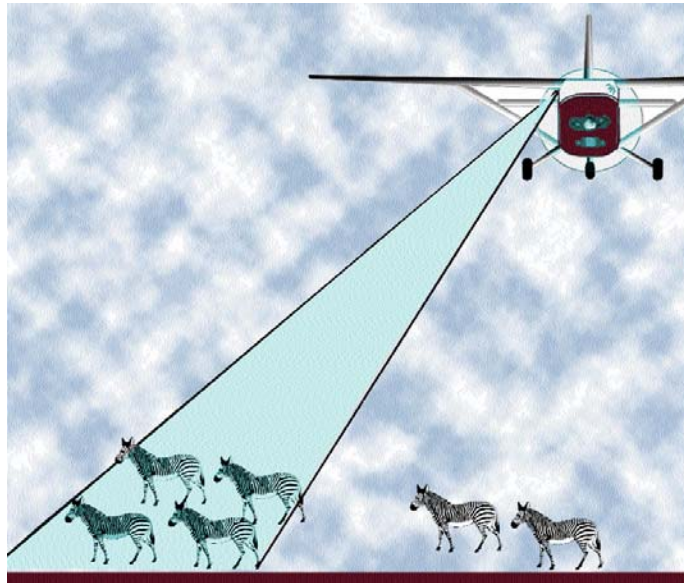


AERIAL CENSUS in the SELOUS-NIASSA WILDLIFE CORRIDOR

Dry Season 2006



Conducted by
TANZANIA WILDLIFE RESEARCH INSTITUTE
CONSERVATION INFORMATION AND MONITORING UNIT
in collaboration with

**TANZANIA NATIONAL PARKS
WILDLIFE DIVISION**

Commissioned by
Wildlife Division and SNWC/UNDP-GEF/GTZ-IS



Aerial Census in the Selous-Niassa Wildlife Corridor, Dry Season, 2006

Wildlife Division
P.O. Box 1994
Dar es Salaam, Tanzania

With Financial Support from
UNDP-GEF
SNWC/UNDP-GEF/GTZ-IS

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ABBREVIATIONS and ACCRONYMS

CIMU	Conservation Information and Monitoring Unit
ESRI	Environmental Systems Research Institute
FSO	Front Seat Observer
FZS	Frankfurt Zoological Society
GCA	Game Controlled Area
GEF	Global Environment Facility
GPS	Global Positioning System
GR	Game Reserve
GTZ-IS	Gesellschaft für Technische Zusammenarbeit –International Services (Germany Agency for Technical Cooperation)
NGR	Niassa Game Reserve
RSO	Rear Seat Observer
SGR	Selous Game Reserve
SE	One Standard Error
Shoats	Sheep and goats (added together)
SISTA	Survey Information System at TAWIRI
SMC	Selous-Masasi Corridor
SNWC	Selous-Niassa Wildlife Corridor
SRF	Systematic Reconnaissance Flight
TANAPA	Tanzanian National Parks
TAWIRI	Tanzanian Wildlife Research Institute
TWCM	Tanzania Wildlife Conservation Monitoring <i>(now referred to as Conservation Information and Monitoring Unit)</i>
UNDP	United Nations Development Programme
WC	Wildlife Corridor
WD	Wildlife Division
WMA	Wildlife Management Area

SUMMARY

- A Systematic Reconnaissance Flight survey was conducted on 9,096 square kilometers of the Selous-Niassa Wildlife Corridor during the dry season 2006 to enumerate wildlife and human activities and compare the results with previous surveys.
- Elephants with an estimated population size of $3,330 \pm (712 \text{ SE})$, were the most numerous species followed by Buffaloes ($1,456 \pm 949$), by eland, and sable antelope. Other wildlife species encountered included zebra, hippo and duiker.
- The population of sable antelope in the Corridor showed a declining trend while elephant, buffalo and eland remained stable compared to the 2000 dry season census results. Trend of other wildlife species was indeterminable from results of the two censuses.
- Human settlements and cultivation increased significantly while timber harvesting appeared to have decreased in the Corridor compared to 2000.

RECOMMENDATIONS

- Control of trans-boundary poaching, will need well coordinated cross-border law enforcement between Tanzania and Mozambique possible through intergovernmental cooperative agreement. To give wildlife the right of way, there is need of promoting the efforts being taken to create a network of Village Wildlife Management Areas to complement the small forest and game reserves found in the area.
- There is a need of carrying out another wet season census to get an assessment of the species of wildlife that got missed in dry season.

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INTRODUCTION

This Census was requested by the project SNWC/UNDP-GEF/GTZ-IS. The survey was conducted during the dry season in year 2006 over Selous-Niassa wildlife corridor, here referred to as the Selous-Niassa Corridor (SNWC).

The Selous-Niassa Wildlife Corridor (SNWC) is a sparsely settled area to the south of the Selous Game Reserve with 30-40 km width and about 200 km long, ending at the Ruvuma River which forms the northern border of the Niassa Game Reserve (NGR) in Mozambique. The corridor is composed mainly of Miombo woodland that is interrupted by wetlands and riverine forests. It is believed to form a traditional migratory route for elephants between Tanzania's Selous Ecosystem and Mozambique Niassa ecosystem which form a combined stronghold of elephant (TAWIRI 2001).

The censuses had the following objectives:

- i) The distribution and densities of large animal species;
- ii) The distribution and densities of human activities;
- iii) To assess trends in wildlife populations and human activities by comparing with previous surveys.

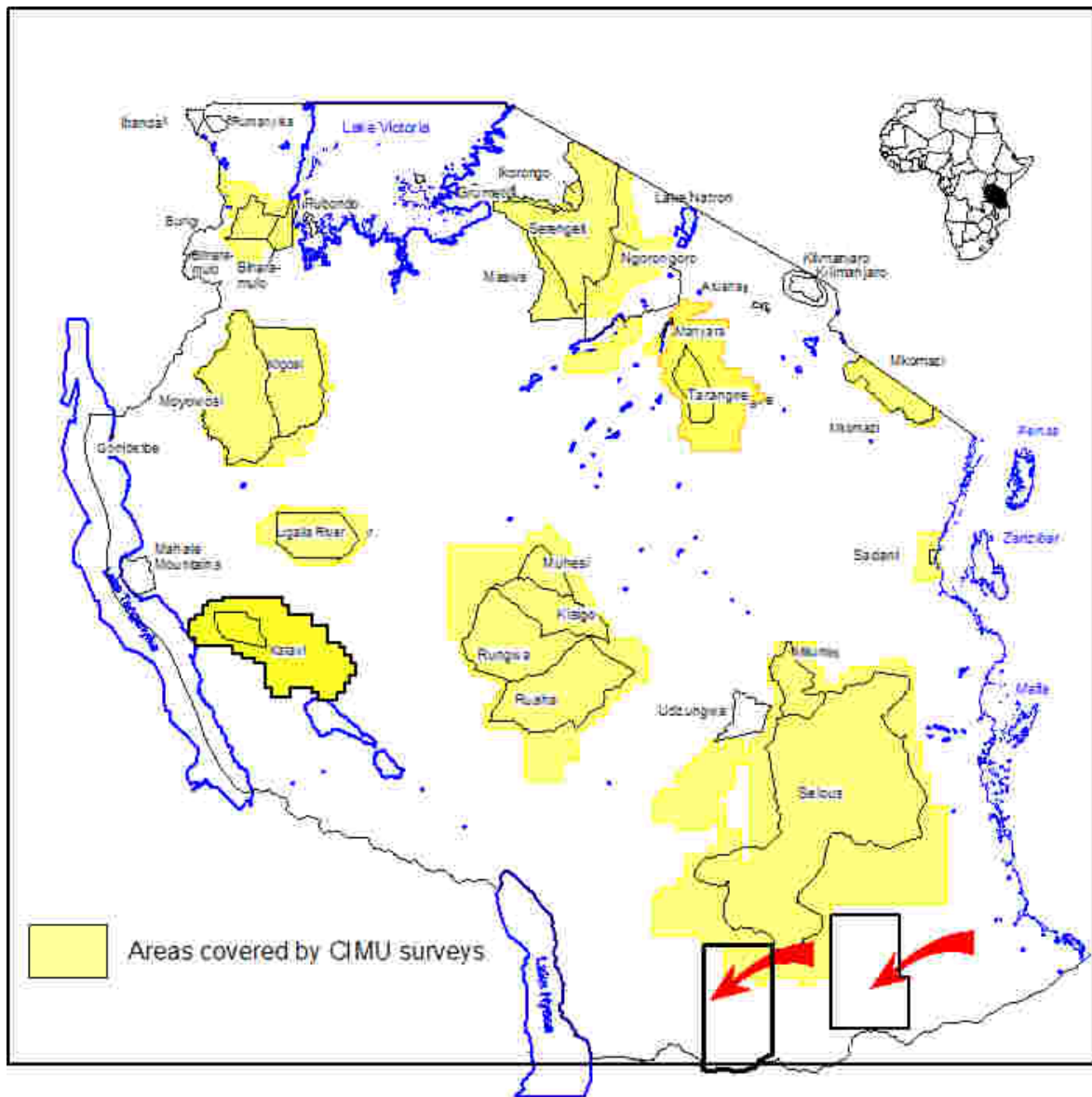


Figure 1: Map of Tanzania showing the location of the Selous-Niassa Wildlife Corridor (Left pointer) with the other corridor (right pointer) and other wildlife protected areas

