Feasibility Study on Elephant Movement between the Greater Ruaha Ecosystem and Selous Ecosystem in Central Eastern, Tanzania

By

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May 2009

ABSTRACT

The study to conduct a preliminary investigation of the elephant migration between Greater Ruaha and Selous ecosystems was conducted in 2008/2009. The study was intended to establish if there are elephant movements between Ruaha and Mikumi NPs. Specifically the study attempted to establish and track the existing and possibly dead elephant migration routes from Ruaha to Mikumi, and identifying important locations along the route and threats facing the corridor and elephants in the survey area.

The survey used a number of techniques including literature survey, interviews and direct field observations. Researchers tracked on foot from Ruaha to Mikumi the elephant routes, taking GPS coordinates at important locations, taking photographs, interviewing people and assessing habitat and elephant dung along the migration routes. Vehicles, motorcycles and bicycles were used to assist researchers reach certain locations for investigation. The study was spread in three regions of Iringa, Dodoma and Morogoro and encompassing four districts of Iringa rural, Mpwapwa, Kilolo and Kilosa. Villages covered during the study from Ruaha National Park towards Mikumi National Park include Kinyika, Kisanga, Mboliboli, Makuka, Izazi, Migori, Makatapora (Kinyari subvillage), Migori in Iringa Rural District, Mkulula, Nyanzwa, Igunda, Mgowero, Mtandika and Ruaha Mbuyuni in Kilolo District. Others are Malolo, Kisanga, Msolwa, Madizini, Kidai, and Ihombwe in Kilosa District. Two additional villages of Idodoma and Singonari were from Mpwapwa District.

Evidence collected from this study strongly supports the hypothesis that there is elephant migration between Greater Ruaha and Selous ecosystems. This is also supported by a significant number of people ($P < 0.001$) interviewed in the survey area. Villagers showed researchers the elephant routes, described the routes and explained when and how elephants pass in their areas including seasons, time of the day and associated human elephant conflicts. Other information included dead elephant routes, changing patterns of elephant routes and threats facing the elephant corridor. Villagers were able to tell about presence of resident elephants, group sizes of migrating elephants and even differentiate between elephants originating from Mikumi against those from Ruaha in terms of body and tusks size, colour and behaviour.

The study reports that there is basically one broad elephant corridor (with several routes) from Ruaha NP up to areas around Ruaha Mbuyuni a place which appears to be the point of departure. From here there are three separate corridors two leading to Mikumi National Park and one leading to Udzungwa NP and possibly also to Mikumi. Nevertheless, some sections of the routes are yet to be verified. Field observations revealed that the elephant routes are under serious threat from farming, settlements, livestock keeping, human disturbances including noises, and combination of these factors.

Since there is convincing evidence of the presence of the elephant link between the two ecosystems a more detailed study using radio/satellite tracking is proposed as well as immediate efforts to rescue the landscape, the elephants paths and habitat in places where they are seriously encroached. This will ensure that the elephant populations of the Greater Ruaha ecosystem are

linked with the Selous and Niassa ecosystems to form the biggest elephant mega population in recent times.

Key words: corridor, ecosystem, elephant, mikumi, national park, ruaha

Acronyms and Abbreviations

Bonn Convention	Convention of Migratory Species of Wild Animals
CBD	Convention on Biological Diversity
CCM	*Chama Cha Mapinduzi*
EMA	The Environmental Management Act No. 20 of 2004
GCA	Game Controlled Area
GPS	Global Positioning System
GR	Game Reserve
MBOMIPA	*Matumizi Bora ya Maliasili Idodi na Pawaga*
NEP	National Environmental Policy (1997)
NLP	National Land Policy (1995)
NP	National Park
TANAPA	Tanzania National Parks
TAZAMA	*Tanzania Zambia Mafuta* (Pipelines)
VGS	Village Game Scout
WCA	Wildlife Conservation Act No. 12 of 1974
WD	Wildlife Division
WMA	Wildlife Management Area
WPT	Wildlife Policy of Tanzania (2007)

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1.0 INTRODUCTION

In conservation biology, animal movements involve movement of animals across landscapes and consequent movement of genes within and among populations of organisms. Movements are notably classified as daily movement, seasonal movement and Migration. Daily movement involves movement of animals from morning to dusk looking for water, shade and fodder. Seasonal movements refer to the type of movements whereby animals utilize certain parts within the same area for a certain season and the other part in another season. Migration involves the movement of animals, involving long distances, from one part to other in search of food, breeding site, security or water. Usually animal migration makes use of wildlife corridors. Migratory species are protected by the Bonn Convention to ensure that the species, routes/corridors and habitats used by migrating species are protected.

Corridors are passages or parcels of land whereby animals pass from one geographical area to the other. They are usually narrow areas which are composed of different types of vegetations for animals to utilize. These areas connect different habitats or protected areas.

Newmark (1993) documents that corridors are supposed to increase the rate of immigration and consequently increase the number of species within the park and/or reserve. In addition, the corridors should allow individuals to supplement resident park populations thus reducing likelihood of local extinction. Also, corridors are known to increase the effective size of the park hence lowering the chances of extinction of these species through provision of additional feeding and breeding habitat.

Corridors have a number of advantages including connecting populations of different populations so allowing interbreeding, facilitation of gene flows, facilitating habitat utilization through reducing pressure in grazing or browsing areas and provision of resources where animals move through the corridor. Corridors are therefore important in maintaining and increasing biological and ecological viability of species and populations. However corridors may also sometimes help to transmit diseases between different areas.

1.1 Research problem/hypothesis

It has long been reported though not verified that there is a link between the Greater Ruaha ecosystem and western miombo elephant populations. Likewise there are reports that the Greater Ruaha Ecosystem is ecologically linked to the Selous ecosystem by some elephant migration routes. Studies have proved that the Selous elephant population is linked to the Mozambican elephant population through the Selous-Niassa wildlife corridor (Mpanduji 2004), an area of approximately 6,000 – 10,000 sq km covering a distance of approximately 200km. The corridor links the world's largest Miombo woodland ecosystems and covers a traditional migratory route for elephants between two of the biggest intact elephant populations in Africa. It is also reported that there is an elephant corridor connecting Greater Ruaha population and Selous population via Nyang'oro hills a hypothesis strongly supported by local people and some literature (Jones et al 2007, TAWIRI 2009). Some preliminary investigations of the corridor have been conducted by some individuals (B. Mbano pers. Comm. 2008 and Seraphin Mngara pers. Comm. 2007) but no detailed studies have been done previously to understand elephant movements between Ruaha

and Mikumi. This was the first detailed attempt of preliminary investigation of elephant movement between the two areas.

It was hypothesized that there is an existing elephant wildlife corridor linking Greater Ruaha and Selous ecosystems.

1.2 Research objectives

Generally the study aimed at investigating the movement of elephants between Great Ruaha and Selous ecosystems.

Specifically the survey was aimed at:
i Establishing existing and dead elephant migrating routes between Ruaha and Mikumi

ii Assessing extent of corridor utilization based on abundance of elephant (dung count) as an index of abundance

iii Identifying important locations with regard to elephant migration routes, and

iv Identifying threats facing the elephant corridor and elephants in the survey zone.

1.3 Methods/Limitations

1.3.1 The study area

The survey study was conducted in a belt landscape between Ruaha NP and Mikumi NP running from the Great Ruaha basin in south east of Ruaha NP through the mountainous ranges of Nyang'oro, Mkulula, Kideto, Image, Ipala, and Malolo through Msanga hills to Mikumi. A range of villages were visited from those near to Ruaha National Park through villages located along the investigated corridor to Mikumi NP. Among the village covered include Kinyika, Kisanga, Mboliboli, Makuka, Izazi, Makatapora (Kinyari subvillage) and Nyanzwa/Igunda village. Others are Ruaha Mbuyuni, Malolo, Idodoma, Mtandika, Kisanga (Kilosa), Msolwa, Madizini and Ihombwe. Elephant crossing points and routes in all those villages were identified.

1.3.2 Data collection

Data collection in this preliminary study was carried out using a number of methods including Questionnaires and Direct observation. The questionnaire method involved interviewing respondents and filling in the answers in the questionnaire by the interviewer. The interview questions were meant to provide the necessary information about the elephant movement and occurrence in the areas visited. Interviewees were biased towards people with knowledge of animals and local environment in general. At least 79 people were interviewed in the whole study area.

Direct observation involved Elephant dung count, GPS tracking of the elephant migrating routes and recording the locations in each village where elephants cross. Alongside this task was to record GPS points at intervals in those places which constitute the elephant migrating routes. Other tasks associated with GPS tracking included photographing important locations and noting down the physiognomy, economic activities of people in the study area in order to associate the

local economic activities with threats facing the elephant corridor. Most of the tracking of elephant routes was done on foot except in some places where researchers had to circumvent the routes due to inaccessible terrain or thick vegetation. In such occasions records were taken based on local people's accounts. Also in such cases use of alternative transport such as bicycles, motorcycles, and rarely vehicles was done. Bicycles and motorcycles were often used to go and verify elephant routes or crossing points if they were reported to be further away from where the researchers were passing.

Elephant dung count was carried out on transects. One kilometer (1km) transects were established by step counting up to 1000 paces (calibrated) which were equivalent to 1km transect. Three people walked along the transect one assistant went ahead pacing while the researcher followed making observations and recording data. The third person was assisting the two while local people were present to help in clearing the way in case of obstruction by vegetation and security of the group. Wherever elephant dung was spotted records of its decay stage, observation distance (Distance covered), perpendicular sighting distance, other elephant signs, other animals/signs present and habitats were recorded. The perpendicular sighting distances were recorded using a tape measure.

1.3.3 Sampling techniques

Sampling techniques require the right representative samples of subjects to be observed. This implies categorically that questionnaires should avail to and be filled in by subjects (interviewees) of mixed age and sex groups. However, in this study people were sampled according to their readiness and responsiveness to be interviewed and were also biased towards people with knowledge of wildlife and local environment.

1.3.4 Data analysis

Data were analyzed using Statistical Package of Social Science (SPSS) where charts and tables were drawn. Chi squire tests were also done to test differences in frequencies. Due to scanty nature of elephant dung data obtained along the studied corridor no detailed analysis was conducted instead dung density was calculated as a simple index of abundance and was compared between locations.

1.3.5 Research constraints

The survey was very challenging with most of the time requiring walking on foot to verify the routes which pass in very remote areas some with inaccessible vegetation or rough terrain. Some few very distant points also reported to be associated with elephant movements in the landscape were not visited due to logistical and time constraints. Occasionally some local people and respondents in interviews were reluctant to cooperate especially upon realising that the researchers were not of local origin. Notably villages which are reported to be notorious in poaching were even hostile to researchers by the mere fact of asking questions about wildlife. They associated the research on intelligence on poaching activities in the area. Overall the research team enjoyed good cooperation in most of the places visited during the surveys.

2.0 RESULTS AND DISCUSSION

2.1 Habitats and terrain

The survey area falls under a mosaic of habitats ranging from forests, bushed shrub land, shrub land, bush land, wooded shrub land, woodland including miombo to wooded grassland distributed depending on the physical landscape, soils and drainage of the Great Ruaha river basin where most of the corridor lies. The corridor commences from the flood plain of the Great Ruaha River south east of Ruaha NP passing through undulating landscapes and mountains and sometimes rugged terrain with valleys for most of the distance until it connects with the Mkata floodplain adjoining Mikumi NP. Occasionally the routes pass through sparsely settled areas and farmland. Reports and field observations suggest that a number of settlements and cultivation now appearing along the corridor are recent. For those settlements which existed from a distant past some have grown in size in recent years. There is a general tendency of people settling in areas rich in wildlife basically for poaching purposes.

Elephants may start their journey in Kinyika village east of Ruaha NP in places dominated by closed stand of *Acacia* woodland, shrub land and very few species of palm trees like *Borassus* and *Hyphaene* (doum palms).

This habitat is continuous from Kinyika village to Kisanga interspaced by patches of fallow, farms and new settlements owing to the increasing human population in the area.

The physiognomic vegetation in Mgwagu area in Kisanga village is predominantly a mosaic of Bush lands of Salvadoraceae and bush thickets intermingled with large trees of A*cacia* spp. These vegetation mosaics excluding the cultivated areas proceed to Mboliboli and Makuka villages. Mboliboli village is so named because the surrounding areas of that village are dominated by *Acacia* trees known as 'miboliboli' in Hehe tribal dialect.

