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The influence of human activities on wildlife in Kwakuchinja migratory corridor, Tarangire/Manyara Ecosystem, Northern Tanzania

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Abstract. *Njamasi YR, Ndibalema VG, Kioko J. 2022. The influence of human activities on wildlife in Kwakuchinja migratory corridor, Tarangire/Manyara Ecosystem, Northern Tanzania. Intl J Trop Drylands 6: 26-38.* Human population growth in areas adjacent to protected areas is high and has seriously threatened wildlife management across Africa. Local communities around protected areas engage in illegal activities that destroy habitats and threaten wildlife migration routes. Additionally, there is a local extinction of five species of large mammals in Kwakuchinja, Tanzania. Therefore, this study focused on assessing the impact of human activities on wildlife in the Kwakuchinja flyway in the Tarangire-Manyara Ecosystem (TME), Northern Tanzania. The data were collected using Tresect Walk, domestic questionnaires, important informants, and secondary materials. The comparison data of the groups for natural groups were analyzed with the help of Mann Whitney's U-Test man. At the same time, the Pearson test was used to compare relationships between animals in nature, cattle, and human settlements. Additionally, the chi-square test was used to compare the relationship between wildlife status and time spent by the respondent in the study area. The study found that migratory corridors for wildlife had shrunk from five to three. Common wildebeest had the highest density (area of 450 km^2), while Thompon's gazelle had the lowest. Trends in nature from aerial survey data show a 50% decrease in the number of large mammals in the ecosystem in the 2000s compared to the 1990s, and land use has changed to cultivation with a 4.2% increase in 'the study area. An insignificant relationship was observed between the number of wild animals and human settlements (r= 0.714). Therefore, these results suggest that human settlements harm the number and distribution of fauna. Since wildlife and livestock share grazing and watering areas, the study recommends using an integrated land use plan, law enforcement, and sustainable use of natural resources to protect the Kwakuchinja Wildlife Corridor.

Keywords: Corridor, human activities, Tarangire/Manyara, wildlife

INTRODUCTION

A wildlife corridor is an area of land used by wildlife in their seasonal migrations from one part of an ecosystem to another in search of basic needs such as water, food, space, and habitat (URT 2009). In addition, wildlife corridors allow the free movement of animals to other geographic locations where access to resources essential for survival and the exchange of genetic material occurs (Hassan 2007). Wildlife corridors are, therefore, essential components of continuity of the species population, ecological integrity and the long-term survival of ecosystems (Noe 2003; Pla-Ard et al. 2021).

Globally, wildlife corridors have been considered important for connectivity, for example, in the case of Kenha and Pench National Parks in Madhya Pradesh, India, where habitat connectivity was important for tigers (*Panthera tigris* Linnaeus, 1758). The main problem in the Kenha-Pench landscape was habitat fragmentation caused by dense human settlements, railways, roads, and agricultural land expansion (Rathore et al. 2012). To mitigate these issues, emphasis has been placed on identifying appropriate wildlife corridors to reduce genetic isolation, offset habitat fragmentation issues, and increase animal dispersal while allowing for ecological processes (Rathore et al. 2012). Wildlife corridors before project development and implementation, such as roads. For example, a study to identify mammalian path crossing patterns in northern New Hampshire avoided unnecessary habitat fragmentation and successfully modeled and identified wildlife corridors (Leoniak et al. 2012).

In Africa, a study of the seasonal home ranges of elephants (*Loxodonta africana* Blumenbach, 1797) between the Sabi Sand Reserve (SSR) and Kruger National Park (KNP) revealed that the protection of wildlife corridors is important because elephants depend on the resources of both parks (Thomas et al. 2012). In Nairobi National Park in Kenya, wildlife is migrating into kitengela range, but the challenge has been population growth, agricultural expansion, and deforestation, all of which have threatened wildlife survival. To prevent wildlife migration from Nairobi National Park to Kitengela during the rainy season, it was decided to compensate private landowners (Rodriguez et al. 2012). The Tarangire-Manyara Ecosystem (TME) in Tanzania covers a large area of approximately 35,000 km^2. The area extends along the eastern edge of the Great Rift Valley and includes Lake Natron and the game-controlled area of Mto-wa-mbu; Lake Burunge and the Burunge Game Controlled Area; Kwakuchinja Open Area and LMNP; Game controlled area of Mkungunero and Kimotorok; Loikisare and Simanjiro Game Controlled Area and the plains of Simanjiro (Maasai Steppe). Many animal species are found in this area. Many of these animal

species, especially elephants, zebras, and wildebeest, depend on the high nutritional value of Maasai grasslands.

The Kwakuchinja Wildlife Corridor is located in TME, the northern part of Tanzania, connecting Tarangire National Park (TNP) and Lake Manyara National Park (LMNP) (Marttila 2011). Biodiversity is threatened by the growth of human settlements and agricultural development (Msoffe et al. 2011). The Kwakuchinja Wildlife Corridor, a subset of an area designated as an Open Game Area, a conservation category that does not restrict habitation or cultivation (Gamassa 1989), faces a serious threat from human activities. As a result, many protected areas in Tanzania are becoming isolated. Reasons for isolation include the increase in human population in areas adjacent to protected areas and the change in land use towards agriculture, infrastructure, and settlements in previously uninhabited areas (Newmark 2008). There are also human-related impacts occurring in and around protected areas, such as habitat loss of wildlife, physical development, overexploitation of natural resources, wildlife competing with other types, use of soil, and pollution that seriously impacts wildlife.

The increased pressure exerted by the human population and its negative impact on habitat loss for wildlife in African countries, including Tanzania, is a common phenomenon (Kideghesho et al. 2006). This situation applies to TME, where some of the species in the wild have become locally extinct due to habitat destruction and overfishing, indicating a high pressure of human influence on populations in the wild (Shemweta and Kideghesho 2000). So far in the TME, five major mammal species: oryx (*Oryx gazelle* Linnaeus, 1758), hartebeest (*Alcelaphus buselaphus* Pallas, 1766), cheetah (*Acinonyx jubatus* Schreber, 1775), leopard (*Panthera pardus* Linnaeus, 1758), and black rhino (*Diceros bicornis* Linnaeus, 1758) are locally extinct (Hassan 2007). Extinction is largely attributed to settlement growth and agriculture blocking animal movements, increased poaching, and human disturbance.

