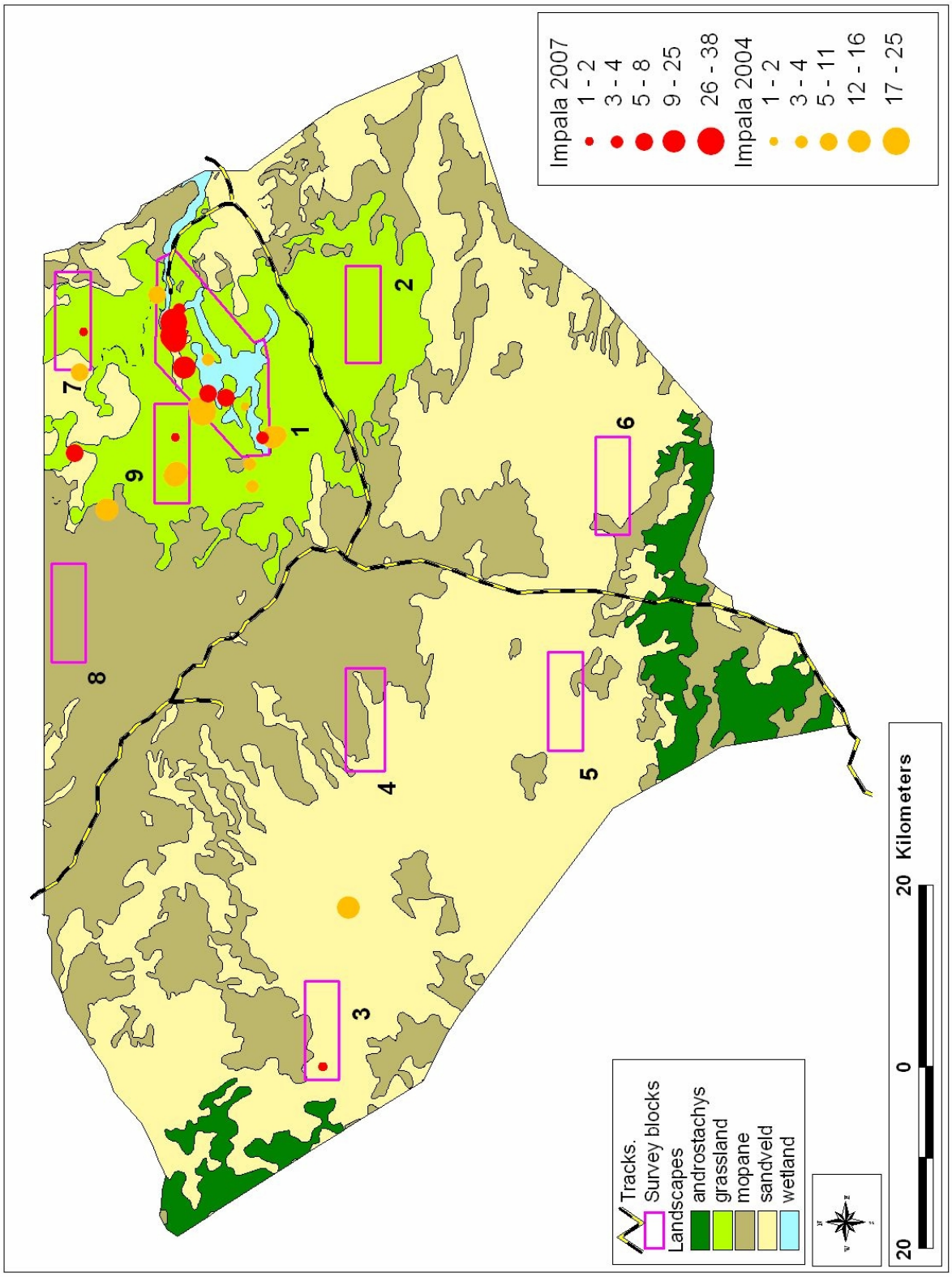

Fig. 6: Distribution of impala during the 2004 and 2007 surveys of Banhine.