There is a mixture of *Acacia* woodland and bush lands existing from Ruaha National park across Great Ruaha River up to Kilala and Matulya areas between Mboliboli and Makuka village. This continues to Izazi village at Nyang'oro areas of Mlawi and Mwenga Magoha rivers.

Forests and bush thickets are important vegetation habitats at Izazi and Makatapora villages especially along Nyang'oro ranges, Mtera and Ifambo. Some woody species present in those forests include, *Grewia* spp, *Cassia* spp. (Mikwata) and others locally known as Mihavava, and Mikungugu.

From Luhomelo to Ipala areas in Igunda village along great Ruaha River are a mixture of patches of bushes of *Salvadora* shrub land and woodland of *Acacia* trees along the hills and by the river sides.

Moving from Ipala (Igunda village) to Ruaha Mbuyuni the area is also characterized by forests and bushed shrub land along the Great Ruaha. However, on these areas hills are mostly covered by forests. Common trees include *Tamarindus indica*, *Ficus sue* (mazombe), and *Acacia* spp.

From Ruaha Mbuyuni to Mikumi through Malolo, Madizini and Ihombwe the vegetation is predominantly forests and miombo woodlands with relatively small portions of grassland or

wooded grasslands. This area is also hilly sometimes with rugged terrain. The habitats include the Ukwiva and Palaulanga catchment forests, Msanga and Iyovi forests which run all the way to Mikumi National Park and are dominated by *Brachystegia* spp, *Pterocopus angolensis*, and *Combretum* spp. The elephant corridor enters Mikumi NP through the Mkata flood plain on the northwest of the park. The area is characterized by the alluvial plain of the Mkata river basin. The vegetation consists of savannah with scattered tree growth dominated by *Acacia* spp, *Adansonia digitata*, *Tamarindus indica*, *Ficus*, *Hyphaene* palms, and the spindle shaped *Borassus* palm trees locally known as "mikumi" which bears the park its name.

2.2 Villages and people surveyed

At least 21 villages were surveyed during this study. They include Kinyika, Kisanga, Mboliboli, Makuka, Izazi, Migori, Makatapora (Kinyari subvillage), Migori in Iringa Rural District, Mkulula, Nyanzwa, Igunda, Mgowero, Mtandika and Ruaha Mbuyuni in Kilolo District. Others are Malolo, Kisanga, Msolwa, Madizini, Kidai, and Ihombwe in Kilosa District. Two additional villages of Idodoma and Singonari were from Mpwapwa District in Dodoma region (Table 2.1).

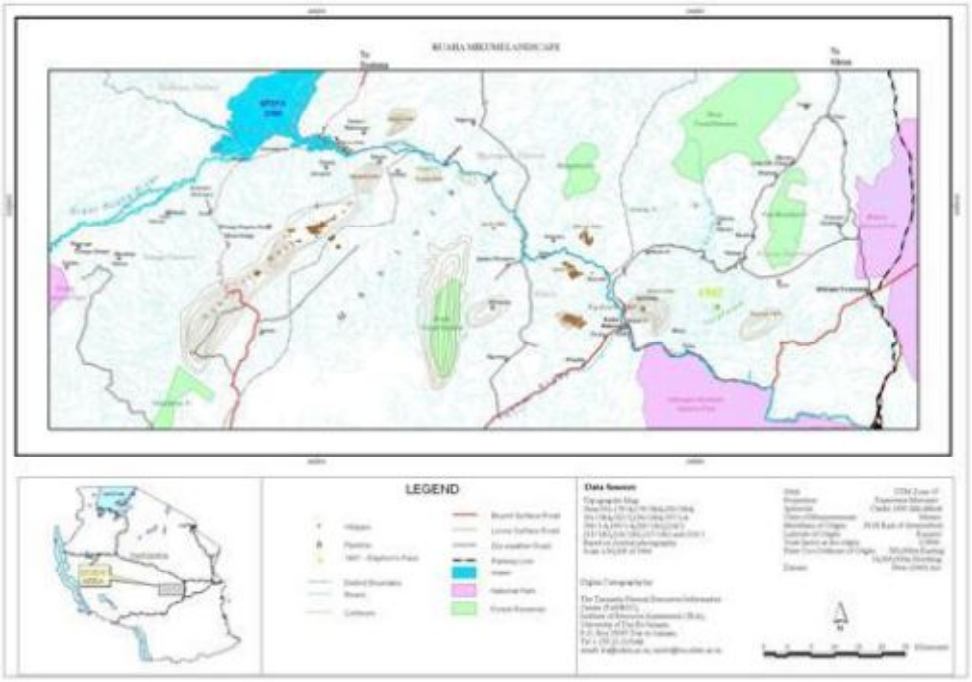
Different people in survey villages responded variably to interview questions. Responses varied depending on the nature of the economic activities of the people. For example people who were suspected to be involved in illegal utilization of wildlife and natural resources were reluctant to speak, sometimes they were hostile and their responses had to be treated with caution. Some villagers in places like Kisanga (Kilosa) and Msolwa were unable to provide useful information because villagers were not familiar or aware of elephant movement in their areas as elephant crossings were far away from the settled areas. Also immigrants with few years residence who were not familiar with local environment could not provide detailed information as expected. It was also noted that in most villages females did not respond and pleaded not to answer the interview questions claiming that they are unaware and not acquainted to the areas where elephants cross. Most males generally appeared to respond appropriately to the questionnaires in the whole study.

2.3 Elephant populations, availability and group size

During the survey it was not easy to sight elephant herds but residents provided useful information regarding elephants in the area. This was correlated with similar observation in other parts to decide the validity of provided information. Results demonstrates that elephants are present in all villages surveyed and this was supported by all 100% (n = 79) respondents interviewed. On the time of day when one is likely to sight elephants within their village areas about 62% said that elephants are usually available at night, 2% said are seen during the day, while 36% said are available during both day and night. These results are similar to observations made by Nahonyo (2001) on elephants of Greater Ruaha Ecosystem who were often reported to be active mostly at night in areas close to human habitation and farmland.

Table 2.1 Description of villages, sub villages and locations in the study area

SN	**Village**	**Sub villages**	**Locations**
1	Kinyika	Mbuyuni, Mkwajuni, Kinyika	Liamapogolo thickets, Kili forests
2	Kisanga	Ilambalyelo, Lyanika, Kisanga	Mgwagu,
3	Mboliboli	Uwanja wa ndege, Mboliboli	
4	Makuka	Makuka A, Makuka B, Majengo	Matulya and Makuka
5	Izazi	Chekechea, Sokoni, Barabarani, Kiwanjani	Itemagu (Bwawani Mtera), Mbogeko (along Nyan'oro ranges), Mlawi, Mwenga Magoha,
6	Migori		Nyang'oro ranges
7	Makatapora	Kinyari, Kikuyu	Mbweleli along Nyang'oro ranges, Mtera forests.
8	Mkulula	Iwondo, Luhomelo, Kiseke	Western sides of Nyang'oro ranges, Ifambo forests, Igoka forest hills
9	Nyanzwa		Matanana
10	Igunda	Mpakani, Madukani, Beku, Balali, Idodi	Ipala forests, Mazombe
11	Mgowero		
12	Mtandika	Kichangani, Mtandika	
13	Ruaha Mbuyuni	Kidodi, Ruaha Mjini, Ruaha Mbuyuni, Kwale	Tazama pipelines,
14	Malolo	Malolo A, Malolo B	Mgongwe, Kijiro
15	Kisanga (Kilosa)	CCM, Kikonga	Mbala forests, Ukwiva
16	Msolwa		Ukwiva
17	Madizini	Madizini kati, Temeke, Lamu	Ukwiva, Mhoswa
18	Kidai		Kidai, Iyovi, Msanga forests.
19	Ihombwe	Mnazini, Mashineni, Shuleni	
20	Idodoma		
21	Singonari		Kisima (Makolongo), Kilimbe, Kiseke



On elephant group size reports from respondents (n = 76) suggested that elephants are found at variable group sizes including 1-10 elephants reported by 22% of respondents, 11-20 elephant as reported by 42% respondents, 21-30 reported by 13% respondents, 31-50 by 6% respondents, 61-80 by 2% respondents. Some respondents (7%) only reported that elephants occur in large groups, and 4% said they occur in small groups, while 1% said they appear in a mixture of small and large groups. At least 3% said they did not know anything on elephant group size. The elephant group sizes reported by local people differed significantly ($\chi^2 = 135.6$, $P < 0.001$) with most people reporting seeing elephant group sizes of between 1 and 20 elephants. The results are similar to observations in other places where elephants generally tend to appear in relatively small groups and occasionally in large groups of above 50 individuals.

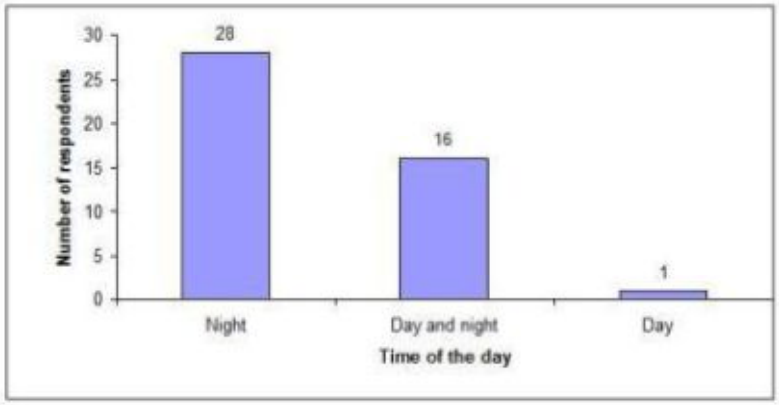


Figure 2.1: Time of the day when elephants are likely to be found (n = 45)

2.4 Resident elephants

The landscape between Ruaha and Mikumi comprises of vast wilderness capable of accommodating resident elephant populations. Although the area has been facing encroachment in recent years still a number places have vegetation cover capable of keeping elephants all year around. Results show that 54% of respondents said that there were no resident elephants, 44% of respondents said there were resident elephants and only 2% said they did not know if there are resident elephants. Locals provided differing accounts as to why elephants were resident in their areas (Table 2.2). Nevertheless it is known and was observed during the survey that some of the villages in the study area have resident elephant populations all year around. These include Izazi, Mtandika and Madizini (Table 2.3). In the past elephants are reported to have been wide spread in the whole landscape but their presence has been fading gradually in recent decades.

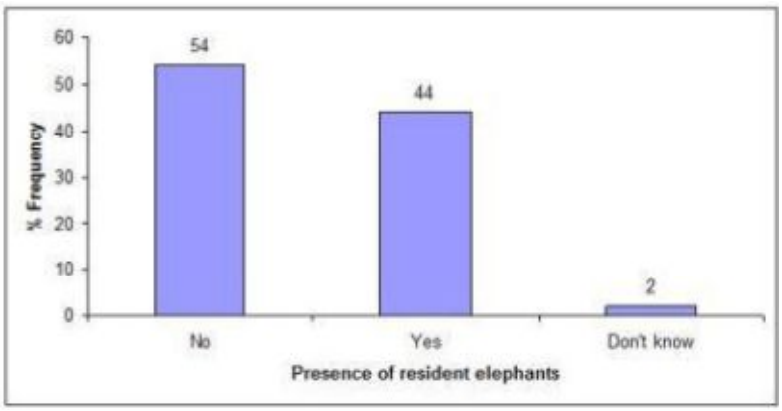


Figure 2.2: Response of local people with regard to presence of resident elephants in the study area (n = 69)

Table 2.2: Responses by village on whether there are resident elephants in the study area or not (n = 69)

Village	Yes	No	Don't know	Total
Kinyika	1	6	0	7
Kisanga	0	6	0	6
Mboliboli	2	5	0	7
Makuka	1	3	0	4
Izazi	5	3	1	9
Makatapora	3	0	1	4
Igunda/Nyanzwa	3	6	0	9
Ruaha Mbuyuni	1	3	0	4
Malolo	0	1	0	1
Mtandika	5	2	0	7
Kisanga(Kilosa)	0	2	0	2
Madizini	8	0	0	8
Ihombwe	1	0	0	1
Total	30	37	2	69

Table 2.3: Reasons given by respondents on why the elephants are resident

Reason for being resident	Frequency	Percentage
Habitat availability and no disturbance	3	13
Security, enough pasture and water	4	18
Availability of pasture and water	6	26
Indigenous to those areas	3	13
Ageing and security	1	4
Presence of forests, grass and water	1	4
Availability of forests and water	4	18
No poaching	1	4
Total	**23**	**100**

Resident elephants in the study area are found in Nyang'oro mountains (at Mbogeko) because of availability of water sources, forest/habitat cover and favourite pasture. Izazi villagers, Ward executive officer Mr. Jummanne Said and Ward Game and Fisheries officer Mr. Verdesto Kitulwe confirmed the availability of resident elephants in Izazi, Migori, Makatapora and in other forests of Nyang'oro mountain ranges. Izazi villagers mentioned to experience elephants coming from Mikumi through Nyang'oro ranges then move to Ruaha NP. They also reported that some elephants thought to be resident in Nyang'oro mountain forests move from those forests to Ruaha NP during June/October (summer) when water sources in mountains apparently dry out. During movement they may stray over farms and raid crops and injure people in villages they pass.