However, wildlife corridors are seriously threatened by population pressures resulting from a range of population pull factors in the grazing areas and push factors in the areas of high agricultural potential. Secondly, there is a lack of legislation to protect corridors from unsustainable uses and activities incompatible with biodiversity conservation. TME is one of the areas where population pressure is increasing. The main pull factors of the population in this area include demand for agricultural land, construction of the Minjingu phosphate factory, the establishment of fishing camps, small-scale mining activities (Marang forest), tourism growth, and other economic opportunities. In addition, push factors related to the population of areas of acute land scarcity, such as the Kilimanjaro region, have also impacted the Lake Manyara basin. The major outcome of all the identified factors is an increased threat to the existing wildlife corridors, which provide ecological links between LMNP and TNP (Jones et al. 2009). Since the identified factors are not well known, there is a need to document the extent of the impacts caused by these identified factors above on wildlife and the Kwakuchinja wildlife migratory corridor.

The specific objectives were: (i) to map the distribution of wildlife, livestock, and human settlements in the Kwakuchinja wildlife migration corridor concerning their habitat, (ii) assessment of population trends and current status of flyways in terms of wildlife use over the past 16 years (1998-2014), (iii) assess the impact of land use/land cover change on wildlife in the Kwakuchinja Wildlife Corridor.

MATERIALS AND METHODS

Description of the study area

Location

The study was conducted in the three villages of Mswakini, Olasiti, and Kakoi in the Kwakuchinja open area, Tanzania. The Kwakuchinja Wildlife Corridor is part of the Kwakuchinja Open Area (450 km^2) between LMNP and the TNP. It is located between latitudes 03º35'38" and 03º48'02"S and longitudes 35º48'21" and 35º59'25"E. (Figure 1).

Soil and vegetation

The vegetation is mainly savannah with wooded areas along the waterways. In the natural corridor of Kwakuchinja, there are two types of savannah. These include microphyllous savannahs in river basins dominated by *Acacia tortilis* (Forssk.) Hayne and deciduous broadleaf savannahs on ridges and upper slopes dominated are by *Combretum* and *Commiphora* species (Marttila 2011; Pittiglio et al. 2012). Black cotton soil predominates on the floodplains (foot slopes), and dark red sandy clay loam on the upper slopes.

Rainfall

The rainfall pattern is bimodal, with short rains from November to December and long rains from February to May (Marttila 2011). March and April are the wettest months, while July and August are the driest. Estimated rainfall is between 450-650 mm (Caro et al. 2009).

Wildlife

The Kwakuchinja Wildlife Corridor was once vital for 25 large mammal species, some of which (including elephants) moved between the two parks (Msoffe et al. 2011). Field observations from two decades ago suggested that elephants (*L. africana*) moved from the LMNP to the corridor through the Marang Forest (adjacent to the LMNP) and then preceded the NPT through the Lake Burunge area. Currently, some populations of bushbuck (*Tragelaphus scriptus* Pallas, 1766), impala, and vervet monkey (*Cercopithecus aethiops* (Linnaeus, 1758) use the corridor all year round, together with cattle (Hassan 2007).

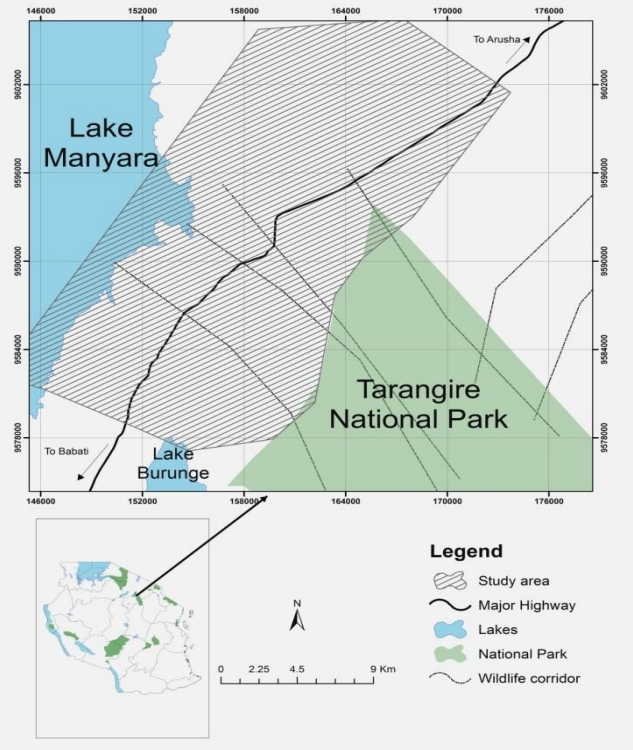


Figure 1. Map of Tanzania showing Kwakuchinja wildlife corridor (Source: GIS Center Tarangire National Park 2013)

Ethnicity and socio-economic activities

The Kwakuchinja wildlife corridor is home to several ethnic groups in five villages (Hassan 2007). In this study, a group of huts under a family or families under the same roof as an elder was considered a settlement. This was necessitated by the social (polygamous) way of life of many ethnic groups in the region, especially pastoralists and agro-pastoralists. Their occupations include cattle herding, subsistence and/or commercial farming, and trades. In addition, fishermen from surrounding areas and up to the town of Babati migrated to the area and established temporary fishing villages (Goldman 2003).

Research design

The study used a cross-sectional research design for data collection. The design allowed for data collection at a given time from a sample chosen to represent the entire population. The design used is quick and lends itself to the description and interpretation recommended by Babbie (1990).

Sampling procedure

Through purposeful sampling (Babbie 2007), three villages were selected from six available villages. The villages chosen were Olasiti, Kakoi, and Mswakini. These villages were chosen because they are within the Kwakuchinja Wildlife Corridor. Households were randomly selected from lists provided by respective village administration officials for each village. The communities found in the Kwakuchinja Wildlife Corridor made up the study population, using families as the base sampling unit in each village. The sampling framework used was the list of the population available in each village. To have accurate data, the intensity of the sampling involved 45 families in each village, and a total of 135 families was sufficient for the study. Bailey (1994) reported that studies requiring statistical analysis require a sample size of ≥30 regardless of population size. Therefore, the criteria for selecting 45 families meet Bailey's recommendation, above the minimum required.

Reconnaissance surveys

A preliminary survey of the study area was conducted to familiarize themselves with the study area and gather general information on the migration route of the wildlife, the identification of pedestrian transit areas, the terrain, and the accessibility of the study area. The study also included the selection of three study villages. As part of the exploratory survey, questionnaires were pre-tested in one of the villages, and necessary adjustments to existing local conditions were made.

Data collection

Data collection included primary and secondary data collection methods in the study area. Primary data were collected in the field through direct observation, a household questionnaire, a cross-sectional walk, and interviews with key informants. In addition, quantitative and qualitative data were collected.

Direct observation

Direct observation has been used to gather information about human activities. It included observational activities such as farming, collecting firewood, felling trees, and grazing animals. Indeed, the direct observation method was used to tie together the more discrete elements of the data collected by other methods.