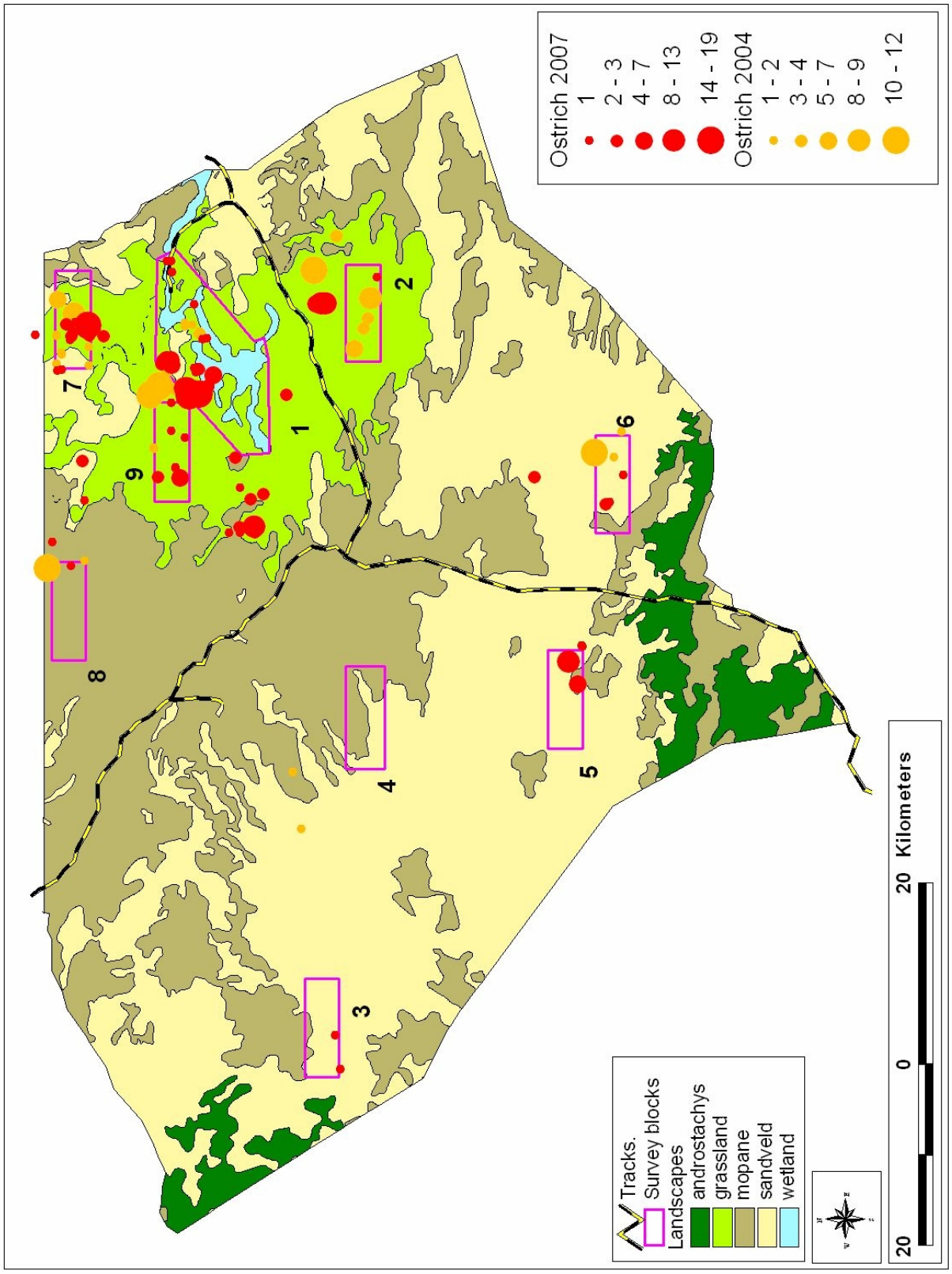

Fig. 7: Distribution of ostrich during the 2004 and 2007 surveys of Banhine.

