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# Assessment of habitat and wildlife density in Community Wildlife Sanctuaries Amboseli Ecosystem, Kenya

Claire Poelking

Community wildlife sanctuaries within the Amboseli ecosystem serve as a wildlife corridor for migratory species from Amboseli National Park. The sanctuaries are community-based conservation areas that provide wildlife with necessary resources outside of Amboseli National Park and grant the local community managerial rights to the land and its resources. Data were collected in six sanctuaries located in Kimana Group Ranch. Foot counts were used to collect information on habitat types, vegetative health, and species presence within the sanctuaries. Each sanctuary was individually assessed upon habitat availability – measured by habitat proportion and vegetative health – based on a scoring system modified from Herlocker (1993). Wildlife density and habitat preference by wildlife were calculated using the Jacob's Index. Additionally, seasonal and annual wildlife density variations were determined using similar data collected since 2010. Habitat heterogeneity proved to be the best predictor for wildlife presence in the sanctuaries, while habitat quality was less influential in observed wildlife presence. A one-way ANOVA revealed no significant difference in the annual variation of wildlife densities among the sanctuaries. The six community wildlife sanctuaries have been found to act effectively as a wildlife corridor for the species observed throughout the study.

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## Introduction

Kenya is home to some of the world's most iconic wildlife including the elephants of Amboseli and the lions of Tsavo. Conservationists increasingly recognize that parks alone are inadequate to maintain Africa's far-ranging wildlife. They now work to gain space for wildlife beyond park boundaries, often by collaborating with local communities. The Amboseli ecosystem, surrounding Amboseli National Park, is composed of community group ranches that are owned and occupied by the local Maasai people (Fig 1 Map). This area serves as a key conservation block in Kenya, as over 80% of large mammals from Amboseli are found outside of the formally protected area during the wet season (Okello, 2010). The Amboseli ecosystem is composed primarily of open rangelands, which have been predominantly used for livestock production (Emerton, 1998). However, this region's rangelands are increasingly over-grazed or converted to agriculture to support growing local populations. As a result, the land's traditional role as a dispersal area for wildlife from Amboseli National Park is threatened.

An emerging solution to this problem is the establishment of community wildlife sanctuaries that belong to and are managed by the group ranches. Such 'community-based conservation' (CBC) refers to wildlife conservation that involves the local people in resource planning and management (Hackel, 1998). In the case of Amboseli's community wildlife sanctuaries, the local community has managerial rights to the land and its natural resources as well as the opportunity to make an income from the sanctuary in terms of tourism. This innovative land use strategy retains the current land tenure and ownership system, and encourages community wildlife conservation through financial incentives.

The goal of these community wildlife sanctuaries is to serve as a wildlife corridor, which is a land use method used to connect two or more patches of wildlife habitat (Mech, 1999).

Corridors provide necessary space and resources for migratory wildlife by preserving habitats and reducing fragmentation. Corridors are particularly important for sustaining the migratory wildlife of Amboseli, which must disperse in the wet season to find food resources outside the Park. This ancient seasonal migration is increasingly disrupted by human settlements. When migrating wildlife enter fields and consume crops, local citizens suffer economically and as a result may sometimes resort to poaching animals.

The community wildlife sanctuaries resemble a compromise between the efforts of conservationists to increase protected areas for wildlife and the local communities' desire to reduce crop losses to wildlife and earn tourism income instead. Yet, to achieve a healthy, connected corridor, the sanctuaries cannot simply be any parcel of land set aside for wildlife, they must enable wide-ranging animals to travel, migrate, meet mates in order for genetic interchange to occur, and reduce demographic stochasticity (Beier & Loe, 1992; Mech & Hallett, 2000). To meet these requirements, the corridor must be the appropriate size and contain adequate resource availability and quality. These corridor attributes were selected due to their recognized importance in corridor research and wildlife conservation. This study aims to ascertain if six of the current connected community wildlife sanctuaries in the Amboseli ecosystem are a viable wildlife corridor for various species of migratory animals surrounding Amboseli National Park.

It also provides an account of the attitudes and perceptions held by residents of the community wildlife sanctuaries. Despite idealized models of full support from local communities, in practice communities may be divided as to the merits of participation in corridor initiatives. Some citizens see promise where others see a threat to local livelihoods or land use rights (Okello 2005). Thus, as a complement to the core field data on wildlife, I interviewed residents of Kimana group ranch, in which all the sanctuaries in this research are located, to learn their opinion on the community wildlife sanctuaries and coexistence with wildlife. More specifically, this study works to:

1) Test the presence and abundance of mammal species known to leave Park boundaries against sanctuary attributes including:

a) proximity to the National Park,
b) size (length and width),
c) habitat availability,
d) habitat quality, and
e) livestock density.

2) Describe the attitudes and perceptions about the community wildlife sanctuaries held by the surrounding residents.

This research was conducted throughout April 2012 in collaboration with the School for Field Studies – Center for Wildlife Management; an education program long engaged with local communities and conservation efforts in the Amboseli region.

To set the context for this study and explain its broader significance, I first describe the Amboseli ecosystem and its management history. Then, I review two related areas of research: 1) the importance of wildlife corridors in conjunction with an evaluation their effectiveness, and 2) attitudes and perceptions of the residents neighboring East African parks.

Amboseli Ecosystem (Background and Study Site)

The Amboseli region is a dynamic ecosystem containing some of the world's most magnificent creatures. From the tenacious Acacia trees that bore through the unforgiving soil to dot the landscape to the massive elephants that proudly march across the savanna, this region has exhibited its conservational merit time and time again: "It is the last place on earth where the Pleistocene herds of large mammals which once roamed every continent still linger," (Western, 1997, p. #). Moreover, Amboseli (in addition to Kenya's other National Parks) contributes to Kenya's tourism revenue to the tune of an estimated $250 million USD per year (Emerton, 1998). This 5,700km$^2$ region located in southern Kenya between the Chyulu Hills, Mt. Kilimanjaro, and Tsavo West National Park (Okello, 2005) is composed primarily of Amboseli National Park and the surrounding group ranches (Fig 1 Map).

