Vanishing Corridors

A Last Chance to Preserve Ecological Connectivity between the Udzungwa and Selous Ecosystems of Southern Tanzania

A Feasibility Study

Trevor Jones, Francesco Rovero & John Msirikale

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Photographs and figures

All photographs, maps and other figures by Trevor Jones, except where credited.

Authors' contact details

Trevor Jones
Research Fellow
Environmental Sciences Research Centre
Department of Life Sciences
Anglia Ruskin University
Cambridge, UK

And:
P.O. Box 692
Iringa
Tanzania

Email: tembomkubwa@gmail.com

Francesco Rovero
Vertebrate Zoology Section
Museo Tridentino di Scienze Naturali
Via Calepina 14, 38100 Trento, Italy

And:
Udzungwa Ecological Monitoring Centre
c/o Udzungwa Mountains National Park
P.O. Box 99, Mang'ula, Tanzania

Email: francesco.rovero@mtsn.tn.it

John Msirikale
Independent consultant
P.O Box 41341
Dar es Salaam
Tanzania.

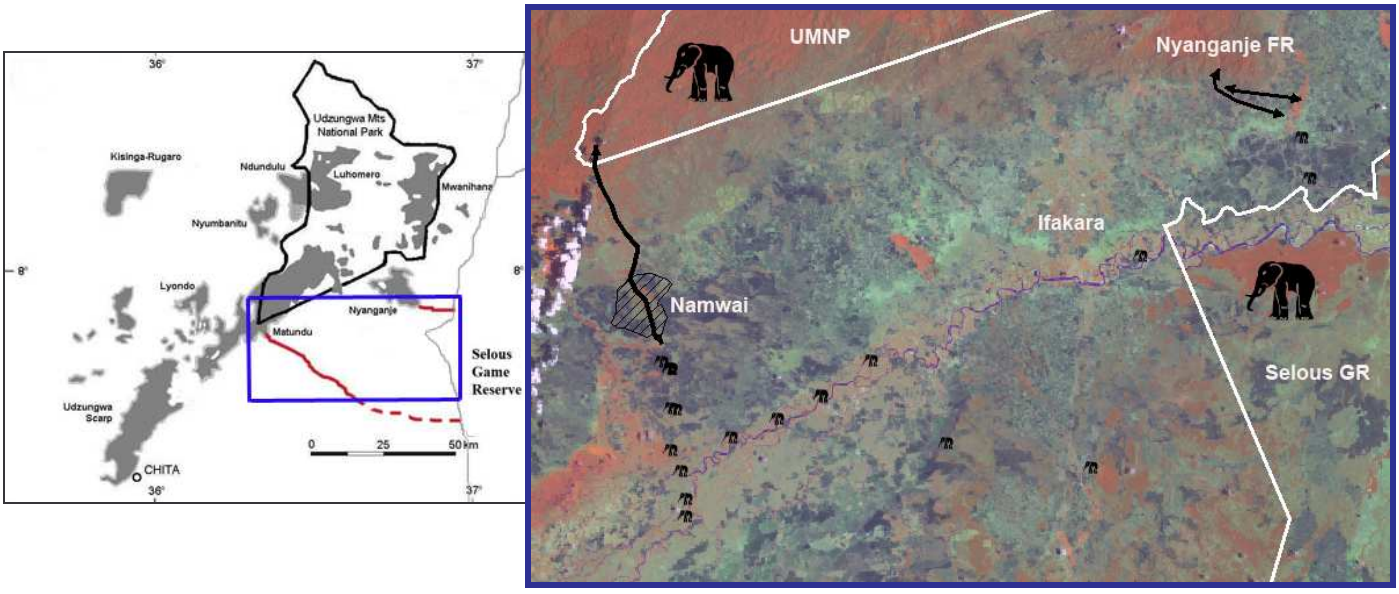
Email: jsmbmw@yahoo.com

Executive Summary

This report presents results and recommendations from a year-long investigation into the feasibility of maintaining ecological connectivity between the Udzungwa Mountains and the Selous Game Reserve of south-central Tanzania. Connectivity is defined here in terms of gene flow between populations of large mammals, made possible by movements of individuals between the two Protected Areas. We introduce the national and regional contexts of connectivity among Tanzania's Protected Areas, explaining the rationale behind this study in terms of 1) the general importance of managing corridors to preserve connectivity; and 2) the critical situation in the Kilombero Valley, where rapid immigration and widespread conversion of forest and woodland to farmland has completely blocked off the majority of traditional large mammal routes. We argue that the consequences of these changes are as potentially damaging for the local human population as they are for the other mammal populations.

We used a number of methods to first identify and then assess the remaining corridor areas, including conventional dung and disturbance transects, ground-truthing of boundaries and habitat types, analysis of high-resolution geo-referenced aerial imagery, questionnaires and interviews. We also analysed existing maps and secondary data. All data obtained were analysed using GIS wherever relevant, and practical recommendations were generated for management of the most important areas.

Our study confirmed that several previously used mammal corridors have been closed off by human settlements and agriculture in the last twenty years. However we found that two remaining, narrow corridors are still used by elephants, buffalo and (in the case of one of the corridors) other large mammals moving between the Udzungwa and Selous ecosystems. We have called these corridors the "**Nyanganje Corridor**" and the "**Ruipa Corridor**".



Map showing the position of the two remaining active elephant corridors in the Kilombero Valley. Thick arrowed lines and elephant symbols indicate observed or reliably reported incidence of elephant presence during or since 2004. Inset shows the Udzungwa Mountains and the western boundary of the Selous GR.

We present available evidence pertaining to the continued use of these routes, and evaluate their chances of persisting in the future. Both of these corridors are critically threatened by continuing immigration, land use changes, uncontrolled destruction of habitat, and increased grazing of cattle. The Ruipa Corridor in particular gives grave cause for concern, with reports suggesting that elephants have failed to pass by their usual route over the last two years.

We predict that unless urgent interventions are made to protect these two remaining corridors, both corridors will be irreversibly blocked by the end of 2009.

We have identified those sections of each Corridor in most urgent need of intervention, and the key stakeholders associated with these areas. Management options for each area were presented to and discussed by some of these stakeholders at a Workshop on the conservation of the southern Udzungwa Mountains held in March 2007; and are also presented here.

We recommend that a Corridor Management Committee be formed for each of the Corridor areas, comprising representatives of all stakeholders affected by the Corridor, in order to plan and manage more effective protection of the critical areas. Management options include: land use planning of each village and the set-aside and gazettement of 'Village Forest Reserves' to protect Corridor areas; training and assistance for communities with effective crop-raiding mitigation measures; facilitation of these activities at the local level by an experienced Tanzanian conservation-minded NGO. Other complimentary options in certain areas include purchase of critical areas of land and private management for conservation; gazettement of National Forest Reserves by the Forestry and Beekeeping Division (especially in the case of Namwai within the Ruipa Corridor); and a limited extension of the Udzungwa Mountains National Park to protect part of the Corridors.

It is our hope that at least some of the recommendations presented in this report will soon be acted upon, before this ancient and immeasurably valuable ecological connectivity is lost.

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Acknowledgements

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Tables and Figures

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1. Introduction

1.1 Background and Rationale

The Udzungwa Mountains (or 'Udzungwas') are well recognised, on account of their extremely high levels of species endemism and richness, as a critical site for conservation in East Africa (Burgess *et al*., 2007). In December 2004, the Critical Ecosystem Partnership Fund (CEPF) organised a 3-day Stakeholders Workshop in Morogoro, Tanzania, for the purpose of identifying and discussing the most acute conservation problems currently facing the Udzungwa Mountains (Sumbi *et al.*, 2005). One of the four issues identified as most important was the maintenance of ecological connectivity between the Udzungwas and other Protected Areas (PAs). The Udzungwas are central to an impressive network of large PAs in southern Tanzania, also comprising the Selous Game Reserve, Mikumi National Park and the Rungwa-Ruaha PA complex (fig. 1).