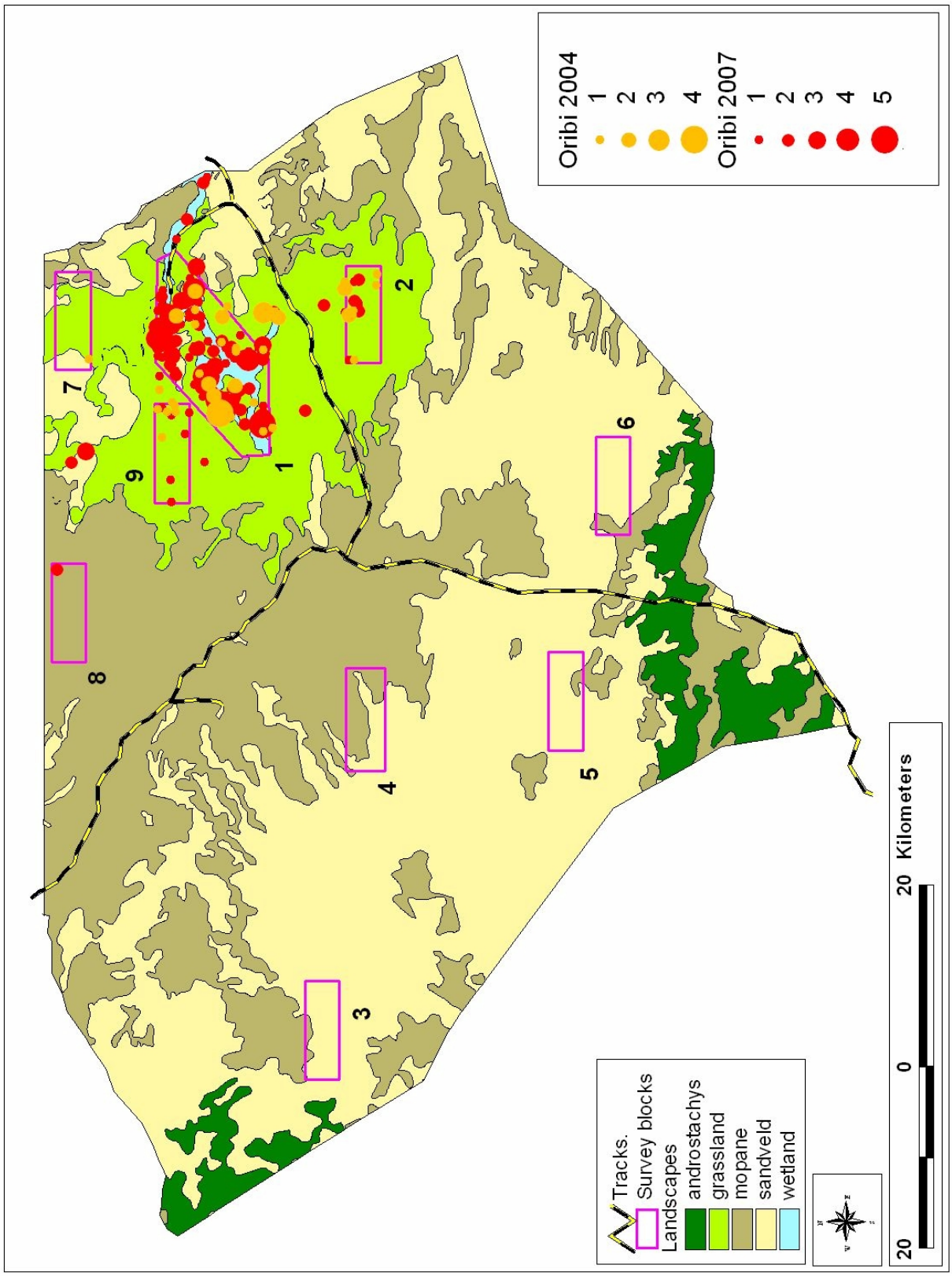

Fig. 8: Distribution of oribi during the 2004 and 2007 surveys of Banhine.

