AERIAL CENSUS OF LARGE ANIMALS
IN THE
SELOUS -MIKUMI ECOSYSTEM

DRY SEASON, 2013

POPULATION STATUS OF AFRICAN ELEPHANT

Conducted by

TANZANIA WILDLIFE RESEARCH INSTITUTE

in collaboration with

FRANKFURT ZOOLOGICAL SOCIETY

TANZANIA NATIONAL PARKS

WILDLIFE DIVISION

Commissioned by

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AND

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Systematic Reconnaissance Flight (SRF) Census Report

Population Status of African Elephant

in Selous – Mikumi Ecosystem, Dry Season, 2013

Front cover photograph: African elephant (*Loxodonta Africana*) seen from the air.

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INTRODUCTION

An aerial survey was conducted by TAWIRI in collaboration with WD, TANAPA and FZS in the Selous – Mikumi ecosystem during the dry season of 2013 (October 4-__, 2013). The census zone comprised of Selous Game Reserve, Mikumi National Park, Kilombero Game Controlled Area, Selous-Niassa Corridor and surrounding open areas and village land (Figure 1). The total surveyed area was 87,421 km^2. The aim of the census was to establish the population size of large animals, identify their diversity and geographical distribution. This preliminary report focuses on the African elephant (*Loxodonta africana*) population estimate because of its urgency. A full report presenting results of all counted species will be presented at a later date.

Census objectives: To assess population status of large animals in the Selous-Mikumi Ecosystem and to determine their population trends by comparing results with previous estimates.

Previous censuses.

Several systematic reconnaissance flight (SRF) surveys have been conducted in Selous-Mikumi ecosystem since the 1970s (Table 1). However, the size of surveyed areas varies considerably from about 5,000 to 98,725 km^2.

Table 1. Wildlife Surveys in the Selous Ecosystem, 1976 - 2013

Year	Season	Survey Area	Area (km^2)	Source
1976	Wet	Selous ecosystem excluding Kilombero	73,959	Douglas-Hamilton (1976)
1976	Dry	Selous ecosystem excluding Kilombero	74,131	Douglas-Hamilton (1976)
1979	Wet	Rufiji Basin	6,354	Ecosystems Ltd (1980)
1979	Dry	Rufiji Basin	6,354	Ecosystems Ltd (1980)
1981	Wet	North & Eastern Selous GR	19,550	TWCM (1981)
1981	Dry	North & Eastern Selous GR	10,780	TWCM (1981)
1986	Dry	Selous Ecosystem	74,000	Douglas-Hamilton (1986)
1988	Wet	Northern Selous	4,831	Campbell (1988)
1989	Dry	Selous Ecosystem	77,866	Tanzania WD (1989)
1991	Wet	Selous Ecosystem	78,551	TWCM (1991)
1994	Dry	Selous Ecosystem	91,981	TWCM (1994)
1998	Dry	Selous Ecosystem	98,725	TWCM (1999)
2002	Dry	Selous Ecosystem	94,009	TAWIRI (2002)
2002	Dry	Kilombero Valley	2,080	TAWIRI (2003)
2006	Dry	Selous Ecosystem	80,883	TAWIRI (2008)
2009	Dry	Selous Ecosystem	80,390	TAWIRI (2009)
2011	Dry	Selous-Mikumi Ecosystem	79,206	In progress
2013	Dry	Selous-Mikumi Ecosystem	87,421	This report

METHODOLOGY

Aerial Survey Work

Aerial census was conducted using Systematic Reconnaissance Flight (SRF) technique as described by Norton-Griffiths (1978). Transects were drawn covering all critical areas of the ecosystem and were flown in east – west directions (Figure 2).

Three aircrafts (Appendix 1) were flown at an average height of 350 feet above ground and speed of 180 kilometers per hour. Transects were spaced 5 and 10 km based on (*i*) administrative area for Mikumi National Park, and (*ii*) adaptive stratification depending on observed density of elephants (Figure 3). Animals were counted within a strip width of 150m on either side of the aircraft (300m wide per transect).

Data analysis

Population estimates were calculated using Jolly's Method 2 of Unequal Sized Units (Jolly 1969) and change in population size determined using d-test (Cochran 1954).