Evidence indicates movement of elephants and other large mammals across all of the unprotected zones between these wilderness areas. However, it is also clear that this ecological network is severely threatened, as the final remaining corridors of undisturbed habitat between the PAs are lost to expanding settlements and agriculture. Amongst these threatened corridors, we identified the area between the Udzungwa Mountains and the Selous Game Reserve, or the Udzungwa-Selous Corridor, as the area in most urgent need of critical conservation intervention. Here, in the Kilombero Valley, a combination of high immigration of subsistence farmers from other areas of Tanzania and the expansion of commercial cane growing is threatening to completely close off connectivity between the Udzungwas and the Selous. This is a potential disaster for the entire area, both for people and for wildlife. Human-elephant conflicts in particular are increasing, and better governance of the area is therefore needed for the welfare of local farmers. Precedents from elsewhere in Africa also suggest that the rich forests of the Udzungwa Mountains will be threatened if elephants become confined and unable to move in and out of the Udzungwas.

1.2 The Importance of Maintaining Connectivity

In practical terms, when planning to conserve a landscape and its biodiversity, there are two broad categories of connectivity which may be considered. The first is connectivity of important habitats, e.g. corridors connecting fragmented forest patches, or water channels linking ponds. The aim of this kind of connectivity is often to maintain healthy populations of endangered species of restricted range, e.g. forest birds. Being dependent on a particular habitat type, these species may have specialised habitat requirements, making certain characteristics of the corridor (e.g. plant composition, structure, size) critical to its effectiveness (Newmark, 1993). Creation or restoration of these kinds of habitat usually requires great effort and expertise, including detailed information on the ecology of the target species.

The second kind of connectivity relates to maintaining migration corridors for so-called landscape species; the aim is to conserve mammal or bird populations which need to move over large areas that cannot realistically be encompassed within Protected Areas. These species are generally more flexible in their habitat requirements, thus while minimum size (width) of corridor will still be critical, other habitat characteristics may be less important. For example, elephants, buffalo, rhinos and wild dogs usually inhabit mosaics of several habitat types, including woodland, dry bush, grassland, wetlands and forest, thus a corridor's plant composition and structure may be less important.

Considering this second category, why is it important to maintain connectivity between large mammal populations? There are three compelling reasons which are relevant to the corridors assessed in this study:

1) To reduce human-wildlife conflict (HWC): effective management of animal corridors protects lives and livelihoods through emphasis on mitigation of HWC.

2) To conserve gene flow and demographic links between populations, which is required for maintaining healthy populations of large mammals, especially when endangered.

3) To reduce pressure on ecosystems, i.e. to reduce habitat destruction that can be caused by confined animals, by maintaining natural migration and dispersal patterns.

1.3 The National Context

Tanzania's impressive array of protected areas (within which are found all of the remaining core areas for elephants) have suffered increasing pressure around their boundaries in recent decades, as the human population and associated conversion of wild lands to agriculture have rapidly expanded. A major consequence has been the loss of connectivity and gene flow between populations, turning the Protected Areas into isolated islands of habitat, many of which are predicted to be too small to support viable animal populations in the long-term, especially of those species with the largest home ranges. The importance of maintaining viable corridors between different elephant populations in Tanzania will therefore be a key element of the proposed national strategy for elephants (T. Davenport, pers. comm.).

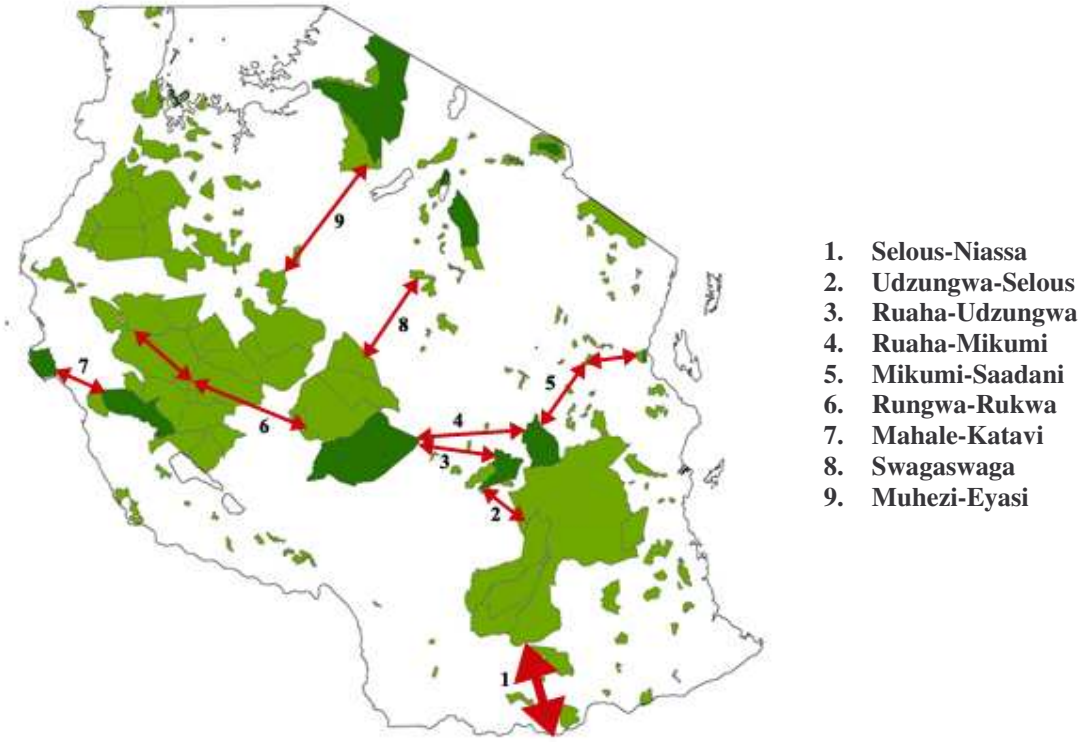

Figure 1. Major confirmed or suspected elephant corridors between the Protected Areas of Tanzania. National Parks in dark green; Game Reserves and Forest Reserves in light green; Corridors in red.

1.4 The Regional Context: South-central Tanzania and the Kilombero Valley

Across south-central Tanzania, a diverse community of large mammals can still be found outside of the Protected Areas, comprising both resident populations and animals moving in and out of the PAs. A loose network of researchers has begun documenting this diversity in recent years. In the areas of dry bush alone between Ruaha, Mikumi and Udzungwa National Parks (i.e. excluding the highland forests of Image and the Rubeho Mountains), Epps (2007) has so far recorded a minimum of 35 large mammal species outside of PAs, including Greater and Lesser kudu, reedbuck, lion, caracal and aardwolf. In terms of elephants, records across this area make it likely that the Ruaha population is still connected with the Udzungwa/Mikumi populations, at least in terms of gene flow. Epps (2007) found a positive correlation between the presence of elephants in an area and the local diversity of other large mammals. A few key sites for elephant movements have so far been identified and continue to be monitored, including the "Mtandika Corridor" and Ilole forest in the Rubeho Mountains (fig. 2). The Endangered Black rhino are probably now absent from this area, but as recently as 2000 a skull was found in Image forest (Dinesen *et al*., 2001).

