Movement of elephants in the Selous–Niassa wildlife corridor, southern Tanzania

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Abstract

This study reports on distribution and movements of elephant and their associated migratory pathways through the Selous–Niassa wildlife corridor (SNWC). Data were obtained through village public meetings, questionnaire surveys and field observations in 21 villages found in the corridor. Results show that elephants are abundant, occurring throughout the year, with peak occurrences between April and May. The corridor harbours a number of well-established traditional migratory routes and numerous areas that are important as seasonal or year-round habitat for elephants and other wildlife species. Three major migratory routes from Ruvuma to the centre of the corridor and four other routes from the centre of the corridor northwards have been identified, which elephants use for their movements, ultimately connecting the Ruvuma River and Selous Game Reserve. Similar connections have been reported to exist between the centre of SNWC and the eastern corridor. Elephant migratory routes described from the centre of the corridor to Selous Game Reserve are Malimbani, Ritungula and Nampungu ya Chakame while the Sasawala–Lukumbule elephant route connects SNWC and Mwambesi Game Reserve on the eastern side of the corridor. It was further observed that the major elephant movement routes are likely to depend on large, permanent river systems. Movements of elephants are reported to proceed from south to north between March and April, and from north to south between June and December. The key factors responsible for these movements and migrations are thought to be availability of water, food and in some places, increased disturbance from humans.

Résumé

Cette étude traite de la distribution et des déplacements des éléphants et de leurs voies de migration à travers le corridor pour la faune Selous-Niassa (SNWC). Les données ont été récoltées grâce à des réunions de villages, des enquêtes et des observations de terrain dans 21 villages situés dans le corridor. Les résultats montrent que les éléphants sont abondants et qu'il y en a toute l'année, avec des pics en avril et mai. Le corridor contient un certain nombre de voies de migration traditionnelles bien établies et de nombreux endroits qui sont importants en tant qu'habitats saisonniers ou permanents des éléphants et d'autres espèces sauvages. On a identifié trois voies de migration importantes qui vont de Ruvuma vers le centre du corridor, et quatre autres qui partent du centre vers le nord ; les éléphants les empruntent lors de leurs déplacements reliant de ce fait la Ruvuma à la Réserve de Faune de Selous. On a rapporté des connections semblables entre le centre du SNWC et le corridor de l'est. Les voies de migration des éléphants décrites du centre du corridor vers la Réserve de Faune de Selous sont Malimbani, Ritungula et Nampungu ya Chakame, tandis que la voie Sasawala-Lukumbule relie le SNWC à la Réserve de Faune de Mwambesi, du côté est du corridor. On a aussi remarqué que les principales voies de migration des éléphants dépendent probablement des réseaux des plus grandes rivières, qui sont permanentes. On rapporte que les déplacements des éléphants se font du sud vers le nord en mars – avril et du nord vers le sud entre juin et décembre. On pense que les facteurs clés responsables de ces déplacements et des migrations sont la disponibilité en eau, en nourriture et, à certains endroits, les perturbations croissantes d'origine humaine.

Introduction

The Selous–Niassa ecosystem in southern Tanzania and northern Mozambique is one of the largest trans-boundary natural ecosystems in Africa, covering over 154,000 km^2. In this ecosystem various categories of protected areas currently contribute to an official protection status of about 110,685 km^2. This area in Tanzania includes Selous Game Reserve (48,000 km^2), wildlife management areas as buffer zones (7500 km^2), Mikumi National Park (3000 km^2), the Kilombero game-controlled area (6500 km^2), the Muhuwesi game-controlled area and forest reserve (1500 km^2), the Mwambesi game-controlled area and forest reserve (1000 km^2), Lukwika Lumesule–Msanjesi Game Reserve (400 km^2), and Sasawala Forest Reserve (385 km^2). In Mozambique it includes Niassa Game Reserve (23,400 km^2) and several hunting blocks as buffer zones of Niassa Game Reserve (19,000 km^2). SNWC connects Selous Game Reserve in Tanzania with Niassa Game Reserve in Mozambique, covering approximately 8000 km^2 of an area that is currently sparsely settled over a distance of 160 km.

SNWC connects across a distance of 160 km the world's largest protected areas and provides a major link between the two largest miombo forest ecosystems. In addition to enhancing animal movements and gene flow, it has great value as habitat for plant and animal communities. It supports large numbers of globally significant large animal species like the African elephant, the Roosevelt sable antelope, the wild dog, the Nyassa wildebeest and the Nile crocodile. It is one of the main migration routes for elephants between Tanzania and Mozambique. The entire corridor is currently threatened by poaching for meat and ivory as a trans-boundary problem, habitat degradation because of uncontrolled and destructive bush fires, and a high population growth rate with associated agricultural expansion (such as raising tobacco and cashew nuts), which may result in converting this biologically intact corridor into cultivated land. This process will ultimately prevent movement of the wildlife populations between Selous Game Reserve and Niassa Game Reserve, increasing human–wildlife conflict. Long-term effects include genetic isolation of wildlife populations, which increases the potential for inbreeding and chances of population extinctions in both reserves. This study reports on major elephant migration routes and movement patterns in SNWC.

The study area

SNWC is located in southern Tanzania, north of Niassa Game Reserve in Mozambique. The corridor is separated from Niassa Game Reserve by the Ruvuma River, which forms the international boundary between Tanzania and Mozambique. The corridor lies within the Ruvuma region in the two districts of Songea (major western section of SNWC) and Tunduru (smaller eastern section). In total, SNWC covers approximately 6000 to 8000 km^2 and extends some 160 to 200 km in a north–south direction. The area is mostly covered by miombo woodland and wooded grassland, with substantial areas of open savannah, seasonal and permanent wetland, and riverine forests along numerous rivers and streams (fig. 1). Major wildlife species include but are not limited to African elephant, sable antelope, duiker species, eland, Liechtenstein's hartebeest, greater kudu, leopard, lion, spotted hyena, Cape buffalo, warthog, waterbuck, wild dog, Nyassa wildebeest and zebra. Minor species include aardvark, yellow baboon, bushbuck, bush pig, crocodile, hippo, jackal, porcupine, and African hare. Cattle are rare, and in most villages goats, sheep and poultry are present but in modest numbers. Twenty-one villages surround SNWC. The 1988 national census showed a total population of 37,298 people with an estimated density of 3 persons per square kilometre and a projected annual growth rate of 4.1%. Currently, the figure is likely to be higher as new villages emerge. Subsistence farming is the main activity for the local people supplemented by fishing in areas near major rivers and streams and by hunting—usually illegal. The farming system is extensive; it is based on shifting cultivation with crop acreage expanded by clearing bush, using the hand hoe. Cashew nuts and tobacco are major cash crops; maize, rice, cassava, sorghum and millet are the main food crops. Coconut trees are becoming increasingly common in some areas since public campaigns conducted by the Songea District Rural Development Programme (formerly Songea Development Action, SODA). Other commonly grown crops include pigeon pea, simsim, sweet potato, various legumes, onion, groundnut, banana, sugar cane and orange.