Household questionnaire

Householders used a semi-structured questionnaire. The questionnaire was administered, and the researcher asked questions from the questionnaire and noted the respondents' answers. Questionnaires were used to collect demographics, wildlife information, human migration patterns, habitat protection, and land use. A total of 135 households participated in the questionnaire survey.

Transect walk

Data collection on the distribution of wild animals, farm animals, and settlements was carried out by foot sampling. Foot sampling included eight (8) transects of varying lengths and spacing (Western and Grimsdell 1979) within the study area. After transepts, these transepts were made in Manyara Ranch, Mswakini Juu, Oltukai, Open Area Community, Burunge WMA, Vilima Vitatu, and Malamboi, established by Hassan (1998), the corridor of the wildlife of Kwakuchinja. The recording of animals in nature, the cattle, the settlement, and the respective perpendicular distance were carried out inside a 400 m fixed transept width on each side of a line transept (Norton-Griffiths 1978; Hassan 2007). Due to the type of habitat

and visibility. The transepts were arranged in two sets that ran east to west with a compass reading of 2790. One set ran from the TNP border to the Arusha-Babati paved road, and the other set ran from the paved road to the lakeshore Manyara. GPS coordinates were used to establish the locations of wildlife, settlements, and livestock locations and their perpendicular distances. A digital camera was used to photograph wildlife, livestock, and settlements. Accessibility, type of land use, and vegetation cover determined the distribution of transects.

Key informants interview

Key informant interviews were used to collect data on various issues related to wildlife, human settlement by livestock, historical uses of the corridor, and poaching. Key informants for this study included village chiefs, town councilors, community leaders, and staff from TNP, Manyara Ranch, and Burunge WMA present in the study area. A checklist of questions was used to obtain information from key informants. A total of five (5) interviews with key informants were conducted in the study area.

Secondary data on wild population trends, habitat types, and migratory routes used by the animals were obtained from published and unpublished reports in Tanzania National Parks (TANAPA), Tanzania Wildlife Research Institute (TAWIRI), and NGOs of research conducted in the study area. In addition, land use/cover data was obtained from the TNP GIS Center. The data assessed land use/cover changes and their impact on wildlife based on habitat loss and local extinction. Satellite imagery for 2000 and 2013 was used to generate land use/cover changes from 2000 to 2013.

Data analysis

Both qualitative and quantitative data were analyzed. Quantitative data were analyzed using Statistical Package for Social Sciences (SPSS) version 16.1, whereby descriptive analysis involving measures of central tendencies, frequencies, and standard deviations were computed.

Mapping distribution of wildlife, livestock, and human settlement in Kwakuchinja wildlife migratory corridor

During the transect walk, wildlife sighting coordinates were identified using GPS, and then Arc GIS was used for mapping. Following Sutherland (2001), calculations on population density and size were calculated as follows:

Density:

$$D = n/2WL \quad [1]$$

Population size:

$$N = DA = An/2WL \quad [2]$$

Where:

N : population size estimate;
D : density estimate of the population;
A : total area of the census zone;
n : total number of animals or objects counted;
L : total length of the transect lines; and
W : mean perpendicular distance.

Mann Whitney - U -test was used to test the differences in the size of the natural group between the numerous Ranch and Burunge WMA. Pearson's correlation was used to analyze the relationship between wild animals and cattle and the numbers of natural and human settlements. One of the rationales for using Pearson's correlation analysis was that wildlife, settlements, and livestock are numerical values.

Assessment of the population trend and present status of migratory corridors concerning wildlife use for the past sixteen years (1998-2014)

Data based on a questionnaire survey were analyzed using SPSS, and the Chi-square test was used to test the decrease or increase of wildlife based on respondents' perceptions. Also was used to test the relationship between wildlife increase and respondents' time spent in the study area.

Assessing the impact of land use/cover changes on wildlife in the Kwakuchinja wildlife corridor

Landsat TM (UTM / WGS84) images from Tarangire GIS Center were interpreted using patch analysis from the Arc GIS (Projection 1960) program to generate land use/cover maps for 2000 and 2013. They were also used to compare changes in land use. In addition, the interpretation of aerial photographs and land use maps was used to gather information and create land-use change charts. Finally, content analysis was used to analyze respondents' views on land-use change and wildlife status in the study area.

RESULTS AND DISCUSSIONS

Demographic and socio-economic characteristics of the respondents

The demographic and socio-economic characteristics of the respondents comprised the gender, age, educational level, occupation, residence status, human population, and the tribe of the respondents. More men than women were interviewed. This is due to the nature of the male dominance of the Maasai. The traditional Maasai ethic is male dominance; in most cases, it is men who respond to visitors in the house, leaving women shy or sometimes fearful of going out and talking to the counters. This argument is supported by Noe (2003), who also reported on male dominance in Masai traditions. This is the case in the Kwakuchinja study area, as many respondents were men. Most of the respondents were over 47 years old. The involvement of different age groups in the study was very important because different age groups had different experiences with the past situation of the Kwakuchinja natural corridor, in particular with the movement pattern and the wildlife status. The survey also found that most respondents had completed primary education, and only a few had secondary education (Table 1). The low level of formal education was due to the traditions of pastoral communities such as Maasai, which do not encourage their children to go to school; instead, many stay at home to look after livestock. Only those considered troublemakers and didn't care for livestock were allowed to attend school.

They then spent most of their lives looking after livestock for those who were not considered troublemakers, who were the community's illiterates.

In Tanzania, the Maasai are traditionally herders (Rodriguez et al. 2012). However, this is not the case in Kwakuchinja, as they are also involved in growing food crops. Thus, this study revealed that the main socio-economic activities of the respondents were polyculture-livestock, and very few were only farmers (Table 1). Most of the respondents mainly depend on intercropping and livestock as their main source of income. This is, in part, a strategy to meet the demand for food and other expenses after realizing the costs associated with raising large herds of cattle and a lack of pasture. Furthermore, during the 2007 drought, many cattle died from a lack of grazing (Muyungi 2007). Therefore, the situation may have forced many of the farmers to switch from their normal traditional farming lifestyle to a mixed farming system.

The survey found that most respondents were from the Maasai tribe and very few from other tribes (Table 1). It was also found that most of them had immigrated to the study area from Arusha, Arumeru, and Monduli, mainly for cattle breeding and grazing. Furthermore, all respondents said that the number of people in the study area is increasing.