Figure 1: The Selous-Mikumi ecosystem showing surveyed area (outer red solid line).

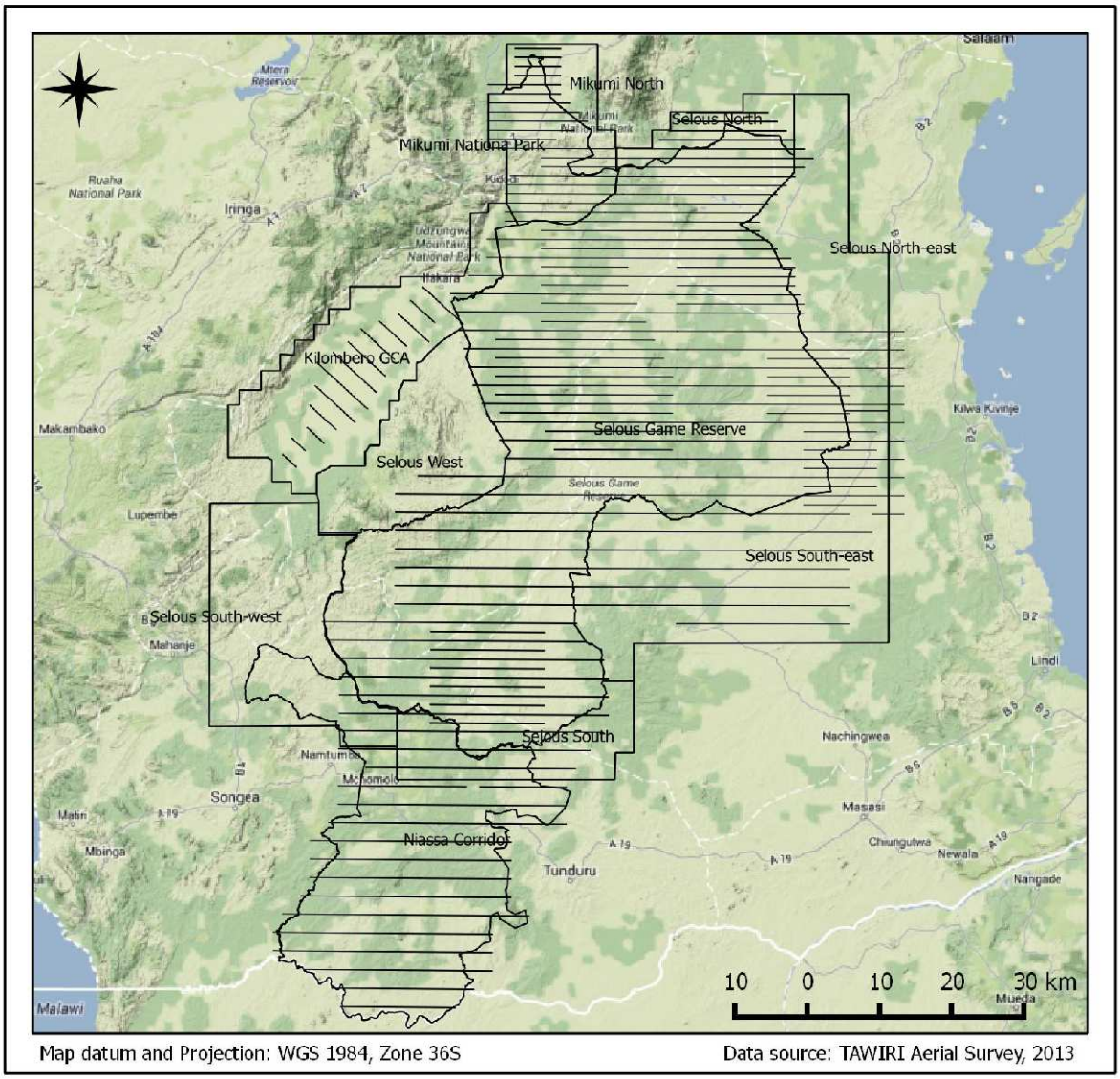

Figure 2. Planned transect for the 2013 dry season Selous-Mikumi ecosystem aerial survey.