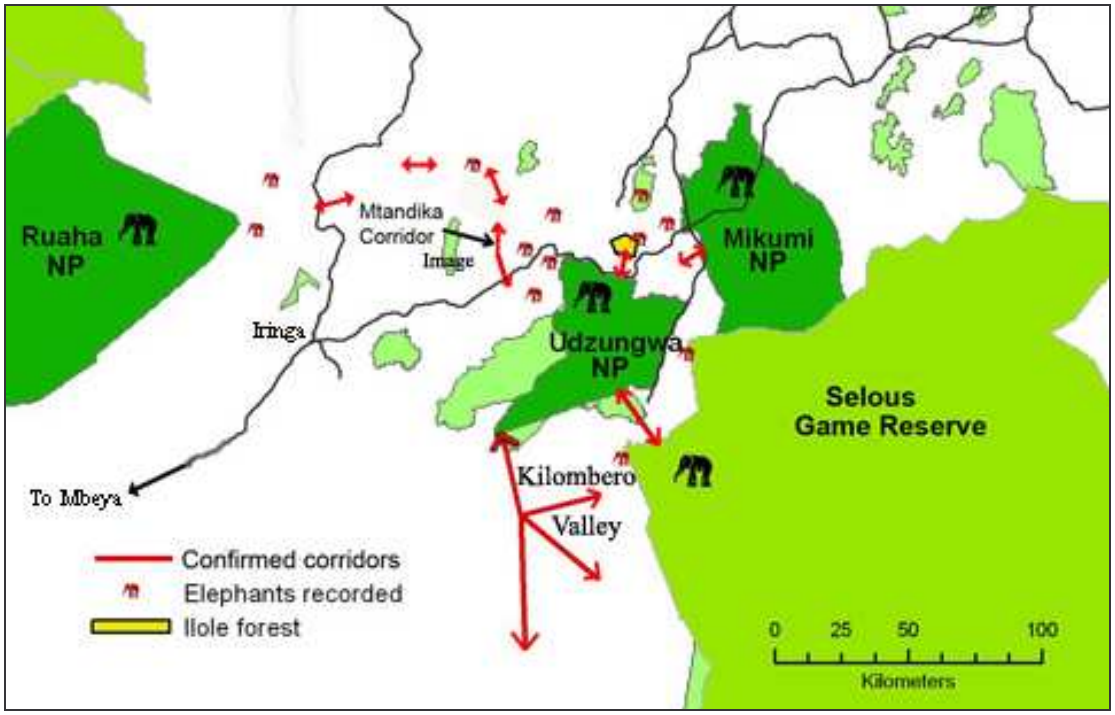

Figure 2. Currently confirmed occurrence and movements of elephant outside of Udzungwa Mountains National Park and neighbouring Protected Areas.
Sources: this study; Epps (2007); WCS Rungwa-Ruaha Landscape Conservation Program (2006); unpublished data (T. Jones, F. Rovero).

Of all the actual and potential corridor areas across this region, the Kilombero Valley presents the greatest and most urgent challenge for conservation. This area is critical for maintaining connectivity between the Udzungwa and Selous ecosystems, yet despite the proximity of the two Protected Areas, little opportunity remains for movement of animals between the two sites. This is because of the dramatic changes to land use throughout the Kilombero Valley in recent decades. The valley is a designated RAMSAR site, in recognition of its internationally important wetland habitats and their value to wetland species, especially birds (Starkey *et al*., 2002). However the Valley is also widely recognised within Tanzania as one of the most fertile areas in the country for cultivation of both cash and subsistence crops, and as a result its conversion to agriculture has been widespread and rapid. There are two major kinds of agriculture: commercial sugar-cane growing and subsistence farming. Most of the northern part of the valley is owned by Illovu Sugar Company and is a vast, mono-cultural sugar-cane plantation with virtually no diversity of habitat. Further south, subsistence farming of rice, maize and other crops is the dominant activity and land use (though some rice is also transported for sale in Dar es Salaam). Throughout the valley there has been rapid immigration of people from all over Tanzania over the last twenty years, driven by the national population boom and the increased demand for fertile land and jobs (Jones, 2006). A 2006 survey of communities in southern Kilombero Valley found that 71% of residents are recent immigrants (Harrison, 2006). This has resulted in increased settlements and widespread conversion of wetlands, forest and woodland to agriculture, destroying natural habitats and cutting off most of the traditional migration routes of animals. Another factor affecting ecological connectivity is the recent increase in cattle grazing in the south of the Valley.

Elephants are known to roam throughout the Udzungwa Mountains National Park (T. Jones, unpubl. data), and within the last 30 years were known to cross regularly from the Udzungwa Mountains to the Selous and back along several routes across the Kilombero Valley, from Msolwa in the north to Mngeta in the south (as reported by participants of the 2004 Udzungwa Workshop, Morogoro; Doody, 2005). These days, nearly all of these paths have been completely blocked by human settlements and agriculture.

Several other large mammals have also been recorded moving between the two ecosystems in recent years, including African wild dogs, lions, buffalo and sable antelope (De Luca & Mpunga, 2005; T. Jones, unpubl. data). Another important species, the black rhino, is rumoured to have been present within recent decades in Matundu forest in the Udzungwa Mountains, and is currently reported from north-west Selous and occasionally, from south-east of Mahenge Mountains (F. Alpers, pers. comm.).

1.5 Objectives of the Study

Objectives of the Study were as follows:

1) To assess the presence and locations of active large mammal corridors between the Udzungwa and Selous ecosystems in the Kilombero valley.

2) To survey and map land use, habitat types and wildlife presence in those unprotected areas adjacent to the Udzungwas identified as the last remaining possibilities for preserving connectivity.

3) To investigate and geo-reference the incidence of human-wildlife conflict in these areas, and research local attitudes to wildlife.

4) To investigate the legal status of these areas.

5) To assess all these results in order to generate recommendations for effective long-term management of the remaining corridor areas.

2. Research methodology

The study was carried out from December 2005 to April 2007. From December 2005 to February 2006 and during May 2006, training was undertaken in using Geographical Information Systems. Fieldwork was carried out between February and November 2006 (primarily during the months of April, May, August and October), with follow-up interviews and research, data analysis and report writing between December 2006 and April 2007. On 23rd March 2007, the results of the study were presented to 60 participants of the "Conservation and Management of the Southern Udzungwa Mountains: The Way Forward" Stakeholders Workshop, Morogoro, Tanzania (WWF-TPO, 2007).

Fieldwork and data analysis methods were standardised with the complimentary study, "Assessing the potential for restoring connectivity and evaluating options for improved conservation management of the south-eastern Forest Reserves in the Udzungwa Mountains of Tanzania", funded by CEPF and implemented by F. Rovero and collaborators (see report: Museo Tridentino di Scienze Naturali, 2007).

2.1 Primary data

2.1.1 Dung Transects

Thirty-eight dung transects were conducted with the aim of counting dung to collect data on wildlife presence. They were 0.5 to 1 km long, measured by GPS, and followed almost straight-line routes. These transects were randomly placed within identified or suspected corridor areas, regardless of habitat type, and were walked at a slow pace by two researchers. All elephant, duiker and other mammal dung was counted within 2 m of each transect. We analysed these data in terms of mean number of signs per km of transect walked.

2.1.2 Disturbance Transects

Forty-four disturbance transects were completed, following a method adapted to assess forest disturbance that has been routinely used in other forests in Tanzania (e.g. Doggart, 2006). The difference from the dung transect is that disturbance transects were done in forest/woodland areas with the aim of assessing human disturbance, primarily indicated by pole and timber tree cuts. Transects were walked by two researchers. The length of transects was 0.5 km measured by hand held GPS unit (Etrex, Garmin Ltd., UK). Transects were randomly sited in forest areas. All stems within a strip of 5 m each side of the researcher that were greater than 5 cm DBH were counted and classified as follows: poles (DBH 5-15cm) and timber (DBH >15cm); and divided into 4 classes: alive, fresh cut, old cut, and dead. Fresh cut is when the panga (machete) or saw mark is visible and the surface is clean. Thus, an old cut is defined as anything other than clean (usually darkened by fungi or bearing regenerating stems). All other disturbance signs such as snares, pitsawing sites, charcoal burning sites, etc. were recorded.

For each site we computed the mean values per km of transect walked of the various variables measured. We also computed an index of freshly-cut stems (and of freshly-cut timber trees) as the ratio of stems (or timber trees) to the total number of both cut and live stems (or timber trees) counted. This represents the proportion of all stems in the sample that were cut, and gives an estimation of disturbance easily comparable across habitats that may vary in stem density as a result of old management regimes or habitat type.

2.1.3 Ground Mapping

Ground-truthing of corridor areas was carried out, during which land use, habitat types, legal boundaries and animal trails were mapped using GPS units. Significant boundaries and trails were walked and waypoints marked at regular intervals. Along trails all key features and changes in habitat type were also recorded.

2.1.4 High and low resolution geo-referenced aerial imagery

Digital Aerial Photograph Mosaics of each corridor area were provided by the WCS Conservation Flight Program in 2 formats: as a single medium spatial resolution (10 m) mosaic of the entire area surveyed, and as a collection of contiguous high resolution (range of 0.5 to 1 m depending on altitude of image acquisition) 5 km x 5 km tiles. Datasets were processed by WCS with the objective of providing auxiliary information for ground truthing, and to provide general land cover information.