Wildlife distribution, livestock, and human settlements in the Kwakuchinja wildlife corridor

Wildlife sightings, abundance, and distribution

Five large herbivore species have been recorded at twenty-seven observation points in the Manyara Ranch and Burunge WMA. These include Burchell's zebra (*Equus burchelli* Gray, 1824), wildebeest (*Connochaetes taurinus* Burchell, 1823), Masai giraffe (*Giraffa camelopardalis* Linnaeus, 1758), impala (*Aepyceros melampus* Lichtenstein, 1812), and Thomson's gazelle (*Gazella thomsonii* Günther, 1884) (Figure 2). The results show that Burchell's zebra was more conspicuous than other wild species, while Thomson's gazelle was the least conspicuous. Elephant droppings (*L. africana*) were also observed but excluded from population estimates because it was not possible to estimate their numbers. Two cheetahs (*A. jubatus*) were found dead on December 12, 2013, after being killed by Olasiti villagers for being associated with killing livestock (according to key informants interviewed).

The results from the transect survey showing the abundance of species are presented in Table 2. A comparison of densities among large mammal species in the study area shows that wildebeest rank high with an average number of 221 ± 102 SE, followed by Burchell's zebra with 28 ± 20 SE, impala with 7 ± 5 SE, Giraffe with 3 ± 2 SE and Thomson gazelle with 4 ± 0SE (Figure 3). The variation is so high because little data is collected due to time and resources. A comparison of wildebeest group sizes between Manyara Ranch and Burunge WMA was carried out. Mean wildebeest group size was 221 ± 102 SE. At Manyara Ranch, a single group of Common Wildebeest was found about 2 km from the paved road leading to the Manyara Ranch Dam. At Burunge WMA, five groups were found beside Lake Manyara in Malamboi.

Zebra group sizes did not differ between Manyara Ranch and Burunge WMA in the study area. Total group size for zebra was 30 ± 7 SE (n1= 48, n2= 23, U= 8.5, p= 0.712). The size of giraffe groups did not differ between Manyara Ranch and Burunge WMA. The total group size of giraffes in the study area was 3±1 SE (n1= 1, n2= 5, U= 0.5, p= 0.264). Area. The total group size for the impala was 8 ± 3SE, (n1= 3, n2= 33, U= 0.5, p= 0.1). Only one group of Thomson's gazelle has been found at Burunge WMA adjacent to the Lake Manyara-Malamboi.

Table 1. General demographic and socio-economic characteristics of the respondents

Attribute		Percentage %
Sex	Male	60.7
	Female	39.3
		98.5
Tribe	Maasai	
	Others	1.5
		43.7
Residency	Indigenous	
	Immigrants	56.3
		1.5
Occupation	Farmer	
	Livestock keeper	0.0
	Farmer and livestock	98.5
		36.4
Education	Illiterates	
	Primary	60.7
	Secondary	2.9
		22.9
Age (Years)	18-27	
	28-37	31.2
	38-47	13.3
	>47	32.6
		100.0
Human population	Increasing	
	Decreasing	0.0

Table 2. Wildlife abundance

Species	Counts (number)	Density (number/area)	Mean group size (counts/sightings)	Population	Percentage %
Common wildebeest	1324	177.2	221	4646	75.4
Burchell's zebra	283	37.9	28	993	16.2
Impala	125	16.7	7	1096	7
Maasai giraffe	15	2	3	53	0.9
Thomson's gazelle	4	0.2	4	8	0.5

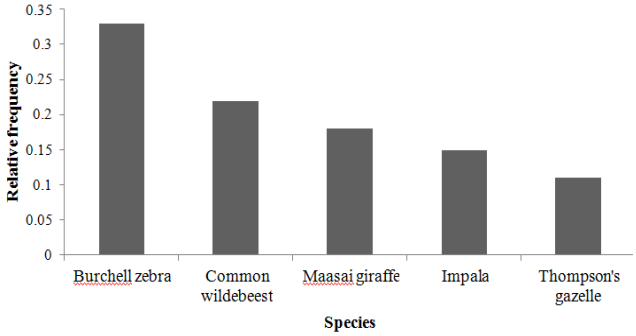


Figure 2. Wildlife species sighting relative frequencies in Kwakuchinja wildlife corridor, Tanzania (n= 27)

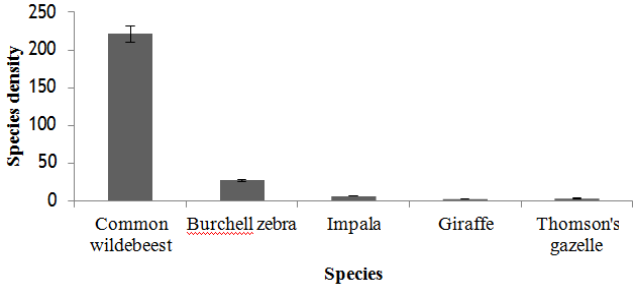


Figure 3. Wildlife species group size comparison (N=1751)

Wildlife distribution

Animal species were recorded in the Manyara Ranch and Burunge WMA during the transect studies and not in the open area (Table 3). In Manyara, wildlife has been found in grassland habitats. Manyara Ranch has a protected land-use status; rangers patrol the ranch, monitor wildlife, and fend off poachers. The Burunge WMA (Municipality Protected) fauna was found in areas of forest and bush, which are ecologically important for the fauna (Figure 4). Burunge WMA occupies the terrestrial and migratory corridors between Tarangire, Lake Manyara, and the adjacent Manyara Ranch, making it an area of high conservation importance. The municipal outdoor area has no wildlife protection status. Surveys revealed that wildlife was not present in the open areas of the community due to displacement and loss of habitat. The increase in physical development in the corridor leads to the displacement of wildlife and, hence, the decline of the Kwakuchinja Wildlife Corridor. Examples of physical development range from institutions such as schools and pharmacies to the Minjingu Phosphate Mining Factory in Minjingu Village in the corridor. Others contain tourist campsites. Some of these are directly on migratory routes within the corridor, resulting in movements of endangered wildlife that may have led to diversions of wildlife routes. Others have addressed the diversion of effects due to the placement of physical structures in wildlife migration routes (Soini 2006; Ogutu et al. 2012). In addition to those institutions and the factory, it has also been established that the human settlements in the village are expanding Minjingu and becoming a small town, which is also indicated by Hassan (2003).

The results showed that although the correlation coefficient between settlement and livestock and wildlife is not statistically significant at the 5% level of significance, there is a greater correlation between wildlife population and wildlife establishment (r= 0.714) than between wildlife and livestock (r= 0.263). This reasonably implies that colonization has more impact on wildlife than on livestock. The results that colonization is more strongly correlated with wildlife population are consistent with comments by Kideghesho et al. (2006) found that human activities such as colonization, deforestation, bushfires, mining, cultivation, and overgrazing are the main causes of habitat destruction and hence population reduction of wild animals.