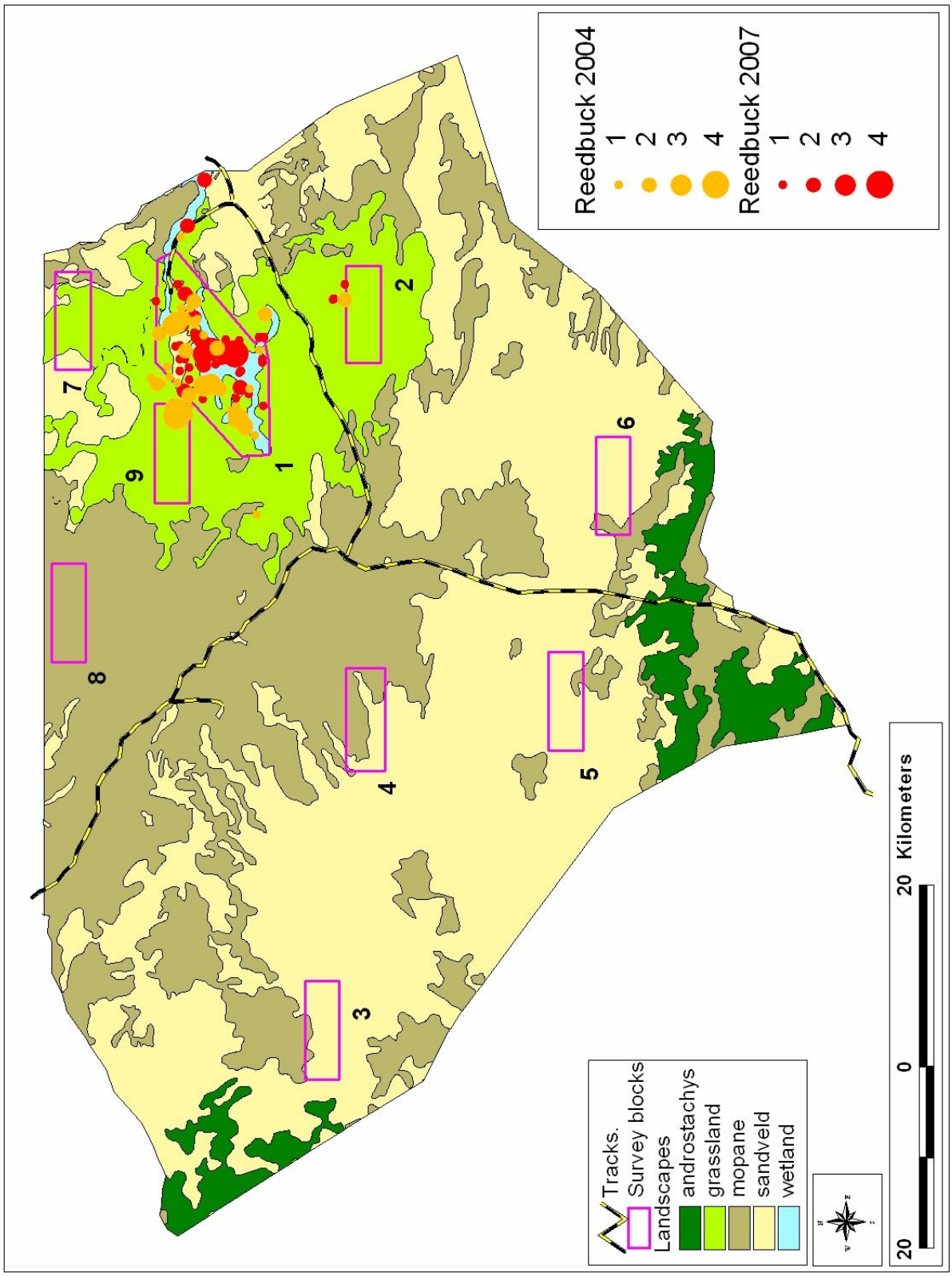

Fig. 9: Distribution of common reedbuck during the 2004 and 2007 surveys of Banhine.

4.2. Comparison between 2004 and 2007

Any comparison between the 2004 and 2007 counts must take into account that the overall sampling percentage for the Park is low. Furthermore the count blocks are open and animals can easily shift their distribution, especially as conditions in the Park have considerably changed with the drying out of the wetland (Fig. 3). The count figures have been consolidated by landscape (using Table 3 for the landscape make-up of the survey blocks).

Bushpig numbers were slightly down in 2007 (Table 9) (Fig. 9). This species can be expected to perform better during wet cycles. Warthog seems to have experienced an appreciable drop in numbers. This is not unexpected given the very dry conditions in 2006/2007.

The differences in impala numbers are not that large considering the sampling intensity and possible shifts in distribution. It is safer not to make any firm conclusion as to whether the species is stationary, in decline or expanding. The greater number of nyala recorded in 2007 may be attributed to chance.

Kudu numbers are significantly up. This may very well reflect a growing population. Fairly large herds have been observed. Block 6 where significant numbers were observed in 2004 had a much increased number in 2007. A herd of kudu was even observed to the south outside of the Park in the sandveld. The increased population can be explained by a 17% annual growth. This is very feasible.

The duiker and steenbuck numbers are much higher. This may reflect on the one hand better survey conditions as these small species are easier seen now that the grass is much shorter. On the other hand it probably also reflects an influx into the formerly wetter areas.

The oribi definitely seem to have shifted from the grassland areas into the wetland block (Table 9).

The biomass of animals per km^2 has increased considerably for the wetland block. This increase seems to have been fed by dispersal from the grasslands (Table 10). It could be that under these very dry conditions the grassland landscape constitutes the poorest landscape at this time of the year. The woodlands (sandveld and mopane) probably already offer some new growth on the trees and shrubs even if the grass has not yet started growing. The wetland area that was previously inaccessible probably offers some of the best remaining grass.

The problem with the relatively low coverage of the Park is that this explanation can not be proven as there is insufficient coverage of areas where numbers would be lower than those recorded in the previous survey.

Table 9: Comparison between 2004 and 2007 survey for each landscape.