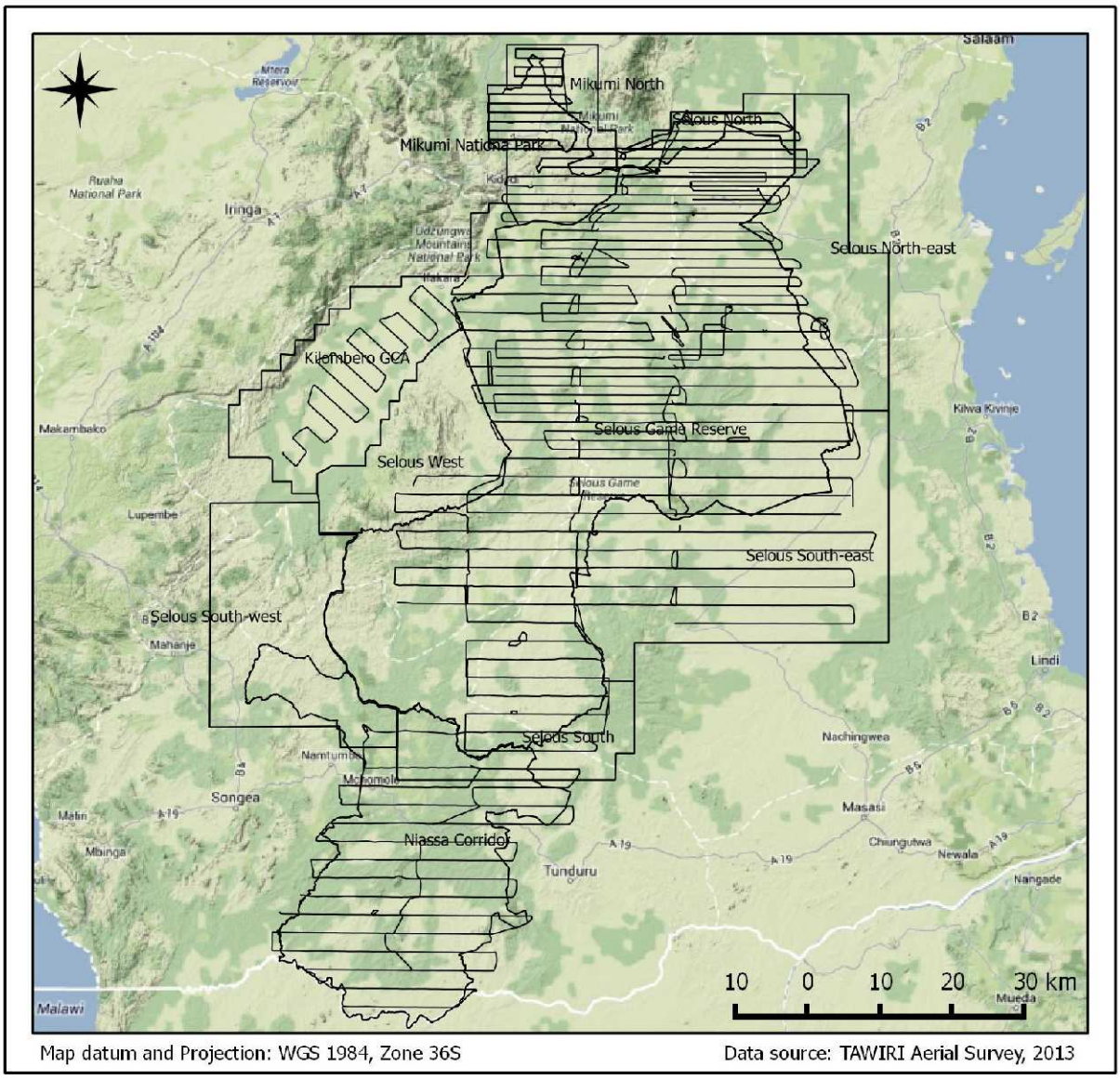

Figure 3. Track log of flown transects in the Selous-Mikumi and Selous-Niassa Corridor SRF.

RESULTS

Elephant population estimate

A total of 203 transects were covered (Figure 3), along which 712 elephants were counted. This gave an estimate of **13,084 (± 1,816 SE)** elephants (Table 2), the lowest ever recorded in the ecosystem since when censuses began in 1976.