In addition, lower resolution photographs were taken from the air of the target corridor areas with a standard digital camera by T. Jones and F. Rovero during overflights on 13th December 2004 and 7th March 2006. Tracklogs of the flight were recorded using GPS units to verify the locations of all areas photographed.

As part of our preliminary assessment of the feasibility of the remaining corridor areas, imagery of key areas was checked to verify our ground-based assessments of habitat type and density of human habitation. There is scope for follow-up work involving much more detailed, finer-scale analysis of the hi-res imagery than was carried out for this study.

2.2 Secondary Data

2.2.1 Questionnaires and Interviews

Specially devised questionnaires were answered by 127 targeted households living near corridor areas, to gather information on wildlife movements, damage to crops and other human-wildlife conflict, and attitudes towards wildlife. The full questionnaire used is reproduced as Appendix 1.

In addition, the following people were interviewed and consulted:

- Mr. George Mbega, Kilombero District Forest Officer
- Mr. Amani Madaraka, Kilombero District Game Officer
- Mr. Elias Mwaijele, Kilombero District Catchment Forest Officer
- Mr. Avit Mbelenge, Wildlife Division Game Scout
- Mr. Nyenza, Kilombero District Land Officer
- Mr. Zakaria, Farm manager, Kilombero Farm Limited

2.2.2 Existing information on corridor areas

We gathered all available existing data on land cover, vegetation, Regional, District, Village & Protected Area boundaries. The legal status of different areas within the corridors and the correctness of boundaries were determined through consultations with officials of the Land Office, Ifakara, and Village Chairmen. Verified Village boundaries were then digitised.

The following materials were used:

- Topographic maps of scale 1:50,000 produced by the Surveys and Mapping Division, Ministry of Lands, Tanzania (1983)
- Landsat images provided by the Center for Applied Biodiversity Science at Conservation International.
- Various GIS layers made available mainly by the Tanzania Forest Conservation Group and the UNDP/GEF Conservation and Management of the Eastern Arc Mountains Forests Project
- Maps of village land boundaries, from the Land Office, Kilombero District Authority, Ifakara (K1/D/GEN, 28/03/02).

Table 1. Summary of data types and sources

	Data	Source
Primary	Presence of wildlife in corridor areas	Dung Transects
	Land use and forest/woodland degradation	Disturbance Transects
	Land use and habitat types	Ground mapping
	Vegetation type and land use	Aerial imagery[1]
Secondary	Wildlife movements, human-wildlife conflict, local attitudes	Questionnaires and interviews
	Legal status of corridor areas	Government maps; interviews

[1] WCS Conservation Flight Program

2.3 Data Analysis

Results were analysed using a Geographical Information System (GIS). All transect locations, ground-truthed boundaries, and maps obtained in hard copy form, were first digitised and geo-referenced then uploaded into a GIS program (ArcGIS 8.1, ESRI). These new layers were then integrated with the high-resolution aerial imagery, vegetation maps and other relevant layers obtained. All data were then analysed, and recommendations generated, with reference to questionnaire, interview and transect results. Our recommendations regarding management options also benefited from discussions with stakeholders following the presentation of these results at the Udzungwa Workshop in Morogoro on 23rd March, 2007 (WWF-TPO, 2007).

ALL RAW DATA ARE AVAILABLE ON REQUEST TO ALL STAKEHOLDERS AND INTERESTED PARTIES

3. Results and Discussion

3.1 Two Remaining Corridors

Overall, our study identified that only two elephant corridors remain active, i.e. corridors allowing movements of elephants and other wildlife between the Udzungwa Mountains and the Selous Game Reserve. We have called these areas the Nyanganje Corridor and the Ruipa Corridor (fig. 3).

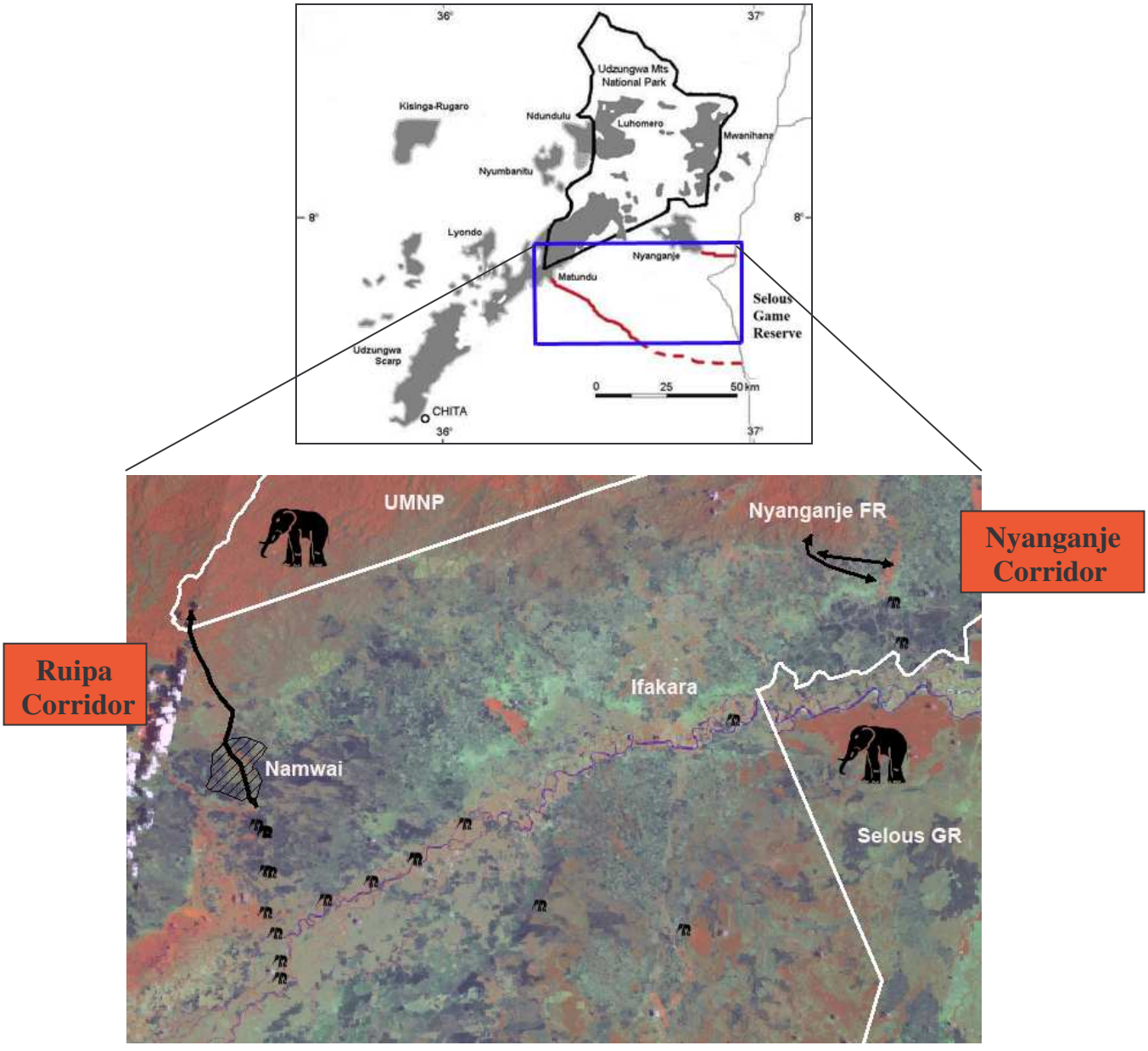

Fig. 3. Map showing the position of the two remaining active elephant corridors in the Kilombero Valley. Thick arrowed lines and elephant symbols indicate observed or reliably reported incidence of elephant presence since 2004. Inset shows the Udzungwa Mountains.