METHODS

Study area:

Selous-Niassa wildlife corridor is comprised of mixed Miombo (*Brachystegia* spp) and grassy woodlands that are dominated by *Acacia* spp. There are permanent water sources that include the Mbarangandu, Lukimwa, Msangesi and Sasawara Rivers and the Ruvuma forming its southern boundary which also form the international boundary between Tanzania and Mozambique. It is in Ruvuma Region covering a total of approximately 6,000 to 8,000 km² within Tunduru and Namtumbo Districts. This surveyed covered 9,096 km². Figure 2 shows the location of the surveyed area south of the Selous GR while Figure 4 shows how it connects the two game reserves while Figure 12 shows its location relative to the Niassa ecosystem.

Census Technique:

This survey applied the Systematic Reconnaissance Flights method according to (Norton-Griffiths 1978) with transects spaced 2.5 km apart. Transects were flown in East-West direction. The Pilot recorded the starting and end points of each transect by using the Global Positioning System (GPS) on the flight map. Each transect was divided into 30 second sub-units for geo-referencing purposes within the survey area. The front seat observer (FSO) recorded (i) the radar altimeter reading at the start of each sub-unit. (ii) GPS geo-referencing information on data sheets and called out the number of each sub-unit. Rear seat observers (RSO) recorded onto recorders all wildlife observed within counting strips defined by streamers fitted to the wing struts on either side of the aircraft. Observations were transcribed onto data sheets after each flight. The Survey parameters are summarized in Table 1.

Data Analysis:

Analysis was done by using SISTA software developed for analysis of SRF data based on Norton-Griffiths (1978) and Jolly Method 2 (1969). Population trend was determined using *d-test* (Cochran, 1954). Distribution maps were created using ArcGIS 9.0 (ESRI).

Table 1. Wildlife surveys in the Selous-Niassa Wildlife Corridor, 1989 - 2006

Year	Season	Area covered*	Area (km ²)	Source	Survey Code
1989	Dry	Partial*		TWCM 1989	SL03
1991	Wet	Partial*		TWCM 1991	SL04
1994	Dry	Partial*		TWCM 1995	SL05
1998	Dry	~50% of wet 2000 survey		TWCM 1998	SL06
2000	Wet	Selous-Niassa WC	10,576	TAWRI 2001	SN01
2000	Dry	Selous-Niassa WC	9,644	TAWRI 2001	SN02
2006	Dry	Selous-Niassa WC	9,096	This report	SN03

* Partial coverage does not include estimates for the area; only distribution comparisons were made

Table 2. Survey parameters of the Selous-Niassa Wildlife Corridor dry season count, 2006

AIRCRAFT	5H-SGR	5H-MPK	COMBINED
Survey Area (km ²)	4,760.25	4,335.95	9,096.2
Total number of transects	14	12	26
Sample Fraction %	5.4	3.8	4.6
Flying height (feet)			
Average	350	358	353
Mode	350	350	350
Median	350	360	350
Standard deviation	25	22	47
Minimum	330	340	330
Maximum	450	500	500
Total number of Sub-units	581	496	1,077
Transect Distance (km)	2,110	1,820	3,930
Ground Speed (km/h)	232	243	237
Sample Area (ha)	30,210	28,501	58,711
Mean Strip Width (meters)			
Left Observer (RSO)	106	88	149
Right Observer (RSO)	101	91	173
Combined	217	279	161

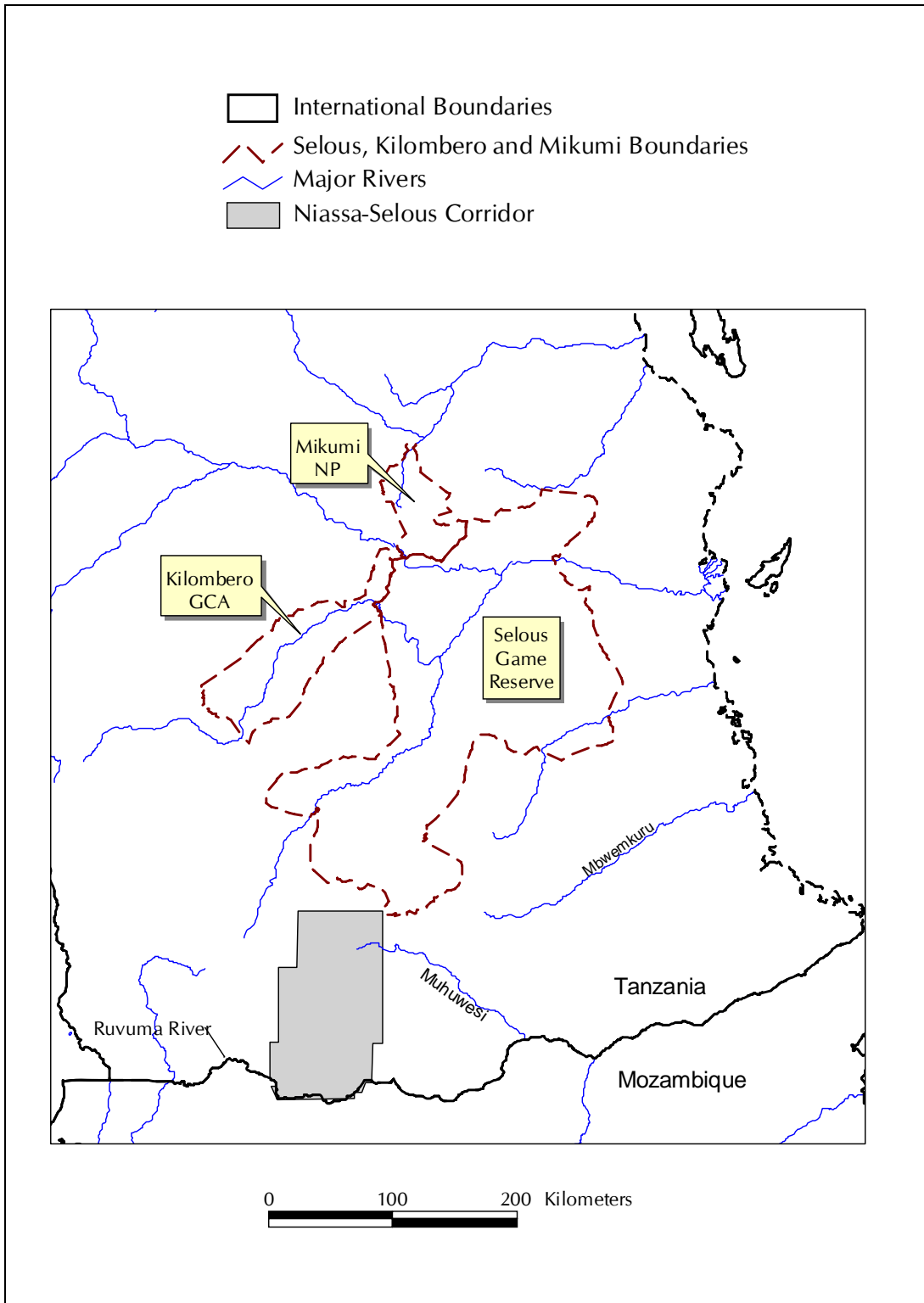


Figure 2. The Selous Ecosystem showing Selous-Niassa survey area (September 2006) and major rivers

RESULTS AND DISCUSSIONS

Population estimates for the Selous-Niassa wildlife corridor are presented in Table 3 and 5 for wildlife populations and human activities respectively. All tables present the following data:

- *Estimate* – the calculated population size for the survey area.
- *Standard error* – a measure of sampling error
- *Actual counted* – the number of individuals observed during SRF for each species.
Note that estimates are less reliable where the actual observed is less than 30 individuals (Norton-Griffiths 1978).