Table 2. Estimates of elephant population size shown by administrative areas

Stratum	Surveyed area (km^2)	Counted elephants	Estimated population size	SE
Selous GR	45,221	574	10,208	1,477
Mikumi NP	2,988	25	338	178
Niassa Corridor	18,513	32	1,006	810
Kilombero	392	0	-	-
Outside	18,138	81	1,533	654
Total	**85,252**	**712**	**13,084**	**1,816**

Elephant distribution

The density of elephant was not uniform across the ecosystem. Relatively higher densities were found in small pockets in the north-west, west, central and southern areas (Figure 4).

Almost 80% of elephants were found inside Selous Game Reserve and 12% outside protected areas (in open areas). Only 8% and 4% elephants were found in Niassa Corridor and Mikumi National Park, respectively. None were counted in Kilombero Game Controlled Area.

Estimate of elephant carcasses

A total of 314 elephant carcasses were recorded in four classes (Table 3). The classification is based on age of the carcass since when the animal died as shown in the last column of Table 3. However, sample sizes for Class 1 and 2 were too small for statistical treatment and were lumped together. This gave an estimate of **6,516 (± 534 SE)** elephant carcasses spanning over a period of about 3 years. Results indicate that more than two thirds (67%) were killed between 18 and 30 months ago. Much fewer elephants were killed in the last 18 months (<5%).

Table 3. Estimate of elephant carcasses for the census zone

Category of carcass	Counted carcasses	% of total	Estimate	S.E.	Age of carcass (months)
EC1	5	1.6%			< 1 mo
EC2	9	2.9%			1 – 12
EC3	211	67.2%			> 12
EC4	89	28.3%			>30-120
Total	**312**		**6,516**	**534**	