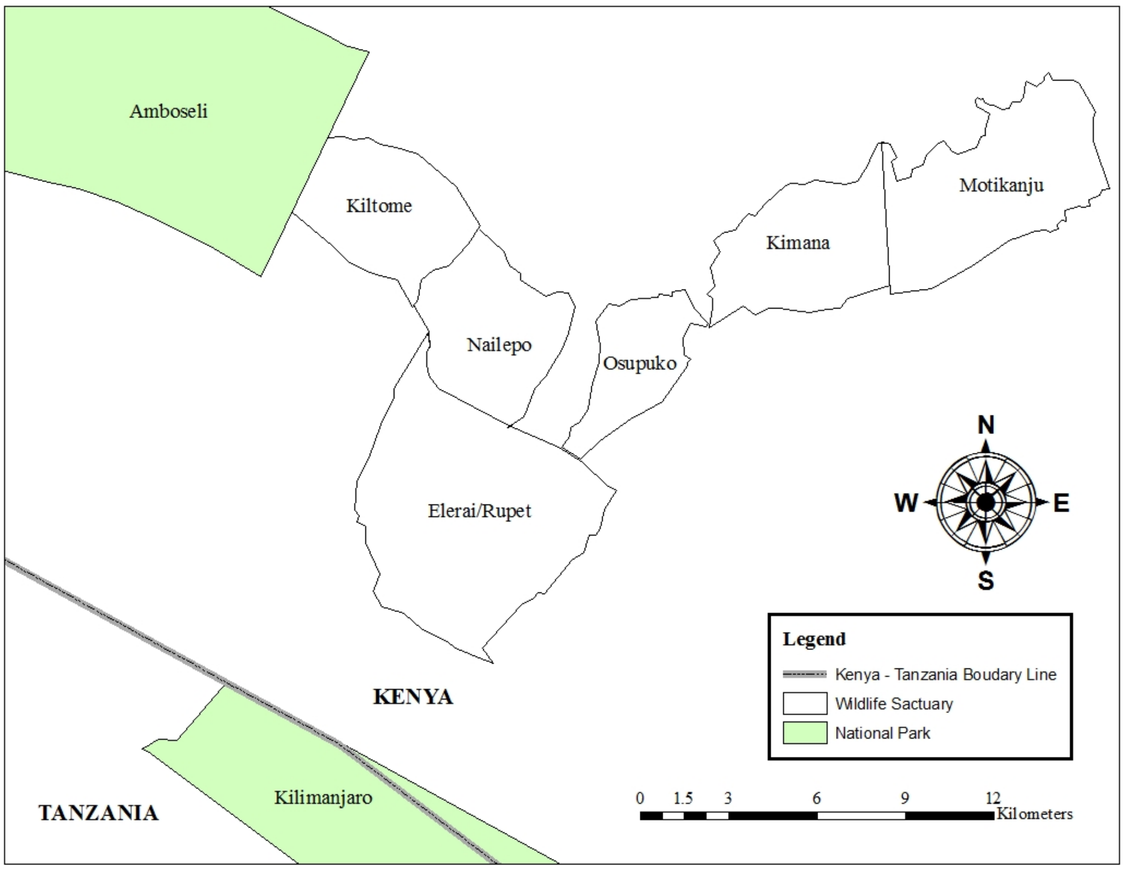


**Fig 1** Map of Amboseli ecosystem - protected area (Amboseli) and the sanctuaries (Kilitome, Nailepo, Elerai-Rupet, Osupuko, Kimana, and Motikanju) located within Kimana group ranch (Mwasi, 2012).

The climate in this region is warm and varies between semi-arid and arid environments. Annual rainfall averages between 400–600mm; the rain comes in the two wet seasons – the long rains occur March through May and the short rains occur October through December (Okello, 2005). The majority of the land is classified as ‘bushed grassland,’ which is characterized by poor soils, low rainfall, and high susceptibility to degradation, especially in the presence of agriculture (Western, 1994). A large accumulation of zebra (*Equus burchelli*), wildebeest (*Connochaetes taurinus*), gazelle (*Gazella granti* and *Gazella thomsonii*), and elephants

(*Loxodonta africana*) all migrate from Amboseli National Park to the surrounding area during the rainy season (Western, 1994).

Amboseli was officially established in 1906 as the 'Southern Reserve' – in the region known as Maasailand, a Maasai territory much reduced after British colonization (Western, 1994). It was not established as a National Park until 1974 when 392$km^2$ were set-aside to conserve the core of the Amboseli ecosystem (Western, 1994). Soon after the Park's creation, the communal land holdings that had belonged to the Maasai across the region were subdivided into group ranches as a result of new centralized political power in Kenya and increased pressure for legal land ownership. The design of the group ranches was to retain some of the features of previous communal land holdings so that the Maasai community could still cooperatively manage the land (IUCN, 2003).

Previous research suggests Maasai attitudes towards wildlife have shifted from "indifference to antagonism" (Western, 1994). Prior to colonial conservation, wildlife was viewed as a 'second cattle' among the pastoralist Maasai, who would consume wild animals as a substitute to livestock only in times of drought. The Maasai tolerated wildlife as a result of this relationship, however with the establishment of the Park they perceived that the government gave wildlife priority over the people. The strictly protected animals not only ceased to be useful, but actually surpassed the Maasai in terms of rights, like access to water and grazing land – at least within the Park – and the attitude shifted towards hostility (Western, 1994). Meanwhile, Kikuyu and Kamba, both agriculturalist peoples began to move into the Amboseli region around the same time, thus competition for land, forage, and water intensified.

The geography of the Amboseli ecosystem is most suitable for pastoralism and wildlife conservation. Yet, many Maasai pastoralists are transitioning from their traditional transhumance lifestyle into a more sedentary one, consequently altering the dynamics of the landscape and creating a number of problems. Permanent settlement has led to excessive depletion of tree and shrub cover resources used by local communities for food, medicine, and construction materials (Okello & Kiringe, 2004). Increased irrigated agriculture has caused serious conflict and competition over water resources between the local communities, livestock, and wildlife (Macharia & Ekaya, 2005). Human infrastructure – such as *bomas*, fences, and roads – has modified and fragmented important wildlife habitats, thus blocking key wildlife dispersal routes and causing Amboseli National Park to become insularized. Some argue that the National Park system is, in part, to blame for these problems. Given that land and resource use are often forbidden within the Park boundaries, people intensify land use on their own property outside Park boundaries, the only available land left to meet their needs (Hartter, 2007; Western, 1994; Goldman, 2009).

During recent decades, local communities within the Amboseli ecosystem felt ignored in the shadow of Amboseli National Park (IUCN, 2003). Starting in the early 1990s, the United States Agency for International Development (USAID) and Kenya Wildlife Service (KWS) in a partnership with community leaders worked to integrate community interests with wildlife conservation through community wildlife sanctuaries. Community wildlife sanctuaries present the neighboring people with the opportunity to benefit from the wildlife, rather than be burdened by it. The sanctuaries were designed with the following elements: consumption user rights to the local community, land use plans that maximize community benefits, a conservation fund to lease ranges for wildlife alongside pastoralism, and the "encouraging [of] communities to tap into the lucrative tourism industry" (IUCN, 2003).

In the spirit of conservation and subsequent tourism entrepreneurship group ranches, namely Kimana, Kuku, Ololorashi-Olulugui, Imbirikani, Rombo, and Eselengei, began to set aside land to be used as community wildlife sanctuaries. The Kimana community wildlife sanctuary, within Kimana group ranch was the first formally established community wildlife sanctuary in Kenya, founded in 1996. This research focuses on the six community wildlife sanctuaries within Kimana group ranch, which comprises a total area of 506,857 hectares in the Loitokitok district. The community wildlife sanctuaries studied in this research were: Kilitome (24.0 $km^2$), Nailepo (21.9 $km^2$), Elerai-Rupet (52.5 $km^2$), Osupuko (13.3 $km^2$), Kimana (22.9 $km^2$), and Motikanju (32.4 $km^2$) (ordered from west to east an by proximity to Amboseli National Park). These community wildlife sanctuaries were chosen because they form a continuous corridor from the southeastern portion of Amboseli National Park extending both east and west, consisting of a total area of about 166.7$km^2$.