The Ward Executive Officer at Izazi village reported that they differentiate their resident elephants basing on colour, aggressive behaviour, body and tusk sizes. Generally elephants from Mikumi are said to be small and more aggressive than those from Ruaha. However there are resident elephants in Izazi area which are reported to be more aggressive than those from Mikumi and their aggressiveness is attributed to excessive poaching and disturbance in the locality. Also resident elephants in Nyang'oro forests are said to be smaller in size as compared to those from Ruaha NP and Rungwa GR but have stout and heavy tusks. Reports suggest that elephants from Mikumi and resident elephants in Nyang'oro ranges are generally of equivalent size but tend to differ in colour, and behaviour with Nyang'oro elephants being slightly more aggressive. Likewise elephants from Ruaha/Rungwa are reported to have larger tusks compared to those from Mikumi. Villagers account on the differences in body and tusk sizes and behaviour of elephants from different parts in the landscape need further verification.

Other areas reported to have residents elephants are Ifambo forests, Igoka forests and forest areas in Igunda/Nyanzwa, Mtandika and Mgowelo villages because of presence of forests and water from Great Ruaha River. Resident elephants are also said to occur in Ukwiva and Palaulanga catchment forests in Kilosa district as reported by Kisanga, Msolwa, Madizini and Ihombwe villagers. Palaulanga is reported to be a good elephant breeding site and it has plenty of water and conducive environment.

2.5 Elephant population trends

Local people had varying responses on whether elephants in the area were increasing or decreasing. The responses were somehow influenced by the village the respondents came from. The results show that 65% of the respondents said elephants were increasing, 16% said were decreasing, 3% said populations were stable while 16% did not know the direction of elephant population trends. Most people in many villages had the perceived opinion that elephants were increasing. The major reason given in support for the increase in elephants in the area included absence of poaching (30.6%), high rate of reproduction (13.9%) and a combination of high rate of reproduction and protection by villagers and TANAPA (13.9%). Other reasons were effective protection (11.1%), community conservation and protection and a combination of lack of poaching and law enforcement (Table 2.4). Those who said that elephants were decreasing had a number of reasons, including encroachment reported by 33.3% of respondents, a combination of harassment, injuring, and stabbing of elephants (22.2%), poaching, elephant human conflicts, encroachment and noises each reported by 11.1% of respondents respectively (Table 2.5). However, in many places increase in human-elephant conflicts has been associated with increase in elephant numbers.

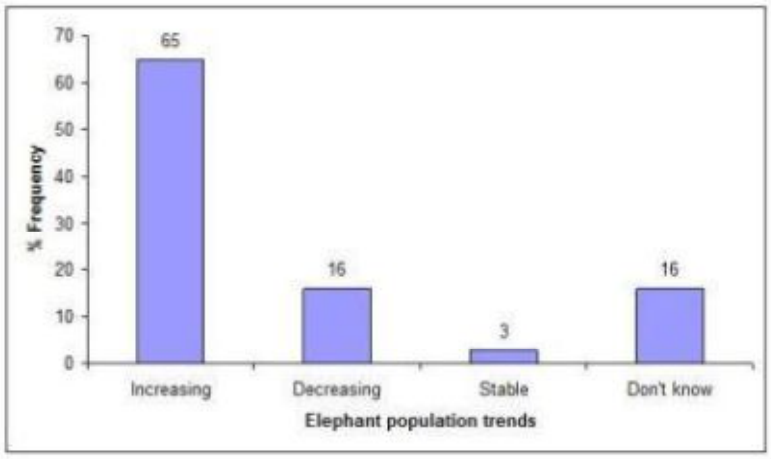


Figure 2.3: People's responses on elephant population trends in the study area

Table 2.4: Reason for increasing of elephants in the study area

Elephant increase reason	Frequency	Percentage
No poaching	11	30.6
Abolition of ivory trade	1	2.8
Conservation education and community conservation	1	2.8
Community conservation and protection	3	8.3
High reproduction, protection by villagers and TANAPA	5	13.9
Effective protection	4	11.1
Lack of poaching and effective protection	2	5.6
High Reproduction	5	13.9
High reproduction and no poaching	1	2.8
Closeness to national park	2	5.6
Availability of pasture in rain season	1	2.8
Total	36	100.0

Table 2.5: Reason for decrease in number of elephants in the study area (n = 9)

Reason	Frequency	Percentage
Poaching	1	11.1
Encroachment	3	33.3
Emigration	1	11.1
Harassment, injuring and stabbing of elephants	2	22.2
Elephant human conflicts	1	11.1
Encroachment and noise	1	11.1
Total	**9**	**100.0**

2.6 Elephant movements

Reports and field observations indicate that the landscape between Ruaha NP and Mikumi NP is suitable elephant range. Elephant populations include resident populations and migratory ones. It is the elephants reported to move between Ruaha and Mikumi NPs which form the core interest of this study.

Most people interviewed reported that elephants move from either West to East or East to west which generally related to the expected direction of movement considering the relative position to each other of Ruaha and Mikumi/Udzungwa NPs respectively. However, some stated categorically that elephants move from Mikumi to Ruaha national parks. But there are also cases when local people informed of elephant movement directions which deviated from the east-west orientation although these routes later joined the major migration routes. These intermediate routes apart from being used for migration may also be used by elephants to utilize ranging areas in localities which they pass during migration or by resident elephant populations.

2.6.1 Elephant routes and migration patterns

All respondents (100%, n = 79) interviewed in the survey area acknowledged having elephant routes through or in proximity of their villages. Among villages surveyed 91% of interviewees responded that there are special routes, 4% interviewees said no special routes while 5% responded that they did not know (n = 76).There was a significant difference ($\chi^2 = 112.89$, $P < 0.001$) among responses in the three categories in favour of presence of special elephant migration routes (Figure 2.4). Moreover, 99% responded that the special elephant routes still exist, 1% of interviewees did not know if the routes still existed (Figure 2.5, Table 2.6). This question supports well known facts that elephants often tend to use established routes during migration and herds keep memory of the routes usually through the long living matriarchs who take lead of the breeding and migrating herds.

There appears to be a more clearly defined elephant routes between Ruaha NP and Nyanzwa areas. From here a number routes tend to emerge taking elephants to either Mikumi or Udzungwa national parks. Detailed descriptions of the routes are provided below, in Appendix II and the Map. A number of routes are still in use some as recent as 2008. Local people reports that the elephant migration was almost an annual phenomenon in the past but in recent years due to encroachment and severe disturbance by human activities the movements are sporadic.

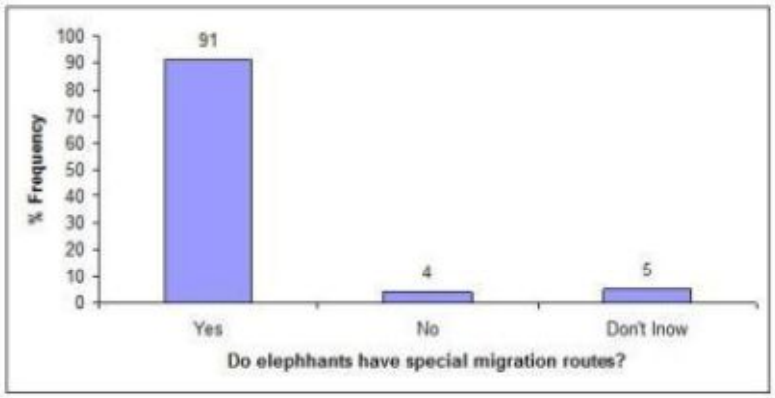


Figure 2.4 People's responses on whether elephants tend to migrate in special routes (n = 76).

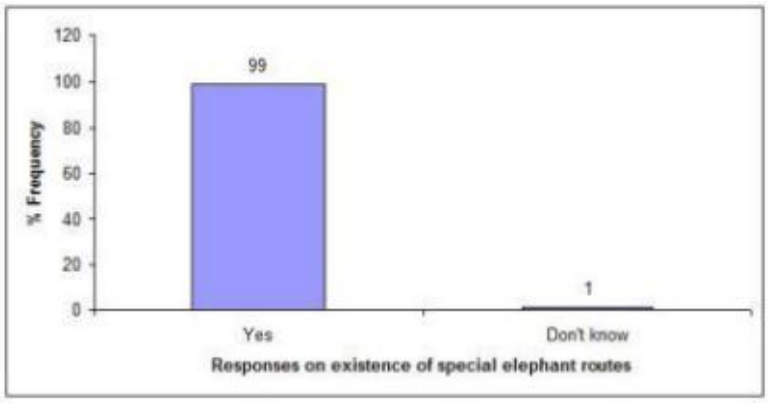


Figure 2.5: People's responses on the existence of special elephant routes between Ruaha and Mikumi NPs (n = 71)

Table 2.6: Responses by village on the presence of special elephant routes during migration

Village	Yes	No	Do not know	Total frequency
Kinyika	5	0	2	7
Kisanga	4	2	0	6
Mboliboli	6	0	1	7
Makuka	5	0	0	5
Izazi	9	0	0	9
Makatapora	5	0	0	5
Igunda/Nyanzwa	7	0	1	8
Ruaha Mbuyuni	4	0	0	4
Malolo	1	0	0	1
Mtandika	7	0	0	7
Kisanga(Kilosa)	2	0	0	2
Madizini	7	1	0	8
Ihombwe	7	0	0	7

	69	3	4	76

After a thorough analysis of information from interviews and field verification the migration routes of elephant between Ruaha and Mikumi can be described as follows (and see also Map, and Appendix II):

From Kinyika to Nyang'oro mountains

Elephants start their journey from Ruaha National Park to **Kinyika** village areas in May to August months. Some may raid crops and go back to the park while others are reported to continue with migration. While here they usually damage crops such as rice, sweet potatoes and maize. Often crop raiding is done at night but also (rarely) in day time. In 2008 villagers of Kinyika tried in vain to prevent a herd of elephants after the matriarch led the group past the village centre and residents had to flee (Mr. Makarios Mtati pers. comm. 2008).

Some elephants may pass through Kinyika to other villages in the eastern side crossing through farming areas or rather through a stretch of vegetation at **Liamapogolo** forests (in Kinyika village) via **Kili** forests to **Magwagu** area at **Kisanga** village. Elephants may also move from Kisanga either through uncultivated or cultivated areas to **Mboliboli** village (Mr. John Sasa pers. comm. 2008).

Residents of Kinyika and Kisanga villages' report that elephants which stray over their farms often go back to Ruaha NP after crop raiding but those going to other villagers usually come back during the rainy season. This differentiated between elephant who make visits for crop raiding and those who pass on migration.

Villagers of Mboliboli reported that they see elephants of different types criss-crossing their surroundings. Some are small, short and aggressive which are believed to be coming from Mikumi national park and the larger ones which are non aggressive are said to come from Ruaha national park. However, elephant crossing points at Mboliboli village are found somewhere between this village and **Makuka** village at **Kilala** and **Matulya** locations. Kilala and Matulya areas are dominated by *Acacia* woodland and shrub land and few scattered trees of *Adansonia digitata*. Antelope footprints were also spotted alongside elephant routes at Matulya.

Alternatively, elephants may move directly from Ruaha national park crossing Ruaha River at **Komsangoo** then through Kilala and Matulya to Nyang'oro mountain ranges.