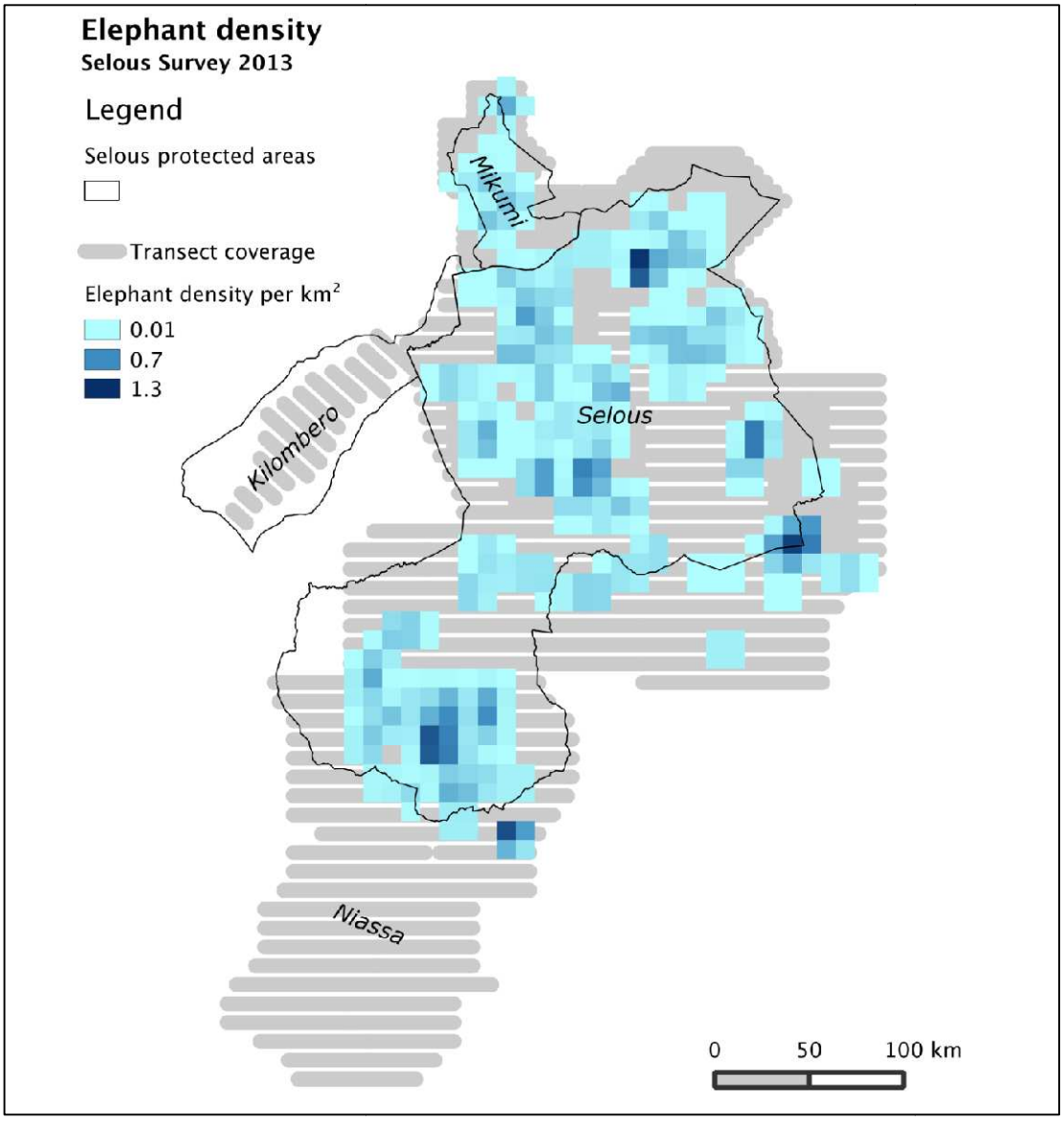

Figure 4. Density of elephants in the Selous-Mikumi ecosystem including the Selous-Niassa Corridor**.**

Elephant carcass distribution

Elephant carcasses were distributed across the historical and current areas of higher elephant density. Higher carcass numbers were found in the Kingupira sector, Northern part of Mikumi National Park and central parts of Selous Game Reserve (Figure 5). Over 95% of sighted carcasses were estimated to be more that 18 months old.