Research objective

The principal objective of this study was to trace and locate the traditional migratory routes of elephants,

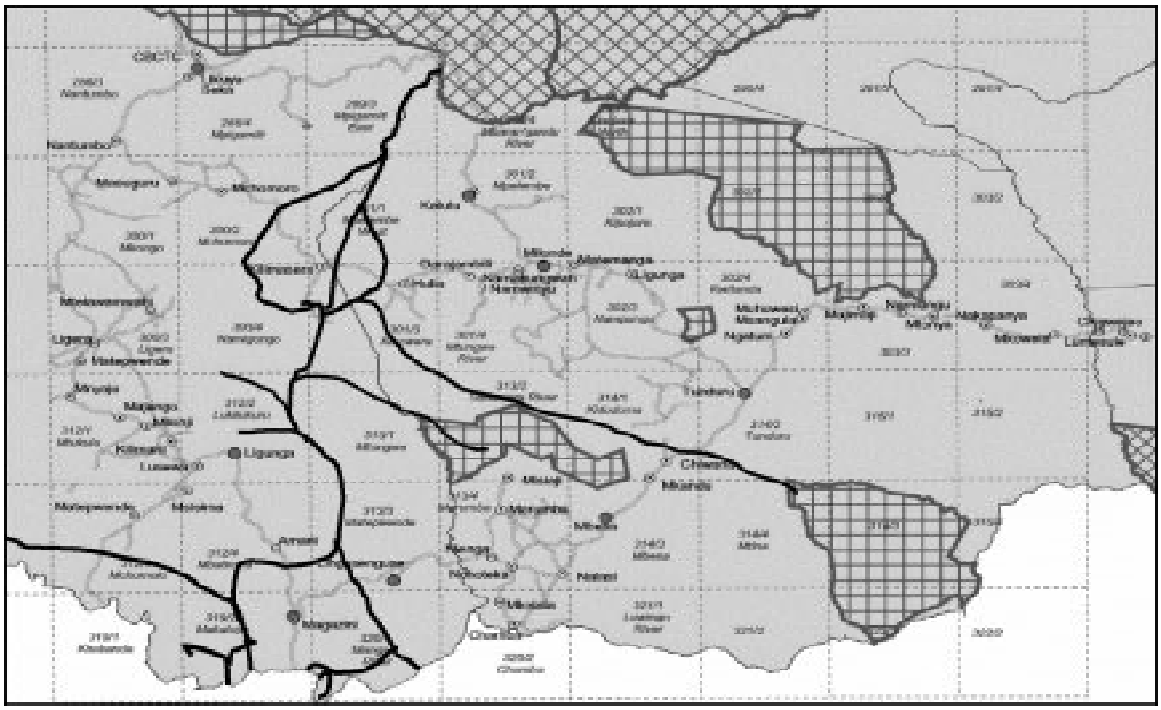

Figure 1. The Selous–Niassa Wildlife Corridor—bordered in the north by Selous Game Reserve (large hatched area) and in the south by the international boundary between Tanzania and Mozambique along the Ruvuma River. Sasawala Forest Reserve is in the centre of the corridor. Each square is approximately 33.3 km. Elephant migratory routes run from the Ruvuma River to Selous Game Reserve and from the centre of the corridor to Mwambesi Game Reserve in the south-east.

which would provide baseline data to be used in planning for the long-term requirements for wildlife conservation in SNWC and implementing them.

These data will be used to assist in preserving the genetic viability and persistence of two of the largest elephant populations in Africa and implementing methods that should minimize conflict between wildlife and local communities.

Method

Data were collected by conducting public village meetings, using questionnaires for standardized personal interviews, and making field observations. Individual questionnaires were filled in to obtain more detailed information, particularly on the presence or absence of elephants on village lands and seasonality of their presence, plant species that elephants might prefer as food plants, and the timing of their fruiting or peak maturity in relation to elephant migrations. Direct field observations were made in remote areas of village land to confirm information previously recorded in the public meetings and questionnaires. Elephant signs such as tracks, faeces and feeding sites were observed and entered in a field observation book. Plant species that had been reported during interviews as being preferred foods were identified, collected and stored for future identification. The locations of tracks and migratory routes for elephants were recorded using the global positioning system (GPS) and later downloaded to computer (Fugawi® software, Northport system, Canada) and the routes marked out. For each village, field observation took a minimum of two days and was carried out by the first author, accompanied by one or two traditional hunters, porters and an armed game ranger.

Results

Distribution and migration routes of elephants in SNWC

Elephants were reported to occur frequently and everywhere. According to 74% (n = 65) of the informants, elephants were reported to be common and widely distributed everywhere except near Lusewa in the southern section of the corridor, an area conspicuous for its impoverishment in wildlife species. It was further pointed out that both resident and migratory herds of elephants occur in the corridor, with the migratory herds moving all along from Selous to Niassa in Mozambique. In most cases, mixed herds of adults and young elephants were reported to be common, occurring all year round with peak occurrence during April and March (fig. 2).

Three major migratory routes were identified through which elephants move from the Ruvuma River to the centre of SNWC (fig. 1).

The first migratory route starts at Lukawanga, about 27 km east of Magazini village, at a junction between the Lukawanga River in Mozambique and the Ruvuma River. This route continues northward along the Msanjesi, Majimahuu and Matepwende Rivers to the Changalanga and Mtungwe mountain area in the centre of the corridor.

The second route starts as four separate crossing points some 14 km west of Magazini village; the area includes the Mkasha Mountains, and Lusanyando, Ajemsi and Rutukila along the Ruvuma River. All these routes join at the Binti Uredi seasonal stream and proceed north-east via the Namisegu River to join the Lukawanga route.

The third route also starts at four separate points, which include a point near the Ndalala River in Mozambique, Binti Hasani, Msawisi and Kipembele Rivers south-west of Magazini village in Tanzania; it runs north-west to the southern face of London Mountain near Msisima village and also northwards along the Msawisi River to Luyati and Tingilafu Mountains and their associated rivers and forests near Amani village.

From here, some elephants cross the Amani–Magazini road to join the Lukawanga route. However, those from London Mountain and the associated forest are reported to proceed westwards via Nambwela Forest and the Lisugu and Kimbande Mountains and their associated forests to Lukimwa River and Ngoma Litako swamp. They are then reported to change their course northwards by the way of Lukimwa River to Mtelamwahi areas at the centre of SNWC.