Residents at Makuka village including the village game scout reported that elephants move past their village during months of May to December. Some herds were moving from Ruaha towards Nyang'oro and while other groups were moving from **Nyang'oro** to Ruaha. Even in November, 2008 elephants were found at Kilala area (very close to the village) believed to be from Nyang'oro mountains, they later moved to Ruaha National Park. Mr. Jailos Nzeku who is the village Game scout based in Makuka village said that instead of elephants moving to Mboliboli, Kisanga and Kinyika villages they may cross at Makuka village (Kilala and Matulya) directly to Ruaha National park after they have crossed the Little Ruaha river at Komsangoo which is the permanent elephant route linking the park to other areas to the East towards Nyang'oro mountains.

Elephants move from Makuka village (Kilala/Matulya) to Nyang'oro mountain ranges after crossing the Iringa-Dodoma main road at various points between **Mlawi** and **Mwenga Magoha bridges** at **Izazi** village. The area between the two bridges is a very important elephant route in such a way that during elephant migration people and especially drivers have to be conscious not to collide with elephants. There are very remarkable elephant trails between and on each of the two bridges indicating that elephants passed here in March and May 2008 as reported by Izazi village residents. The Izazi village executive officer Mr. Abdul Issa said that in 2007 and April, 2008 elephants passed at Izazi only once but in 2006 elephants reached and stayed for months on village areas.

From Nyag'oro mountains to Nyanzwa/Ruaha Mbuyuni/Mtandika

When elephants reach Nyang'oro mountain ranges they may range/ forage in these forests or move along the foot of the mountain ranges to **Mtera** areas at **Kinyari** subvillage. In the course of movement along the mountain ranges they keep Izazi, Migori and Makatapora villages to the North west. When they reach Mtera they go to **Makolongo** areas (in Dodoma region). It is important to note that in the past elephants used to move from Kinyari (Nyang'oro Mountains) to Kikuyu areas through Ifambo forests, Luhomelo, Kiseke to Nyanzwa but nowadays they avoid Kikuyu and Iwondo sub villages keeping them to the South east and alternatively crossing Dry Ruaha River (water here flows through the underground tunnels for hydropower production) at Mtera forest to Makolongo (Kisima) areas via **Kilimbe** mountain areas to **Singonari** GCA located on the other side the Great Ruaha river in Dodoma region. Elephants then move through Singonari up to the points where they again cross the Great Ruaha River to Iringa side of the riverbank at **Luhomelo**, **Kiseke** and **Idodoma/Ipala** crossing points.

Elephants crossing the Great Ruaha river at Luhomelo from Singonari (Dodoma) to Luhomelo (**Mkulula** village in Iringa region), may either move back to forage at Ifambo forests (which is continuous to **Iwondo** and **Kikuyu** sub villages to Kinyari (Nyang'oro mountains) or they may move to Kiseke where they join elephants crossing at this point (Kiseke) from Singonari side of the riverbank and moving through woodland, bushes or forest areas to **Igoka** forests. Here at Igoka there believed to be a branching of the elephant routes. The left (north) subdivision is the route that elephants may take and move along the Ruaha river banks to Ipala forest areas of Igunda village and they may proceed to either Ruaha Mbuyuni or Mtandika villages. The right path (south) is taken by elephants moving through mountainous/highland areas to Matanana/Ilambo mountain forests at Nyanzwa village to Mgowero village where they may proceed to Mtandika village then cross Lukosi river to Udzungwa National Park. But also elephants can move from Mgowero areas and Igunda forest areas to Ruaha Mbuyuni where they cross the Great Ruaha river at any point between Mazombe and Pipeline areas, Kijiro inclusive to Malolo/Mgongwe areas.

From Ruaha Mbuyuni/Mtandika to Mikumi/Udzungwa

Elephants crossing Great River Ruaha at Idodoma from Singonari (Dodoma side of riverbank) move to Ipala forests (Iringa side of riverbank) then to Ruaha Mbuyuni where they cross the Ruaha river again to Malolo in Kilosa District; or else from Ipala forests via Mgowero and Mtandika villages to Udzungwa national park after they have crossed Lukosi river.

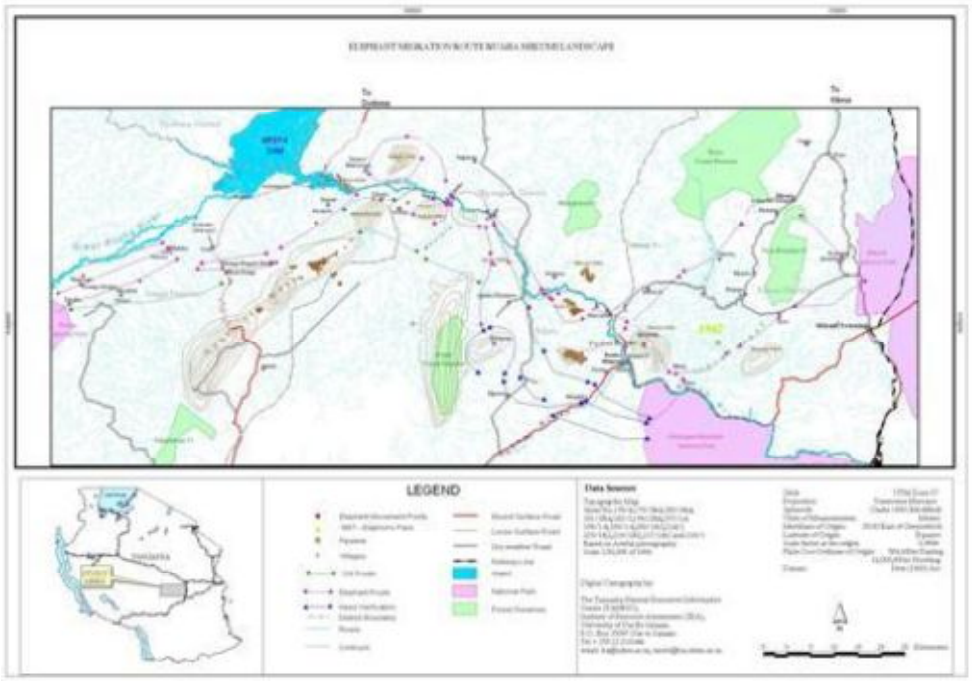
It is reported that elephants lastly crossed Great Ruaha river at Ruaha Mbuyuni to Malolo in 2006. These excludes resident elephants that are frequently seen coming to drink water from Igunda forests and go back without crossing the river (Mr. Saidi Mzigua pers. comm. 2008). Residents report that elephants are likely to abandon to cross the river to Malolo/Mgongwe because of increasing encroachment close to the river and physical harassment to elephants by farmers.

After elephants have crossed the river at either Mazombe or Kijiro they move to Mgongwe subvillage areas of Malolo village. They have to find a low lying area in Mgongwe (Malolo ranges) mountain ranges. As from here elephants take two routes.

Firstly, From Mgongwe areas they move to Ukwiva catchment forests after they have crossed Mwega River at Malolo B. However, residents at Malolo B (The village headquarters) have not experienced elephants in their village areas except at Malolo A near to Ruaha Mbuyuni. From Ukwiva they move to Madizini village at Lamu subvillage (Mhoswa areas) to Palaulanga catchment forests then through Ihombwe village to Mikumi national park.

Secondly, From Mgongwe areas they move to Ilole forests up to Mikumi National park. Kidai villagers (Mr Fidelis and Mr. Jumanne pers. Comm. 2008) reported that after elephants have crossed at Kijiro (Malolo/Ruaha Mbuyuni) they move to Ilole forests which include Mbala forests (Kisanga village), Msanga forests (Kidai village) and Iyovi. Elephants reach Mikumi national park at an area between Kisanga-Mikumi-Kilosa road junction and Mikumi Township (see Map below).

From Udzungwa national park elephants may cross again the Great Ruaha River at Kidai village and proceed to Mikumi. However, this information needs to be ascertained. Villagers report that elephants tend to cross past Kidai ferry unnoticed. The area is dominated by thick forests hence it may not be easy for people to see elephant signs unless one takes trouble of visiting the forests. It has to be noted that in some villages of Kilosa District such as Malolo B, Msolwa, Kidai and Kisanga, elephants and migration routes are very far away from village centres and in forested areas, therefore, villagers may not be aware that there are elephants or that elephant move through their areas.



2.6.1.1 Elephant availability and last sightings

Information from local people suggests that there are irregularities in terms of seasons when elephants are available or pass in surveyed villages. However, the patterns and causes of elephant movement in the landscape appear to be complex and need detailed investigation. The confusion possibly arises from the difficulty among the villagers to differentiate resident elephants, from elephants that make short movements within the landscape and those thought to migrate between Ruaha and Mikumi. It is reported that from May to June elephants move from Ruaha to Mikumi and come back from Mikumi to Ruaha in September – November. Migrating elephant herds are formed by groups of about 20 – 100 individuals. Respondents in most villages reported that elephants are available in their area between May to October. Although in some villages different elephant availability seasons beginning as early as April were reported. There is a general agreement among people and places that elephants tend to appear in most villages when it starts raining and during crop harvesting (See Appendix I).

The months of May to June are rice flowering and harvesting periods for most villages in Pawaga and Ismani divisions in Iringa rural district. In Madizini and Ihombwe villages in Kilosa district people said that they see elephants either before or after March, April and May which are rainy seasons in most areas in Kilosa district.

Irregularity of elephant availability and movement may also be influenced by proximity to protected areas, forests and water sources. For example elephants seen in Ihombwe village near Mikumi national park; Kinyika, Kisanga and Mboliboli villages near Ruaha national park may be associated among other reasons to their proximity to the NPs. Often elephants stray to these villages and go back to parks.

In most villages, villagers responded differently on the last time when elephants crossed past their villages. Residents in Kinyika, Kisanga, Mboliboli and Makuka had their last crossings in November 2008, and Izazi village was in June 2008. From Kikuyu and Iwondo subvillage to Luhomelo where elephant dungs of variable decay grades were observed it was estimated that elephants passed there sometime in September/October, 2008 as there were also signs of recent elephant browsing suggesting that elephants pass through and forage in those areas all the time. From Igunda/Nyanzwa village at Ipala /Idodoma there were relatively old elephant dung and Mazombe areas near Ruaha Mbuyuni there were also elephant dung of grade E showing that elephants crossed here in possibly sometime in 2008. At Ruaha Mbuyuni and Malolo it was reported that except for resident elephants, the migrating elephants last crossed the Ruaha river to either Malolo or Ruaha Mbuyuni in 2006.

2.6.2 Dead elephant routes

Survey has shown that there are a number of elephant routes which are no longer in use. This was supported by 44% (n = 70) respondents while 37% said that there were no dead routes. At least 18% of interviewees did not know whether there are dead routes or not. Some of those who supported the presence of dead routes maintained that they were aware of existence of such routes in the past and were also aware of the different causes that contributed to blockade of such routes and in some cases emergence of new existing routes. Factors contributing to closer of elephant routes include farming, settlement, livestock keeping, noises, and combination of these factors as shown in Table 2.7 below.

There are at least four dead elephant migration routes that have been reported by residents (See Map above). One was running from Ruaha Mbuyuni via Beko to Idodoma. This route could not be traced on the map because we could not get the exact position of Beko from the information gathered from local people. The second route was from Kinyari via Mkulula to Nyanzwa. This route died due to poaching and encroachment. There is a location called Kilolo along the route which is a centre for poachers hence are thought to have contributed in scaring away elephants from using the route. A third route was coming from Kinyari via Kikuyu to Ifambo/Luhomelo. This route is heavily encroached and is blocked by cultivation and settlements. The fourth route originated from Ruaha NP via Ihwavi (at Mboliboli village) to Nyang'oro mountains. This route died probably due to encroachment, pastoralism, settlements and poaching.