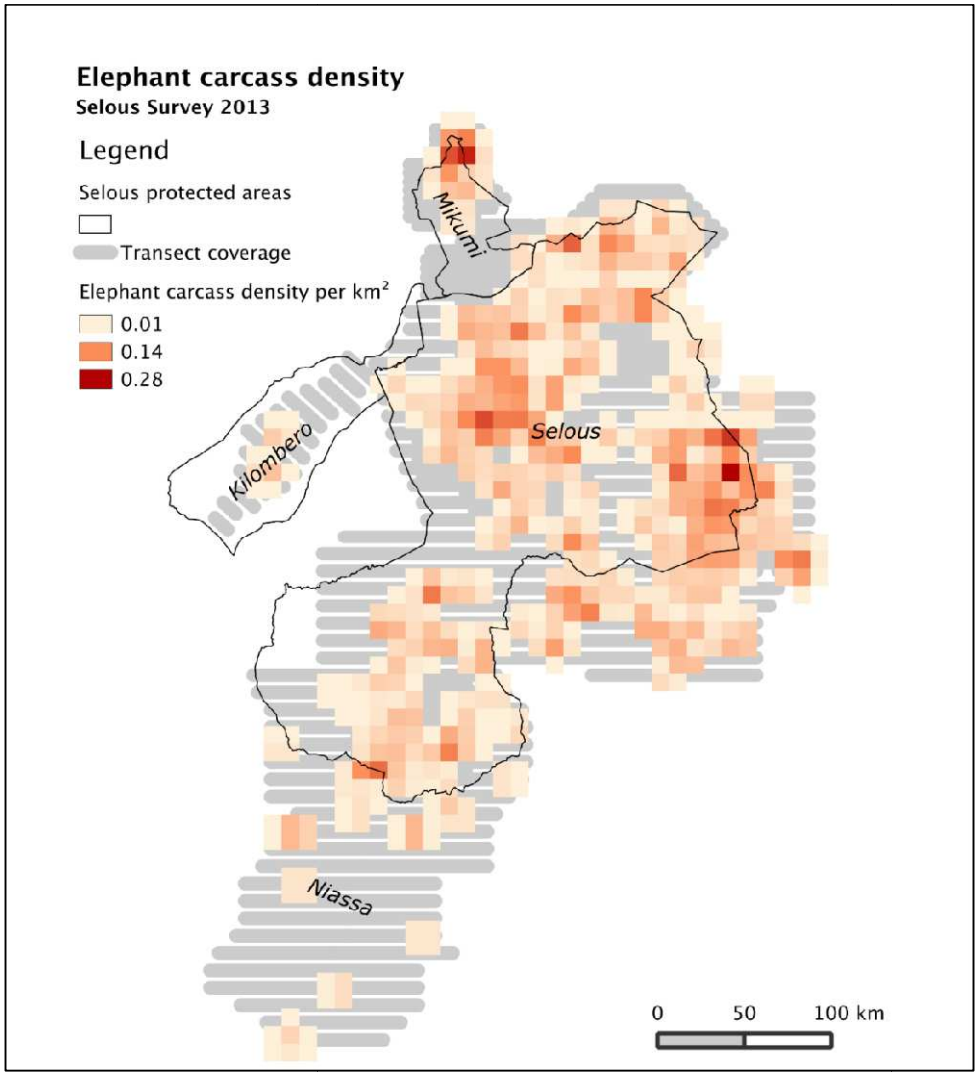

Figure 5. Density of elephant carcasses in the Selous-Mikumi ecosystem including the Selous-Niassa Corridor, dry season 2013**.**

Elephant carcass ratio

Carcass ratios can be used as an index of mortality in elephant populations. Using counted numbers of live elephant (712) and skeletons (312), the calculated carcass ratio was **30%** indicating a population that is suffering unnaturally high mortality. A

carcass ratio of about 7-8% is considered to represent natural mortality (range 4 to 16%; Douglas-Hamilton and Burrill 1991).

Elephant population trend in Selous-Mikumi ecosystem (1976 to 2013).

The estimated population size of elephants (13,683 ± 1,967 SE) is the lowest ever recorded in the Selous-Mikumi ecosystem since when censuses began (Table 4, Figure 6). The current estimate is significantly lower compared to that of 2009 (*d*-test = 8.07, $p<0.05$).

Table 4. A list of censuses conducted in the Selous-Mikumi ecosystem that are considered comparable (Note differences in size of census area).

Year	Season	Size of surveyed area (km^2)	Estimated population size	Std error	Source
1976	Dry	74,131	109,419	8,222	Douglas-Hamilton (1976)
1986	Dry	74,000	55,153	5,460	Douglas-Hamilton (1986)
1989	Dry	77,866	30,889	3,643	Tanzania WD (1989)
1991	Wet	78,551	22,208	1,873	TWCM (1991)
1994	Dry	91,981	52,234	5,330	TWCM (1994)
1998	Dry	98,725	55,672	7,690	TWCM (1999)
2002	Dry	94,009	63,039	8,136	TAWIRI (2002)
2006	Dry	80,883	70,406	24,843	TAWIRI (2008)
2009	Dry	80,390	38,975	2,644	TAWIRI (2009)
2013	Dry	87,421	13,084	1,816	This report