Wildlife

A total of seven wildlife species were counted in this census including elephant, buffalo, sable, eland, hippopotamus, zebra and duiker (Table 2). Elephants were the most numerous followed by buffalo, sable antelope and eland. Others included eight zebras, three hippos and one unspecified species of duiker.

The dry season aerial census conducted in the Selous-Niassa corridor in 2000 provided baseline data for comparison with results obtained in this census.

Only sable antelope population estimate showed a declining trend compared to 2000 estimates. Population estimates of elephant, buffalo and eland remained stable while trends of remaining species counted in this census could not be determined.

Table 3. Wildlife Population estimates in the Selous-Niassa Wildlife Corridor Census Zone, September 2006

Wildlife species name	Counted	Estimated	SE
Elephant	215	3,330	712
Buffalo	94	1,456	949
Duiker	1		
Eland	26	402	377
Hippo	3		
Sable Antelope	28	433	273
Zebra	8		

Table 4. Wildlife population estimate trends in Selous-Niassa WC, 2000 – 2006

Transects	27		25			
Area	9,644		9,096			
Season	Dry 2000		Dry 2006		2000/06	Trend
Wildlife species name	Estimated	SE	Estimated	SE	<i>d-test</i> value	
Elephant	3,114	1,407	3,330	712	0.13697818	Stable
Buffalo	6,407	6,145	1,456	949	0.7962563	Stable
Duiker	204	80	1		2.5375	Unclear
Eland			402	377	1.0424	Unclear
Sable	5,335	2,004	433	273	2.4237215	Decline

Declining Species

Sable Antelope:

A total of 28 sable antelopes were counted giving an estimated population of 433 ± 273 (SE) animals but this should be taken with caution because the total counted did not reach the required minimum of 30 samples to make the estimate reliable (Norton-Griffiths 1978). Estimated population of sable antelope in the SNWC appears to have declined significantly from $5,335 \pm 2,004$ observed in 2000 to 433 ± 273 of this census (Table 4 & Figure 3 & 4). The mobility of this antelope (Kingdom 1997) may be reason for the observed fluctuation in population size and distribution responding to forage availability and seasonal changes in the corridor.

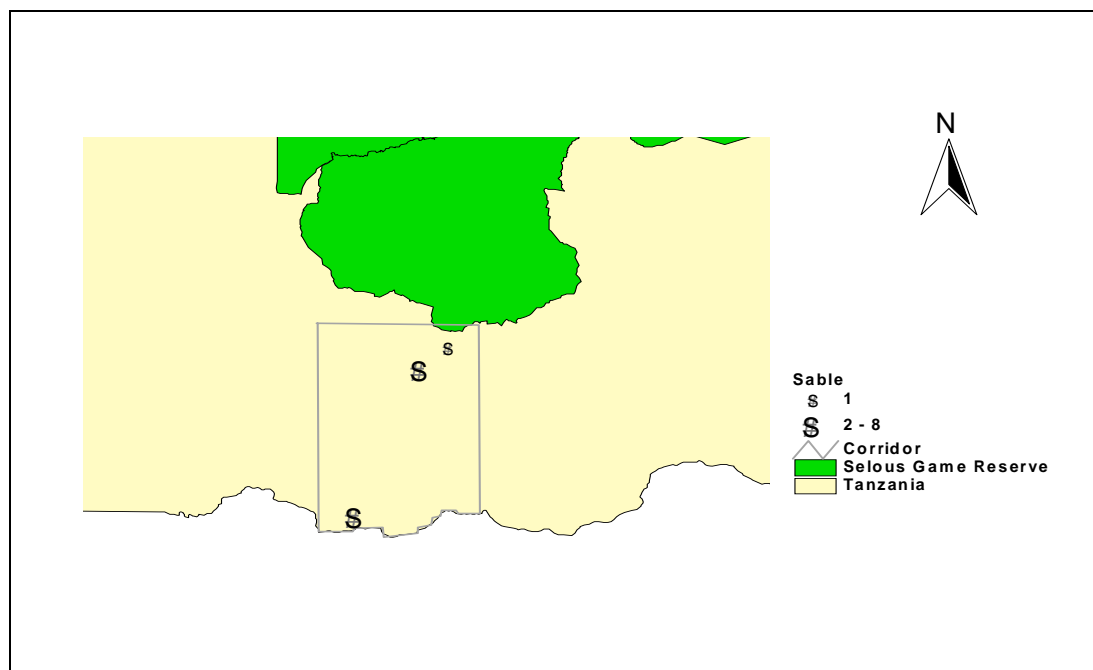


Figure 3. Density and distribution of sable antelope in the Selous-Niassa WC, September 2006

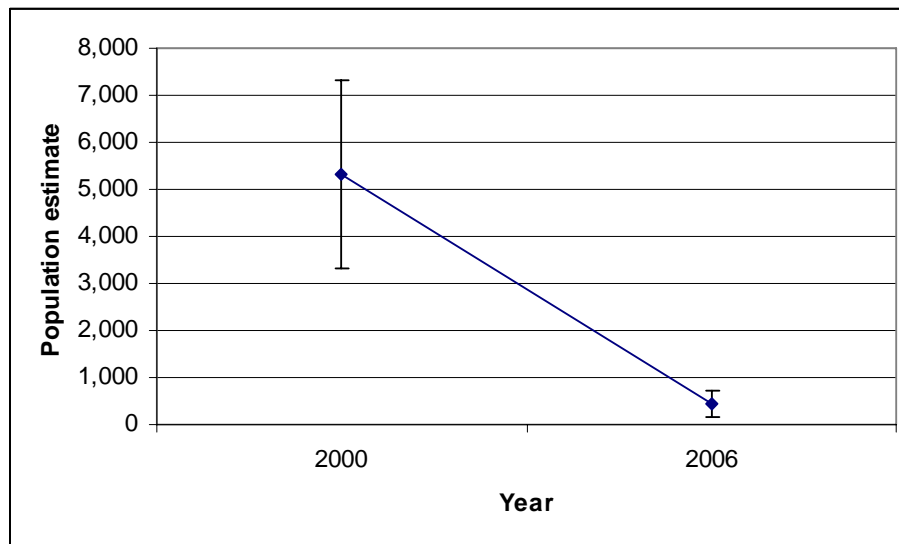


Figure 4. Sable antelope population estimate trend in the SNWC, 2000-2006

Species with Stable population

Elephant:

A total of 215 elephants were counted in the SRF samples giving an estimated population of $3,330 \pm 712$ (SE) elephants in the corridor (Table 3). This estimate remained stable with estimated $3,114 \pm (1,407$ SE) elephants of the dry season census of 2000 (Figure 6). However during the 2000 survey there were some elephants near Ruvuma River during dry season. This suggests a possible movement of elephants between Selous and Niassa game reserves through this corridor (Figure 12). This is an indication of the importance of the northern area of this corridor to the Selous GR's elephant conservation. It may be serving as dispersal area of southern Selous elephants.

Like in 2000, most of the elephant groups were found clustered on the north eastern quarter of the corridor with none in the southern half (Figure 5).