3.1.1 Nyanganje Corridor

Evidence of a seasonally active large mammal corridor adjacent to Nyanganje Forest Reserve (fig. 4) was obtained from observations of animal sign, and from the responses of local farmers who were questioned.

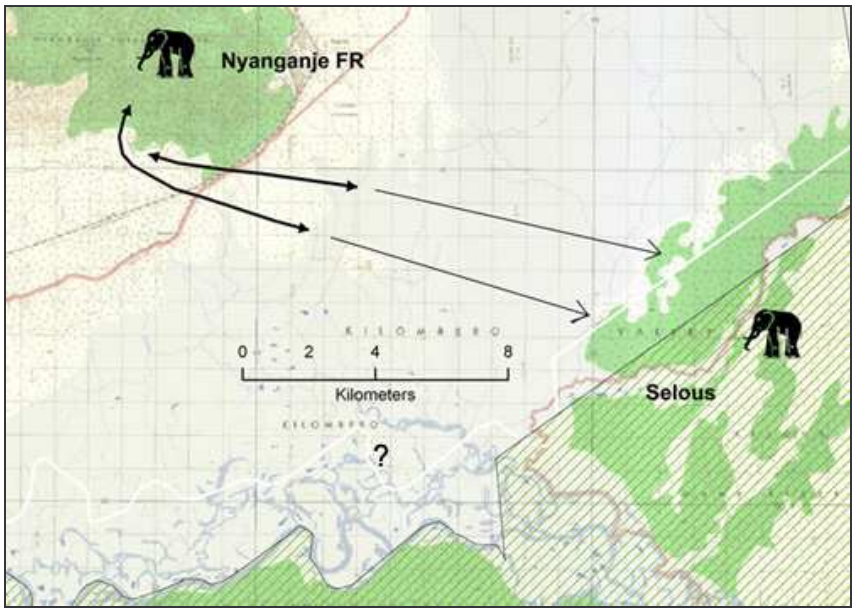

Figure 4. Map of the Nyanganje Corridor, an active corridor for movements of elephants and other large mammals between the Udzungwa Mountains and the Selous Game Reserve.

Dung and disturbance transects confirmed the presence of several large mammal species less than 1 km inside the boundary of Nyanganje Forest Reserve (69 km^2, centred on 36 ^{o}47'E, 8 ^{o}00'S), including Udzungwa red colobus, black-and-white colobus, red duikers and notably, a relatively high density of elephants compared to other forests in the Udzungwas (e.g. Mwanihana, fig. 5). Results from our questionnaire survey (see below) confirmed the movement of elephants and buffalo in the valley, outside of the forest. The transects and ground mapping exercises did not record sign of elephants, however they were carried out outside of the months when they are present in the corridor area.

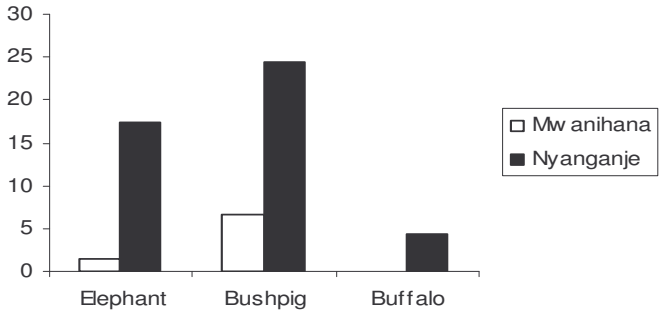

Fig. 5. Mean number of sign detected per km of selected large mammal species in Mwanihana and Nyanganje forests. Data derived from disturbance transects randomly placed in Mwanihana forest (within UMNP) and in an area of Nyanganje Forest Reserve adjacent to the Nyanganje Corridor.

Questionnaires were completed by 52 respondents in the villages of Signal (Maili Mia and Mbalaji subvillages) and Sagamaganga (subvillage Sagamaganga A). *A full summary of responses is given in Appendix 2*. Key results were as follows:

- **80% of respondents have elephants passing through their farms**
- **47% have buffalo on their farms**
- **29% perceive conflict with wildlife**
- **Elephants are passing each year during the rainy season months of January, February and March; buffalo are moving across farms all year round**

	Nyanganje FR	Nyanganje Corridor
African elephant *Loxodonta africana* (VU)	**X**	**X**
African buffalo *Syncerus caffer* (CD)	**X**	**X**
Bushpig *Potamochoerus larvatus*	**X**	**X**
Udzungwa red colobus *Procolobus gordonorum* (VU)	**X**	
Angolan colobus *Colobus angolensis palliatus*	**X**	
Sykes' monkey *Cercopithecus mitis cf moloneyi*	**X**	x
Yellow baboon *Papio cynocephalus*	**X**	**X**
African civet *Civettictis civetta*	**X**	
Marsh mongoose *Atilax paludinosus* (EN)	**X**	
Leopard *Panthera pardus*		x
Lion *Panthera leo* (VU)		x
Aardvark *Orycteropus afer*	**X**	
Eastern tree hyrax *Dendrohyrax arboreus* (VU)	**X**	
Harvey's duiker *Cephalophus harveyi* (CD)	**X**	x
Puku *Kobus vardoni*		x
Bushbuck *Tragelaphus scriptus*	**X**	x

Table 2. Large mammals detected or reported within Nyanganje FR (adjacent to the Corridor) and within the Nyanganje Corridor area (within 3 km of the FR). EN (Endangered), VU (Vulnerable) and CD (Conservation Dependent) indicate species' current IUCN threatened status (www.redlist.org). A small "x" indicates probable presence, though it was reported by less than 50% of questionnaire respondents.

In the Nyanganje area the railway, as well as marking the boundary of the Forest Reserve, marks a sharp change in habitat type. North and west of the railway is miombo woodland; south and east of the railway (and road) is farmland, with only a few scattered trees remaining (figs. 4 & 6). This general habitat extends over an area up to 5 km southeast from the railway, before giving way to rough pasture and marshy ground. However, elephants are reported to use two narrow routes only out of Nyanganje forest and across the farms (the thick lines in fig. 4), and aerial photos show that at about 3 km southeast of the forest, the cultivated areas become much more scattered and interspersed with bushes and occasional trees. Moreover, there are very few settlements among the cultivated fields. Thus for an elephant or buffalo, this relatively short crossing of cultivated land is probably an attractive option compared with more densely cultivated and settled areas to both the north and south. The low perception of conflict by farmers compared with how many have elephants on their farms suggests that the elephants mostly travel rapidly across this area, probably at night, without pausing to raid crops. It is also not surprising

that this Corridor is still active since geographically it represents the shortest possible direct route from the Udzungwa Mountains to the Selous Game Reserve (minimum straight distance of approximately 13 km).

The thick arrowed lines in figure 4 therefore represent the narrow stretches of corridor which were identified as active for elephants from January to March. To the east and south of these lines we have no ground-truthed data but there appear to be no serious hurdles to elephant movement, and thus the dashed lines represent speculative routes along which they may continue. A further option might be to head south (through the area marked with "?" in figure 4); there are many records of elephants crossing the Kilombero River in this area (Starkey *et al*., 2002; F. Rovero & T. Jones, unpubl. data).

In summary, the Nyanganje Corridor is still used year round by buffalo and seasonally by elephants, and since it represents the shortest possible corridor between the two Protected Areas, represents a significant opportunity to preserve this connectivity. Moreover, the critical area of corridor close to the road which is most in danger of being blocked off if cultivation is intensified, is fairly small: 0.5 – 2.5 km wide, about 3 km long, making a total area of about 5 km^2 which should be given urgent attention.

Photos by F. Rovero

Fig. 6. Aerial photographs of the Nyanganje Corridor.

3.1.2 Ruipa Corridor

Evidence of an active large mammal corridor close to the Ruipa River (fig. 7) was obtained from observations of animal sign, and from the responses of local residents who were questioned. However there are indications that this corridor is currently being closed off.