2004

Landscape	Bushpig	Reedbuck	Duiker	Impala	Kudu	Nyala	Oribi	Ostrich	Steenbuck	Warthog
Wetland	46	53	44	70	28		27	17	2	12
Grassland	4	14	31	38	7		12	54	19	4
Mopane			31		27	7			16	5
Sandveld			43		67			13	16	4
	50	**67**	**149**	**108**	**129**	**7**	**39**	**84**	**53**	**25**

2007

Landscape	Bushpig	Reedbuck	Duiker	Impala	Kudu	Nyala	Oribi	Ostrich	Steenbuck	Warthog
Wetland	28	81	111	78	25		174	71	91	8
Grassland		2	60	3	7		18	59	39	
Mopane	9		126		25	17	2	1	65	3
Sandveld	9		127	2	148			13	35	2
	46	**83**	**424**	**83**	**205**	**17**	**194**	**144**	**230**	**13**

Table 10: Relative distribution of animal biomass across the different landscapes.

Landscape	**2004 Biomass kg km^{-2}**	**2007 Biomass kg km^{-2}**	**Ratio 2007/2004**
Wetland	84	130	1.5
Grassland	68	56	0.8
Mopane	63	99	1.6
Sandveld	92	199	2.2

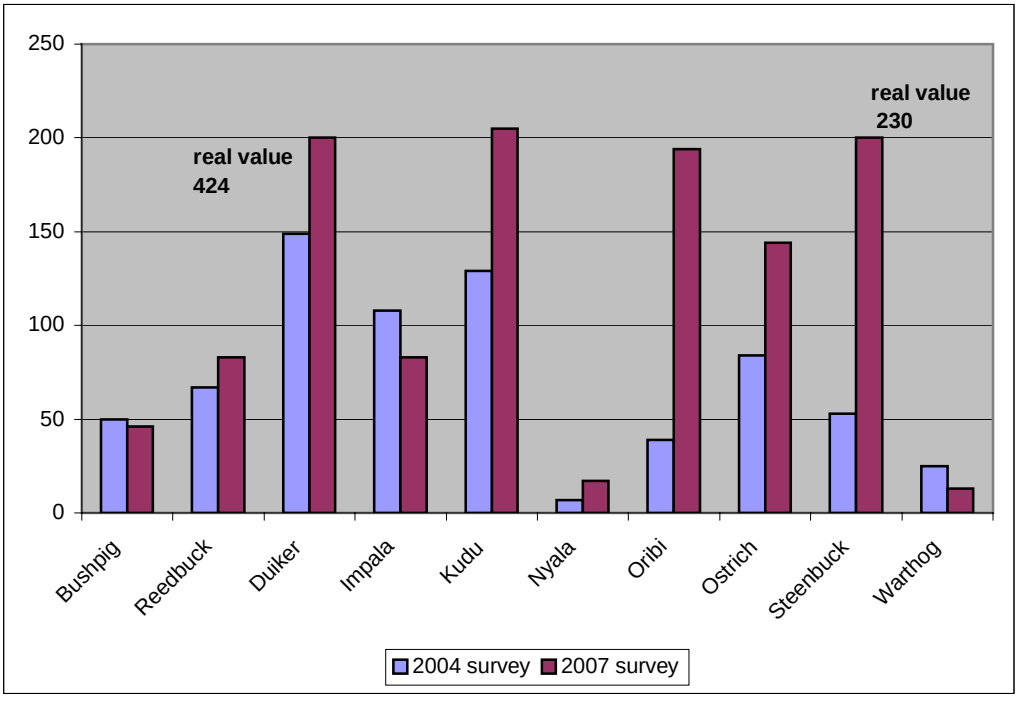

Fig. 10: Comparison between 2004 and 2007 wildlife numbers in Banhine survey blocks.

4.3. Current densities in the context of carrying capacity

How do the densities that were recorded compare to what the habitat could support? This is an important question to ask as its answer is very relevant to the efforts to restore the Park.

No formal assessment of carrying capacity for the Park was made. This fell outside the Terms of Reference for this survey. However, there are general equations available that relate rainfall to carrying capacity (Coe et al. 1976) and rainfall in combination with soil fertility to carrying capacity (Fritz & Duncan 1994). Furthermore, the results for a carrying capacity of the Sanctuario in the Limpopo National Park (Stalmans & Peel 2003) can be used to a certain extent.