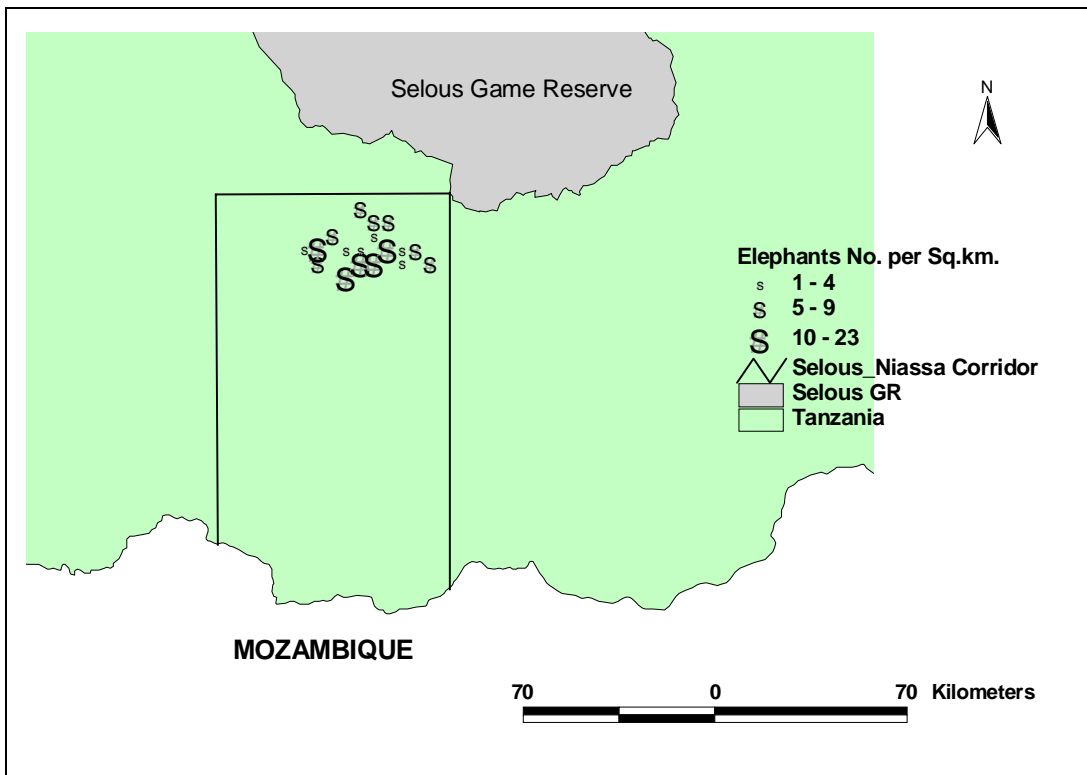


Figure 5. Density and distribution of elephants in the Selous-Niassa Wildlife corridor, September 2006

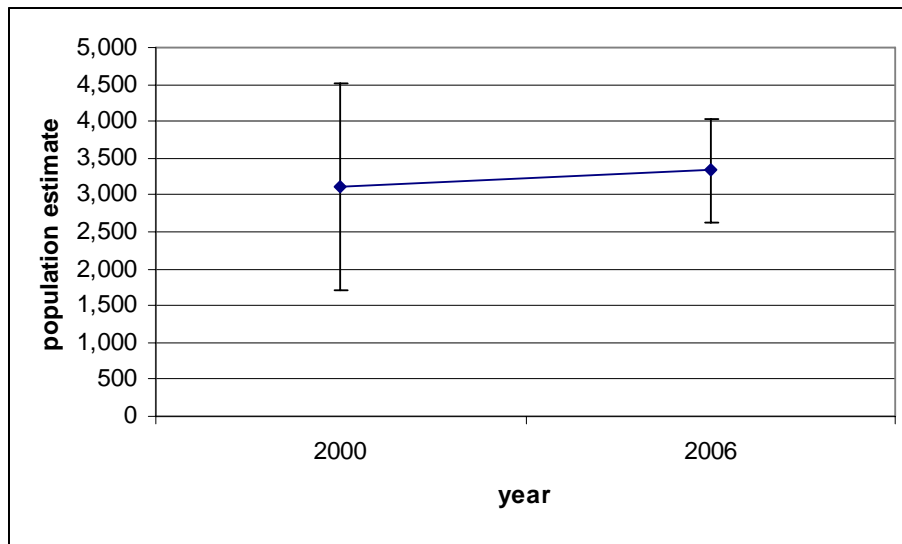


Figure 6. Elephant population estimate trend in the SNWC, 2000-2006

Buffalo:

Estimated population of buffaloes in this survey was $1,456 \pm 949(\text{SE})$ (Table 3). This population was stable compared to the estimated $6,407 \pm 6,145$ buffaloes of the 2000 census (Table 4 & Figure 8) due to the large SE accompanying the previous estimate. However, the SRF may not be the appropriate method for counting animals like buffalo that congregate to large herds where very few groups are encountered for the entire surveyed area. All the buffaloes were found near the northern boundary of the survey area (Figure 8).

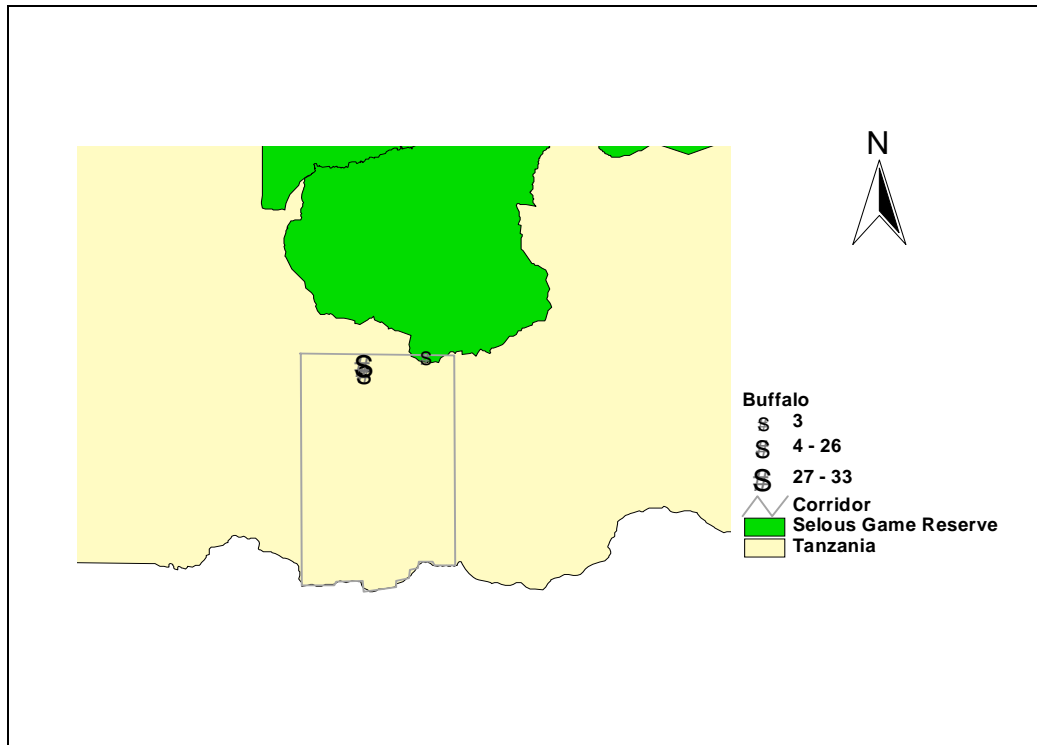


Figure 7. Density and distribution of buffalo in the Selous-Niassa WC, September 2006

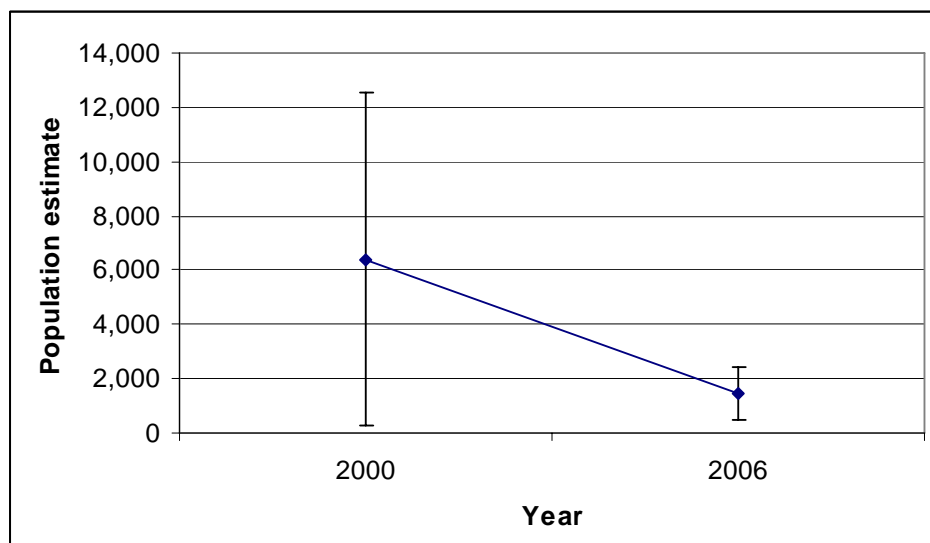


Figure 8. Buffalo population estimate trend in the SNWC, 2000-2006

Eland:

Only a total of 28 elands were counted in this survey giving an estimate of 402 ± 377 (SE) (Table 3). Again like sable antelope, the sample count is too small statistically to generate reliable estimate. However, the current estimates are indicating a consistently small population of eland in the area (Figure 10). All the elands counted were found on the southwestern tip of the surveyed area (Figure 9).