## Wildlife Corridors

### *Importance of Wildlife Corridors*

According to David Western, one of the most prominent long-term experts on Amboseli, the best conservation strategy for the present situation in the Amboseli ecosystem is "to preserve whole ecosystems of sufficient size and habitat diversity to maintain representative trophic structures and critical species," (Western, 1994, p. #). Preserving entire ecosystems is nearly impossible, but a corridor may serve as a reasonable substitute.


**Fig 2** Graphical representation of two protected wildlife areas connected by a wildlife corridor.

A corridor is simply a “linear landscape element that connects two or more patches of natural habitat and function to facilitate movement” (Soule & Gilpin, 1991, p. 3) (Fig 2). The goals of wildlife corridors, according to Simberloff (1992, p. 493), are:

1) to lower extinction rates, based on the equilibrium theory,

2) to lessen demographic stochasticity,

3) to stem inbreeding depression, and

4) to fulfill an inherent need for movement.

The principle behind corridors is that of island biogeography, which essentially states that species richness increases with the size of island patches and with proximity to mainland sources (Hilty *et al.*, 2006). Without pathways or corridors the protected wildlife areas will become isolated ‘islands,’ (Goldman, 2006; Mwalyosi 1991). The ‘corridor’ idea is then that the isolation of ‘islands’ will be reduced through the presence of corridors, thus decreasing the rate of extinction. Corridors are important to the movement of wildlife, but they can also help maintain or even enhance natural habitat (Hilty *et al.*, 2006). Increased connectivity facilitates dispersal and genetic interchange among both animal and plant populations (Beier & Loe, 1992). The block of community wildlife sanctuaries are intended to provide a corridor for the wildlife of Amboseli to resources outside the Park during the wet season.

Ideally, the community wildlife sanctuary, and the corridor as a whole, should develop buffer-zone land-use systems that can provide both goods and services to the people and habitat to the wildlife (Western, 1994). The establishment of a sanctuary does not ultimately guarantee that biological diversity will be conserved. Newmark (1993) notes that this may be due to inadequate protection of the sanctuary, a lack of other protected areas (isolated ‘islands’), and insufficient size.

Beier & Loe (1992) classify two types of species which populate corridors: passage species – which need corridors to allow individuals to pass directly between two areas in discrete events of brief duration – and corridor dwellers – that use the corridor anywhere from several days to several generations. More often than not large herbivores like elephants and other megafauna present in Amboseli are passage species (Beier & Loe, 1992). These large herbivores are a 'focal species' in the Amboseli ecosystem – that receive disproportionate attention from conservation biologists and practitioners due to their role as 'ecological engineers' and their high tourism value (Fleishman *et al.*, 2000). Therefore this study focuses on large herbivores to assess the community wildlife sanctuary viability. The species I expected to observe in the community wildlife sanctuaries were zebra, wildebeest, gazelle, and elephant, which are all known to exit the park boundaries.

*Measuring the Effectiveness of Wildlife Corridors*

Leading ecologist McKenzie (1995) outlined five goals that articulate the parameters for a successful wildlife corridor:

1) wide-ranging animal can travel, migrate, and meet mates,
2) plants can propagate,
3) genetic interchange can occur,
4) populations can move in response to environmental changes and natural disasters, and
5) individuals can recolonize habitats from which populations have been locally extirpated.

The size of a wildlife corridor must be considered. Large parks have space to allow for the maintenance of ecological and evolutionary processes (Noss, 1993). This includes the needs of key species, which must be met in order to uphold processes like seed dispersal and nutrient cycling. Width may be the leading concern for an effective corridor. Estimating the minimum corridor width involves considering the size of the home range for focal species inhabiting a given ecosystem (Table 1). Beyond simple movement requirements, if a focal species is highly territorial it could result in a corridor that is impeded by compounded social interactions, like aggression (Beier & Loe, 1992). A width greater than the home range is generally encouraged as it mitigates negative edge effects (Bennett, 2003). Edge effects can include: microhabitat changes, pollution, the disturbance of edge specialists, and the introduction of invasive species, predators, and/or competitors (Bennett, 2003). Increased width also allows for the incorporation of a greater diversity of habitats, which increases the likelihood that a linkage could support a greater abundance and diversity of wildlife.

**Table 1** Top ten largest average home ranges of migratory species observed within the community wildlife sanctuaries (Estes, 1991, information collected in Serengeti National Park, Tanzania). All species not listed have a home range of less than 2.0km$^2$, including the common wildebeest.

| Species | Home Range (km$^2$) |
|---|---|
| African elephant | 1757 |
| Burchell's zebra | 315 |
| Common eland | 298 |
| Maasai giraffe | 163 |
| Olive baboon | 22 |
| Grant's gazelle | 20 |
| Greater kudu | 11 |
| Thompson's gazelle | 3 |
| Gerenuk | 2.4 |
| Lesser kudu | 2.2 |

Suitable corridor length is the next essential dimension to evaluate in the size of an effective wildlife corridor. In contrast to width, a longer corridor does not necessarily imply a more successful corridor. In general, the longer the corridor, the less likely an individual will be able to traverse the corridor per unit time, therefore, a longer corridor would need to contain more habitat resources, like forage and cover, in order to serve a species (Newmark, 1993). Increased length also exposes animals to cumulative disturbances and increases the risk of vulnerability to predation and/or poaching (Bennett, 2003).

The linkage from one wildlife sanctuary to the next plays an important role in the connectivity of a corridor. Linkages constitute known pathways taken by animals like seasonal migratory or daily foraging routes of large mammals, stopover points of migratory birds, or habitats commonly used by dispersing individuals (Bennett, 2003). Moreover, the insularization of a sanctuary, where adjacent habitat is not present or not easily accessible could potentially inhibit its use by wildlife. Furthermore, rare species or those that are incapable or reluctant to use human-modified habitats will be particularly prone to future extinction in areas with poor linkages (e.g. crossing a road to continue through the corridor) (Newmark, 1996).

Habitat availability and quality are crucial to a functioning wildlife corridor. The heterogeneity among habitat types is another indication of habitat health in insular ecosystems and may prove more important than reserve size for retaining diverse species (Cromsigt *et al.*, 2009). In small conservation areas or corridors, a mosaic of habitat patches can possibly compensate for lack of land or migration options. The quality of habitat within a corridor may also determine whether wildlife chooses to use the corridor (Hilty et al., 2006). Habitat quality can be viewed as a continuous variable that ranges from low, which is based solely on resources for survival, to median, meaning based on resources available for reproduction, and lastly to high, which is based on resources available for population persistence (Krauman, 1999).