From the centre of the corridor, elephants appear to have four separate migration routes—Malimbani, Nampungu ya Chakame, Ritungula and Sasawala-Lukumbule—that ultimately connect Ruvuma River in the south with Selous Game Reserve in the north and Mwambesi Game Reserve in the southern east.

The Malimbani elephant route links Mbarangandu in the north and Kitwanjati in the south near Mtungwe (fig. 3). The elephants use nine small tributaries that drain into the Lukimwa River, but they do not follow the main river course. The route crosses the Songea–Tunduru main road between Mchomoro and Kilimasera, about 16 km from Kilimasera.

The Nampungu ya Chakame elephant route, which has its origins on Mbarangandu River catchments, crosses the Songea–Tunduru main road at Mt

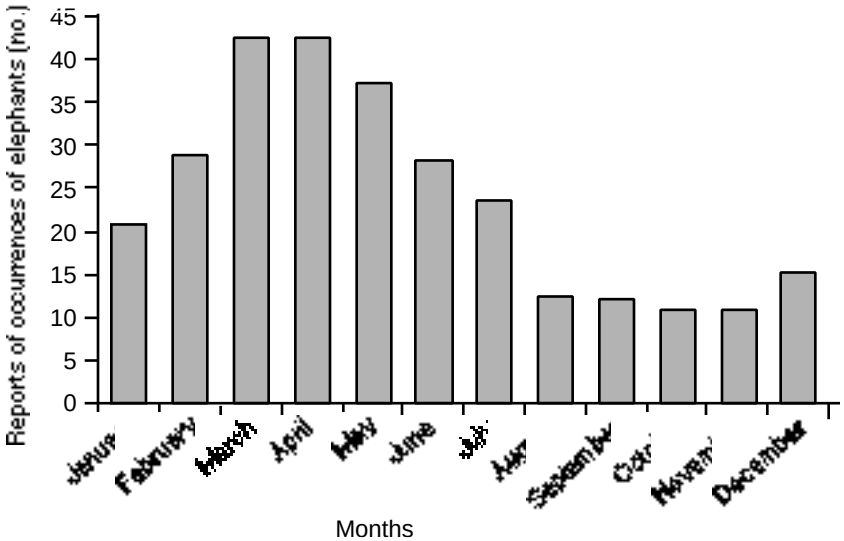

Figure 2. Monthly occurrences of elephants in SNWC (n = 47).

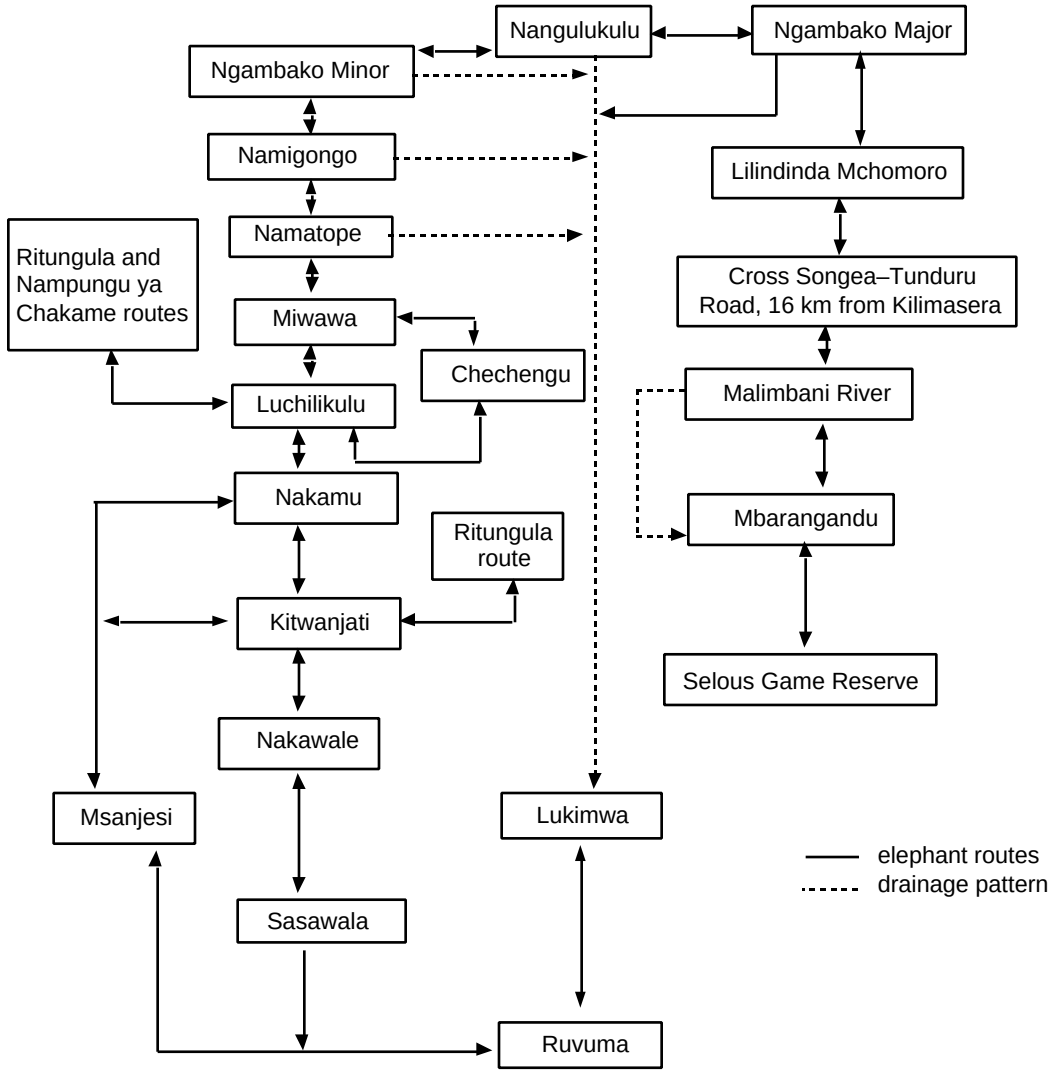

Figure 3. Tree diagram showing the Malimbani elephant route.

Kilimasera. It continues south via three important tributaries: Nampungu ya Chakame, Nampungu ya Kalwembe and Nampungu ya Wazee, to the Mbawa River, which drains into the Nampungu River (fig. 4). From here, the route continues via the Luchilikulu River and Nkalela Forest to the upper banks of the Msanjesi River.