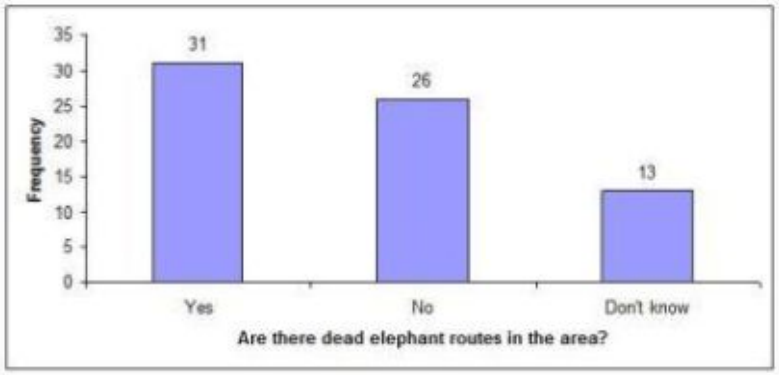


Figure 2.6: Responses of people on the presence of dead elephant routes in the study area (n = 70)

Table 2.7: Reasons on what caused some elephant migration routes to die

Reason	Frequency	Percentage
Settlement	17	45
Farming and settlement	6	16
Farming	4	11
Don't know	4	11
Noises	2	5
Livestock	1	3
Livestock and settlement	1	3
Drought/Shortage of water	1	3
Drought, lack of pasture in summer	1	3
Settlements, farming and injure elephants	1	6
Total	**38**	**100**

2.6.3 Threats to elephant routes

One of the important observation and concern during this survey was the threat facing the elephant migration routes between Ruaha and Mikumi. Apparently the reasons stated by people on the causes of having some dead routes in the area are the same reasons which threaten the existing elephant routes. The results showed that 75% of informants (n = 63) said there were threats to the routes, while 19% of respondents said no threat to routes and only 6% of respondents did not know if there threats to elephant routes or not. There was significant variation in responses to presence of threats to elephant routes among respondents ($\chi^2 = 47.2$, $P < 0.001$). The responses in many villages revealed the presence of threats to the routes except for respondents in Madizini and Igunda who said there were no threats to the routes (Figure 2.7, Table 2.8).

At least seven types including combinations of threats were mentioned and observed during the surveys. These include farming mentioned by 32% of respondents, settlements by 29% of respondents, farming and settlements by 16% respondents, farming, population growth and settlements by 10% respondents, human elephant conflict and farming by 7% respondents, passing in human footpaths and farming by 3% respondents, settlement and livestock keeping by 3% respondents (n = 31) as shown in Table 2.9.

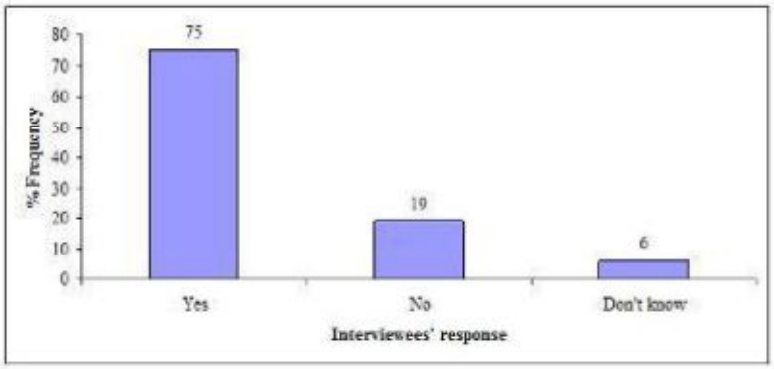


Figure 2.7: Responses of interviewees on whether there were threats to elephant routes or not (n = 63)

Table 2.8: Frequency of respondents by village on presence of threats to elephant routes

Village	Yes	No	Don't know	Total
Kinyika	3	1	1	5
Kisanga	6	0	0	6
Mboliboli	6	1	0	7
Makuka	3	0	0	3
Izazi	8	1	0	9

Table 2.8 continued

Village	Yes	No	Don't know	Total
Makatapora	5	0	0	5
Igunda/Nyanzwa	3	3	0	6
Ruaha mbuyuni	4	1	0	5
Mtandika	2	0	3	5
Kisanga (Kilosa)	1	1	0	2
Madizini	2	3	0	5
Ihombwe	4	1	0	5
Total	47	12	4	63

Table 2.9: List of threats to elephant routes between Ruaha and Mikumi NPs as mentioned by people and observed in the field.

Threats	Frequency	Percentage
Farming	10	32
Settlements	9	29
Farming and settlements	5	16
Farming, population growth and settlements	3	10
Passing in human footpaths	1	3
Human - elephant conflicts and farming	2	7
Farming, settlements and livestock keeping	1	3

	31	100

2.7 Human elephant conflicts

Both resident and migrating elephants have always been in conflict with local communities when human and elephant ranges have common interface (Nahonyo 2001, 2004). The encounters tend to take varying forms depending on environment. In the study area results show that 88% of respondents said that elephants cause damage to life and property while 12% said they did not experience elephant damage (Figure 2.8, Table 2.10). The two responses which were significantly variable (χ^2 = 45.2, P < 0.001) suggest how the interactions differed between localities. Type of damage caused included crop damage as reported by 65% respondents, damage of crops and injuring people by 17% respondents, damage crops, injure people and kill people by 11% respondents, killing people 6% and injure people by 1% of respondents respectively (Table 2.11). The crops damaged included rice by 30% respondents, banana and sorghum by 17% respondents, sweet potatoes and maize by 13% respondents and sugarcane and cassava by 4% respondents (Figure 2.9). Most of the respondents in respective villages responded that elephants cause damage as shown in Table 2.10. Migrating elephants were reported to cause damage to crops and infrastructure when these were located along their traditional migration routes.

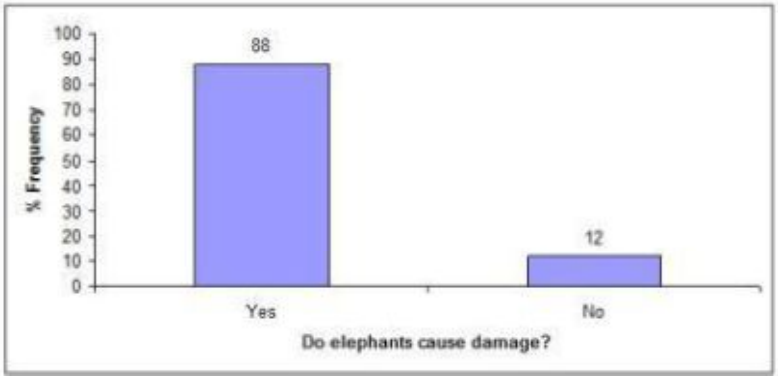


Figure 2.8: Percentage of respondents who responded to damage caused by elephants.

Table 2.10: Responses by village on whether elephants caused any damage

	Yes	No	Total
Kinyika	7	0	7
Kisanga	6	0	6
Mboliboli	7	0	7
Makuka	5	0	5
Izazi	9	0	9
Makatapora	5	0	5
Igunda/Nyanzwa	6	3	9
Ruaha Mbuyuni	5	0	5
Malolo	1	0	1
Mtandika	7	0	7
Kisanga(Kilosa)	1	0	1
Madizini	2	6	8

Ihombwe	7	0	7
Total	68	9	77

Table 2.11: Types of damage caused by elephants in Ruaha - Mikumi landscape

Damage	Frequency	Percent (%)
Crop damage	42	65
Injure people	1	1
Kill people	4	6
Damage drops and injure people	11	17
Damage crops, injure and kill people	7	11
Total	65	100

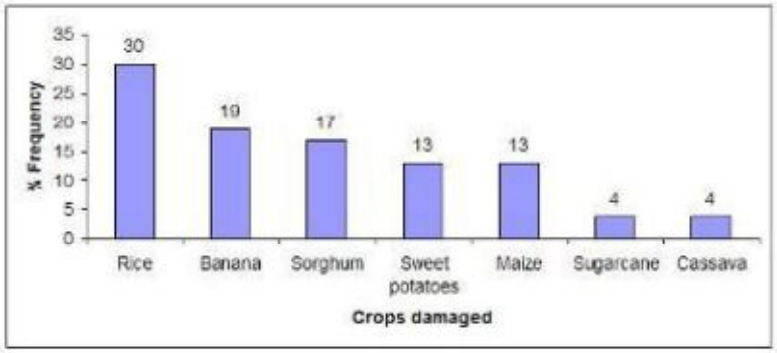


Figure 2.9: Types of crops damaged by elephants in the study area (n = 23)

2.7.1 Human damage to elephants

The survey was also interested to learn what kind of damage human's cause to elephants. The results showed that 73% of respondents denied humans causing any damage to elephants, 18% responded that they cause damage to elephants while 9% did not know if there is human damage to elephants (Figure 2.10, Table 2.12). Human effects to elephants include killing of elephants mentioned by 29% of respondents, encroaching elephant routes and habitats (21%), killing elephants and encroaching elephant routes (21%), farming along elephant routes (14%) and harassing and injuring elephants (14%). However, majority of respondents in surveyed villages responded that there is no human damage to elephants as shown in Table 2.13.

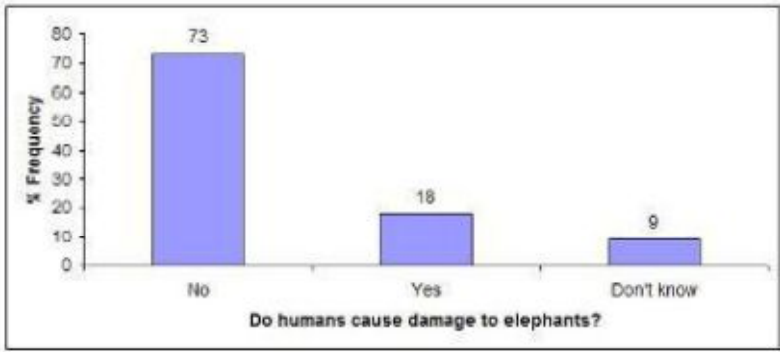


Figure 2.10: Respondent's views on whether humans cause damage to elephants

Table 2.12: Responses on types of human effect to elephants in Ruaha – Mikumi landscape

Human effect to elephants	Frequency	Percentage
Killing elephant	4	29
Encroaching elephant routes and habitat	3	21
Killing and encroaching elephant routes	3	21
Farming in elephant routes	2	14
Harassing and injuring elephants	2	14
Total	14	100

Table 2.13: Responses by village on human damage to elephants

Village	Yes	No	Don't know	Total
Kinyika	1	4	2	7
Kisanga	0	6	0	6
Mboliboli	2	5	0	7
Makuka	1	3	1	5
Izazi	3	6	0	9
Makatapora	1	3	0	4
Igunda/Nyanzwa	2	5	1	8
Ruaha Mbuyuni	1	3	1	5
Malolo	0	1	0	1
Mtandika	0	5	0	5
Kisanga(Kilosa)	0	2	0	2
Madizini	1	5	0	6
Ihombwe	1	4	1	6
Total	**13**	**52**	**6**	**71**

2.8 Elephant dung count

2.8.1 Elephant dung densities

Overall elephant dung density in the sampled area was estimated to be 2,025 dung piles per km^2 (n = 96). Densities of dung outside and inside protected areas were 1,709 dung piles/km^2 (n = 81), and 316 dung piles/km^2 (n = 15) respectively of the whole sampled area. Over 56% of the total sampled area was outside PA and 44% was inside protected areas. Dung densities in village land in sampled areas were 1,329 dung piles/km^2 for Luhomelo (n = 63), 380 dung piles/km^2 for Mazombe (Igunda village) (n = 18), 253 dung piles/km^2 for Kinyika (n = 12) and 63 dung piles/km^2 for Kisanga (n = 3) village respectively (Figure 2.11). It has to be noted that most of the elephant corridor between Ruaha and Mikumi lies outside protected areas.

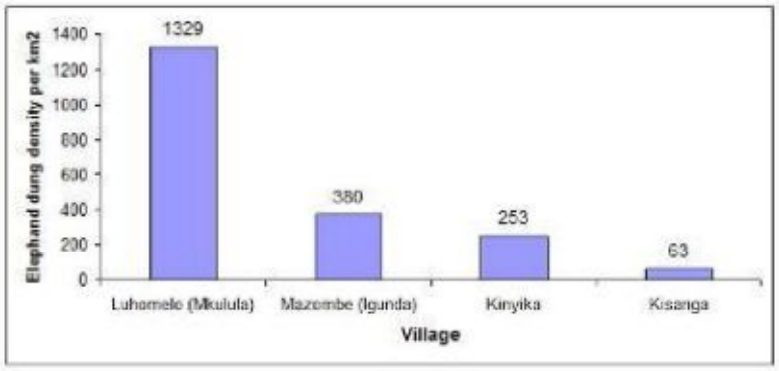


Figure 2.11: Elephant dung densities (uncorrected indices) in sampled villages in the study area

2.8.2 Elephant and other animals signs, dung decay stages

Elephant signs observed were 88 dung piles and 8 Dung piles and footprints, 11 footprints and 8 browsing signs (Table 2.14). Other animal signs seen were 93% cattle trampling (n = 86), 4%, cattle trampling and donkey dung, 2% cattle dung, and 1%, cattle trampling and primate skull (Table 2.15).