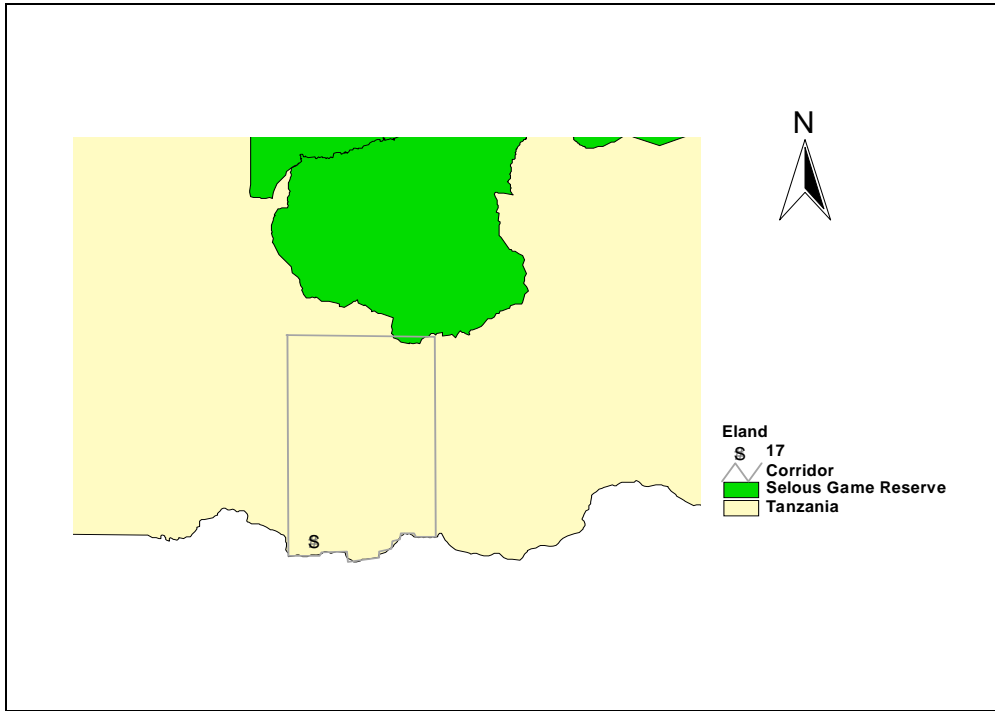


Figure 9. Density and distribution of eland in the Selous-Niassa WC, September 2006

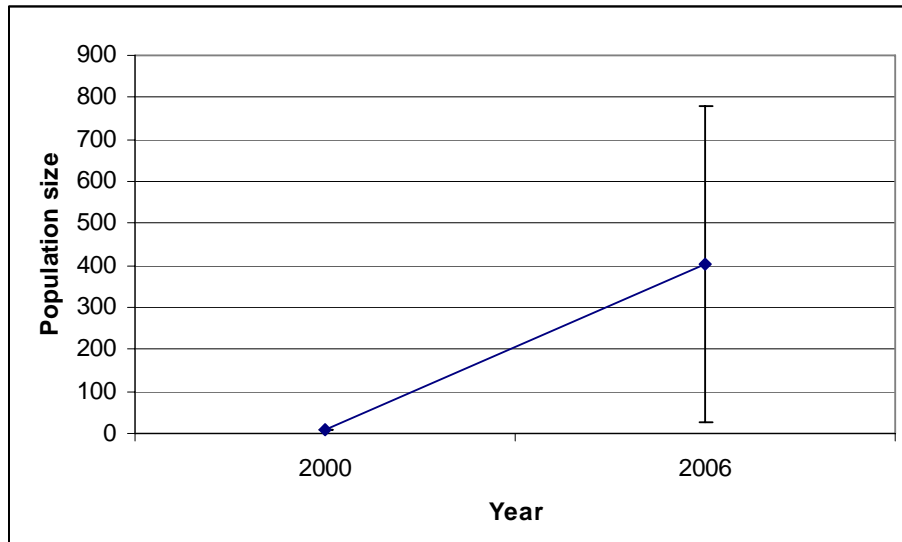


Figure 10. Eland population estimate trend in the SNWC, 2000-2006

Zebra:

Only eight zebras (Table 3) were counted in this survey making it unreliable to give accurate estimate of the species' population in the corridor. Comparing the results of this census with that of 2000 when only six zebras were counted; the population in the area must have remained consistently small. All the zebras were found near the north-western border of the survey area (Figure 10).

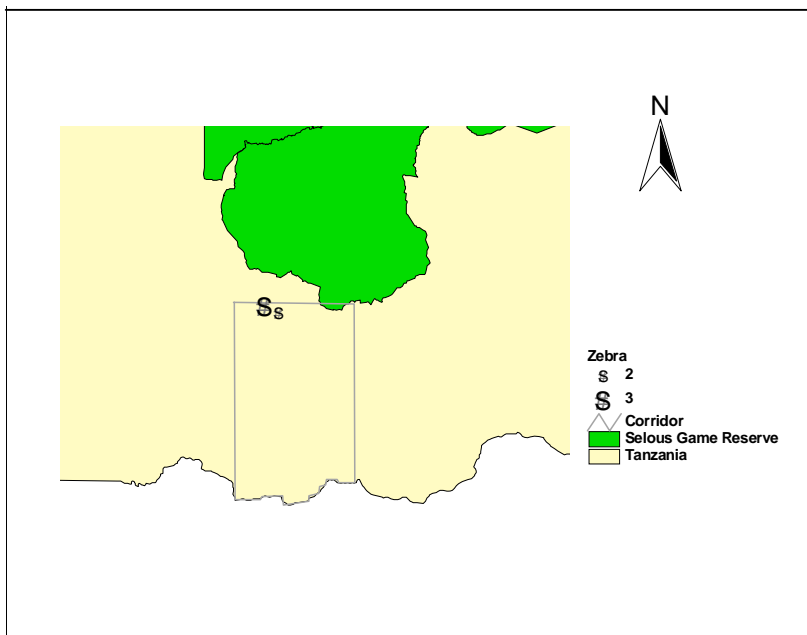


Figure 11. Density and distribution of zebra in the Selous-Niassa WC, September 2006

Other wildlife species:

Other wildlife species counted in this survey included duiker (1) and hippopotamus (3) with actual number counted (Table 3).