The Ritungula elephant route broadens as it emerges from Selous Game Reserve. The elephants are reported to follow the Ritungula River or the Muhuwesi River via a series of small tributaries: Manoni, which drains into Mbarangandu, or Miwawa, which drains into Muhuwesi, to Kumbuja (which itself drains into Miwawa). The elephants then enter the Kapesula River and thereafter go to Muhuwesi before proceeding to the Ritungula River (fig. 5).

The route crosses the Songea–Tunduru main road at Mlima Simba and the former Mwembenyani village near Hulia. The elephants then proceed southwards via a series of three small tributaries draining into the Nakapeye before it enters the Nampungu River. From Nampungu the elephants raid crops in the nearby villages of Changalawe, Hulia, Mbatamila, Mnenje, Nampungu and Namwinyu. The route continues farther south through Nkalela Forest and Mtumbitumbi and Malisafi

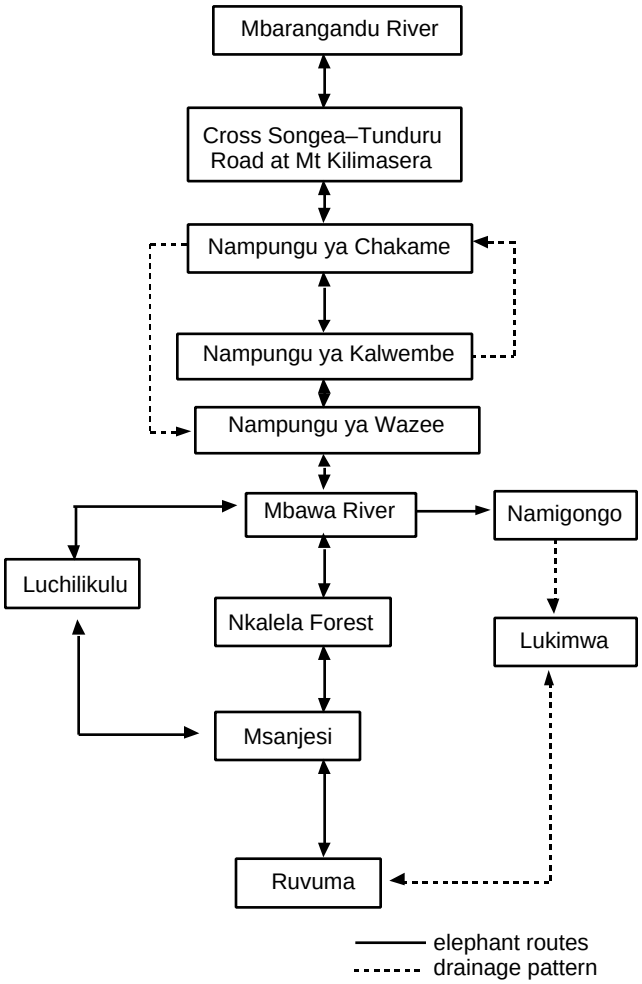

Figure 4. Tree diagram showing the Nampungu ya Chakame elephant route.

Rivers to the upper banks of the Msanjesi River. Nkalela Forest links the Ritungula elephant route with the Malimbani and Nampungu ya Chakame routes via the Luchilikulu River and its associated forest. Another link is reported to exist between Ritungula and Malimbani routes via Kitwanjati River (figs. 3, 5). The elephants are also reported to traverse between Msanjesi and Sasawala Rivers via Nakawale and Namakong streams. Namakong is a small permanent stream draining into Msanjesi. It is known to provide good shelter and grazing ground for elephants and other herbivores year round.

The Sasawala-Lukumbule elephant route uses a series of eight small tributaries draining into Sasawala before it enters Kiumbe Forest, Lukumbule River and the Mwambesi Game Reserve (fig. 6). Mwambesi Game Reserve is separated from Niassa Game Reserve by the Ruvuma River. This route suggests a link between the eastern and the western wildlife corridors. Elephants from Mwambesi Game Reserve were reported to have killed one person during April 2001. These animals (a cow and two calves of different age groups) were followed and reported to have gone as far as Nampungu village in the central portion of the corridor.

Seasonal elephant movements

In all villages, the peak occurrences of elephants were reported between March and April, which corresponds to the peak rainy season (fig. 2). This is the same period during which the elephants are reported to proceed from south to north. The north-to-south movements are reported to occur between June and December. The key factors responsible for these movements are thought to be the availability of water, food, and in some places, increased disturbances by humans. During early March to April, elephants are likely to move northwards upstream to avoid swollen rivers and flooded wetlands after heavy rain. The north-to-south movements are probably triggered by a decline in availability of forage and water. At this time of the year, most of the trees shed their leaves and the seasonal streams run dry. The major sources of tree foliage and water are then permanent water sources such as the Ruvuma River, permanent swamps, and some smaller permanent streams. Thus, elephants are likely to concentrate in riverine forests during the dry season. Interviews also revealed that on the Mozambiquan side, elephants move towards the Tanzanian border during the dry season between June and December. This movement had been linked to lack of water and food plants on the Mozambiquan side as most rivers and streams are seasonal and dry up completely, and bush fires occur then.