Dung decay stages as per Barnes (1993) included 69% (n = 96) dung piles of Grade E, 25% were Grade C2, 3% were Grade C1 and 3% were Grade B (Table 2.15).

Table 2.14 Elephant signs observed in Ruaha - Mikumi landscape

Elephant signs	Frequency	Percentage
Dung piles	88	77
Footprints	11	10
Dung piles and Footprints	8	7
Browsing	8	7
Total	115	100

Table 2.15 Elephant dung decay stages and other animal signs in Ruaha - Mikumi landscape

Other animal signs			**Elephant dung decay stage**		
	Frequency	**%**		**Frequency**	**%**
Cattle trampling	80	93	B	3	3
Cattle trampling and skull of a monkey	1	1	C1	3	3
Cattle dung	2	2	C2	24	25
Cattle trampling and donkey dung	3	4	E	66	69
Total	86	100	Total	96	100

The elephant dung count was done in different habitat types including forests, bushed shrub land, shrub land, wooded grassland and bush land. No dung count was done in areas where dung were very sparsely scattered but was only noted.

The elephant dung densities were found to differ among the four village areas where dung survey was conducted. The low densities at Kisanga and Kinyika villages were perhaps attributed to large number of cattle grazing in those areas hence trampling on elephant dung. This was evidenced by the presence of numerous scattered doume palm nuts in certain locations in Kisanga village which originally were embedded in elephant dung piles. The other reason is the survey was done during rains in Iringa rural district therefore it is possible that most elephants were inside Ruaha national park where there is plenty water during this time of the year and elephants do not have to come outside the park in search of water. Whilst the high dung densities in Luhomelo area of Mkulula village and Mazombe area between Igunda and Ruaha Mbuyuni were associated to their nearness to Great Ruaha river and suitable habitat hence attracting presence of resident elephants.

Dung observed during the survey was at different decay stages. Elephant dung of Grade E was numerously counted in the study. Among Grade E dung some closely resembled the soil due to decomposition by termites. However, recent elephant dung such as that of grade B were seen at Luhomelo areas. Recent elephant dung was found there because it is a place where elephants cross from Singonari (Dodoma riverbank side) to Luhomelo (Iringa riverbank side). Sometimes it was confusing to judge the decaying stage of dung at Luhomelo as dung at different decay stages was closely packed together. Also excessive sunshine made some dung to appear like it is at C stage but actually it was a B stage because the dung externally appeared very dry but was very fresh inside.

Elephant dung was abundant in shrub land and bushed grassland relative to other habitat types. These are preferred elephant habitats and characteristic vegetation along the Great Ruaha River at Luhomelo and Mazombe.

The elephant dung density was found to be higher outside protected areas of Luhomelo (Mkulula village) and Mazombe area (Igunda/Ruaha Mbuyuni) than inside protected areas i.e. the WMAs in Kinyika and Kisanga villages managed by MBOMIPA. Also fresh elephant browsing was more common outside than inside protected areas because some areas outside protected areas were close to river and had forests where elephants could stay.

Other animal signs seen during elephant dung count include cattle trampling, grazing and livestock trails. No livestock signs were seen in thick forests but were common in relatively open areas and in some parts of forests. It is said that the Barbaig and Sukuma livestock keepers have extensively occupied large areas in the landscape and are increasingly driving their livestock in new areas in search of fresh pasture.

2.8.2.1 Habitat types encountered in dung count

A total of 4.5km distance was covered in total during dung count along transects. Out of 96 recordings of elephant dung piles 27% were found in bushed shrub land, 21% in shrub land, 17% in bush land, 14% forests, 14% wooded shrubland, 4% in wooded grassland and 4% in woodland (Figure 2.12).

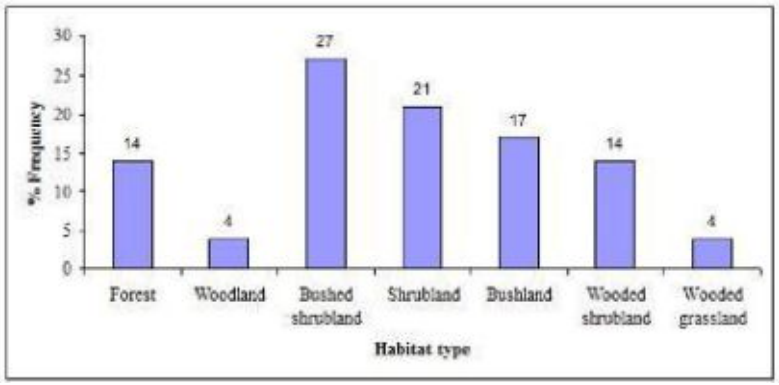


Figure 2.12 Percentage frequency of elephant dung piles per habitat type in Ruaha – Mikumi landscape (n = 96)

3.0 IMPORTANT LOCATIONS IN THE LANDSCAPE

The survey has revealed that some residents in surveyed villages are knowledgeable about wildlife and particularly elephants that they were able to mention elephant crossing points in their own respective villages as well as from other villages. The following are elephant crossing points or important locations with respect to villages in the survey area between Ruaha and Mikumi landscape.

Kinyika village

Liamapogolo forests and surrounding areas in **Kinyika village**. There are physiognomicaly dense woodland, patches of *Acacia* wooded grassland and shrub land. This area has got elephant dung of mostly Grade E. Elephants moving from Ruaha national park pass through this area where they move along Kili valley forests to Magwagu area at Kisanga village.

Kisanga village

The elephant crossing points in this village are at Mawindi subvillage, Kisanga and Magwagu. Magwagu is an important area dominated by *Acacia* woodland and bushland where remarkable elephant foot prints trodden in mud during the rain season were observed. In some patches of harvested rice farms and few elephant dung piles were also visible. Few elephant dung piles were visible because of being trampled by cattle and rapid decomposition. However, indicators of presence of elephant dung were remains of doum palm nuts which are favourite food for elephants. The palm nuts were originally embedded in dung but after decomposition they remained scattered in the area. Mr. Mpapuka, Mbomipa VGS in Kisanga said that Magwagu (in Kisanga village) is the point among others which connect the elephant route with Kinyika village and other locations like Kilala and Matulya (in Makuka village). Other animal signs seen in the area were abundant dik-dik pellets.

Mboliboli and Makuka

Between **Mboliboli** and **Makuka** villages are elephant crossings notably Kilala and Matulya. The former is very close to Makuka village. These are points through which elephants may either cross directly from Ruaha national park or from Kisanga and Mboliboli villages. The area is dominated by *Acacia* woodland and few scattered trees of *Adansonia digitata*. There were seen signs of antelopes at Matulya. Makuka VGS Mr. Jailos Nzeku reported other animals inhabiting the areas included Greater and Lesser kudu, duikers, dik diks and other small antelopes.

Bwawani (Mtera) or Itemagu, Mbogeko, Mlawi and Mwenga Magoha in Izazi village

Mlawi and Mwenga Magoha bridges are along Dodoma-Iringa road at **Izazi** village. They are near to Nyang'oro Mountains along which there is Mbogeko hills (within Nyang'oro ranges) area which is a known important elephant habitat. Between Mlawi and Mwenga Magoha are very dense woodland (villagers refer to them as forests) of various trees like *Acacia* spp (dominant), *Commiphora* spp, *Cassia* spp, *Sterculia Africana* and others. There are very remarkable elephant trails said to be made by elephants crossing in very large numbers which sometimes impose potential threats and delays to road users including vehicles (Pers. Comm. with Mr. Andrew Makuka, December. 2008). Elephants in these forests prefer fruits of, *Grewia* spp. (Mperemehe), *Cassia* sp. (Mkwata) and other plants locally known as Mihavava and Mluse.

Kinyari subvillage

Elephant locations are at areas known as **Mbweleli** near forested areas at the foot of Nyang'oro mountains and Mtera forest. There are human foot paths in Mbweleli areas which are said to have been started by elephants in the past but nowadays elephants have been displaced to further up the Nyang'oro mountains as result of encroachment in these areas which are reported to be village forest reserves. Mtera forests form the link through which elephants move to Makolongo area across Great Ruaha in Dodoma Region when trying to avoid the encroached Kikuyu and Iwondo subvillage at the extreme eastern end of Nyang'oro mountains which is the past migration route. Settlements are being expanded and new farms are increasingly being opened in the area.

Kikuyu and Iwondo subvillage

These sub villages are between Mtera and Ifambo forests. Elephants used to pass there but nowadays they do not pass there because the areas have been cultivated (slash and burn agriculture) and settled. Worse enough it was observed during the survey that farmers were increasingly opening new farms on mountainous areas. However, residents reported signs of elephants which passed their village through Mtera forests going to Makolongo (Dodoma) in 2007.

Ifambo forests

These are thick forests lying between Kikuyu/Iwondo sub village and Luhomelo area. Along the human footpath in the forest (when moving from Kikuyu towards Luhomelo) are very recent elephant footprints and fresh/green browsing signs in the forests. In places where the forests were discontinuous (i.e. in open patches of bushed grassland), old elephant foot prints and few scattered dung were seen. These are among places having few resident elephants. This area is continuous to Luhomelo which is very close to Great Ruaha River. It is said that elephants residing in that forests come from Luhomelo.

Luhomelo sub village areas

Luhomelo is close to Ifambo forests. This is the point where elephants from Singonari area (Dodoma side of river bank) cross Great Ruaha River to Luhomelo (Iringa side of river bank). Luhomelo is a Hehe's word meaning Mass killings or Massive deaths. This is a reference to the mass killings during tribal wars between Hehe (Iringa side) and Gogo (Dodoma side). Mass killings were attributed to the fact that this is the only location of the river where it is shallow

and people can cross easily on foot to either side, hence it was used as battle ground. Mr. Mbweta a Makatapora ex-village Game scout who was an escort said the river water at such point is not so much deep, thus, that was the reason people used to cross there and currently even elephants cross there. "Singonari" is also a Hehe word meaning "Long neck". It was named so when the Hehe defeated the Gogo and their allies and when they crossed the river into Dodoma side they saw a beautiful tall animal whose neck was tall which they had not seen before, hence they (Hehe warriors) named it as Singonari (Long neck). The animal was in fact a giraffe. Until now the area at Dodoma side is called Singonari while Iringa side of riverbank remains to be Luhomelo. There are numerous elephant dung piles and recent elephant foot prints at the area. The elephant dung were of grade B, C1, C2 and many of E. Apart from elephant crossing it is also used as an animal drinking site. Elephants that have crossed here from Singonari either continue to Kiseke up to Nyanzwa (those which are migratory) or move back to Ifambo forests.

Kiseke

This is an area which is situated between Luhomelo and Nyanzwa. Elephants moving from Singonari to Iringa side may cross the Ruaha river at this point. However, no elephant signs were seen on the area. From Kiseke elephants move to Igoka forests areas. The area has forest cover on hills which are also said to be elephant foraging areas. There are few scattered temporary shelters belonging to fishermen along the river from Luhomelo to Kiseke subvillages.

Igunda/Nyanzwa village

In this village elephant crossing points are at Ipala forests (from Idodoma/Singonari) and Matanana. Others are said to be at Mgowero village where it is reported there are resident elephants. The Ipala forests point was marked because it is visited by elephants moving from Idodoma/Singonari going to Mazombe, Ruaha Mbuyuni, Mgowelo to Mtandika. Matanana locations were not visited in this study but residents at Nyanzwa village reported the area to have resident elephants.

Ruaha river crossing points from Ruaha Mbuyuni to Malolo

Ruaha Mbuyuni and Malolo villages are only separated by the Great Ruaha River such that the western side of the river bank belongs to Ruaha Mbuyuni and the eastern river bank to Malolo. The area between Mazombe and Ruaha Mbuyuni are said to be locations where elephant cross the river. The points include Mazombe, Kijiro and Pipeline areas. Elephants from Igunda or Ruaha Mbuyuni may cross the river at Mazombe. It is a very important point which marks the border between Igunda village and Ruaha Mbuyuni but very near to Ruaha Mbuyuni. Mazombe in Hehe language means *Ficus sue* trees since the area on either side of the river is dominated by large *Ficus sue* trees mixed with bushes which altogether provide nice shade.