Land use practices

Regarding land use, all respondents (100%, N= 135) surveyed in the study area indicated that animal and wildlife species readily share the same pasture and drinking water at different times of the day. They also said that cattle and wild animals have co-existed for a long time without any problems. This was observed during the study period in transept walks where wildlife and livestock shared the same habitat. The results suggest that the coexistence of wildlife and livestock is possible, provided that changes in land-use patterns are regulated in a way that does not compromise the habitat requirements necessary for wildlife conservation. Cultivation has also been reported to be bad land use for wildlife. Preserve wildlife habitats; most respondents said this could be achieved through law enforcement. Also, preventing animals from leaving protected areas and preventing trees (Table 5). Bhola et al. 2012) suggest that livestock facilitate the feeding of small and medium-sized herbivores in the rainy season and help create and maintain conditions that allow movement.

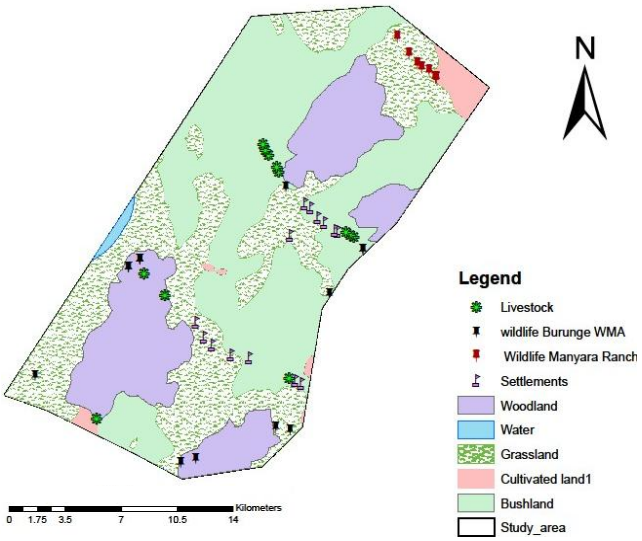


Figure 4. Map of Kwakuchinja, Tanzania, showing wildlife, livestock, and human settlement distribution concerning habitat

Table 3. Wildlife numbers counted in respective areas

Species	Manyara ranch	Burunge WMA	Community open area
Zebra	145	138	0
Wildebeest	18	1306	0
Impala	25	100	0
Giraffe	3	10	0
Thomson gazelle	0	6	0
Total	191	1560	0

Table 4. Livestock population in Kwakuchinja study zone, Tanzania

Area	Counted number (n)	Density (n/A)	Population	Percent (%)
Manyara ranch	130	18.1	475	8.1
Burunge WMA	525	73.2	1919	32.8
Community open area	945	131.8	3455	59.1
Total	1600		5849	100

Table 5. Respondents' views on land use practice

Parameter	Response	N=135	Percent (%)
Land use	Livestock keeping	1	0.7
	Cultivation	4	3.0
	Livestock keeping & cultivation	130	96.3
Bad land use	Cultivation	115	85.2
	Hunting	9	6.7
	Cultivation and hunting	11	8.1
Habitat conservation	Tree cutting	25	18.5
	Law enforcement	64	47.4
	Prevent animals	46	34.1

Table 6. Human settlement in Kwakuchinja study zone, Tanzania

Year	Settlement	Increase	% increase	% annual increase
1988	1281	0	0	0
1998	1582	301	23.5	2.4
2013	2378	795	33.5	3.3

Livestock distribution

During the transect survey, livestock was sighted in all three areas in the study zone. Livestock sightings in open community areas were high, followed by Burunge WMA and Manyara ranch (Table 4).

Settlement distribution

Settlements were found in the open community area, not Manyara ranch or Burunge WMA. Results also show that wildlife and livestock were found in woodlands and bushland habitats (Figure 4).These habitats are ecologically favorable to both wildlife and livestock.

Human population estimates in areas around TME are constantly changing, but nearly one million people are believed to live in areas covered by wildlife migration and grazing patterns (Marttila 2011).This study shows that from 1998 to 2013, there was an increase in human settlements of 33.5%, representing an annual increase in settlements of 3.3% (Table 6). This is consistent with the study by Gamassa (1989) and Hassan (1998) in the study area, which indicated a 23.5% increase in human settlement, corresponding to an annual increase of 2.4% in the establishment. Also, all kinds of human activities such as settlement, agriculture, animal husbandry, ranching, charcoal burning, and even commercial farming are accelerating around the study area from Kwakuchinja. Annual population growth (3.8%) is higher than the Tanzanian average (2.8%) (URT 2012). Therefore, this trend of increasing population and the current trend of agricultural expansion make no doubt that the existence of the Kwakuchinja flyway will be threatened and endangered shortly.

Assessment of the population trend and present status of migratory corridors concerning wildlife use for the past sixteen years (1998-2014)

Wildlife population trend

During the study, it was observed that wild animals and livestock grazed harmoniously at Manyara Ranch and Burunge WMA, except that in Burunge WMA, where hunting is permitted, the animals were very alert and fearful and kept a long flight distance. Hunting alters the reproductive behavior, population structure, and spatial and temporal distribution pattern of wild animals. The study found that the practice of hunting in the study area can affect wildlife, both legal and illegal (poaching. The study also found that the level of wildlife protection is high at the Manyara Ranch, as explorers have patrol equipment to deploy law enforcement. This is not the case in Burunge WMA, where protection is poor as scouts do not have patrol equipment and poaching is unavoidable in Burunge WMA. In addition, during the questionnaire survey, 51.1% of respondents indicated that the number of lions is decreasing. The reason for the reduction is due to trophy hunting and retaliation.

The total number of large mammals was estimated to be more than 120,000 in 1980. Still, in 1999-2000 the number was about 45,000 large mammals, of which 34,000 were seasonal migrants, oryx (*Oryx beisa* Rüppell, 1835), lesser kudu (*Tragelaphus imberbis* Blyth, 1869), gerenuk (*Litocranius walleri* (Brooke, 1879), included (Arron 2001). Two migratory species counted were zebras (15664) and wildebeest (9103). This aerial survey data point shows a more than 50% decrease in the number of large mammals in the ecosystem over the past decade (the 2000s compared to the 1990s) (Arron 2001), and the long change was more dramatic. The 2004 aerial survey counted 23,440 large mammals, including 5249 buffalo (*Syncerus caffer*), 12,000 Thomson's gazelle (*G. thomsonii*), 1151 eland (*Taurotragus oryx* Pallas, 1766), 113 oryx (*O. beisa*), 1426 Maasai giraffe, (*G. camelopardalis*), 338 Common waterbuck (*Kobus elipsiprymnus* Ogilby, 1833), 170 Bushbuck (*Tragelaphus sylvaticus* Pallas, 1766), 72 leopards (*P. pardus*), 140 hyenae (*Crocuta crocuta* Erxleben, 1777), 25 cheetahs (*A. jubatus*), 48 wild dog (Arron 2004) and 200 lions (*Panthera leo* Linnaeus, 1758) (Martilla 2011).