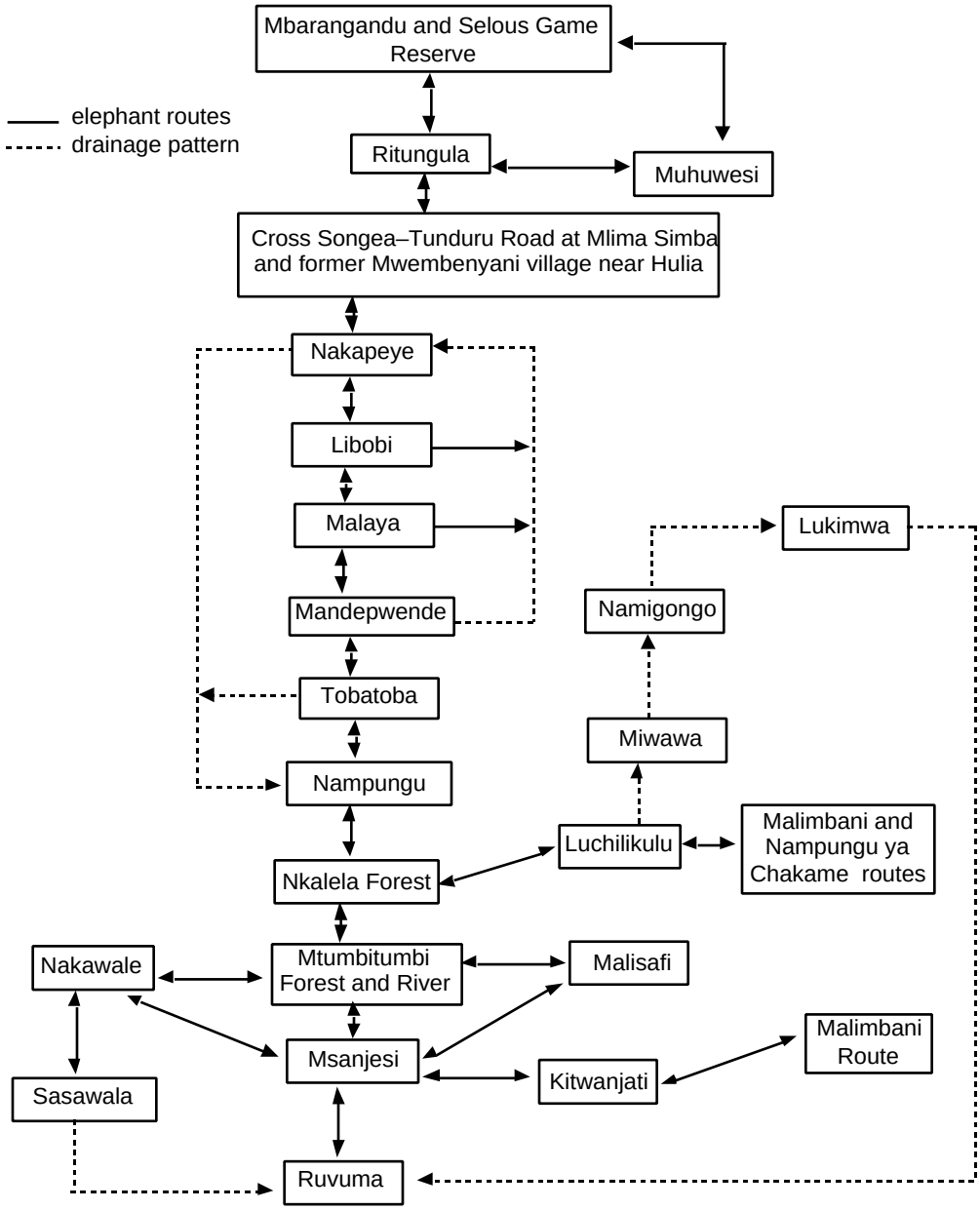

Figure 5. Tree diagram showing the Ritungula elephant route.

During this time the elephants cross the Ruvuma and its associated islands to Tanzania in search of riverine food plants. Both personal field observations and interviews suggest that all major elephant movement routes are likely to depend on large, permanent river systems. Table 1 describes in greater detail several of these river systems in the centre of the corridor. The Msawisi River system forms another important elephant migratory route in the southern section of the corridor.

Common food plants for elephants

During this study, 31 plants were named as food plants preferred by elephants that were subsequently identified during field observation. Elephants were reported

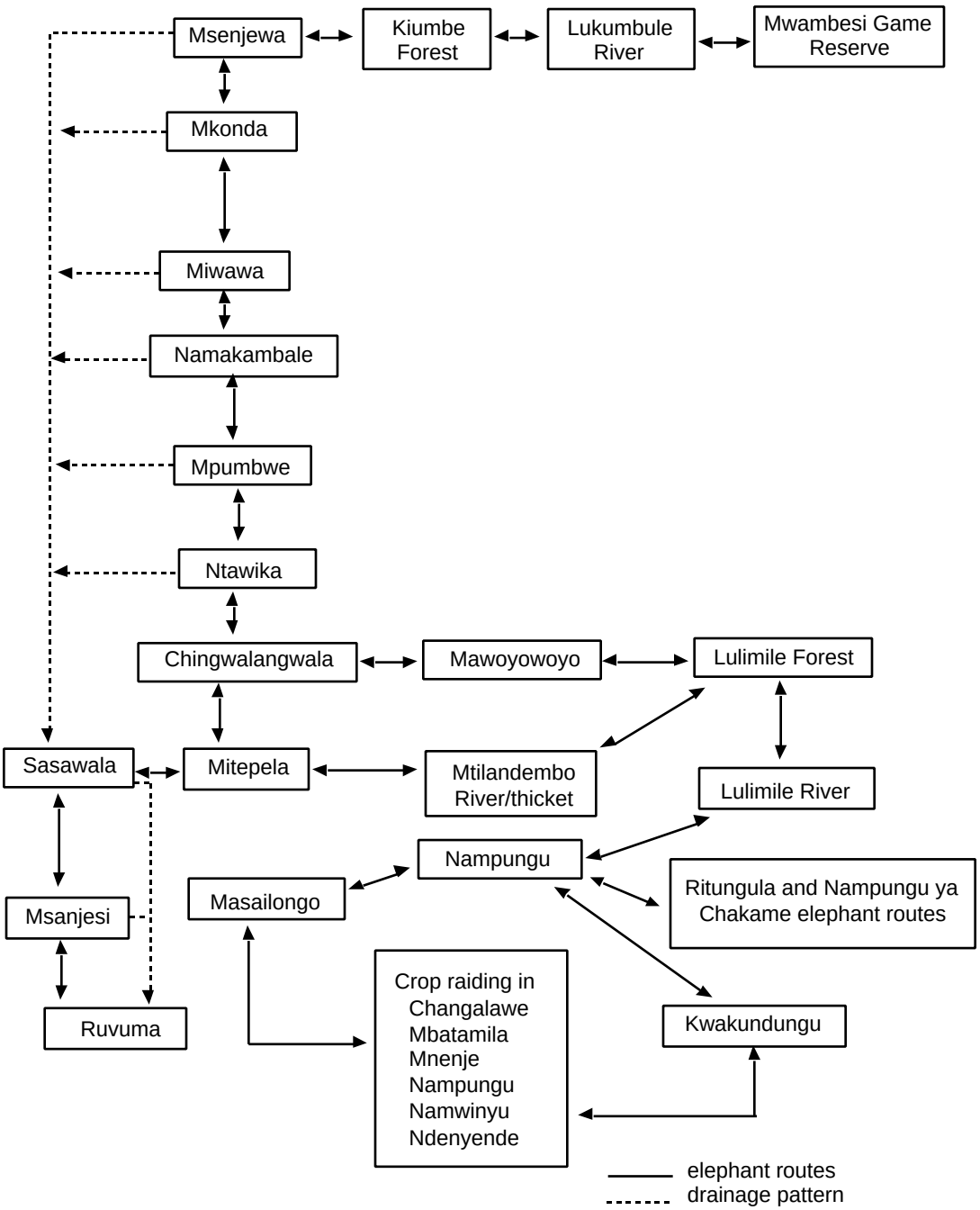

Figure 6. Tree diagram showing the Sasawala–Lukumbule elephant route.

to forage on leaves, bark, tubers, or whole plants in 20 tree species, fruit in 10 tree species and in one species on both leaves and fruit.