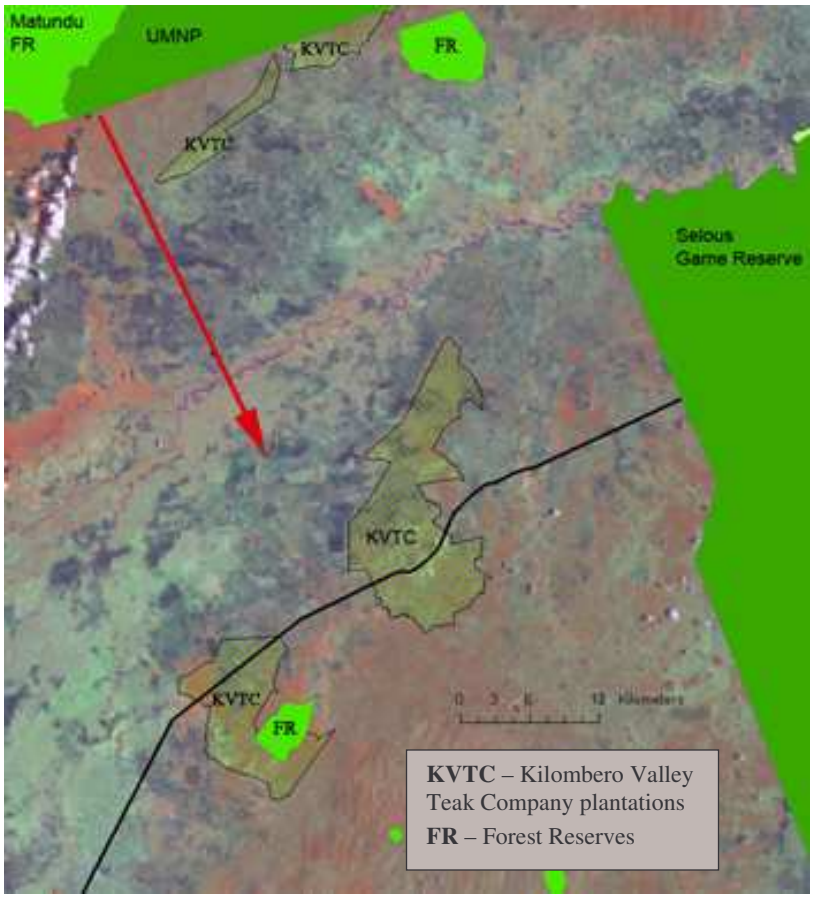

Figure 7. The Ruipa Corridor, an active corridor for movements of elephants and other large mammals between the Udzungwa Mountains National Park and the Selous Game Reserve, via the Kilombero Valley.

The large Matundu forest (ca. 250 km^2, centred on 36^{o}21'E, 7^o 86'S) is known to have a rich large mammal community including elephant, hippos and leopards, with a higher density of primates and duikers within the Udzungwa Mountains National Park (east of the Ruipa River) than in the Matundu Forest Reserve (west of the Ruipa) (Marshall, 2007). Our dung and disturbance transects confirmed the presence of all these species within the forest along the Ruipa, and the presence of large mammals along a corridor area which extends south from the forest as far as the Kilombero River (fig. 9). Questionnaire and interview results confirmed the annual movements of elephants in recent years between Matundu forest and the Kilombero Valley floodplain, as illustrated in figure 7. However respondents also stated that elephants *did not* pass the Mofu area to the south in 2005, for the first time in living memory. There were no records from this section of the Corridor in 2006 either, and only one elephant recorded from January to May 2007 (Frontier Tanzania, pers. comm.)

Interviewees also stated that until 2-3 years ago, there were other routes for elephant, sable antelope and buffalo moving south out of the Udzungwa Mountains National Park (UMNP), in the area to the east of the currently active corridor, including through Ihanga FR. However, it was reported that these corridors are no longer used because of increased levels of hunting and the barriers of the KVTC teak plantations (fig. 7).

Questionnaires were completed by 65 respondents in the villages of Kisegese (Kisegese and Bomamzinga B subvillages), Namawala (Bomamzinga A and Idandu subvillages), and Mofu (Mwaya subvillage). *See Appendix 2 for full summary of responses*. Key results were as follows:

- **78% of respondents have elephants on their farms**
- **59% have buffalo**
- **45% perceive conflict**
- **Elephants crossing March, April, May**
- **Buffalo present all year round**
- **Udzungwa red colobus, Black-and-white colobus, Duikers, Waterbuck, Aardvark and Leopard are also present along the Corridor, especially in the Namwai area. Sable antelope were also found until recently along the Corridor, but no longer.**

	UMNP (Ruipa)	Ruipa Corridor
African elephant *Loxodonta africana* (VU)	**X**	**X**
African buffalo *Syncerus caffer* (CD)	**X**	**X**
Bushpig *Potamochoerus larvatus*	**X**	**X**
Hippopotamus *Hippopotamus amphibius*	**X**	**X**
Udzungwa red colobus *Procolobus gordonorum* (VU)	**X**	**X**
Angolan colobus *Colobus angolensis palliatus*	**X**	**X**
Sykes' monkey *Cercopithecus mitis cf moloneyi*	**X**	x
Yellow baboon *Papio cynocephalus*	**X**	**X**
Vervet monkey *Cercopithecus aethiops*		x
Spotted hyena *Crocuta crocuta* (CD)	**X**	**X**
African civet *Civettictis civetta*	**X**	**X**
Marsh mongoose *Atilax paludinosus* (EN)	**X**	
Leopard *Panthera pardus*	**X**	x
Lion *Panthera leo* (VU)	**X**	x
Aardvark *Orycteropus afer*	**X**	**X**
Crested porcupine *Hystrix cristata*	**X**	**X**
Eastern tree hyrax *Dendrohyrax arboreus* (VU)	**X**	
Harvey's duiker *Cephalophus harveyi* (CD)	**X**	**X**
Puku *Kobus vardoni*		x
Waterbuck *Kobus ellipsiprymnus* (CD)	**X**	**X**
Bushbuck *Tragelaphus scriptus*	**X**	x

Table 3. Large mammals detected or reported within UMNP (adjacent to the Ruipa Corridor) and within the Ruipa Corridor area. EN (Endangered), VU (Vulnerable) and CD (Conservation Dependent) indicate species' current IUCN threatened status (www.redlist.org).A small "x" indicates probable presence, though it was reported by less than 50% of questionnaire respondents.

Photos by F. Rovero & T. Jones

Figure 8. Aerial photographs of the Ruipa Corridor.

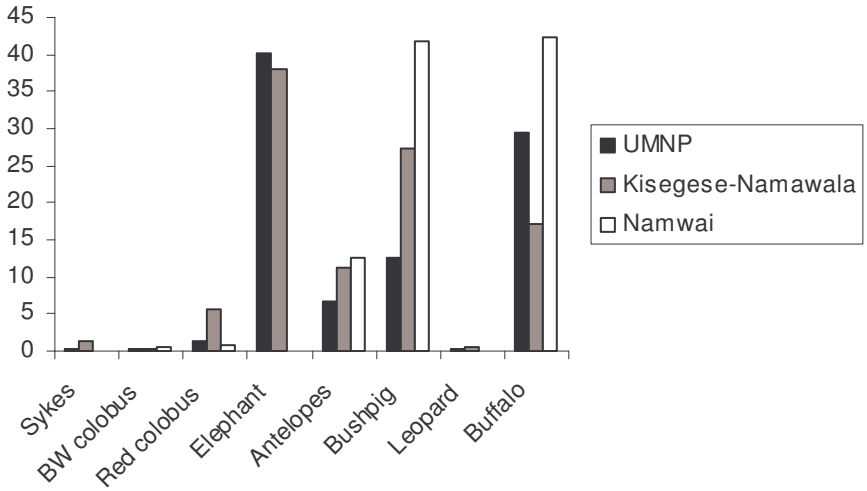

Fig. 9. Mean numbers of sign of different mammal species encountered per km inside the UMNP, and along two sections of the Ruipa Corridor. These results derived from both dung and disturbance transects (see methods). Kisegese-Namawala comprises grassland, woodland and forest in the northernmost section of the Corridor area, including habitat adjacent to the UMNP (and close to the UMNP ranger post). Namwai is in the centre of the Corridor, 11km south of UMNP (see below and fig. 15)

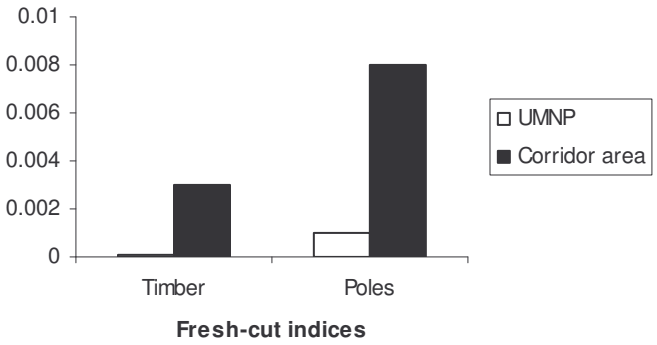

Fig. 10. Indices of freshly-cut timber and poles within UMNP and in the adjacent Ruipa Corridor area. Data derived from disturbance transects (see methods) conducted within UMNP and within woodland and deciduous forest in northern Kisegese-Namawala section of Corridor, close to UMNP.