Previous studies have shown that during migration, lions partially expand their territories outside TNP, where conflicts with pastoralists are inevitable. Most lion prides leave TNP and spend 4-5 months outside the park in ranges where lions face retaliatory killings due to predation by herders (Kisui 2011). There are three causes of death for lions in the Maasai Steppe, including retaliatory killings, trophy hunting, and natural mortality. Although lion population declines have been attributed to trophy hunting, natural death, and conflict, retaliatory killings may be the leading cause of lion mortality in the Maasai Steppe (Kisui 2011). However, further analysis is needed to disentangle the relative contribution of each source of mortality.

In the Maasai Steppe, retrieving lions from livestock predation remains a major challenge for lion conservation. Due to their seasonal migratory nature, lions are only safe if they are in the park during the dry season (Kisui 2011). When most lions follow migrating herbivores to the common land in the rainy season, there is greater interaction between lions and livestock. This is when lions are at a greater risk of being killed due to predation by livestock. Tarangire Lion Project records show that between 2003 and 2011, at least 226 lions were killed in relation to livestock predation, with an average of 20-30 lions killed each year. The prediction is that very few lions will remain in TME by 2020 (Marttila 2011) (Figure 5).

This study observed that when lions expand their territories outside TNP, the Maasai hunt and/or kill them. It was also found that sport hunting is poorly managed; Sport hunters select older, mature males for good trophies, leaving the pride to juvenile males. During the acquisition of female pride, pup mortality is greater as the new males will kill all the pups. The dilemma in TME is the lack of time for males to defend their young from other males, as the hunting season does not allow sufficient time for reproduction and protection of the young until maturity. Consequently, the breeding rate is low, and the number of lions in the area will continue to decline with each hunting season.

Since retaliation is the primary motivation for killing lions (Kisui 2011), one strategy to reduce human-lion conflict is to improve farming. For example, improving livestock security from predators at night using low-tech, low-cost techniques such as chain-link fencing to reduce livestock predation in bomas (a man-made structure used to secure livestock) can reduce the impact of conflict and breeders. More efforts should be made to reduce the impact of reprisal killings through participatory approaches involving pastoral communities in surrounding villages. Improving law enforcement that deals with lion killings can also help reduce the rate of retaliatory lion killings. Data from 2003-2011 show that the lion population in Tarangire was estimated at around 170 individuals (Kisui 2011). This shows a decrease of approximately 15% from the demographic estimates of 2003 when systematic and continuous monitoring began (Figure 6). In 2005, the population recovered briefly from the decline in 2004, but the numbers show a sustained decline since 2005, with the largest decline in 2006. The first half of 2007 and 2008 showed signs of recovery, but in 2009 the population plunged again and reached the lowest point before entering a new phase of recovery in 2010/2011. These fluctuations in population size may reflect regular population dynamics, but it remains whether the upward trend observed in 2011 will continue to reach 2003 levels in the coming years (Kisui 2011).

The most numerous ungulates in the NPT are the Impalas (4088), although their numbers have significantly decreased; the current figures are only a tenth of those of 30 years ago (1980 counted 30,750). The decline in numbers is related to a sharp increase in human activities across the TME (Arron 2004). Tarangire and LMNPs are highly protected by Tanzania National Parks, prohibiting cattle grazing and sport hunting. Manyara Ranch is protected by scouts employed by the Manyara Ranch Conservancy. Manyara Ranch Conservancy is a business that operates in partnership with Maasai communities through the Tanzania Land Conservation Trust and the African Wildlife Foundation. The Conservancy exists to protect the migration corridors that connect Lake Natron, Ngorongoro, Manyara, Tarangire, and the Maasai lands to the south. On the other hand, Burunge WMA is an area designated by the municipality to protect wildlife and habitat where cattle grazing and sport hunting are also permitted.

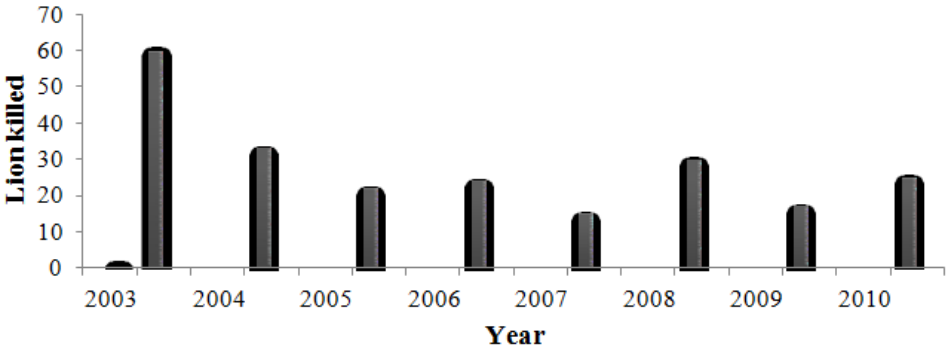


Figure 5. Number of lions killed as a result of livestock predation in Maasai Steppe, Tanzania (Source: Tarangire Lion Project 2011)

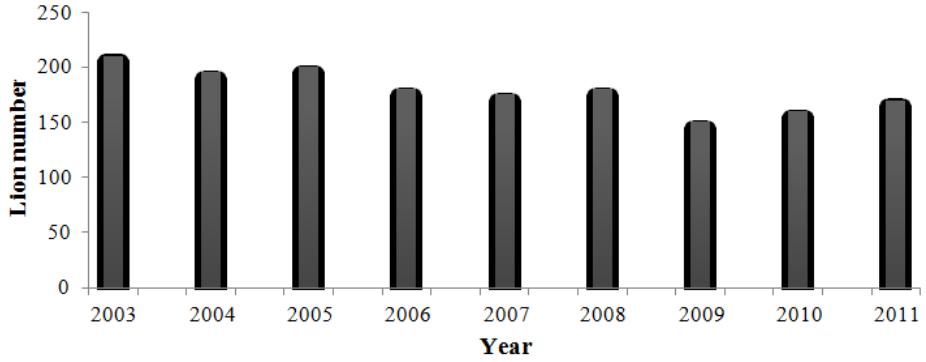


Figure 6. Estimated lion population size in Tarangire National Park, Tanzania from 2003-2011 (Source: Tarangire Lion Project 2011)

Respondents' perceptions of wildlife status

During the questionnaire survey, all respondents stated that no new animal species were found in the study area that was not present in the past or migrated to the study area. However, respondents said giraffes, buffaloes, African wild dogs, lions, and Maasai moose are declining in the area (Table 7).