Table 2 summarizes the detailed information on edible parts, possible habitat and time of maturation of these plants. The peak fruiting period of marula fruit (*Sclerocarya birrea*) was associated with peak occurrences of elephants along the major rivers where these fruit are found. Other fruits and plants were not associated with seasonal congregation of elephants.

Table 1. Major river systems in the centre of SNWC associated with elephant presence

River system and location	Seasonal status	Movement route	Wildlife
Kitwanjati Western side of Mtungwe Mountain to south and slightly to the eastern side where it joins the Lijumu River before entering Msanjesi	Permanent	Between Mtungwe and Msanjesi or Litemela Forest and its associated river	Resident and migratory elephant groups of variable size
Litemela Tributaries starting from Ligunga village then running eastwards through a dense forest until meeting the Msanjesi River	Completely dries up during dry season		Resident and migratory elephants and buffaloes stay during rainy season
Nakamu Along the eastern side of Mtungwe Mountain towards Mtumbitumbi	Permanent in upper parts, dries seasonally downstream	Forms an important link between route from Msawisi to Mtungwe Mountain	Elephants and buffaloes found throughout the year
Msanjesi In the middle of the corridor between Mtungwe and Sasawala River	Permanent throughout the year	Forms important link between the elephants from Ruvuma to Kitwanjati, Lijumu, Naluwale, Milia and Litemela	Both resident and migratory elephants are found here; other animals found are sable, bushbuck and waterbuck
Luchilikulu Small tributary originating from Nkalela thicket and draining to Miwawa, which drains into Lukimwa; situated south of Songea–Tunduru road near Kilimasera on the north, Mtungwe Mountain on the far south	Permanent stream, provides permanent food and water for a number of wildlife species	Forms a link between Malimbani, Ritungula and Nampungu ya Chakame elephant routes	Migratory and resident elephants are found here; other species known to be resident are sable, reedbuck, waterbuck, buffaloes and zebra
Nampungu Important elephant area is the Kwakundungu swamp and its associated riverine forest	Permanent river	Forms a link between Sasawala, Msanjesi and elephants from Selous and Mwambesi Game Reserves	Permanent and migratory elephants; other residents include crocodiles, bush pigs, sable, warthogs and migratory groups of buffaloes

Discussion

African elephants, the largest of all land animals, were originally found throughout the African continent (Haltenorth and Diller 1986). However, in many areas, populations have been greatly reduced by poaching (Dublin and Douglas-Hamilton 1987; Siege 1999) and increase in human population with associated increase of demand for land for agriculture and habitat loss (Lamprey et al. 1967; Laws 1970; Western and Lindsay 1984; Barnes et al. 1998). As a result, most of Africa's elephants are now forced to seek refuge in isolated pockets of protected areas (Cumming et al. 1990; Shauri and Hitchcock 1999).

Having no conservation status, SNWC is faced with many threats attributed to an increase in human activities including human population growth, agricultural expansion, deforestation, uncontrolled bush fires, and illegal fishing and poaching. Uncontrolled human activities will ultimately result in considerable loss of biodiversity, obstruct movements of large herbivores such as elephants and consequently intensify human–wildlife conflicts. SNWC supports large numbers of wildlife (CIMU 2001; Hofer et al. 2001;

Table 2. Tree, shrubs and grass preferred by elephants as food in SNWC

Scientific name	Common name	Part consumed by elephant	Habitat	Time of maturity
Acacia brevispica	mtonya (Y)	soft young tips	swamps, rivers	throughout year
Acacia polyacantha (Acacia campylacantha)	mkwanga (Y)	soft young tips	swamps, rivers	throughout year
Acacia robusta	mchongwe (Y)	bark, leaves, preferably the growing tips	swamps, rivers	throughout year
Acacia xanthophloea	mchonge (Y)	bark, leaves, preferably the growing tips	swamps, rivers	throughout year
Bauhinia petersiae	camel foot (E), kitabu ndogo (S)	bark and leaves	open savannah	throughout year
Boscia albitrunca	chiguluka (Y)	whole tree	open savannah, bushland	throughout year
Borassus spp.	mkonda (Y)	fruit	swamps, rivers	June–November
Brachystegia longiforia	mpapa (Y)	tree bark	widely distributed	throughout year
Brachystegia utilis	miombo (S)	tree bark	widely distributed	throughout year
Burkea africana	mjini (S), mnyongandembo (Y)	bark and leaves, often by old males	widely distributed	throughout year
Catune regum spinosa (Xeromphis obovata)	chisondoka (Y)	fruit	forests, rivers	June–November
Cussonia arborea	mtumbitumbi (Y)	bark	widely distributed	throughout year
Cussonis spp.	mbutibuti (Y)	bark	widely distributed	throughout year
Diospyros spp.	msakala (Y)	fruit	along rivers	July–September
Diplorhynchus condylocarpon	mtomoni (S)	tree bark	widely distributed	throughout year
Esente ventricosum	ndizi pori (S)	leaves and fruit	swamps, rivers	March–April
Julbernardia globiflora	mchenga (S)	leaves and bark	hilly areas	throughout year
Margaritaria discoides	mserechete (Y)	leaves	widely distributed	throughout year
Oxytenanthera abyssinica	mianzi (S)	whole plant, early stage of growth		
Parinari curatellifolia	mbuni (S, Y)	fruits	widely distributed	June–September
Penisetum purpureum	elephant grass (E), matete or mabingobingo (S)	whole plant	swamps, riverbanks	throughout year
Phoenix recliata	mkindu (S)	fruit and leaves	swamps, rivers	throughout year
Piliostigma thonningii	camel foot (E), kitabu kubwa (S)	leaves and bark	widely distributed	throughout year
*Sclerocarya birre*a	marula (S), nNtondowoko (Y)	fruit	along rivers	March–June
Strychnos cocculoides	madonga (S)	fruit	everywhere	May
Swartzia madacascariensis	mng'eng'e (S, Y)	fruit	scattered	June–October
Tamarindus indica	mkwaju (S,Y)	leaves	scattered	throughout year
Vangueria spp.	mavillo (S, Y), mburugutu (Y)	fruit	along rivers	March–April
*Ziziphus pubescen*s	mpenjere (Y), mraba tatu (N)	fruit	along rivers	March
	kitupa (S)	tubers	swamps	wet season
	jack fruit (E), maya (Y)	fruit	along rivers	February–April

Information provided by people interviewed in various villages. Language of common names is indicated in parentheses: D – Kindendeule, E – English, N – Kingoni, S – Kiswahili, Y – Kiyao.