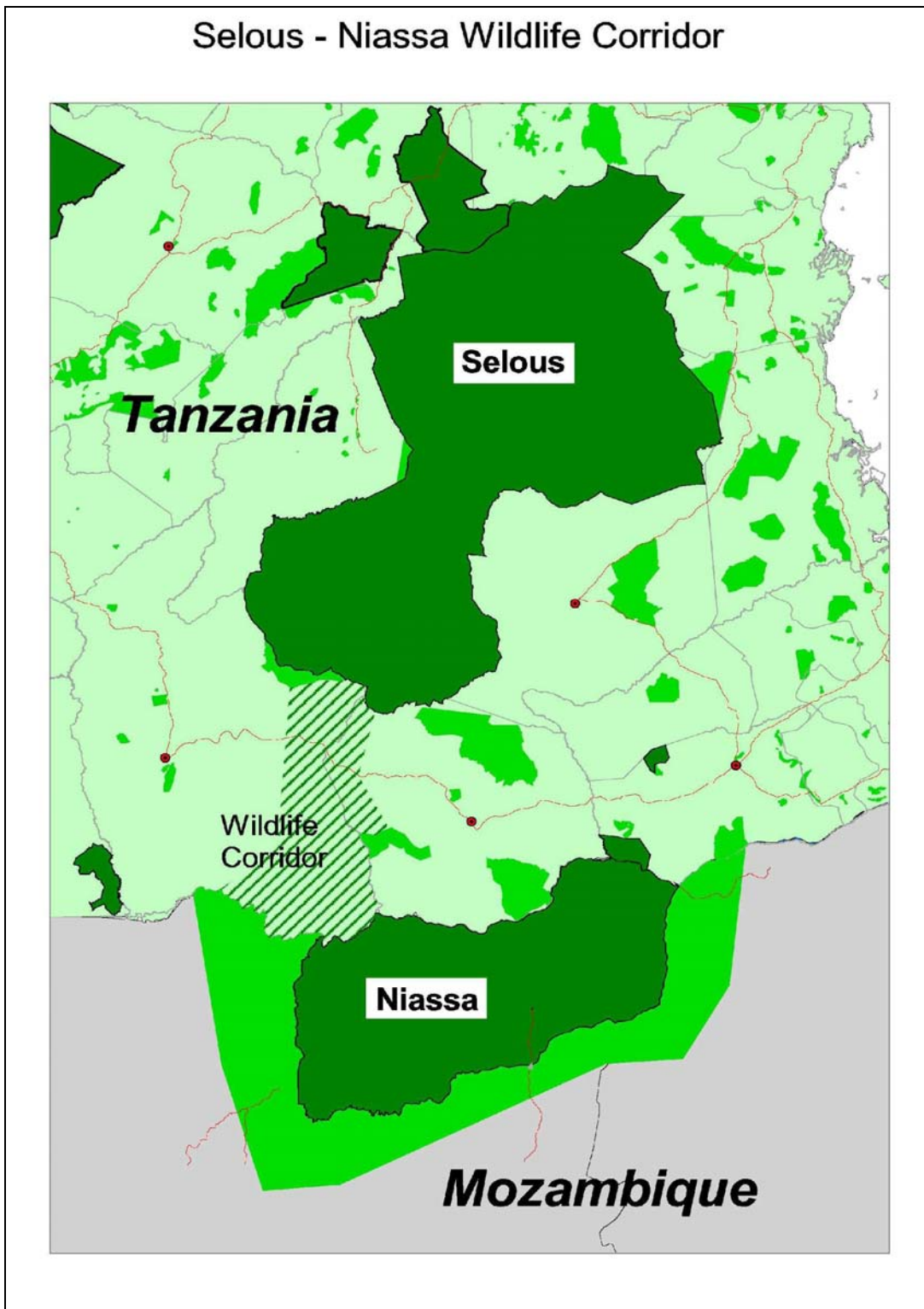


Figure 12. The Selous –Niassa Wildlife corridor location between the broader ecosystems

HUMAN ACTIVITIES

Human activities recorded in the Selous-Niassa wildlife corridor during the SRF aerial census included count of mabati roofed huts, thatch roofed huts and villages to get an assessment of human settlement, cultivated farm plots and saw pits. Human settlements and cultivation were among the most numerous human activities (Table 5).

Cultivation:

Estimated total number of cultivated farm plots in the Corridor was $9,016 \pm (1,477 \text{ SE})$ during this survey. Cultivated farm plots in the SNC showed a significant increase compared to $2,782 \pm 677$ plot estimate of the 2000 census (Table 6 & Figure 13).

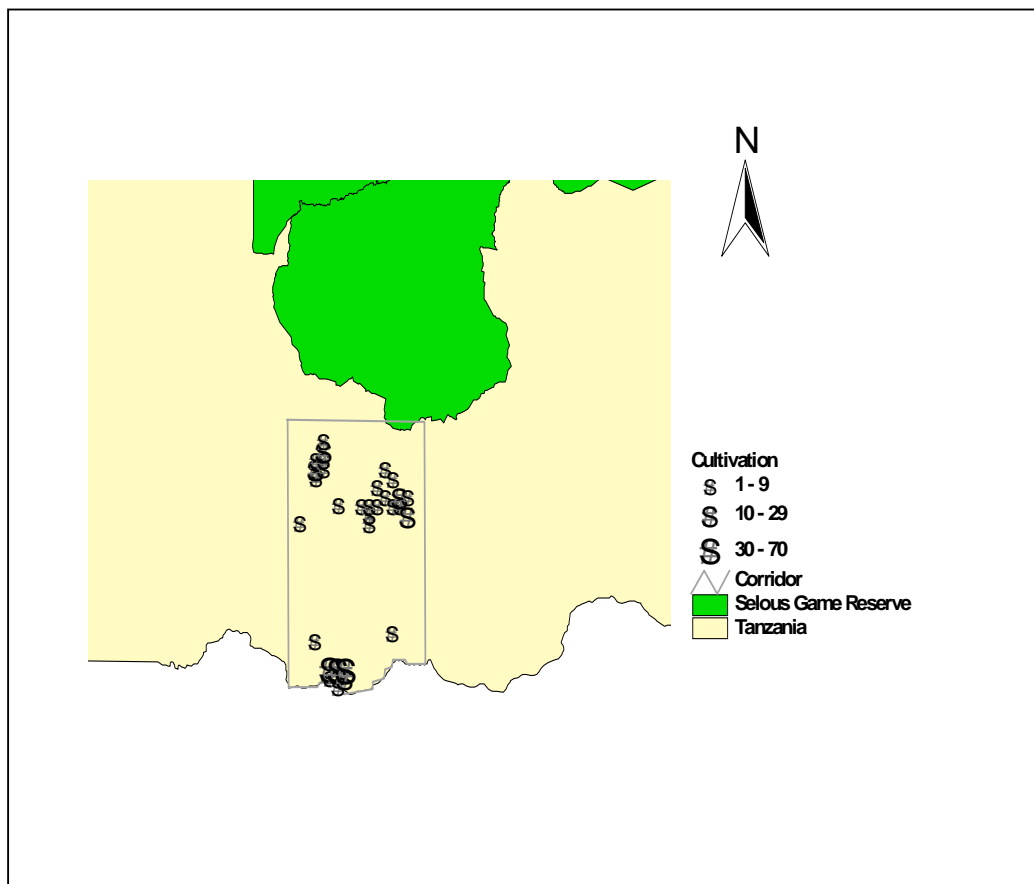


Figure 13. Density and distribution of cultivated farm plots in the Selous-Niassa WC, September 2006

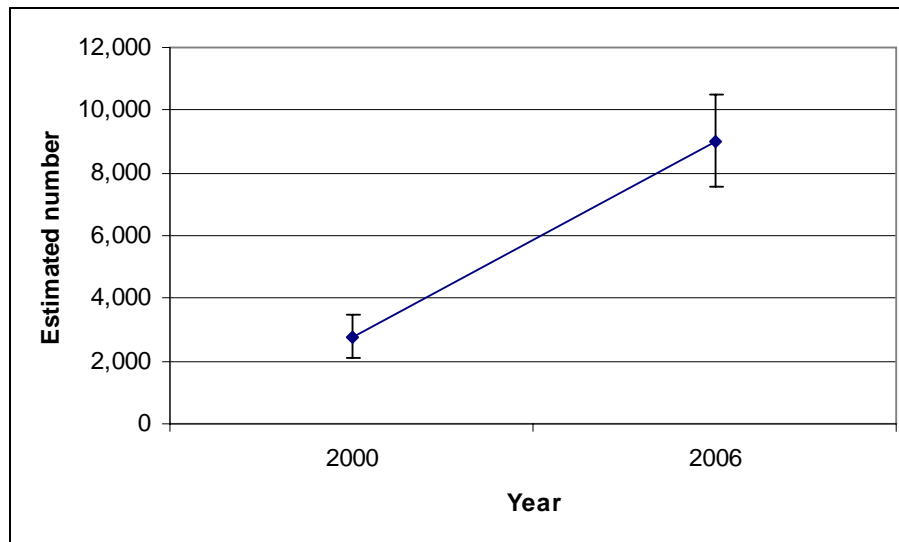


Figure 14. Estimated number of cultivated farm plots in the SNC, 2000-2006

Settlements

The estimated number of mabati roofed huts/houses was $1,456 \pm 477$ and for thatched roofed huts was $1,425 \pm 180$ (Table 5). There is an increase of mabati roofed houses in the area compared to 2000 (Table 6) while thatched roof had insignificant decline (d -test value = 1.53). Settlements as indicated by the distribution of mabati roofs (Figure 15), thatched huts (Figure 16) and village (Figure 17) are concentrated in a band across the northern half of the corridor. Extraction of forest products as shown by the presence of sawpits (Figure 18) is also within this highly settled area. However, they are less than those observed in the previous (2000) census (Figure 19).