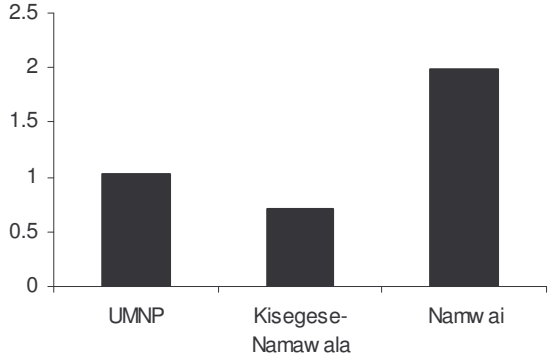

Fig. 11. Mean number of traps, pitsawing and charcoal sites within UMNP and two sections of the Ruipa Corridor. Data derived from disturbance and dung transects (see methods).

According to interviewees, the size of this wildlife corridor, and the number of animals using it annually, has declined considerably over the last 10 years, in particular in the area around Kisegese village, where a large area of forest has been cleared for agriculture. Moreover, the whole of the remaining corridor area between the UMNP and the Kilombero River (0.5 – 6 km wide, 20 km long; a total area of ~ 25 km^2) is now critically threatened by human activity and land uses incompatible with large mammal movements. Of particular concern is the area of Namwai, in the core of the Corridor.

Namwai Forest is a mosaic of lowland moist and riverine forest, miombo woodland and grassland. Buffalo, red duikers, the Udzungwa-endemic red colobus and other wildlife are present all year round. Elephant used to browse this area as they passed through, and Sable antelope were present until 2005. In 2004 the forest was measured and mapped by the Forestry and Beekeeping Division, and beacons erected around its proposed boundary, encompassing an area of 17.9 km^2 with a view to possible gazettement of the area as a

National Forest Reserve. Unfortunately, it has not yet been gazetted. Namwai had no human inhabitants until 2005, when immigrants from outside the area began to clear and settle parts of the forest, forming the new sub-village of Ihenga (Mofu Village). In August 2006 the human population within Namwai was estimated at 100-200 inhabitants, though more recent reports suggest this number continues to rise.

The forest forms a critical section of the Ruipa Corridor, as well as containing important resident mammal populations, but is being rapidly destroyed (personal observations, all authors). Figure 11 gives an indication of a relatively high level of snares, charcoaling and pitsawing of trees in August 2006; further quantitative disturbance data from Namwai has been collected in early 2007 by Frontier Tanzania, and will soon be available in the final report of their Ruipa project (contact frontier@africaonline.co.tz). The problems facing Namwai are severe and also include clearance for agriculture, burning, cattle grazing and commercial logging (fig. 12).

Photos by T. Jones & J. Msirikale

Figure 12. Photographs of Namwai Forest, August – October 2006.

A further problem which has worsened since 2005 is the increasing number of cattle herders grazing cattle, and also settling and planting crops, along the banks of the Kilombero River, within the Kilombero Game Controlled Area and to the east of the Mofu Village boundary. These recent Wasukuma settlers are reported to have a hostile attitude towards elephants, and are preventing them from crossing the river from the north in order to reach the Selous Game Reserve, forcing the elephants to return along the Corridor. This is likely to increase human-elephant conflict in other areas of the Corridor also.

4. Corridor Management Options

In the case of both corridors there are several options for management, the most feasible of which are summarised in Figure 13. Because of the long and narrow nature of the corridors, they inevitably comprise areas under differing management regimes and legal status. It may also be most effective at the local level to protect different sections of the corridor in different ways, depending on local circumstances and practicalities. Thus their comprehensive protection will inevitably involve cooperation between different stakeholders. Even if the critical sections of corridor are to be managed and protected by communities (as may be feasible for the Nyanganje Corridor), it will still involve coordinated planning between more than one village communities. Moreover, all stakeholders will benefit from advice and guidance through the processes for planning and implementing increased and effective protection for the Corridor areas. It therefore makes sense if an NGO can take on the role, in the case of each Corridor, of facilitating the process.

Figure 13. Summary of Management Options for Nyanganje and Ruipa Corridors

Note: The Village Land Act (1999) allows villages to set aside Village Reserve Land for specific purposes. This can include for the protection of critical wildlife corridors.

4.1 Nyanganje Corridor: Management Options

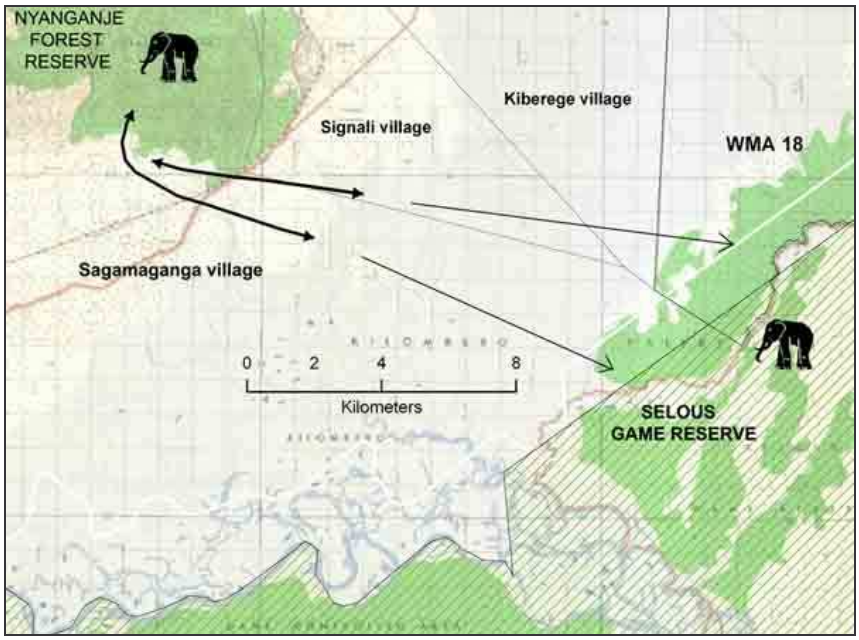

Figure 14. Legal status of Nyanganje Corridor area.

The Nyanganje Corridor passes through the following legally designated areas of land, which are owned or managed by the following stakeholders:

Land	Stakeholders
Nyanganje Forest Reserve	Forestry and Beekeeping Division
Sagamaganga	Sagamaganga village
Signali	Signali village
Kiberege	Kiberege village
Wildlife Management Area (provisional)	Kiberege, Sagamaganga and Signali villages Wildlife Division Kilombero North Safaris hunting company

Table 4. Legal status of Nyanganje Corridor and associated stakeholders.

The section of corridor most critically threatened is the small area closest to the Nyanganje Forest Reserve, where there are a number of small farms within the Village boundaries of Sagamaganga and Signali. However here there is still an opportunity, through a careful land-planning process, to set-aside and properly manage a part of this area to enable the continuation of this Corridor. Such a process would also benefit these communities if it included planning and training for better mitigation of the effects of large mammals on farmers, e.g. the use of chilli plants to keep elephants away from crops (Parker & Osborn, 2006).