D. Mpanduji pers. obs.). The 1990 IUCN Red List of threatened and endangered species included two species that are present in SNWC. These species (with their status in parentheses) include the African elephant *Loxodonta africana* (Vulnerable) and the African hunting dog *Lycaon pictus* (Endangered). The corridor links the gene pools between the two largest protected areas in Africa, the Selous in Tanzania and the Niassa in Mozambique.

Experience in wildlife conservation for over a century in Africa has shown that the critical areas for survival of wildlife species outside protected areas such as breeding sites, migratory corridors, dispersal areas and foraging grounds have been neglected, resulting in intensified land-use conflicts and considerable loss of biodiversity (Kideghesho 2000). The degradation occurring within and surrounding individual protected areas may affect the rate of extinction of some species, particularly the large mammals and other migrant animals that require habitat beyond protected areas (Wilfred and Ruzika 2000). In Tanzania for example, land around protected areas and migratory corridors between them are particularly hard hit in the crowded 'northern circuit'. The areas of Serengeti, Ngorongoro, Lake Manyara, Tarangire, Arusha and Kilimanjaro are reported to have lost most of their wildlife migratory corridors and dispersal areas (Shauri and Hitchcock 1999; Kideghesho 2001a,b, c and 2002), as a result a number of large mammal species have been reported locally extinct in some of these areas (Gamasa 1998; Shombe-Hassan 1998 as quoted by Kideghesho 2002; Silkiluwasha 1998). The situation is quite different south of Selous. In its current status, SNWC passes through sparsely populated villages. The northern section of this corridor, which passes through 17 villages, is currently protected by a series of wildlife management areas managed by local people as part of the Selous Game Reserve buffer zone project guided by the Wildlife Division and the Selous Conservation Programme. However, the southern section of the corridor, which is about 3000–4000 km^2 and contains 18 sparsely located villages, is currently not protected and is vulnerable to unsustainable exploitation of land resources incompatible with wildlife conservation.

Many human development activities are reported to be detrimental to elephant habitats. Construction of roads, railways and human settlements are activities that have been reported to impede the movement of elephants (Johnsingh and Christy-Williams 1999). Already the Songea–Tunduru main road crosses SNWC. Its impact is, however, minimal as elephants traverse the road at different sites. Human habitation and expanded agricultural activities between Mchomoro and Kilimasera and between Kilimasera and Hulia had already increased the number of incidents of conflict between human and elephant (Hahn 2001; Nalim Madatta pers. comm.). Similar phenomena are very likely to occur between Magazini and Amani, Magazini and Likusanguse, and at Ligunga-Amani in the southern end of the corridor.

During this study, all critical elephant migratory routes along the Songea–Tunduru main road were identified. Through the efforts made by the Selous Conservation Programme, a workshop including all stakeholders was conducted in Ruvuma region to include the two districts under SNWC. The district commissioners of Songea and Tunduru; district game, forest, bee, fishery, agriculture and livestock officials; councillors; village chairpersons; and other district and village officials under SNWC attended the workshop. Other invited delegates came from the United Nations Development Programme (UNDP), the Global Environment Facility (GEF) and Niassa Game Reserve in Mozambique. It was agreed during this meeting that areas already identified as important elephant migration routes be protected and kept free of human development activities (fig. 7). It was further agreed to incorporate this decision in village bylaws. Through this decision, the Litungula elephant route was saved from total obstruction, as encroachment was already severe, and the former Mwembenyani village was slowly growing. Inhabitants from this village shifted voluntarily to the nearby villages of Hulia, Kilimasera and Pachani near Milonde and Matemanga. Efforts are being made using satellite telemetry to identify other routes and important elephant ranges.

In this study, elephants are reported to proceed from south to north between March and April and from north to south between June and December; these times conform with the dry and rainy seasons. Haltenorth and Diller (1986) reported movements of large herds over great distances, amounting to approximately 500 km during the late dry season, in search of new growth and fruiting food plants. The peak fruiting period of marula in March was associated with peak occurrences of elephant congregations along the Ruvuma River; other fruits had no known influence on elephant movements.

D.G. Mpanduji

Figure 7. One of the signboards showing where SNWC (Malimbani route) crosses the Songea–Tunduru main road between Mchomoro and Kilimasera in Songea District. Six such signs have been placed in places identified as important elephant crossing areas along the Songea–Tunduru road, to alert people not to carry out activities that will prevent elephant movements.

Several well-established elephant migration routes have been found in the corridor through which elephants and other wildlife move during long-distance migrations. These routes were found to be contiguous with large, permanent water systems, which in most cases are considered to be the dry-season refuge for elephants (Kingdon 1997).

The wet- and dry-season aerial census (CIMU 2001) in SNWC reported high concentrations of elephants in the centre of the corridor towards the Nampungu River and Sasawala Forest Reserve while few or no elephants were found on the south-central parts of the corridor. High levels of human activity in the southern half likely interfered with the movements of elephants between the southern and northern halves. This may equally be true between Niassa Game Reserve and SNWC (Hofer et al. 2001). Detailed information on home ranges, seasonal or periodic long-distance movements, foraging behaviour and spatial use of resources by elephants in SNWC will be understood after detailed analysis of movement data in 10 radio-collared elephants in different areas of the corridor. The information obtained during the present study and in future from the radio-collared elephants is vital for the long-term conservation and management of elephants and other wildlife in SNWC.

An early report by Said et al. (1995) and Barnes et al. (1998) mentioned the possible cross-border movements of elephants between the now-named SNWC north of Ruvuma and Niassa Game Reserve south of the Ruvuma River. Our study identified nine such crossing points through which elephants from either side are reported to cross the Ruvuma River. Uncontrolled wildfires, poaching, and increased human activities, mainly fishing and encroachments along the Ruvuma River, will ultimately prevent the movement of elephants and other wildlife in SNWC. Human habitation and expanded agricultural activities between Mchomoro and Kilimasera and between Kilimasera and Hulia had already affected elephant movements with the associated human–elephant conflicts likely to increase (Hahn 2001). Similar phenomena are likely to take place between Magazini–Amani, Magazini–Likusanguse and Ligunga–Amani in the southern end of the corridor.

The wildlife potential of SNWC has been noted in reports by Hofer et al. (2001) and CIMU (2001). Although SNWC seems to be a critical area for the survival of a diverse number of wildlife, large portions of the southern section completely lack official protection, and hence they are vulnerable to all kinds of use unsustainable for wildlife (Hofer et al. 2001). Participation of local communities in wildlife management decisions, the sustainable use of natural resources, and the distribution of income generated by natural resources on a local level can help to limit over-exploitation and habitat degradation by local communities (Lewis and Alpert 1997).