On the status of wild animals, most of the residents (80.7%) said that wildlife was increasing with a significantly different relationship ($\chi^2 = 51.03$, $p < 0.0001$). Opinions on the increase or decrease in wildlife depended on the number of variables such as sex and time spent in the study area. The respondents' perception of the increase in wildlife and sex was insignificant ($\chi^2 = 0.28$, $p = 0.59$). Most of the respondents surveyed believe that the number of wild animals (81.5%) generally increases with their time in the study area (Table 8). There is a positive and significant association between increased wildlife and the time respondents spend in the study area ($\chi^2 = 53.09$, $p=0.05$).

Migratory corridors have been used by wildlife for the past sixteen years (1998-2014)

Most migratory animal species congregate around the Tarangire River during the dry season. Still, once the rainy season begins in November (with an annual variation of up to two months), the animals disperse through TME. The two wild migratory species, the common wildebeest and the Burchell's zebra are completely abandoning the NPT. Some common wildebeest and burchell's zebras migrate both north and south of the NPT, but most migrate east to grazing and calving areas in the Simanjiro Plains, 20 to 60km away. About 16,000 wildebeest and zebras have been estimated together in the lowlands. When the plains dry quickly from June to July, migratory species return to the Tarangire River; by August, all animals become available in the NPT. Distant migrants such as the beisa oryx can still travel to Lake Natron, or perhaps southern Kenya, and will not be among the first to return (Kahurananga and Silkiluwasha 1997). Elephants to 1890 (2004); 1447 (76%) counted remained within the limits of the TNP (Arron 2004). According to Gamassa (1989), migratory wildlife species, notably zebras and wildebeests, enter the study area on their way to the TNP from mid-June. The peak is in July/August (season dried). The animals use the corridor again on the way back from the TNP at the start of the rains (early November), and the highest density of wild animals is observed at the end of December.

Table 7. Respondent's perception of wildlife status (N=135)

Species	Status	Percent	Reasons
Giraffe	Decreasing	84.4	Human disturbance and loss of habitat
Impala	Increasing	97.8	Conducive habitat
Buffalo	Decreasing	68.9	Hunted for meat and trophy
			Poached
Elephant	Increasing	99.3	They are not hunted in the area, and they are frequently seen in villages
Wild dog	Decreasing	99.3	Loss of habitat, disease, route /corridor blockade
Zebra	Increasing	100	Conducive habitat
Lion	Decreasing	51.1	Hunted for trophy
			Migrated with ungulates
			Killed by Maasai
Hyena	Increasing	100	Availability of food
Eland	Decreasing	88.9	Hunted for trophy
			Poached
			Loss of habitat and displaced

Table 8. Responses of the respondents on the wildlife trend

Wildlife status	Frequency	Percent %
Increasing	109	80.7
Decreasing	26	19.3
Total	135	100.0

It has been observed that agricultural activities, settlements, crops, and livestock are carried out in some areas previously used as faunal corridors and dispersal areas. These human activities have impacted wildlife that previously used the areas to drink water or obtain mineral nutrients not found in other areas. The main threats to the long-term sustainability of the Tarangire/Manyara ecosystem are the loss of some migration corridors and areas outside the national parks. Migration corridors and areas have shrunk, and some of them have been lost due to human activities. The study by Lamprey (1964) identified eight wildlife corridors from TNP, two of which are connected to LMNP. Borner (1985) found that only five remained. In 2000, five wildlife corridors remained in the ecosystem (Msoffe et al. 2011). Only three corridors currently remain, (i) in the northeast, the Kwakuchinja Wildlife Corridor, used primarily by TNP wildebeest and zebra at Manyara Ranch and Lake LMNP; (ii) the TNP corridor through the Loikisare Game Control Area to the Losimingori Mountains, used mainly by elephants, and (iii) the third corridor east of the TNP to the Simanjiro Plains, used mainly by wildebeest and zebras to calving grounds used. All of these are currently under severe threat from extensive agriculture and settlements.

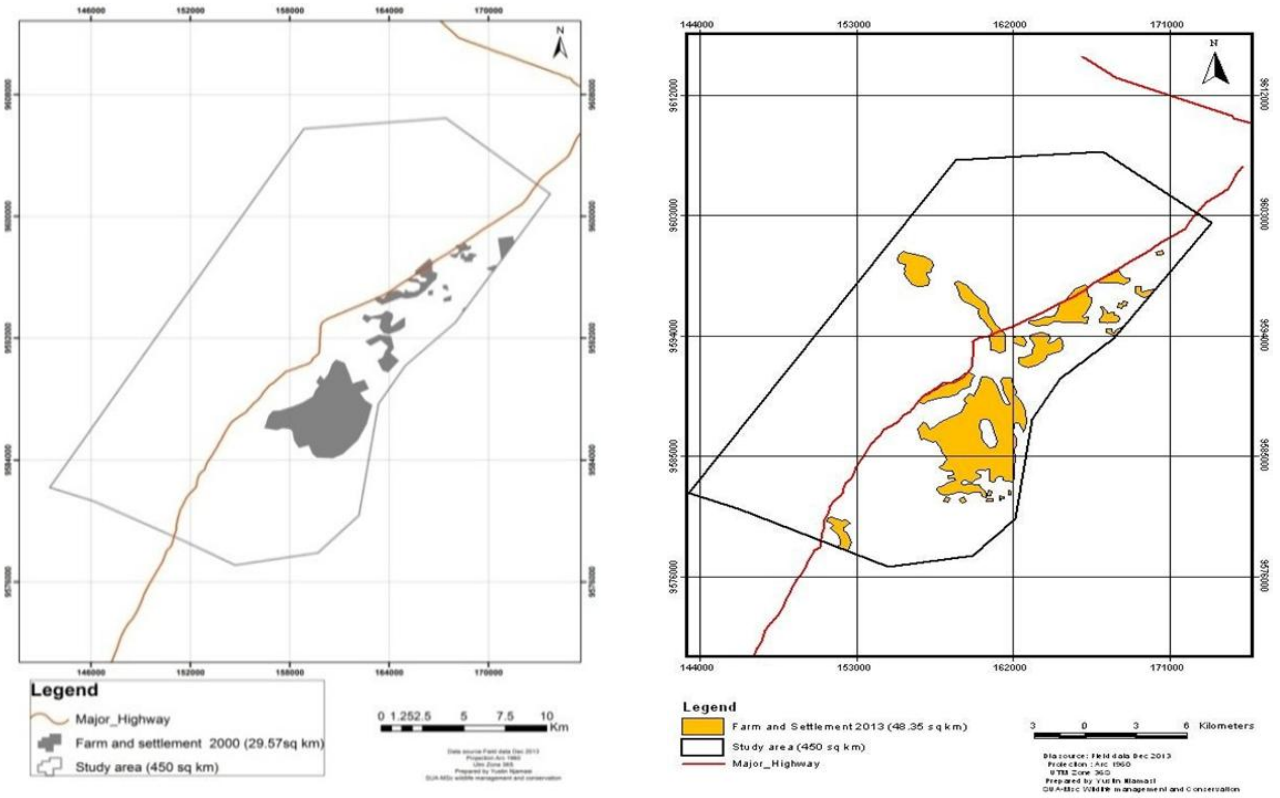
Two corridors that have been blocked are the corridor from the TNP - Vilima vitatu - Mwada - Magara to the LMNP and the one from Tarangire to the Mkungunero range. In addition, there has been an immigration of people from other areas (Babati, Monduli, Simanjiro, and Kiteto) to the study area for cultivation, animal husbandry, work, and fishing. The process of immigration increased the human population and led to the formation and registration of new villages in areas previously used by wildlife. The new villages were founded due to political influences. However, it has been observed that the established villages do not have a land-use plan. This has resulted in communities not having specific areas designated for a particular activity. Hence, habitat due to the needs that the community has acquired from natural habitats (e.g., firewood, infrastructure development, crops, and pastures) was destroyed. The study also found that the increase in human population was related to infrastructure development, most notably the asphalt road from Babati to Arusha, electricity, and the Minjingu Phosphate mining plant.