The width of the river is variable in size but it is not less that 60m.However at Mazombe it was estimated to be about 70m with depth of approximately 2.5m during average season. Besides the *Ficus* trees occupying the riversides at Mazombe; additional plant cover includes *Acacia* shrubs/trees and patches of bushes and bushthickets at Iringa side whereas at Malolo side there are farms and fallow areas. Farmers at Malolo side of Mazombe (Mr. Said and Mzee Saidi Mzigua) reported that the last time elephants were seen crossing the river at Mazombe was in 2006. However, evidence has it that at Iringa side of Mazombe they are said to have elephants which do not cross the river but frequently come to drink and go back and the area had elephant

dung. From Mazombe moving along the river towards Ruaha Mbuyuni are **Kijiro** and TAZAMA Pipe line sections of the river. These sections at the time of survey were bordered with harvested rice farms and green maize farms under irrigation. There is also an area between Mazombe and TAZAMA pipe line where resident elephants from Igunda/Nyanzwa come to drink and move back to the forest.

Some residents at Ruaha Mbuyuni and Malolo said that elephants cross the Ruaha river while others said they do not cross the river claiming that there are separate elephant populations belonging to Malolo (Kilosa) and those belonging to Ruaha Mbuyuni (Iringa side) and they do not mix. However, farmers at TAZAMA pipeline areas responded that elephants lastly crossed the river in 2007 and they can cross at any point of the river within the locality. They said however that there are currently resident elephants which are sometimes seen to go in some parts of the river where there are no farms (near to Mazombe) but they do not cross the river.

Presence of fencing poles on farms near the river at Malolo side supports the hypothesis that elephants do cross the river although not often in recent times. Farmers in such areas said that elephants do cross the river because during the migration season they are used to see in the morning elephants browsing, or damaged crops on either side of the river. Also they are able to notice grazing of some herbaceous and grass material on islands situated in the middle of the river. They further commented that elephants cross there during the seasons when water level is low thereby making it easier to cross the river through walking. But in cases where river depth is high they may swim since elephants are large animals and good swimmers. Moreover, the farmers acknowledged that the decrease in frequent crossing of elephants there was because of human elephant conflicts and encroachment.

Malolo village

The elephant crossings are at Kijiro, Mgongwe mountain ranges and at locations where they cross Mwega River to Ukwiva. Ukwiva catchment forests are at the west of Kisanga and Msolwa village.

Madizini village

Elephant crossing points are at Mhoswa area and Palaulanga which receive elephants from Ukwiva through Mhoswa to Palaulanga catchment forest. Mhoswa area is dominated by miombo vegetation (*Brachystegia*) and *Panicum* grass. This area is said to be narrow strip that is located between Madizini and Ulaya village farms in Kilosa District. It is threatened with slash and burn agriculture. However, villagers said that they have never had crop raid by elephant in their village. Palaulanga catchment forests are between Madizini and Ihombwe village. Palaulanga forests are said to have resident elephants with many breeding herds. Ihombwe villagers report that they see elephants returning to Mikumi national park through Ihombwe from such forests to have a number of young.

Ihombwe

Elephant crossings at Ihombwe villages are at Minazini subvillage, and Bwawani area. The later area is dominated with *Combretum* bush land with *Panicum* grass and a farmland. Another route to the south of Ihombwe passes through areas like Mgongwe forests (Malolo) to Ilole forests

(Mbala, Msanga and Iyovi) to Mikumi. This route was also reported by residents of Kisanga (Kilosa) and Kidai villages.

4.0 ANALYSIS OF THREATS TO ELEPHANT HABITAT AND MIGRATION ROUTES

From field observation during the survey and accounts of local people a number of threats to habitat and elephant routes could be identified. They include slash and burn agriculture, poaching, human overpopulation, habitat encroachment, weak law enforcement and poor communities' participation in conservation.

Slash and burn agriculture, pastoralism

Economic activities among others which are incompatible to wildlife include agriculture especially shifting cultivation. The survey revealed severely affected areas due to agricultural activities to include Kinyari at Mbweleli areas and Kikuyu sub villages, Igunda/Nyanzwa village where farmers open new farms across the elephant migrating routes. In almost all areas surveyed patches of deserted farms or fallows were seen. The problem is exacerbated by migration nature of livestock/ pastoral societies. Pastoralism is among the threats which have made many elephant routes die and others to near to disappearance. It is said in the past elephants were so many in every village all year around but nowadays are reported to be seen only in small numbers and seasonally because of farming.

Poaching

Illegal wildlife off-take is said to take place in some areas. Most animals which fall victims of being poached are Greater and Lesser kudu and other antelopes. Some residents in surveyed villages who requested anonymity reported that elephants have abandoned and are increasingly likely to abandon some important routes too because of being killed. The elephant migration and foraging areas are said to have been locations where poachers can safely operate without being arrested. Thus, this has led to decrease in frequency of movement and dispersal in their ranging areas.

Encroachment and human overpopulation

The increase of human population in different places was singled out as another threat which stresses the environment due to increase in land demand and human activities. For example in most areas that have been surveyed from Ruaha to Mikumi it was revealed that new settlements are opened. In this respect, elephant migration routes are encroached and replaced by new settlements and farms. Worse enough peasant farmers in some villages open new farms in some areas which have been designated as village forest reserves including mountainous forest areas despite clear recognizable boundary demarcations separating protected areas from unreserved village land. This is exemplified in Kinyari and Kikuyu subvillages. Farmers report that the newly established farms are supposed to be less weedy and fertile as compared to farms that have been under cultivation for a long time and this makes the farmers to be fond of starting new farms to avoid weeding costs. The forests and elephant routes are cleared and given away for growing sorghum and maize for food and local brew in many areas (Mr. Mbweta pers. comm., 2008). Hence, Population increase and rapid encroachment pose a threat to elephants as they result in continued shrinkage of elephant corridor and ranging areas making elephants to hardly pass in affected places and are alternatively forced to utilize areas and routes further up the mountains. For example elephants moving from Mbogeko area in Nyang'oro ranges avoid

Kikuyu subvillage of Makatapora village and Iwondo subvillage of Mkulula village and move to Makolongo through Singonari up to Igunda/Nyanzwa village instead of passing through these subvillages to Igunda/Nyanzwa village. Not only are migratory elephants affected but also the resident elephants are affected as they will face the lack of foraging areas and predictably increase the elephant human conflicts.

Human elephant conflicts

Elephants usually migratory in nature and often have big home ranges This is necessary to ensure that elephants get sufficient daily requirements of about 160 litres of water and intake of at least 5% body weight of green material. The excessive requirements often bring elephants into conflict with humans. The problem is intensified by the speedy encroachment of wildlife areas of which elephant use for ranging or movement. Different people on places where elephants cross have suffered differently from crop raids by elephants for example at Ihombwe and Ruaha Mbuyuni villages. This has led to harassment and persecution of elephants by local communities owing to crop raid, loss of life and injuries imposed to some villagers. For example, in 2006 a man was killed at Makatapora, in 2008 a man from Barbaig society was killed at Idodoma, and one man was injured in December, 2008 at Mtandika village. This situation heightens conflicts between elephants and people. In retaliation it is reported that at Ruaha mbuyuni some elephants have been stabbed with spears and others fallen into pit fall traps dug by residents. The hostilities have made some resident elephants to become more aggressive and some have reduced frequency of movement to Ruaha Mbuyuni areas.

Weak law enforcement and negligence

It is commendable that the Government has done the best to advice villages to have protected areas fondly called village forest reserves in which the components are conserved or sustainably utilised. But in any case the issue of wildlife corridors was not early considered. The village forest reserves and catchment forests are of freely accessed by the public without restriction and farms have been opened in these areas. Overall there is general laxity among local government authorities and negligence on the part of village leaders in enforcing wildlife and forest laws. The situation is made worse by poor or lack of community and village leaders' participation in community conservation since they complain of not benefiting from wildlife resources. This is a serious problem especially to resident elephants and other wildlife since the village game scouts in those villages do not mount frequent patrols to their areas (of which some are linking points for elephant migrating routes). In addition the lack of support and incentives to locals (either materially or financially) and well trained manpower in these areas and sometimes lack of wildlife worthiness and sense of ownership to villagers is a mere threat to elephant and other wildlife.

5.0 CONCLUSION

The study concludes that there are highly convincing circumstances suggesting that elephants move between Ruaha NP (Greater Ruaha Ecosystem) and Mikumi/Udzungwa NPs in the Selous ecosystem. Information from direct field observations, local people's accounts and literature all support the hypothesis. There are also short elephant movements between localities within the landscape involving resident elephants found within the wider corridor. The survey has also revealed presence of threats facing elephant routes and ranging and dispersal areas. These include slush and burn agriculture, poaching, settlements, habitat encroachment, human

population increase, and poor local participation in conservation. The threats apart from leading to human elephant conflicts they are also responsible for the closure of some migration routes and decrease of elephant range and other wildlife. In general many activities in the landscape do not comply with policy and legal provisions such as NEP, WPT, NLP, EMA, WCA, CBD and Bonn Convention for protection of migratory species.

6.0 RECOMMENDATIONS

- It is recommended that a more detailed study of elephant movement in the study area using radio/satellite tracking be initiated.

- A thorough survey and mapping of the elephant migration routes should be conducted

- Detailed analysis of the threats facing the elephant corridor in the study area should be conducted

- Immediate measures should be taken to protect the elephant routes and threatened habitats and catchment forests in the landscape which are currently severely degraded.

- Sensitize, support and empower local people through community initiatives outside protected areas in the landscape to ensure they participate in the conservation and protection of the wildlife and natural resources

- Relevant organs including Local Government authorities, WD and Forest Division in collaboration with communities engage in effective patrols in the area control poaching and illegal utilisation of natural resources

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Acknowledgements

I am grateful to the Rufford Small Grants Foundation, and Wildlife Trust – Dr. Patricia Moehlman for funding this study. Many thanks to research assistants Mr. Kibaja Mohamed, Benedict Nyalusi and Fidelis Mgongolwa for their tireless commitment during the entire survey process. I would also like to thank the former Iringa District Natural Resources Officer Mr. Ande Mallango, the former Iringa District Game Officer Mr. Isidori Kimaro and Kilosa District Game Officer Mr. Seraphin Mngara who provided very valuable information to the study. I deeply appreciate the assistance provided in logistics by Mr. Bakari Mbano, Rogasian Mtana and Mr. Leonard L. Chengula. I thank all village leaders and communities in the Ruaha - Mikumi landscape for their cooperation during the study.

APPENDIX I: Elephant availability and sightings in selected locations between Ruaha – Mikumi landscape based on villagers' accounts. Records do not differentiate between resident and migratory elephants

Village	Season of availability as per respondents
Kinyika	Available most of the year from May to December, during crop harvesting and rain season
Kisanga	Seen in May to August sometimes up to November. Common during rain season
Mboliboli	Available most of the year from March to December and during rain season
Makuka	Available between May to December, but most common in May/June
Izazi	Available all year around
Makatapora	Elephants available between April to January of next year
Igunda/Nyanzwa	Elephants resident all year around
Ruaha mbuyuni	Elephants available most of year and commonly seen between April to December
Malolo	Elephants available from July to November
Mtandika	Elephants are available all year around
Kisanga (kilosa)	Available between April to November, mostly after dry season bush fires
Madizini	Available from March to December
Ihombwe	Available mostly during rain season in February to June, but could be seen all year around

Appendix II: GPS Points and elephant movement routes between Ruaha and Mikumi/Udzungwa NPs

Points	Village/Sub village	Crossing points	Remarks
36M0767511 UTM9189939	Kinyika village	Liamapogolo forest & woodland (Mkwata /Ruaha area)	*Acacia* woodland but with forest /thicket along the valley. Elephant dung is present
36M0772858 UTM9193561	Kisanga village	Magwagu area	Bush thickets farm plots are present Elephant footprints and very few dung piles are visible.
36M0784772 UTM91922828	Between Mboliboli and Makuka villages	Matulya	*Acacia* woodland/shrub land
36M0791005 UTM 9198955	Between Mboliboli and Makuka villages	Kilala	*Acacia* woodland/shrub land
36M0802293 UTM 9194787	Izazi village	Mwenga Magoha bridge	Very remarkable elephant trails are visible Closed stand of trees (nearly forests).