Table 5. Estimates of human activities in the Selous-Niassa Wildlife Corridor, September 2006

Activity	Counted	Estimated	S.E.
Mabati roofed hut	42	1,456	477
Cultivated farm plots	582	9,016	1,477
Saw Pits	3		
Thatched roof huts	92	1,425	180

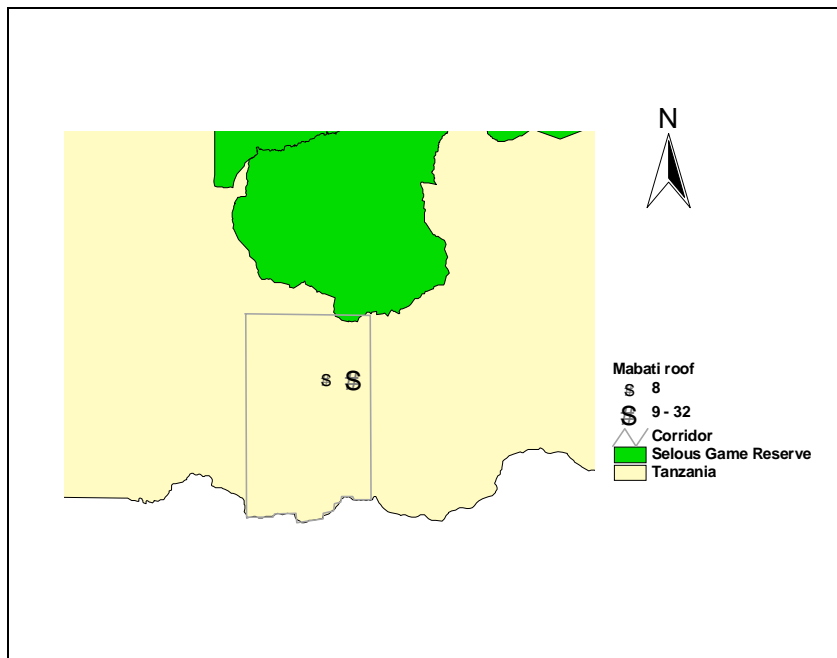


Figure 15. Density and distribution of mabati roofs in the Selous-Niassa WC, September 2006

Table 6. Human activities trend in the Selous-Niassa WC, 2000 – 2006

Transects	27		25			
Area	9,644		9,096			
Season	Dry 2000		Dry 2006		2000/06	Trend
Activity	Estimated	SE	Estimated	S.E.	<i>d-test</i> value	trend
Mabati roofed hut			1,456	477	3.0524109	unclear
Cultivated farm plots	2,782	677	9,016	1,477	3.836865	increase
Saw Pits	230	82	46	45	1.967155	Decrease
Thatched roof huts	2,553	714	1,425	180	1.531902	Stable

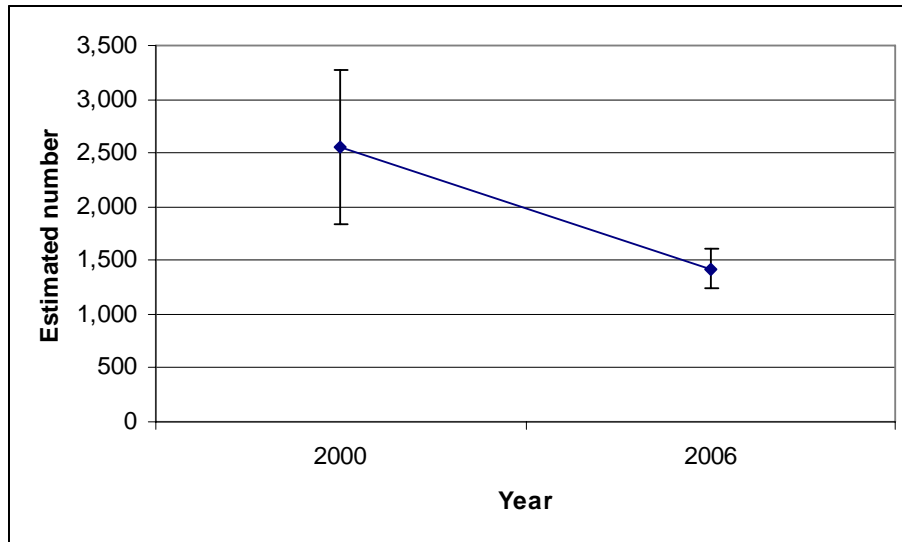


Figure 16. Estimated number of thatched roofs in the SNC, 2000-2006

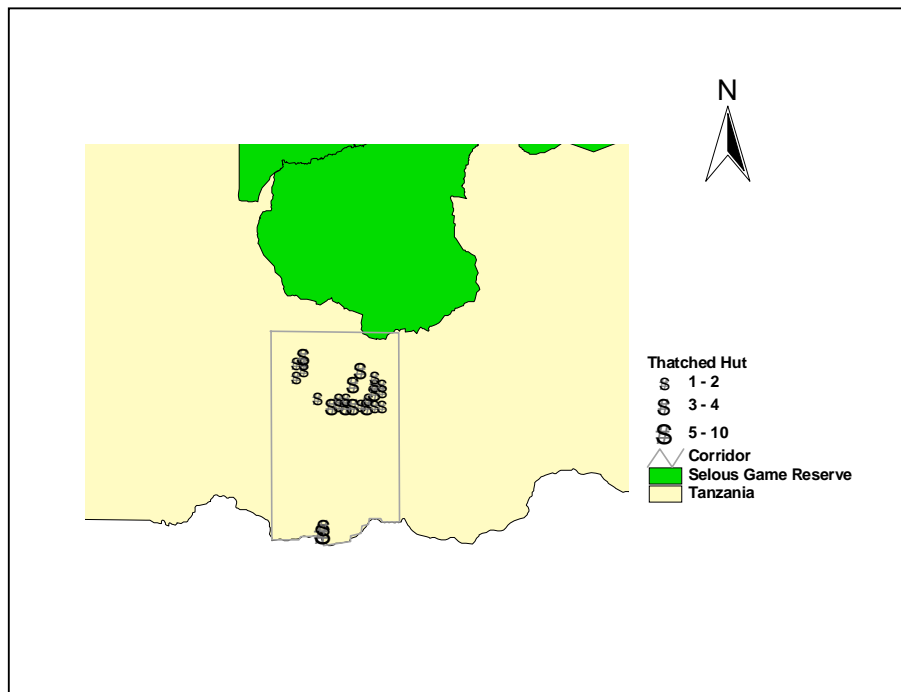


Figure 17. Density and distribution of thatch roofed huts in the Selous-Niassa WC, September 2006

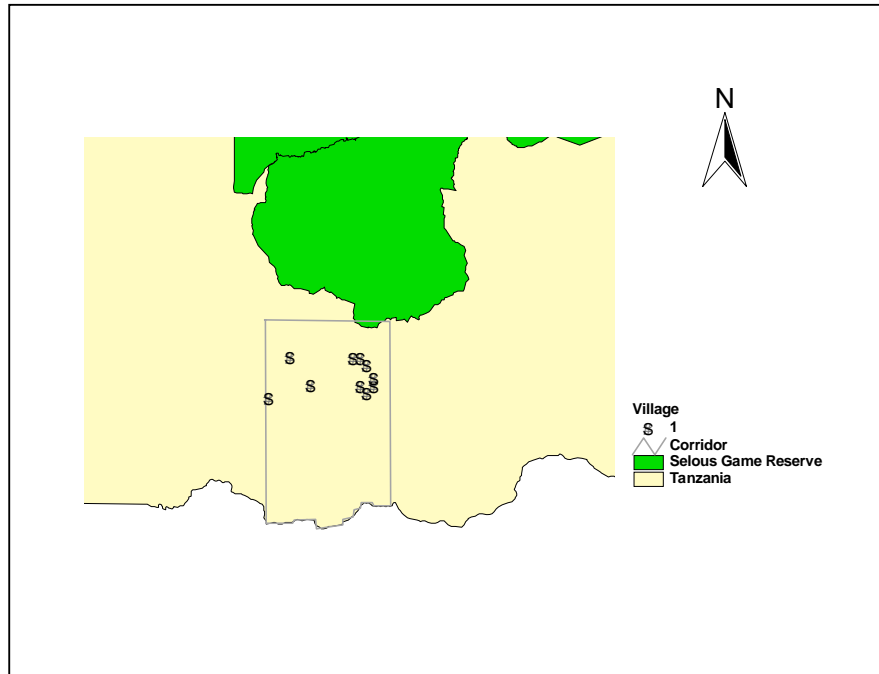


Figure 18. Density and distribution of villages in the Selous-Niassa WC, September 2006