On the other hand, the extensive agricultural expansion in the Mkungunero area led to the obstruction of the corridor. The ranges have been converted to Mamire agricultural fields. These activities have severely affected the corridors and routes formerly used by wildlife.

Strong overlap between land suitable for agriculture and the main wildlife corridors and wet season distribution areas shows that agricultural development is the main blocking factor for five of the eight wildlife corridors. The blocking of the two former historic routes that connected the TNP and the LMNP denies the animal's right of passage to migrate between the two parks. During the investigation, it was found that agricultural expansion leads to the loss of these remaining corridors. In rural areas such as the Kwakuchinja study area, many people depend directly on agriculture, which is still the backbone of the Tanzanian economy, to support their daily needs. Lack of community awareness of the importance of wildlife has led communities to view wildlife as a nuisance because they don't directly encourage it. Therefore, they cannot see the importance of wildlife rather than just as their enemies (Ogutu et al. 2012). As a result, wild animals (especially carnivores) are killed when found on cropland farms and when they attack livestock in their homes. This is also the case in this study, where the lion, leopard, and cheetah have been reduced. Pettorelli et al. 2010) the results reported that agriculture had serious consequences for carnivores, as it was found that they avoided cultivated land.

Assessment of the impacts of land use/cover changes on wildlife in the Kwakuchinja wildlife corridor

Land use/cover change in square kilometers and the percentage was derived from 2000 and 2013 satellite imagery in the study area. In 2000, the cultivated area was 29.6 km^2 (6.6%) (Figure 7A) and 48.4 km^2 (10.8%) in 2013 (Figure 7B). The results show that from 2000 to 2013, the cultivated area in the study area increased by 4.2% in thirteen years. During the study period, it was observed that much of the Kwakuchinja wildlife corridor was under agricultural land. As a result, 4.2% of natural land has been altered for cultivation, reducing the habitat used by wildlife. The current conversion of natural land to cultivation occupying large areas has destroyed natural vegetation and reduced the areas for wildlife to graze and exercise. During the study, it was observed that the current increase in human settlements between the villages of Mswakini, Olasiti, and Kakoi goes hand in hand with an increase in arable land to feed the growing human population. The study also revealed that people who migrate to the study area include agriculture, fishing, small business, animal husbandry, employment, and marriage. Most immigrants immigrated during the period 2000-2010. Physical developments that have taken places, such as schools, pharmacies, tourist camps, and Minjingu phosphate mining in Minjingu Village, are within the corridor. These developments threaten wildlife movement, which may have led to diverging wildlife routes, reduced wildlife populations, and food availability, impacting wildlife.



A B

Figure 7. Map of Kwakuchinja study area, Tanzania: A. Showing land use/the cover year 2000, B. Showing land use/cover change for year2000-2013 (Source**,** field data December 2013, Arc GIS projection 1960)

Kideghesho et al. (2006) support this study, who reported a loss of wildlife habitat to cultivation in the Western Serengeti Wildlife Corridor. It was also reported by Rodgers et al. 2003) that 16% of Kwakuchinja-Gang was converted into agriculture from 1987 to 2001. Most land-use changes in the Kwakuchinja corridor occurred from 2000 to 2010.

Hassan (2003) reported that the expansion of human settlements in the village of Minjingu transformed the village into a small town. Minjingu village is currently divided into three villages, namely Minjingu, Olasiti, and Kakoi. This was caused by the immigration of people from neighboring districts such as Arusha, Arumeru, and Monduli. The increased human settlement in the area has greatly contributed to the lack of free space for wildlife movements; as found during this survey, this observation is also supported by Ndibalema (2010) in the Serengeti ecosystem and Magige (2010), who also reported the loss of bird habitats due to agricultural expansion. This has resulted in narrowing of the corridor area and could block the entire corridor if the current trend of increasing human population continues in the Kwakuchinja Wildlife Corridor. Noe (2003) observed the shrinkage in the size of the Kitendeni Natural Corridor in Kilimanjaro National Park to about 5 km^2 in 2001 from 21 km^2 in 1952. The main reasons were the expansion of cultivated land, human settlements, and changes in the use. of the soil. Kwakuchinja characterizes the same threats today as activities such as settlement, agriculture, livestock farming, coal burning, and even commercial farming are increasing at an accelerating pace.

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In conclusion the study found that wildlife and livestock were in areas with less human habitat destruction. Wildebeest were also found to have the highest density in the study area. There is also a stronger correlation between wildlife population and colonization than between wildlife and livestock. The study found that traditional migration corridors have shrunk from five to three and found local extinctions of five species of large mammals. The natural trend based on aerial survey data shows a decrease of more than 50% in the number of large mammals in the ecosystem in the 2000s compared to the 1990s. These results imply that wildlife and livestock graze and share areas of watering. The increase in the number of animals does not affect the number of wildlife, but an increase in human settlement and cultivation affects wildlife and their habitat.

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