The average as well as the highest overall densities recorded in any block were used for the different landscapes (Table 11). The average wildlife stocking in each landscape as well as the maximum recorded in any block in that landscape are very low compared to what can be expected for these landscapes under 'normal' and 'natural' circumstances. Generally the landscapes of Banhine are stocked at 5 to 16% of the expected norm. Given the fact that the habitats are generally in a very good condition, it is only the past and current illegal hunting that can be considered to be responsible for this state of affairs.

Table 11: Comparison of current wildlife stocking with potential stocking.

Landscape	**Wildlife stocking 2007 (kg km^{-2})**	**Potential stocking (kg km^{-2})**						
		Coe rainfall (min)	Coe rainfall (avg)	Coe rainfall (max)	Fritz & Duncan	Stalmans & Peel	Stocking as % of lowest estimate	Stocking as % of highest estimate
Wetland	130	1,199	2,268	3,336	2,762		10.8	3.9
Grassland	56	1,199	2,268	3,336	2,050		4.7	1.7
Mopane	99	1,199	2,268	3,336	2,050	5,105	8.3	1.9
Sandveld	199	1,199	2,268	3,336	1,148	3,433	16.6	5.8

5. Illegal hunting and wood cutting

Although the survey concentrated on the wildlife, some interesting observations were made that have a direct bearing on the integrity of the park and the security of the wildlife populations.

In block 4 in the central sector of the Park, a long 'fence' line that was made of cut mopane branches was noticed (Fig. 11). This 'fence' was more than a one kilometre in length. The purpose of this 'fence' is to intercept animals and to channel them to small openings in which snares are placed. This is most likely the work of people resident in the Park.

In block 3 in the western sector of the Park, chamfuti trees (*Afzelia quanzensis*) are being illegally cut (Fig. 11). There are a number of old stumps as well as trees that have been cut in the last few months. Numerous vehicle tracks are present. This illegal activity is most likely the work of commercial loggers from outside the Park.