Previous corridor research in the region suggests that width is important to act as a buffer between the wildlife and human settlement (Okello 2005), particularly *bomas* or homes, roads, electric fences and agriculture, all known predictors for low wildlife densities (Okello 2009). Elephants and zebra proved least cautious around human settlement and are most able to traverse corridors amid human-managed landscapes. In contrast, antelope species, specifically the Grant's gazelle, impala, and the Greater and Lesser kudu are most reluctant to enter areas of human development (Okello 2009; Newmark 1993). Additionally, research proposes that habitat requirements be met in the proposed corridor, because wildlife will not necessarily recognize a 'corridor,' but will identify and enter a suitable habitat (Newmark 1993; Beier & Loe 1992).

The School for Field Studies has collected wildlife and habitat data in the community wildlife sanctuaries neighboring Amboseli since 2010. Their work has focused on comparing corridor size, linkages and habitat against wildlife movement. My methods draw directly from their protocol as explained below in 'Materials and Methods'.

Community-Based Conservation

Community-based conservation (CBC) is best known in the context of conserving wildlife in developing nations and represents an effort to integrate the goals of conservationists and the interests of rural peoples. According to Hackel (1999, p. 187) CBC works in three ways:

> 1) allowing people living near protected lands to participate in land-use policy and management decisions,
>
> 2) giving people proprietorship or ownership over wildlife resources, and
>
> 3) giving local people economic benefit from wildlife conservation.

In the 1950s it was recognized that rural communities depended on sustainable use of natural resources, including water, grazing land, forest product, and wildlife (Western, 1994). However, it was not until the 1980s that social justice for ethnic peoples in conjunction with environmental health gained the attention of conservationists. As a result of these movements CBC took root.

CBC reverses the traditional top-down style of conservation by focusing on the people who "bear the costs of conservation," (Western, 1994, p 7). In the old system, at the end of the day conservation usually came down to local people giving up land for conservation purposes, something they were often reluctant to do based on the fact that they also use the land for their own purposes. In contrast, the idea of CBC is that if rural communities can essentially 'put a price' on nature and wildlife that can be economically competitive with other land uses. In this way conservation in partnership with the local community stands a chance (Geist 1988) and holds promise for a future where both the local communities and wildlife are successful.

CBC is, however, not without flaws. The most obvious illustration of this is that the local people must be ready and willing to partake in CBC. While it is hailed by some conservationists and outsiders as a near-panacea the people must 'want' to participate, which is not always the case. Moreover, the community depends on outside markets and is subject to the ever-shifting global economy (Western, 1994). Then, there is the question of whether local communities can resolve resource conflicts and the resulting environmental degradation associated with extra-local threats (Western, 1994). These issues are prominent in the CBC attempts within the Amboseli ecosystem.

In order to create a community wildlife sanctuary the local people must give up a portion of their communal land for wildlife, which they are often disinclined to do because they already use the land for agriculture and pastoralism (Newmark *et al.*, 1994). These are known forms of economic stability for the Maasai. Tourism, the intended source of income from CBC, is not. "We cannot exclude the possibility that this [support for a community wildlife sanctuaries in the Amboseli Ecosystem] was in appreciation of their potential economic benefits rather than because of genuine concern for conservation," noted a report by the International Union for Conservation of Nature (2003, p. 64). If profits from the community wildlife sanctuaries do not accrue, the community may be reluctant to continue its involvement in CBC. Additionally, the issue of people's rights to use natural resources within the sanctuaries causes alarm within the community as to how and when they will be able to use resources. At the present, land that is communally owned (but well suited for community wildlife sanctuaries) is used for a variety of resources namely dry season grazing, water, and firewood (IUCN, 2003). As a community wildlife sanctuary the activities and benefits that are currently available to the local people may become far more regulated (Hackel, 1999).

According to Western (1994), CBC is not a modern colonialism in the sense of evicting people from their land – as was the case in the creation of Amboseli National Park – but more as a stewardship program that combines the needs of people with the needs of wildlife. Areas that have big game animals are more likely to succeed, because the sanctuaries would draw more tourists (Hackel, 1999). If the wildlife serves as a source of revenue for the people, the wildlife in turn becomes valuable to the people. In the best case scenario, CBC is an opportunity for the people to work for themselves (Kleymeyer, 1994).

## Materials and Methods

The fieldwork was conducted in two parts: 1) assessment of the community wildlife sanctuaries as a corridor via transect walks and 2) interviews with members of the surrounding community. This study was conducted over the month of April 2012, the end of the dry season. The corridor assessment consists of six sanctuaries within the Amboseli ecosystem: Kilitome, Nailepo, Elerai-Rupet, Osupuko, Kimana, and Motikanju.

### Assessment of Wildlife Corridor

#### *Description of Transect Method*

Foot counts along transects of varying length were conducted to identify the animal abundance and habitats present within the community wildlife sanctuaries. Line transects and distance-sampling techniques were employed in order to accurately measure habitat proportions and to reduce the likelihood of repetitive data. The first transect in each sanctuary commenced at a central point and ended at the boundary. A fixed width of 300 meters on both sides of the transect was observed (Fig 3). A 300 meter buffer zone was utilized between transects to allow for potential adjustments to be made to individual paths; additionally, this allowed for the fixed 300 meters on each side of the transect to be observed with a low probability of repeated animal sightings on the following transect. The next transect was walked in the opposite direction from the previous one (i.e. if the first transect advanced from east to west, the next advanced from west to east – no north-south transects were conducted). The transect paths were designed to cover greater than 50% of the sanctuary's total area. This allowed for a minimum of 30% coverage – the minimum percentage for an accurate statistical assessment of data.

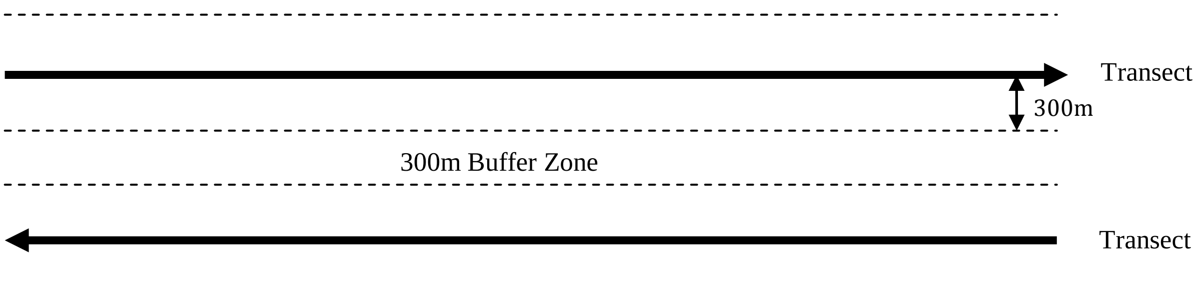


**Fig 3** Diagram of transect method used

*Description of Data Collection*

Three researchers (C. Poelking, B. Whitman, and J. Sista), one local guide (I. Lorgas), and one Kenyan Wildlife Service guard (J. Sakinoi) amounting to five total observers walked the transects together. The transect walks occurred at approximately the same time of day for each assessment, usually beginning at 8 a.m. and concluding around 1 p.m., although this depended greatly on the size of the sanctuary.