Appendix II continued

Points	Village/Sub village	Crossing points	Remarks
36M0802987 UTM9193805	Izazi village	Mlawi bridge	Very remarkable elephant trails are visible Closed stand of trees (nearly forests).
36M0822254 UTM9204125	Kinyari subvillage of Makatapora village.	Kinyari	Forest areas in proximity of Nyang'oro mountains New farms are opened in areas designated as village forest reserves.
37M0171606 UTM9209219	Mtera	Mtera forests	
37M0173245 UTM 9208960	Kikuyu sub village of Makatapora village		Scattered settlements that have blocked the elephant migration route.
37M0177085 UTM9206999	Iwondo sub village of Mkurula village		Scattered settlements that have blocked the elephant migration route.
37M0178933 UTM9208329	Mkulula areas	Ifambo forests	There were very recent elephant footprints suggesting that they passed two days before visit. Presence of many trees locally known as "Mihavava" (preferred elephant fodder)
37M0179678 UTM9209271	Mkulula areas	Ifambo forests	Elephant footprints supposed to be of one day before visit (December 2008)
*37M0182403 UTM9209758	Mkulula areas	Ifambo forests	Signs showed elephants had crossed there recently
37M0183235 UTM9209326	Mkulula areas	Ifambo forest & bushes.	*Commiphora* tree freshly browsed by elephants was observed
37M0184174 UTM9209250	Mkulula areas	Ifambo forests	Very close to Great Ruaha river and had elephant dung around
37M0186568 UTM9208412	Mkulula village	Luhomelo	A point where elephants cross from Dodoma side to Iringa side of (Luhomelo)
37M0187326 UTM9208177	Mkulula village	Luhomelo	
37M0197165 UTM9203880	Mkulula village	Kiseke sub village	
37M0200323 UTM9195581	Mkulula village	Igoka area/forests	

Appendix II continued

Points	Village/Sub village	Crossing points	Remarks
*37M0207943 UTM9188793	Igunda/Nyanzwa village	Ipala forest (Igunda)	Very close to the river; elephants cross here from Igunda to Idodoma village (off the river). The area is currently heavily encroached as new farms and bomas are opened by the Maasai
Point 213 = 37M0221174 UTM9185389	Mazombe/Ruaha Mbuyuni	Mazombe	Elephant dung piles
Point 230= 37M0221639 UTM9184693	Ruaha Mbuyuni	Mazombe /Ruaha Mbuyuni	Elephant crossing the river from Ruaha mbuyuni to Malolo
NB: Between these two points i.e. 230 and 237 located along the Ruaha river elephants can cross the river from Ruaha Mbuyuni to Malolo			
Point 237 = 37M0223299 UTM9178677	Pipeline areas/Ruaha mbuyuni		
Point 231 = 37M0221955 UTM9184455		Malolo side of the river but to the other side of the river is termed as Mazombe (Igunda/ Ruaha Mbuyuni side)	
1st Route. From Ruaha Mbuyuni (cross Ruaha river) to Malolo→ Mgongwe sub village (of Malolo village) → Cross Mwega river at a point between Malolo and Kisanga→Ukwiva→Mhoswa (Madizini village) → Palaulanga forest→Ihombwe village →Mikumi NP.			
37M0246029 UTM9195619		Ukwiva wooded grassland.	Ukwiva catchment forest
37M0244918 UTM 9196266	Msolwa village	Ukwiva wooded grassland	Ukwiva catchment forest
37M0260734 UTM9208785	Madizini village	Mhoswa (very recent elephant crossing)	
37M0260513 UTM9208610	Madizini village	Very close to Mhoswa (no longer crossing)	
37M0270070 UTM9197772	Ihombwe village	Bwawani	Elephants cross here when moving from Mikumi to Palaulanga. There are farms of rice, maize and the owner has been suffering frequent incidents of crop raiding by elephants

Appendix II continued

Points	Village/Sub village	Crossing points	Remarks
37M0270136 UTM9195186	Ihombwe village	Near the Ihombwe Primary school	Fallow land
2nd Route: From Ruaha Mbuyuni→ (Crossing the Ruaha river at Kijiro) → Mgongwe sub village of Malolo→ Ilole forests (Mbala, Msanga and Iyovi forests) to Mikumi NP. This route is said to be a continuous stretch of forests, bushes and woodland to Mikumi (according to Mr. Fidelis and Mr. Jumanne pers. comm. Kidai residents, January 2009). Elephants using this route reach Mikumi NP at an area between 37M0274442; UTM 9192988) and 37M0276598; UTM 9181976 located along Kisanga-Kilosa junction and–Mikumi township.			
3RD Route: From Ipala (*37M0207943; UTM 9188793) and Nyanzwa areas elephants go to Ruaha Mbuyuni (Crossing the tarmac road at Kwale subvillage (37M0221285; UTM 9172117) to Udzungwa NP after crossing Lukosi river.			
4th route From Ipala (*37M0207943; UTM 9188793) and Nyanzwa areas elephants go to Mgowero village then to Mtandika at 37M0209636; UTM 9162137) and thereafter proceed to Udzungwa NP after crossing Lukosi river.			
From Udzungwa NP elephants may cross Ruaha River at Kidai, move to Ilole or Ukwiva then **(see route 1 and 2)** to Mikumi NP.			

Appendix III: GPS Points for surveyed villages and sub villages in Ruaha – Mikumi Landscape

SN	VILLAGE /SUB VILLAGE	GPS COORDINATES
1	Kinyika village	36M 0769741, UTM 9187583
2	Kisanga (Iringa) village	36M 0772267, UTM 9191645
3	Mboliboli village	36M 0780753, UTM 9189302
4	Makuka village	36M 0791005, UTM 9198955
5	Izazi village	36M 0800395, UTM 9198645
6	Kinyari subvillage	36M 0824759, UTM 9207826
7	Kikuyu subvillage	37M 0173245, UTM 9208960
8	Iwondo subvillage	37M 0177085, UTM 9206999
9	Igunda/Nyanzwa village	37M 0200324, UTM 9187143
10	Idodoma village (Mpwapwa district)	37M 0209952, UTM 9192383
11	Malolo B	37M 0229832, UTM 9189838
12	Msolwa village	37M 0252236, UTM 9193307
13	Madizini village	37M 0259501, UTM 9207751
14	Ihombwe village	37M 0270330, UTM 9195562
15	Kidai village	37M 0240570, UTM 9168379
16	Mikumi township	37M 0276598, UTM 9181976

Ruaha - Mikumi Landscape Plates, Tanzania



Plate1: Matulya area permanent elephant migration passage east of Ruaha NP at Makuka village. Elephants crossed this point in November 2008 moving from Nyang'oro hills to Ruaha (Location: 36M 07880050, UTM 9197438).



Plate 2: Mlawi river bridge elephant crossing point close to Izazi village. Elephants moving to Nyang'oro hills and Kinyari from Ruaha NP utilise this route (Location: 36M 0802987, UTM 9193805)



Plate 3: Mazombe - Malolo elephant crossing point through the Great Ruaha River. River width is about 70m and water is c. 1 – 2.5m deep. *Ficus*, *Phragmites* and *Acacia* are among the common plant species at the site. Migrating elephants are reported to swim across the river and in 2006 they crossed this point in large numbers. Currently there are farms only 200m off the river bank on the Malolo side. (Location: 37M 0221955, UTM 9184455).



Plate 4: Lukosi River at Mtandika, Iringa Rural District. Elephants cross this river moving from Mgowero or Nyanzwa to Udzungwa Mountains. Note the turbid water. (Location: 37M 0209636, UTM 9162137).



Plate 5: Maize farm located along elephant migration route at Ihombwe. Encroachment through cultivation is among major causes of closure of elephant routes and human elephant conflicts. (Location: 37M 0270070, UTM 9197772).



Plate 6: Mhoswa elephant crossing point among miombo (*Brachystegia*) woodland near Mikumi NP. Elephants cross the point as they move from Ukwiva to Palaulanga (Madizini village) forests. (Location: 37M 0260513, UTM 9208610).



Plate 7: Elephant pass through Nyang'oro hills at Kinyari (Mbweleli). Note the thickets. (Location: 36M 082254, UTM 9204125).



Plate 8: Farms at Kikuyu at the extreme edge of Nyang'oro Mountains close to Mtera dam. This is an elephant ranging area and migration route closed by farming. (Location: 37M 0173245, UTM 9208960).



Plate 9: Acacia tree damaged through destructive browsing by elephants at Ifumbo area.



Plate 10: Ukwiva plateau showing grazing areas for elephants and buffaloes. The plateau lies along the elephant migration route close to Mikumi NP. To the west of this point is Malolo, south east are Kisanga and Msolwa and east is Madizini village and Palaulanga forest. (Location: 37M 0244918, UTM 9196266).



Plate 11: Great Ruaha River at Luhomelo area. The river here is relatively shallow hence elephants and people can easily cross here (to the left) on foot to either side of the river.



Plate 12: Luhomelo areas showing elephant dung with boli starting to disintegrate. Elephants also cross the Ruaha River here from Singonari (Dodoma side) to Iringa side of the river. (Location: 37M 0187326, UTM 9208177).



Plate 13: *Combretum* and *Panicum* wooded grassland vegetation mosaic at Palaulanga Mountains in Ihombwe village. The area forms part of elephant path from Palaulanga to Mikumi NP. On the right is the village environment officer Mr. Massawe Makinda. (Location: 37M 0270070, UTM 9197772)



Plate 14: The edge of Nyang'oro Mountains at Kikuyu. The landscape was once a frequent ranging area for elephants. Note farms on mountain top threatening elephant range and causing habitat destruction and soil erosion.



Plate 15: A newly cleared farm on Nyang'oro hills at Kinyari sub village (Mbeleli area) of Nyang'oro. Farms on slopes have forced elephants to utilize higher elevation on mountain ranges on the left (Location: 36M 082254, UTM 9204125).



Plate 16: Open space constituting migration route formed by elephants in the past. This is at Kikuyu village. (Location: 37M 0171606, UTM 9209219).



Plate 17: Luhomelo elephant crossing point only 10m from Ruaha River. Mzee Mbwete, a former VGS from Makatapora village points towards the river while standing in the 'furrow' cut across the river bank by elephants constantly crossing the point from Singonari side of the river (Dodoma) to Iringa side of the river; The foreground shows elephant footprints in dust and disintegrating boli (Location: 37M 0187326, UTM 9208177).



Plate 18: Kikuyu village has scattered shelters and is located in the valley between two mountain tops. Settlements and farming have blocked this elephant path for many years now (See Map). (Location: 37M 0173245, UTM 9208960).



Plate 19: Research Assistant and villager holding fruits of "Mkwata" tree a favourite browse of elephants at Mwenga Magoha Bridge, an important elephant migration route and crossing point along Iringa- Dodoma road. (Location: 36M 0802280, UTM 9194799).



Plate 20: Elephant dung count at Liamapogolo forest in Kinyika village (Iringa Rural District). (Location: 36M 0767539, UTM 9189909).



Plate 21: Ruaha River at an area between Ifambo forests and Luhomelo. Across the river is Singonari Game Controlled Area. Elephants from Ifambo often come to drink at this point. (Location: 37M 0184171, UTM 9209250).



Plate 22: Abandoned banana farm near Ihombwe primary school in Kilosa District. Persistent elephant raids on crops forced the farmer to abandon the farm. (Location: 37M 0270136, UTM 9195186).



Plate 23: Kisanga villagers (Iringa Rural District) after interview on elephants. Standing in research the assistant Mr. Kibaja Mohamed



Plate 24: More villagers of Kisanga village after interview with researchers on elephant issues in their area.



Plate 25: Barbaig (Mang'ati) boma at Kilala elephant pass. Clearing of vegetation and pastoralism are among the major factors affecting elephant routes. (Location: 36M 0789758, UTM 9198380)



Plate 26: Mr. Mpaka a MBOMIPA village game scout at Kisanga explaining (at Magwagu area) about livestock and related problems to elephant habitat and movement. (Location: M36 0772874, UTM 9193200).



Plate 27: Harvested rice farms near Magwagu area (Kisanga village). Elephants going to Ruaha NP often damage crops here while passing from Mboliboli and other areas.



Plate 28: Dar es Salaam – Mbeya highway at Kwale sub village of Ruaha Mbuyuni. Elephants cross here from Ruaha Mbuyuni and Igunda forests as they move to Udzungwa NP. (Location: 37M 0221285, UTM 9172117).