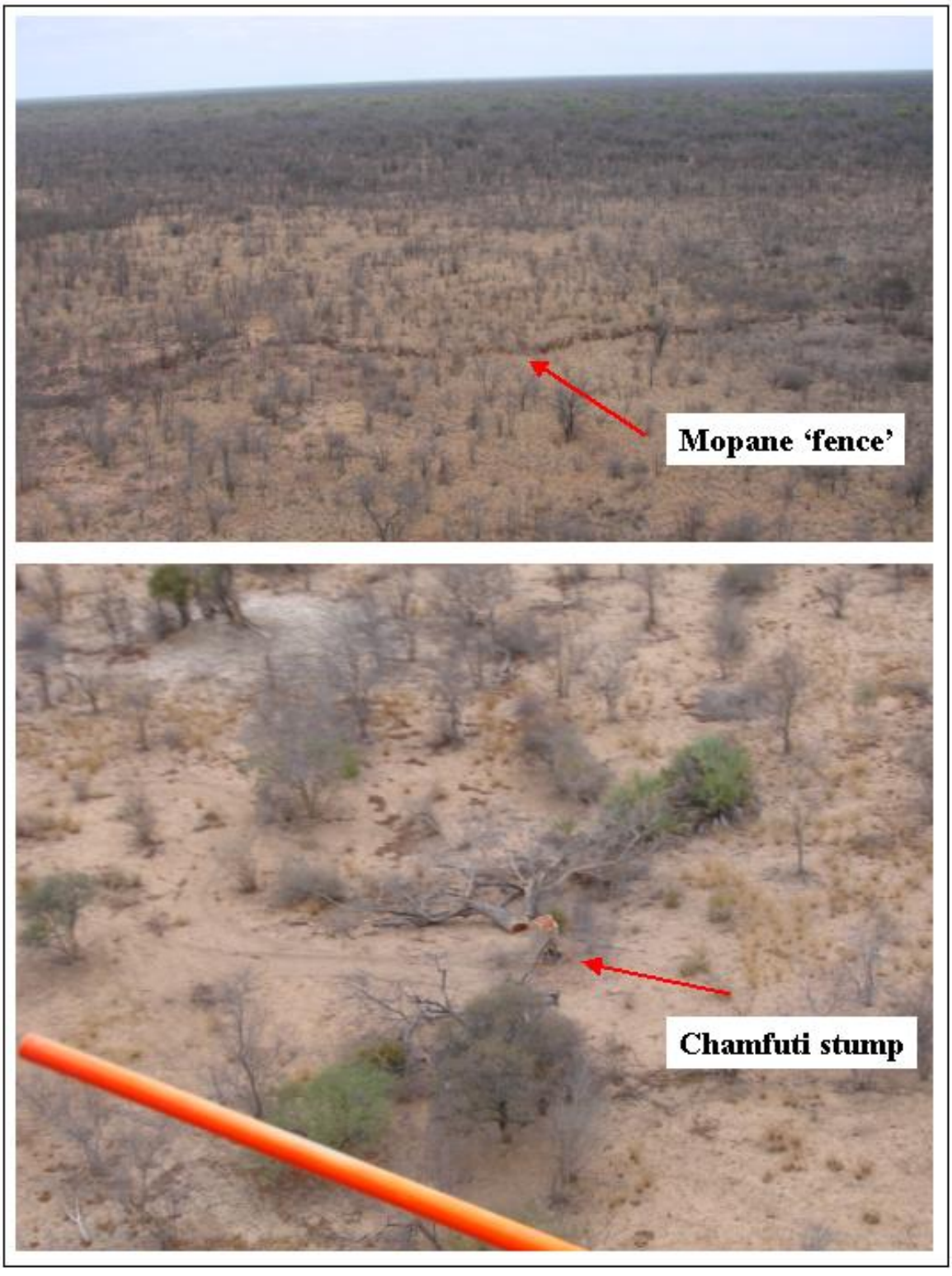

Fig. 11: Signs of illegal hunting: top - 'fence' to herd animals into snares, and bottom – cut chamfuti (*Afzelia quanzensis*) tree. Note vehicle tracks.

6. Park rehabilitation

The wildlife survey provides valuable information for decision-making towards the rehabilitation and restoration of Banhine.

A number of wildlife species have been identified for which the current numbers are more than sufficient to recover speedily under good protection. However, the survey also confirmed that a number of species are extremely likely to be locally extinct or to occur at such low numbers that they cannot be expected to recover in the medium (5 years) or even long term (10 years +).

These locally extinct species (eg blue wildebeest and zebra) must be re-introduced or where the numbers are extremely small (eg buffalo) they must be boosted.

Given the relatively high numbers of people currently present in the Park and the low impact of management, it is recommended that any re-introductions make use of a Sanctuario.

A securely fenced and patrolled Sanctuario will provide a safe environment for the re-introduced species in order to quickly grow in numbers. Once their numbers have significantly increased and conditions for their survival outside of the Sanctuario have improved, they can be released in the larger Park.

This strategy has been successfully employed in the Limpopo National Park and the Parque Nacional da Gorongosa.

One will need to be careful in determining the boundaries of the Sanctuario. If there are such large temporal movements of the wildlife as assumed from the 2004/2007 surveys in response to the flooding and drying out of the wetland, care be exercised that a fence will not prevent influx to and dispersal from key resources.

7. Conclusion

The survey technique that was used replicated the survey that was undertaken during 2004.

Despite the relatively low proportion of the park that was physically covered by the helicopter survey, it can be safely stated that a viable nucleus of bushpig, common reedbuck, grey duiker, impala, kudu, oribi, ostrich and steenbuck exists. In particular, ostrich appear to be doing very well. Banhine probably holds the best population of this species in the GLTP.

Current diversity and numbers are still very low compared to historic patterns and to what the habitats could support. The current impact from hunting (and possibly other human activities such as subsistence farming) is certainly keeping the wildlife recovery back.

The recovery of many species such as zebra, wildebeest, sable and roan will only be possible through their physical re-introduction. A re-introduction strategy that makes use of a Sanctuario is recommended.

The following is recommended to improve the value of the aerial survey:

- Aim for a higher coverage of the Park (15 to 20% at least);
- Include a larger area (of grassland and woodlands) around the wetland block to document the temporal movement of wildlife in response to wetter and drier phases of the wetland;
- Apply a shorter time interval between successive surveys (2 years maximum);
- Institute some form of ecological monitoring at ground level to supplement the aerial survey (sex- and age structure, relative densities in different habitats and seasonal change thereof).

8. References

Buckland, S.T., Anderson, D.R., Burnham, K.P. & Laake, J.L. 1993. Distance sampling – Estimating abundance of biological populations. Chapman & Hall, London.

Coe M.J., Cumming D.H. & Phillipson J. 1976. Biomass and production of large African herbivores in relation to rainfall and primary production. Oecologia 22: 341-354.

Dunham K.M. 2004. Aerial survey of large herbivores in Gorongosa National Park, Mozambique. Unpublished report to the Gregory C. Carr Foundation, Cambridge MA, USA.

Fritz H. & Duncan P. 1994. On the carrying capacity for large ungulates of African savanna ecosystems. *Proc. R. Soc. Lond.* 256: 77-82.