All mammals along the transect, including wildlife and livestock, were counted and any species associations documented. Determining the type of antelope was challenging at times, but the assistance of the local guide improved accuracy. Distinguishing goats from sheep was difficult, thus we pooled them as 'shoats', as per D. Western and others. Location of the observed animal was recorded using a handheld Garmin GPSmap 76CX® unit to provide UTM coordinates, a Bushnell Elite 1500® rangefinder was used to acquire the perpendicular sighting distance the animal was from the transect, and a compass was used to note the cardinal direction. When an animal sighting occurred the habitat type was recorded, as well as a habitat assessment of the ~20 meter radius surrounding the animal. The walking pace was consistent day-to-day, as was the role of each research team member:  one member observed the location, another measured the distance, and third assessed habitat type and quality. This reduced error related to inter-observer variability.

Every 100 meters along the transect habitat type and quality was noted using the scanning techniques of Kittur (2010). The 100 meter distance was measured using a handheld Garmin GPSmap 76CX® unit that marked UTM coordinates. The habitat type was recorded as one of ten possible habitat type categories as per Pratt *et al.* (1977). If more than one habitat type was present the larger habitat was recorded, but this was rare. The habitat quality assessment included recording the presence of water or a kill, in addition to noting vegetation damage, bare ground/erosion, and the presence of invasive plant species.

Vegetative damage was measured by low, medium, or high evidence of grazing/browsing and/or pushing (a common result of large mammals alleviating an irritation like an itch); bare ground/erosion was measured by:  minimal wearing away, evidence of trampling, or bare ground; invasive species was measured by low, medium, or high presence. The local guide was imperative to evaluating these components. The three categories were recorded using a scale of one to four that corresponded to a percentage measuring the component (Table 2). This scale was modified from the Herlocker (1993) method, which distinguished components of rangeland that were broken down into subcategories. Each component receives a range integrity score that is determined by its subcategory rating from one to four. The criteria for each subcomponent differs slightly, but it holds true that a score of one (1) or (2) suggests a healthy rangeland and a score of three (3) or (4) indicates land in poor physical condition.

**Table 2** Habitat assessment scale and their corresponding percentages.

| Scale | Percentage |
|---|---|
| 1 | None |
| 2 | 0-33% |
| 3 | 34-66% |
| 4 | 67-100% |

Source: Herlocker (1993)

*Description of Data Analysis*

The habitat matrix was measured by the number of various habitat types and whether they were suitable for the focal species. The habitat preference for wildlife within the sanctuaries was obtained using the Jacob's Index ([(r - p)/(r + p – 2rp)]; r = used, p = available), which compares expected use with observed used (Cock 1978). If there are two or more community habitat types present, one of which is used by the focal species it was considered successful. Habitat quantity and quality were assessed based on an adaptation of Herlocker's (1993) method as described earlier. Lastly, wildlife and species abundance was considered in the success of the corridor – as a whole. Wildlife abundance, or density, is compared with past data on wildlife presence in the community wildlife sanctuaries and data on wildlife presence from Amboseli National Park.

Interviews with Members of the Surrounding Community

*Description of Interview Methods*

A full exploration of the human-wildlife relationship was not possible in this research, however I made an effort to explore the basic dynamics of people-wildlife interactions and identify possible human-wildlife conflict resolution mechanisms. I used a survey with twenty-one questions (Appendix I) and spoke with fifty families surrounding Nailepo, Kimana, and Motikanju community wildlife sanctuaries. Interviews were conducted in English for the most part, with some of the more complex questions asked in Swahili or Maasai with assistance of my translator and local guide.

**Results**

Corridor Undivided

A total of seventy transects were walked, totaling 171.4 kilometers. Sampling coverage corresponded with sanctuary size, with an average of over 50% of the sanctuary walked on the transects and the other 50% observed from the transects (range of 300 meters on each side of the transect). The six community wildlife sanctuaries studied were: Kilitome (24.0 $km^2$), Nailepo (21.9 $km^2$), Elerai-Rupet (52.5 $km^2$), Osupuko (13.3 $km^2$), Kimana (22.9 $km^2$), and Motikanju (32.4 $km^2$), ordered from closest to Amboseli National Park to the east. Width was measured as well; Elerai-Rupet was the widest and Osupuko the most narrow (Table 3).

**Table 3** Estimated average community wildlife sanctuary widths

| **Community Wildlife Sanctuary** | **Estimated Width (km)** |
|---|---|
| Kilitome | 4.40 |
| Nailepo | 4.70 |
| Elerai-Rupet | 7.88 |
| Osupuko | 2.88 |
| Kimana | 4.50 |
| Motikanju | 3.70 |
| AVERAGE | 4.68 |

A range of habitat types were observed including: forest, bushland, woodland, shrubland, grassland, bush grassland, wooded grassland, shrub grassland, dwarf shrub grassland, riverine, and agriculture. A total of twenty-five mammal species were observed (Table 4). The overall wildlife density varied among the sanctuaries, Kimana had the highest at density at 47 individuals per $km^2$ to Elerai-Rupet with the lowest density at 3.2 individuals per $km^2$ (Fig 4). Livestock proved more abundant than wildlife in all but one of the six sanctuaries. The highest total number of wildlife species (15 species) and the highest number of species per area (22.9 $km^2$) were observed in Kimana sanctuary.

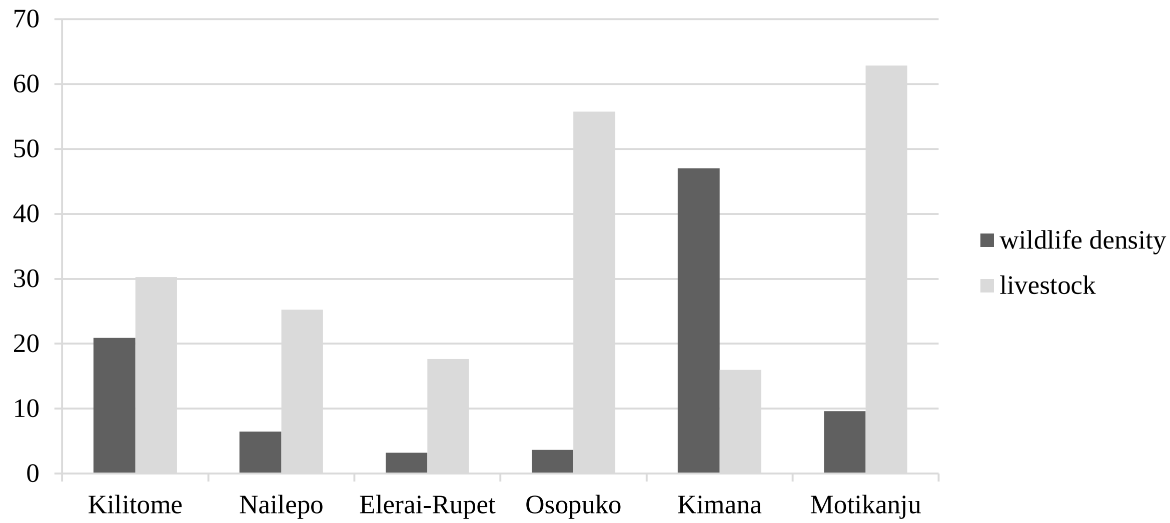


**Fig 4** Total wildlife and livestock density (individual/$km^2$) within the six sanctuaries throughout the study period, sanctuaries arrayed from left to right according to proximity to reserve (Kilitome is adjacent).