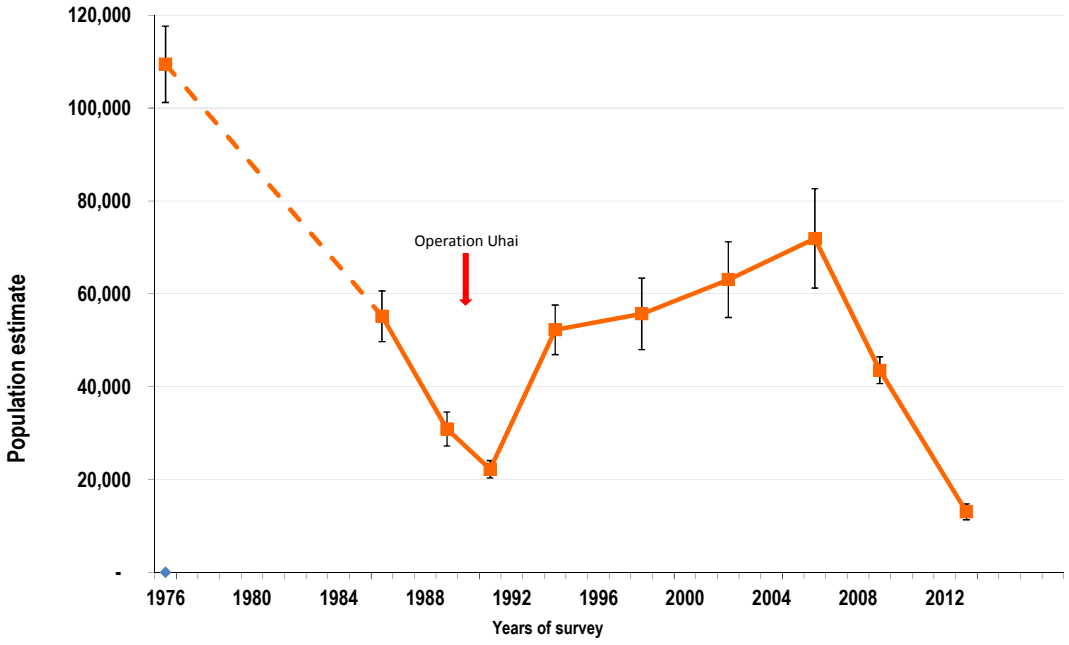

Figure 6. Elephant population trend in the Selous-Mikumi ecosystem 1976 - 2013.

Possible sources of bias

- Undercounting elephants (i) missing animals hidden under thick vegetation cover, (ii)
- Undercounting elephant carcasses because of difficulties of detecting skeletons (*i*) covered in its drying skin, (*ii*) discoloration for EC4, or (*iii*) hidden in vegetation
- Difficulty of estimating age of carcass which in-turn could be confounded by various environmental factors.

CLASS	MONTHS	DESCRIPTION
Carcass 1	< 1	Fresh, still has flesh giving the body a rounded appearance. Vultures probably present and ground still moist from body fluids.
Carcass 2	02 - 12	Recent (<1 year). Rot patch and skin still present. Skeleton not scattered.
Carcass 3	13 - 24	Old (>1 year). Clean bones, skin usually absent, vegetation re-grown in rot patch.
Carcass 4	> 24	Very old (up to 10 years). Bones scattered and turning grey.

Acknowledgements

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- Logistics, FZS (Andre, Kirsten, Henry) and Management of Selous Game Reserve (Benson Kibonde).
- Funding came from GIZ through FZS.
- Census and ground crew for dedication and hard work.

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Appendix 1. A list of aircraft and census crew who participated in the Selous-Mikumi aerial census in October 2013.

Aircraft	**5H-CFA**	**5H-TNP**	**5H - ZGF**
Pilot	David Moyer (Lungu Ltd)	Mackiyu Kajwangya (TANAPA)	Felix D. Boner (FZS)
FSO	Wilfred Marealle (TAWIRI)	Hellman Nyanda (WD)	Hamza Kija (TAWIRI)
Left RSO	Samwel Bakari (TAWIRI)	Wellness Minja (WD)	Chediel K Mrisha (TAWIRI)
Right RSO	Migezo Azori (WD)	Goodchance Chao (TANAPA)	Greyson Mwakalebe (TAWIRI)

Appendix 2. List of other participants of the October 2013 census in Selous-Mikumi ecosystem.

Logistics and Coordination	Honori Maliti, Edward Kohi (TAWIRI), Benson Kibonde (WD), André Baumgarten, Kirsten Skinner, Henry Brick (FZS
Data entry	Damara Samwel (TANAPA), Peter Mwangi (AfEDB), Edward Kohi, Hamza Kija
Validation and Verification	Simon Mduma, Stephen J. Nindi, Edward Kohi, Samwel Bakari, Hamza Kija, Mwita Machoke Honori Maliti, (TAWIRI), Howard Frederick (CRC).
Data analysis	Simon Mduma, Edward Kohi, Mwita Machoke (TAWIRI), Howard Frederick (CRC)
Mapping & geo-referencing	Hamza Kija, Mwita Machoke (TAWIRI), Howard Frederick (CRC)
Report writing	S. Mduma, S. J. Nindi, E. Kohi, S. Bakari, H. Kija, M. Machoke and H. Maliti, (TAWIRI) and H. Frederick (CRC).