4.2 Ruipa Corridor: Management Options

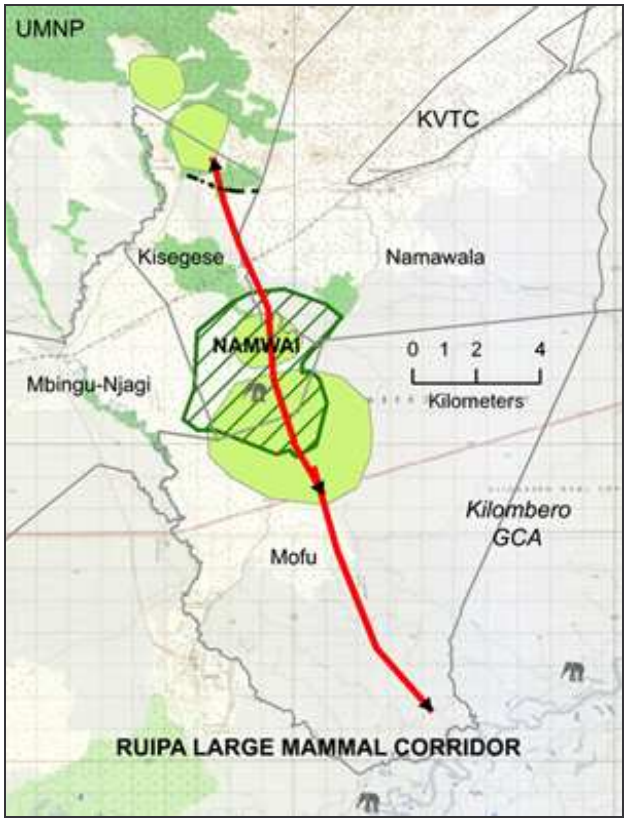

Figure 15. Legal status of Ruipa Corridor area. The red line represents the confirmed corridor along which elephants and buffaloes have been moving in recent years. The light green shading represents areas where we recorded concentrations of large mammals (especially buffalo).

The Ruipa Corridor passes through the following legally designated areas of land, which are owned or managed by the following stakeholders:

Land	Stakeholders
Matundu (and potentially Namwai) Forest Reserves	Forestry and Beekeeping Division
Kisegese village	Kisegese village community
Namawala village	Namawala village community
Mbingu village	Njagi village community
Mofu village	Mofu village community
Kilombero Game Controlled Area	Wildlife Division Kilombero North Safaris hunting company
Kilombero Farm Limited	Kilombero Farm Limited
Teak plantations	Kilombero Valley Teak Company

Table 5. Legal status of Ruipa Corridor and associated stakeholders.

The landscape through which the Ruipa Corridor passes is a complex mosaic of habitat types, land uses and legal designations, with a large number of interested stakeholders (Table 5). The solutions to preserve different sections of this Corridor will be different, and it would be beneficial if the process were coordinated by a Corridor Management Committee comprising representatives of the key stakeholders, and facilitated by an NGO with experience of complex conservation issues.

At the northern end of the Corridor there is an argument for extending the boundary of the UMNP southwards to protect part of the Corridor.

The Namwai area is critical, and since it has already been measured and mapped by the Forestry and Beekeeping Division as part of plans to gazette this area as a National Forest Reserve, the most effective option now could be to proceed with this gazettement as soon as possible. This would necessarily involve halting the current ongoing destruction of habitat, hunting and grazing of cattle currently occurring within the forest.

Other sections of the Corridor must also be protected as a matter of urgency, either through private ownership or through designation by communities as Village Reserves.

5. Summary of Recommendations

On the basis of current rates of change, we predict that unless urgent interventions are made to protect the two remaining corridor areas, **all connectivity between the large mammal populations of the Udzungwa and Selous ecosystems will be lost by the end of 2009**. This will likely be the first time in thousands of years that animals have not moved between these areas, and would be a very difficult development to reverse.

The following practical recommendations are offered as suggestions to communities and other stakeholders attempting to preserve this ancient connectivity.

Nyanganje Corridor

1. Formation of Corridor Management Committee including representatives of all stakeholders.
2. Meetings to plan and implement process of protecting Corridor, facilitated by NGO. Land planning carried out for Sagamaganga and Signali Villages, leading to gazettement of Village Reserves to be managed by respective Village Natural Resource Committees.
3. Assistance provided to communities on mitigation of human-wildlife conflict.
4. Potential for part of Corridor area to be purchased and managed for conservation by private individuals/NGO.

Ruipa Corridor

1. Gazettement of Namwai Forest by Forestry and Beekeeping Division.
2. Possible extension of UMNP to protect part of the Corridor.
3. Formation of Corridor Management Committee including representatives of all stakeholders.
4. Meetings to plan and implement process of protecting Corridor areas, facilitated by NGO. Land planning carried out for Kisegese, Namawala, Mbingu and Mofu Villages, leading to gazettement of Village Reserves to be managed by respective Village Natural Resource Committees.
5. Assistance provided to communities on mitigation of human-wildlife conflict.
6. Potential for part of Corridor area to be purchased and managed for conservation by private individuals/NGO.

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Appendix 1. Questionnaire employed in villages

1. Name:
2. Gender: Man.....Woman.....
3. How many are you in your family?
4. Where do you reside?
5. For how long have you stayed in this area?
   under 5 years , 5 years , 10 years , 15 years , 20 years or more
6. What is your occupation?
7. If you are a farmer, in which area is your farm?
8. Is your farm legally owned?
   Yes , No
9. What kinds of crops are you farming in your farm?
10. Do you know any kind of wild mammals?
    Yes , No
11. If yes, what kind of mammals do you know?
12. (a) Have you ever seen any mammals passing in this area?
    Yes , No
    ...if yes,
    (b) What kind of mammals are those?
    (c) Where have you seen them?
    (d) In what season?
    rainy season , dry season
13. Have you ever been hurt by any wild mammals in your life?
    Yes , No
14. (a) In past days, did wild mammals cross in this area?
    Yes , No
    (b) In which season frequently? rainy season , dry season
15. In which area do they prefer mostly to cross?
16. For those wild mammals which cross there, if you compare their abundance, has it increased or decreased?
    (a) Mammals decreasing in abundance.....
    (b) Mammals increasing in abundance.....
17. (a) Is there any crop raiding in your farm? Yes , No
    (b) What kinds of crops?
    (c) What kinds of mammals are raiding the crops?
18. Where do you get firewood for cooking?
    a) Inside the reserve , b) Outside the reserve , c) other places
19. Where do you get water for cooking
    a) river , b) spring , c) tap water
20. (a) Do you know any protected area which is close to your farm? Yes , No
    (b) If yes, do you know where its boundary starts? Yes , No
    (c) Do you know any laws for protection of the reserve? Yes , No

Appendix 2. Summary of questionnaire results

Village Sub-village	X[1] Y	Total households interviewed	Mean family size	Property owned	Crop 1	Crop 2	Crop 3	Elephants	Buffalo	Antelopes	Baboon	Bush pig	Perceived conflict	Firewood from Reserve	Awareness of reserve
				% yes	Rice	Maize	Cassava	% of people that have animals on the farm					% yes	% yes	% yes
Signal Maili mia	260992 9112201	11	6	73	9	10	2	45	18	9	27	27	36	9	55
Signal Mbalaji	260041 9110008	20	5	60	20	12	6	80	35	30	30	45	5	50	85
Sagamaganga Sagamaganga A	257663 9108338	21	4	57	21	16	0	90	71	29	48	52	57	90	86
Kisegese Bomamzinga B	208206 9097418	20	4	40	19	20	8	80	10	25	50	56	55	25	75
Kisegese Kisegese	206161 9097827	10	4	80	9	10	2	100	70	0	0	30	60	20	80
Namawala Bomamzinga A	209466 9097916	9	5	89	3	9	4	56	22	11	22	22	33	11	67
Namawala Idandu	210352 9092620	11	7	82	8	7	1	100	100	0	18	18	55	27	36
Mofu Mwaya	208526 9086479	15	6	40	14	15	2	60	93	20	53	67	20	47	80

[1]UTM 37S coordinates