*Habitat Assessment*

Each of the six community wildlife sanctuaries has a unique habitat matrix (availability) and overall habitat quality, which are analyzed in the following sections. All of the sanctuaries were awarded habitat assessment scores based upon the data collected every 100 meters along the transects (Table 2). Each of the three components evaluated (vegetative damage, bare ground/erosion, and invasive species) was given a score 0-4, using a modified Herlocker (1993) method. The scores were averaged together (including the number of times a habitat type was observed, thus a score can come out to more than 4) to create the habitat assessment (Table 5). A low score suggests a healthy rangeland and a higher score indicates land in poor physical condition. Across the five sanctuaries, bush grassland appeared to be most degraded.

| | Kilitome (24.0 km2) | Nailepo (21.9 km2) | Elerai-Rupet (52.5 km2) | Osupuko (13.3 km2) | Kimana (22.9 km2) | Motikanju (32.4 km2) | Average |
|---|---|---|---|---|---|---|---|
| African elephant, *Loxodonta africana* | x | x | 0.83 | x | 2.51 | x | .55 |
| Burchell's zebra, *Equus burchellii* | 7.15 | 0.73 | 0.23 | x | 13.96 | 3.82 | 4.32 |
| Common eland, *Tragelaphus oryx* | 4.84 | x | x | x | x | x | 0.81 |
| Maasai giraffe, *Giraffa camelopardalis* | 1.34 | x | 2.17 | x | 1.56 | 0.85 | 0.99 |
| Olive baboon, *Papio cynocephalus anubis* | 1.61 | 0.44 | x | x | 3.12 | x | 0.86 |
| Grant's gazelle, *Gazella granti* | 3.38 | 1.03 | 0.03 | 1.1 | 2.1 | 3.26 | 1.82 |
| Greater kudu, *Tragelaphus strepsiceros* | x | x | 0.03 | x | x | x | 0.01 |
| Thomson's gazelle, *Gazella thomsonii* | 3.01 | 1.54 | x | 1.55 | 9.42 | 0.05 | 2.60 |
| Black-backed jackal, *Canis mesomelas* | x | x | x | x | 0.07 | 0.15 | 0.04 |
| Gerenuk, *Litocranius walleri* | 0.32 | 0.37 | x | x | x | x | 0.12 |
| Lesser kudu, *Tragelaphus imberbis* | x | x | 0.06 | x | x | 0.15 | 0.04 |
| Bat-eared fox, *Otocyon megalotis* | 0.16 | 0.15 | x | x | x | x | 0.05 |
| Common warthog, *Phacochoerus aethiopicus* | 0.05 | x | x | x | 2.64 | x | 0.45 |
| Impala, *Aepyceros melampus* | 0.05 | 1.1 | x | x | x | 0.7 | 0.31 |
| Common wildebeest, *Connochaetes taurinus* | x | x | x | x | 3.93 | x | 0.66 |
| Common reedbuck, *Redunca arundinum* | x | x | x | x | 0.07 | 0.05 | 0.02 |
| Banded mongoose, *Mungos mungo* | x | x | x | 0.44 | x | x | 0.07 |
| Vervet monkey, *Cercopithecus aethiops* | x | x | x | x | 2.03 | x | 0.34 |
| Common waterbuck, *Kobus ellipsiprymnus* | x | x | x | x | 0.61 | 0.05 | 0.11 |
| Kirk's dik-dik, *Madoqua kirkii* | x | 0.29 | 0.03 | x | 0.27 | 0.25 | 0.14 |
| Cape hare, *Lepus capensis* | x | 0.37 | 0.09 | 0.55 | 0.14 | 0.05 | 0.20 |
| Rock hyrax, *Procavia* | x | x | x | x | x | 0.1 | 0.02 |
| Livestock (Cattle/Donkey/Shoat) | 30.48 | 25.7 | 17.67 | 55.74 | 15.99 | 63 | 34.76 |

**Table 4** All animal densities (individual/km2) observed during foot counts throughout the six sanctuaries; 'x' signifies the species was not observed within the sanctuary. Sanctuaries arrayed from left to right according to proximity to reserve (Kilitome is adjacent). Wildlife arrayed from top to bottom according to range size.

| | Nailepo (21.9 km$^2$) | Elerai-Rupet (52.5 km$^2$) | Osupuko (13.3 km$^2$) | Kimana (22.9 km$^2$) | Motikanju (32.4 km$^2$) | AVERAGE |
|---|---|---|---|---|---|---|
| Bushland | 6.2 | 5.05 | 6.48 | 5.25 | 6.38 | 5.87 |
| Woodland | x | X | x | 6.33 | 5 | 5.67 |
| Shrubland | 7.04 | 4.81 | 6.3 | 5.18 | 5.86 | 5.84 |
| Grassland | x | 3.9 | x | 4.97 | x | 4.44 |
| Bush Grassland | 6.73 | 5.64 | x | 5.18 | 7.73 | 6.32 |
| Wooded Grassland | x | 6.13 | x | 5.25 | 7.31 | 6.23 |
| Shrub Grassland | x | 4.47 | x | 4.63 | 6.49 | 5.56 |
| Dwarf Shrub Grassland | x | X | x | 5.4 | x | 5.40 |
| Riverine | x | X | x | 4.33 | 7.18 | 5.76 |
| AVERAGE | 6.67 | 4.86 | 5.76 | 5.17 | 6.56 | - |

**Table 5** Habitat assessment scores (per habitat type). The 'x' signifies the habitat type was not present within the sanctuary (Kilitome is not present, as the assessment data was not collected for this sanctuary). NOTE: forest and agriculture were removed. Forest was removed because it was less than .003% of the habitat observed; agriculture was removed because it is not a 'habitat' that would be used by wildlife.

Livestock and wildlife shared habitats within the community wildlife sanctuaries, and were observed together less often in higher quality habitat (Fig 17).