This aspect has been recognized by the govern-

ment of Tanzania in its wildlife policy published in March 1998, in which it commits itself to 1) involving all stakeholders, particularly local communities, in the conservation and management of wildlife areas, 2) establishing wildlife management areas as a new category of protected area, with local people having a full mandate of managing and benefiting from conservation efforts, and 3) cooperating with neighbouring countries in conserving migratory species and trans-boundary ecosystems.

This study was therefore initiated by the Selous Conservation Programme in collaboration with the Germany Agency for Technical Cooperation (GTZ) Tanzania to provide baseline data for planning and implementing the SNWC development cooperation project whose aim is to protect and manage the southern part of the corridor through a network of village wildlife management areas.

The goal of this project is to protect the wildlife corridor by having local communities participate and benefit from sustainable utilization, and to combat trans-boundary elephant poaching through an agreement of cooperation and law enforcement between the governments of Tanzania and Mozambique. Benefits could include 1) legally supplying game meat, obtained through annual hunting quotas for each participating village, 2) empowering participating villages to protect themselves and their property against problem and crop-raiding wild animals, 3) generating cash income for community projects from sustainable use of wildlife through photo or hunting tourism, and 4) providing employment for youths as village game scouts. The results of the present study are therefore important prerequisites for establishing management procedures for SNWC, particularly in reducing competition between people and wildlife—in this case, elephants.

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References

Barnes, R.F.W., Craig, G.C., Dublin, H.T., Overton, G., Simons, W., and Thouless, C.R. 1998. *The African elephant database*. IUCN Species Survival Commission Occasional Paper 22. IUCN, Gland, Switzerland. 19:104–105.

[CIMU] Conservation Information and Monitoring Unit. 2001. Aerial census in the Selous–Niassa Corridor, wet and dry seasons, 2000. Tanzania Wildlife Research Institute, Arusha, Tanzania.

Cumming, D.H.M., Du Toit, R.F., and Stuart, S.N. 1990. *African elephant and rhinos: status survey and conservation action plan.* IUCN/SSC African Elephant and Rhino Specialist Group. p. 18–19.

Dublin, H.T., and Douglas-Hamilton, I. 1987. Status and trends of elephants in the Serengeti-Mara ecosystem. *African Journal of Ecology* 25:19–33.

Gamasa, D.M. 1998. Stakeholder analysis for the conservation and management of critical wildlife corridors project in northern Tanzania. Technical report submitted to UNDP.

Hahn, R. 2001. Expert meeting: Selous–Niassa Wildlife Corridor information materials. Selous Conservation Programme/GTZ/UNDP/GEF. Dar es Salaam, Tanzania, April 2001.

Haltenorth, T., and Diller, H. 1986. *A field guide to mammals of Africa including Madagascar*. Collins, London. p. 124–128.

Hofer, H., Hildebrandt, T.B., East, M.L., Gortz, F., and Mpanduji, D.G. 2001. Distribution and movements of elephants and other wildlife in the Selous–Niassa Wildlife Corridor. Interim report, August 2001.

Johnsingh, A.J.T., and Christy-Williams, A. 1999. Elephant corridors in India: lessons for other elephant range countries. *Oryx* 33(3):210–214.

Kideghesho, J.R. 2000. Participatory land-use planning for Kwakuchinja Wildlife Corridor. *Kakakuona: Tanzania*

Wildlife, Quaternary Magazine on Nature, Conservation and Environment 19:8–18.

Kideghesho, J.R. 2001a. The status of wildlife habitats in Tanzania and its implication to biodiversity. *Kakakuona: Tanzania Wildlife, Quaternary Magazine on Nature, Conservation and Environment* 21:9–17.

———. 2001b. Who pays for wildlife conservation in Tanzania? *Kakakuona: Tanzania Wildlife, Quaternary Magazine on Nature, Conservation and Environment* 22:8–13.

———. 2001c. The loss of wildlife habitats in Tanzania: what is the way forward? *Kakakuona: Tanzania Wildlife, Quaternary Magazine on Nature, Conservation and Environment* 23:7–15.

———. 2002. Trends in areas adjacent to Tarangire National Park, Tanzania: what community-based land use planning can offer. *Kakakuona: Tanzania Wildlife, Quaternary Magazine on Nature, Conservation and Environment* 24:9–15.

Kingdon, J. 1997. *The Kingdon field guide to African mammals.* London, Academic Press.

Lamprey, H.F., Glover, P.E., Turner, M.I.M., and Bell, R.H.V. 1967. The invasion of the Serengeti National Park by elephants. *East African Wildlife Journal* 5:151–166.

Laws, R.M. 1970. Elephants as agents of habitat and landscape change in East Africa. *Oikos* 21:1–15.

Lewis, D.M., and Alpert, P. 1997. Trophy hunting and wildlife conservation in Zambia. *Conservation Biology* 11:59–68.

Said, M.Y., Chunge, R.N., Craig, G.C., Thouless, C.R., Barnes, R.F.W., and Dublin, H.T. 1995. *African elephant database 1995*. IUCN Species Survival Commission Occasional Paper 11. IUCN, Gland, Switzerland.

Shauri, V., and Hitchcook, L. 1999. Wildlife corridors and buffer zones in Tanzania: political will and wildlife management in Tanzania. Policy Brief No. 2. Lawyers' Environmental Action Team, Dar es Salaam, Tanzania. p. 1–19.

Shombe-Hassan, S.N. 1998. Assessment of space use of the Kwakuchinja Wildlife Corridor in northern Tanzania, by both wildlife and residents. MSc dissertation, Manchester Metropolitan University. Unpublished.

Siege, L. 1999. Selous elephants on the increase. *Kakakuona: Tanzania Wildlife, Quaternary Magazine on Nature, Conservation and Environment* 13:56–58.

Silkiluwasha, F. 1998. Conservation of Lake Manyara Biosphere Reserve. Paper presented at the 4th BRAAF workshop, 30 March to 2 April 1998, Arusha, Tanzania.

Western, D., and Lindsay, W.K. 1984. Seasonal herd dynamics of a savannah elephant population. *African Journal of Ecology* 22:229–244.

Wilfred, N.S., and Ruzika, N.M. 2000. Wildlife conservation outside protected areas in eastern Africa: the role of habitat corridors and dispersal areas. *African wildlife in the new millennium.* Proceedings of a conference held at the College of African Wildlife Management, 13–15 December 2000, Mweka, Tanzania. vol. 2, paper no. 10.