Whyte I. & Kruger J. 2005. Ecological aerial surveys (1977-1997) and aerial line transects (1998-2005) in the Kruger National Park. Unpublished report to the South African National Parks Board.

Smither R.H.N. & Lobão Tello J.L.P. 1976. Check List and Atlas of the Mammals of Mocambique. Museum Memoir No. 8. Trustees of the National Museums and Monuments of Rhodesia, Bulawayo, Zimbabwe.

Stalmans M. 2003. Plant communities and landscapes of the Parque Nacional de Banhine, Moçambique. Unpublished report *Development Alternatives Inc.*

Stalmans M. 2004. Parque Nacional de Banhine – wildlife census. Unpublished report to the African Wildlife Foundation and USAID.

Stalmans M. & Wishart M. 2005. Plant communities, wetlands and landscapes of the Parque Nacional de Banhine, Moçambique. Koedoe 48(2):43-58.

Stalmans M. & Peel M. 2003. Assessment of habitat suitability and carrying capacity for herbivores - the 'Sanctuary', Limpopo National Park. Unpublished report to the PIU, Parque Nacional do Limpopo.

Appendix A: Technical specifications for the study (as defined by MITUR).

1. Aerial sample count of the large and medium size animals in BNP using blocks or transect sample units;

2. Aerial sample count of the large and medium size animals in ZNP using blocks or transect sample units;

3. Use of the same sampling methods and techniques previously adopted for the aerial survey of BNP in 2004, in order to compare data obtained;

4. Semi-random stratify sampling strategy in order to cover all major habitats types existing in BNP and ZNP;

5. Sampling strategy in order to reach a confidence of CV = 0.2 (20%) with p = 0.05. Whereas these confidence limits are not to be reached, propose alternative values providing necessary justifications;

6. GIS database of all animal's sightings;

7. Relevant information, whenever possible, on the animals spotted (i.e. sex, group composition, activity);

8. Quotation should include all costs (e.g. fuel and aircraft/helicopter rental).

Appendix B: Scientific, English and Portugese names of wildlife observed during the wildlife survey of the Parque Nacional de Banhine during 2004 and 2007.

species listed alphabetically with English names first

Common name (English)	Common name (Portugese)	Species (scientific name)
African Wild Cat	Gato bravo africana	Felis lybica
Blackbacked jackal	Chacal de Sela/Chacal de costas pretas	Canis mesomelas
Bushpig	Porco bravo	Potamochoerus porcus
Chacma baboon	Macaco-cão cinzento	Papio ursinus
Grey duiker	Cabrito tinvento	Sylvicapra grimmia
Honey badger	Ratel / Melivora	Mellivora capensis
Impala	Impala	Aepyceros melampus
Kudu	Cudo	Tragelaphus strepsiceros
Largespotted genet	Geneta / Simba de mahas grandes	Geneta tigrina
Nyala	Inhala	Tragelaphus angasi
Oribi	Oribi	Ourebia ourebi
Ostrich	Avestruz	Struthio camelus
Porcupine	Porco espinho	Hystrix africaeaustralis
Reedbuck	Chango	Redunca arundinum
Serval	Gato serval	Felis serval
Spotted hyena	Hiena malhada	Crocuta crocuta
Vervet monkey	Macaco de cara preta / Macaco azul	Cercopithecus aethiops
Warthog	Facocero	Phacochoerus africanus

species listed alphabetically with Portugese names first

Common name (Portugese)	Common name (English)	Species (scientific name)
Avestruz	Ostrich	Struthio camelus
Cabrito tinvento	Grey duiker	Sylvicapra grimmia
Chacal de Sela/Chacal de costas pretas	Blackbacked jackal	Canis mesomelas
Chango	Reedbuck	Redunca arundinum
Cudo	Kudu	Tragelaphus strepsiceros
Facocero	Warthog	Phacochoerus africanus
Gato bravo africana	African Wild Cat	Felis lybica
Gato serval	Serval	Felis serval
Geneta / Simba de mahas grandes	Largespotted genet	Geneta tigrina
Hiena malhada	Spotted hyena	Crocuta crocuta
Impala	Impala	Aepyceros melampus
Inhala	Nyala	Tragelaphus angasi
Macaco de cara preta /Macaco azul	Vervet monkey	Cercopithecus aethiops
Macaco-cão cinzento	Chacma baboon	Papio ursinus
Oribi	Oribi	Ourebia ourebi
Porco bravo	Bushpig	Potamochoerus porcus
Porco espinho	Porcupine	Hystrix africaeaustralis
Ratel / Melivora	Honey badger	Mellivora capensis