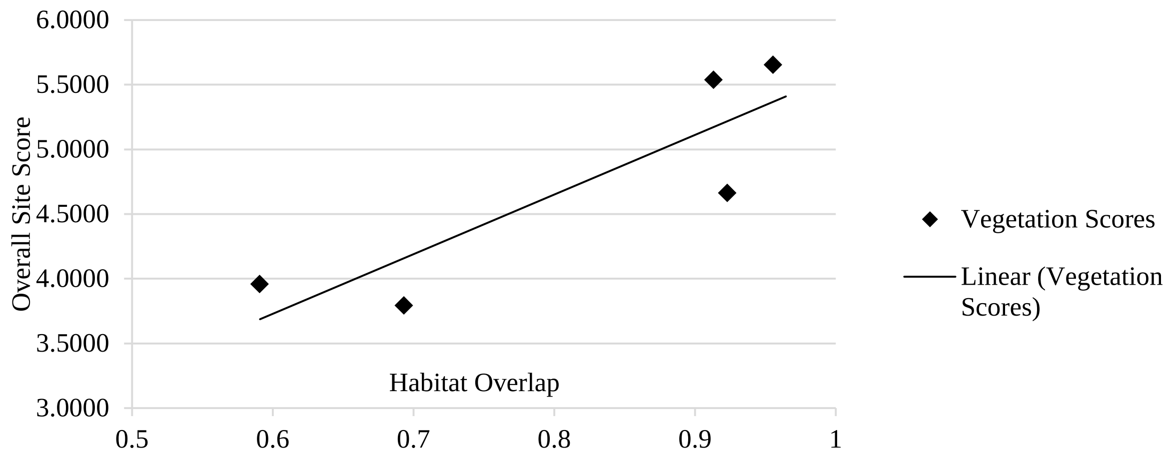


**Fig 17** Overall site score compared to habitat overlap of wildlife and livestock

<u>Individual Community Wildlife Sanctuaries</u>

*Kilitome*

During the dry season of 2012, Kilitome had a pooled wildlife density of 20.91 individuals per km$^2$ and contained nine of the twenty-two overall observed wildlife species. Bushland is the most dominant habitat type making up 64% of the sanctuary (Fig 5). However, bushland habitat is not generally preferred by wildlife (–0.57) ranking behind grassland (–0.93), woodland (–1), and shrub grassland (–1) as avoided habitat types (Fig 6). Still, gerenuk (+1) and impala (+1) preferred bushland. The most utilized habitat type was shrubland (+0.76) followed by dwarf shrub grassland (+0.62) and bush grassland (+0.58). The Burchell's zebra (+0.96) was partial to shrubland habitat, eland most preferred bush grassland (+0.90), while Grant's gazelle (+0.91) and Thomson's gazelle (+0.77) sought out dwarf shrub grassland of which there was very little, making up only .4% of Kilitome.

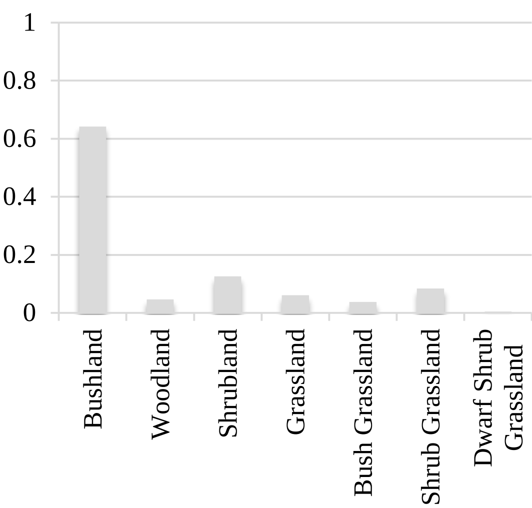


**Fig 5** Habitat proportion in Kilitome

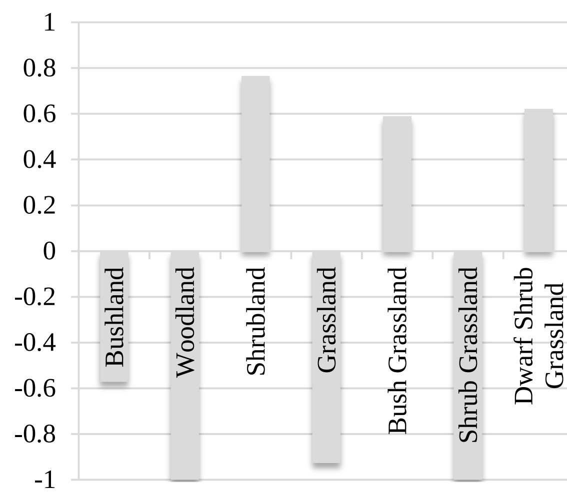


**Fig 6** Jacob's Index for habitat preference in Kilitome

*Nailepo*

During the dry season of 2012, Nailepo had a pooled wildlife density of 6.46 individuals per km$^2$ and contained nine of the twenty-two overall observed wildlife species. Nailepo consisted of bushland (59.4%), shrubland (31.9%), and bush grassland (8.7%) (Fig 7). Bushland habitat was avoided by the Burchell's zebra and gerenuk, used sparingly by the Kirk's dik-dik, but used exclusively by the Grant's gazelle (+1) and Thomson's gazelle (+1). Jacob's Index for individual species showed that bush grassland was shown to be completely avoided by every species observed with the exception of the Burchell's zebra, which strongly preferred the habitat type (+0.95). The number of zebras observed in Nailepo brought up the overall wildlife preference for bush grassland and skewed the data slightly (Fig 8). Shrubland was a highly preferred habitat type, specifically by the gerenuk (+1) and Kirk's dik-dik (+0.73), and avoided by the Grant's gazelle and Thomson's gazelle. Thus, the Grant's and Thomson's gazelle have opposite habitat preference as the gerenuk and usually Kirk's dik-dik in Nailepo.