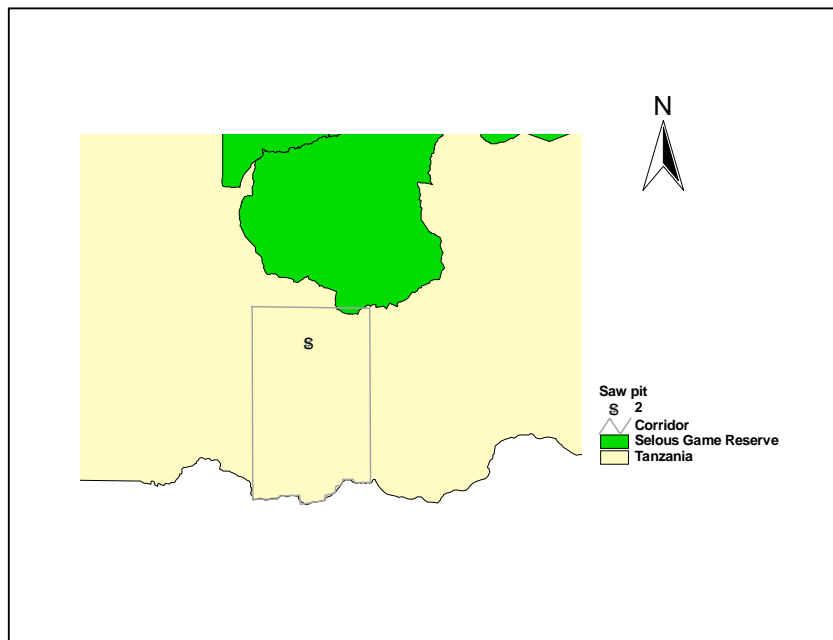


Figure 19. Density and distribution of saw pits in the Selous-Niassa WC, September 2006

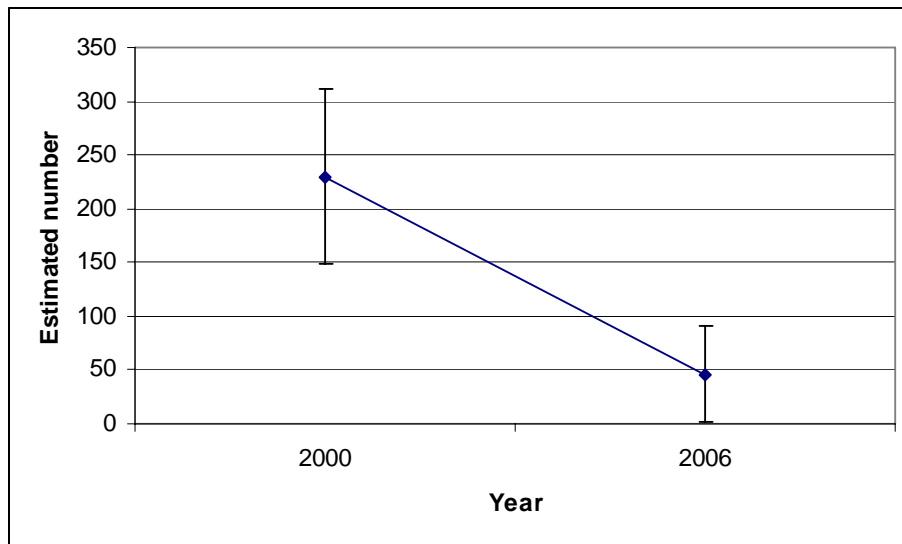


Figure 20. Estimated number of saw pits in the SNWC, 2000-2006

CONCLUSION

The species of wildlife encountered in both the 2000 and 2006 dry season censuses were less than those of the 2000 wet season census (TAWIRI, 2001). In the 2000 wet season, waterbuck (12), ground hornbill (41), hartebeest (5), greater kudu (5), bush pig (3) and crocodile (1) but not in dry season. It means the corridor has a higher diversity of wildlife during wet season that needs ascertaining by repeating the wet season census.

Most of the human activities were concentrated along or near the main roads cutting through the corridor (Figures 4, 12, 15, 16, &17) with the exception of saw pits which were further in to the north where the bulk of the wildlife was concentrated (Figures 3, 5, 7, 11 & 18). With the exception of eland and some sable antelope appearing distributed near the southern most human settlements and cultivation, most of the wildlife is to the north near the Selous GR thus appearing to avoid the main road and human settlements. Mabati roofs not recorded in the 2000 census are recorded this time located near the main road only. This is an indication of increasing permanent settlements of higher social-economic status along the main road requiring concerted effort to maintain right-of-way for wildlife that are dependent on this corridor.

ACKNOWLEDGEMENTS

We are grateful to the Director of Wildlife and Director General, Tanzania National Parks for allowing us to conduct the census.

Special thanks go to the survey crew and to all those who provided assistance in the field.

The Wildlife Division, Tanzania National Parks, Ngorongoro Conservation Area Authority and Tanzania Wildlife Research Institute provided personnel and logistical support. WD and UNDP-GEF with the project SNWC/UNDP-GEF/GTZ-IS financed the survey.

BIBLIOGRAPHY

- Baldus R. D. et al. 2003. The Selous-Niassa Wildlife Corridor. In R. D. Daldus & L. Siege Eds. (Tanzania Wildlife Discussion Paper No. 34).
- Cochran, W. G. (1954). "The combination of estimates from different experiments." *Biometrics* 10: 101-129.
- Jolly, G. M. (1969). "Sampling methods for aerial census of wildlife populations." *East African Agriculture and Forestry Journal* 34: 46-49.
- Kingdon, J. (1997). *The Kingdon Field Guide to African Mammals*. London, Academic Press Limited.
- Norton-Griffiths (1978). *Counting Animals*. Nairobi, African Wildlife Foundation.
- TAWIRI, 2001. *Aerial Census in the Selous-Niassa Corridor, Wet and Dry Season, 2000*.
- TWCM (1989). *Selous Census*. Dar es Salaam, Tanzania Wildlife Division.
- TWCM (1991). *Wildlife Census: Selous*. June 1991. Arusha, Tanzania Wildlife Conservation Monitoring.
- TWCM (1995). *Aerial Survey of the Selous Game Reserve, Mikumi National Park and Surrounding Areas (Dry Season 1994)*. Arusha, Frankfurt Zoological Society.
- TWCM (1998). *Aerial Census in Selous Game Reserve, Mikumi National Park and Surrounding Areas (Dry Season 1998)*. Arusha, Tanzania Wildlife Conservation Monitoring.

APPENDIX I: Crew Participation Selous-Niassa WC census, September 2006.

<i>Aircraft</i>	5H-SGR	5H-MPK
Pilot:	C. B. Shayo (WD)	W. A. Minja (WD)
FSO:	M. N. Mwita (TAWIRI)	P. E. Ng'walali (DW)
RSO (Left):	F. F. Temu (TANAPA)	E. P. Mutabarwa (TANAPA)
RSO (Right):	C. D. Kibwe (TANAPA)	N. J. ole Kuwai (TANAPA)
 Survey co-ordination:	Dr. S. Mduma & E. T. Massawe (TAWIRI)	
Survey ground logistics:	R.Hahn (TA SNWC/UNDP-GEF) & J. Kibebe (DW)	
Data entry and validation:	H. Haji, and A. Mchani (TAWIRI)	
Data analysis:	H. Maliti & M. Mwita (TAWIRI)	
Mapping and Georeferencing	H. Maliti (TAWIRI)	
Reporting:	E.T.Massawe and J.Kaaya (TAWIRI)	

APPENDIX II: SPECIES LIST

The following is a list of all species recorded during the survey.

MAMMALS

Buffalo	<i>Syncerus caffer</i>
Elephant	<i>Loxodonta africana</i>
Duiker	<i>Sylvicapra sp</i>
Eland	<i>Taurotragus oryx</i>
Hippo	<i>Hippopotamus amphibius</i>
Sable Antelope	<i>Hippotragus niger</i>
Zebra	<i>Equus burchelli</i>