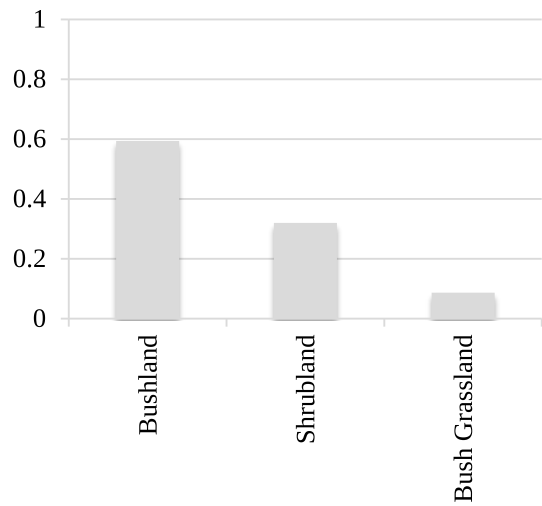


**Fig 7** Habitat proportion in Nailepo

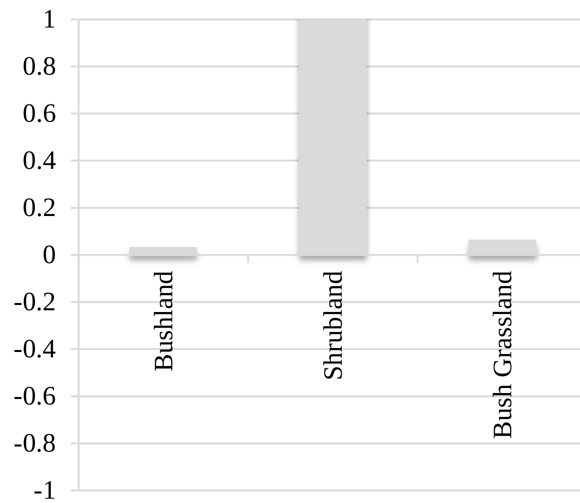


**Fig 8** Jacob's Index for habitat preference in Nailepo

*Elerai-Rupet*

During the dry season of 2012, Elerai-Rupet had a wildlife density of 3.22 individuals per $km^2$ and contained eight of the twenty-two overall observed wildlife species. The sanctuary is composed of a nearly equally distributed habitat types:  shrub grassland (28%), bushland (25%), shrubland (25%), and bush grassland (18%) (Fig 9; NOTE: forest made up only .003% of overall habitat type, as a result it does not seem to appear on Fig 9, but was included for an accurate representation). Forest, grassland, bush grassland, and wooded grassland were all avoided habitats (Fig 10). Bushland was used by the African elephant (+1) and Maasai giraffe (+1), but avoided by all other species present. Shrubland was avoided by the Burchell's zebra (–1) and Grant's gazelle (–1), but highly preferred by the African elephant and Greater kudu (+1).

Burchell's zebra (+1) and Maasai giraffe (+0.91) utilized shrub grassland. The number of Burchell's zebra and Maasai giraffe found chiefly in shrub grassland prompted the overall high preference by wildlife (Fig 11).

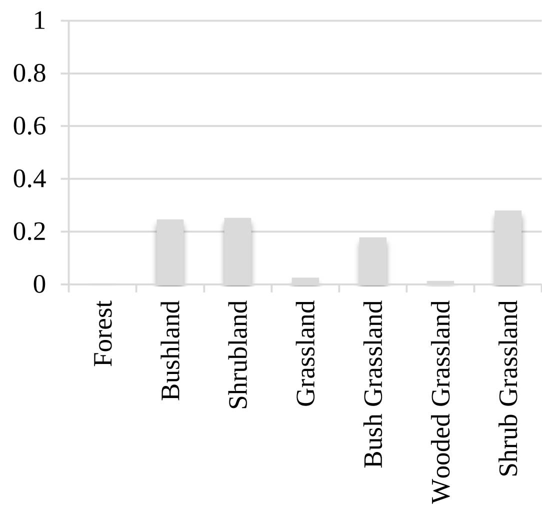


**Fig 9** Habitat proportion in Elerai-Rupet

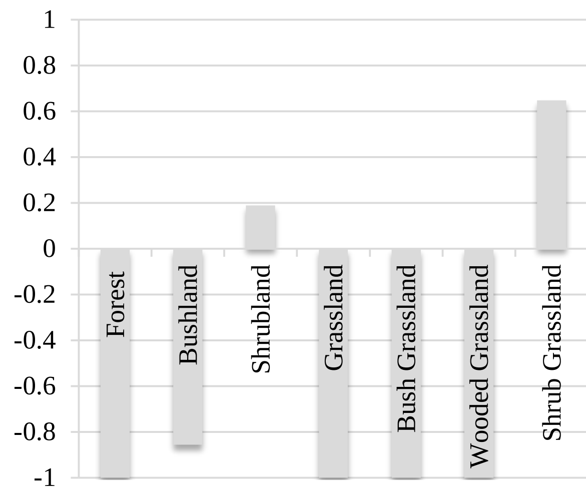


**Fig 10** Jacob's Index for habitat preference in Elerai-Rupet

*Osupuko*

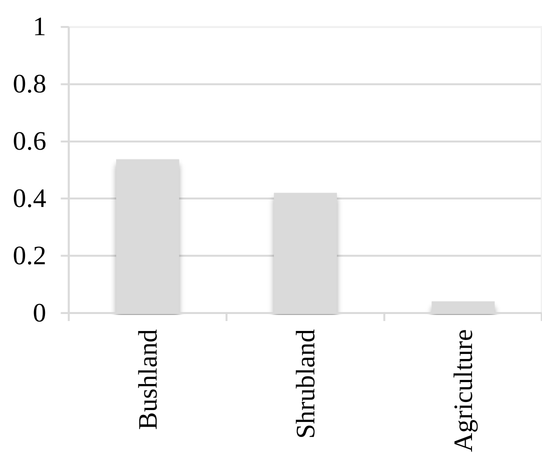


**Fig 11** Habitat proportion in Osupuko

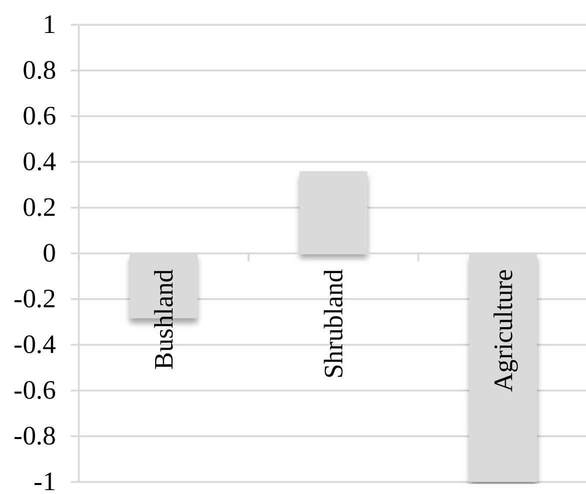


**Fig 12** Jacob's Index for habitat preference in Osupuko

During the dry season of 2012, Osupuko had a wildlife density of 3.64 individuals per $km^2$ and contained four of the twenty-two overall observed wildlife species. The sanctuary is composed of only two habitat types:  bushland and shrubland (Fig 11). There was also a high prevalence of agricultural areas within Osupuko, which were avoided by wildlife entirely.

Shrubland was preferred (Fig 12) by the Thompson's gazelle (+1), and was calculated as a neutral habitat for the Grant's gazelle (–0.25) – the only two grazers within the sanctuary.

*Kimana*

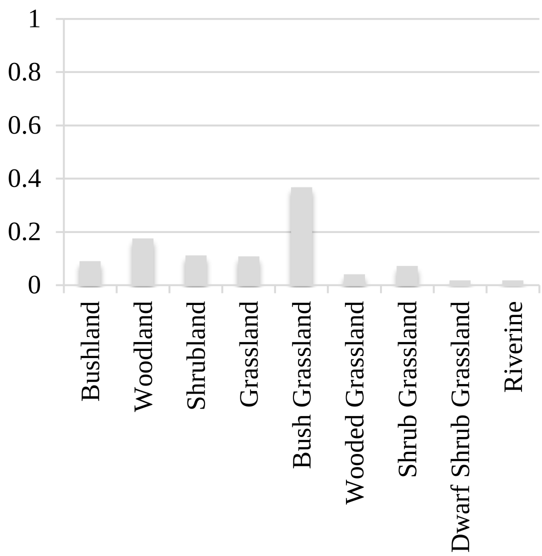


**Fig 13** Habitat proportion in Kimana

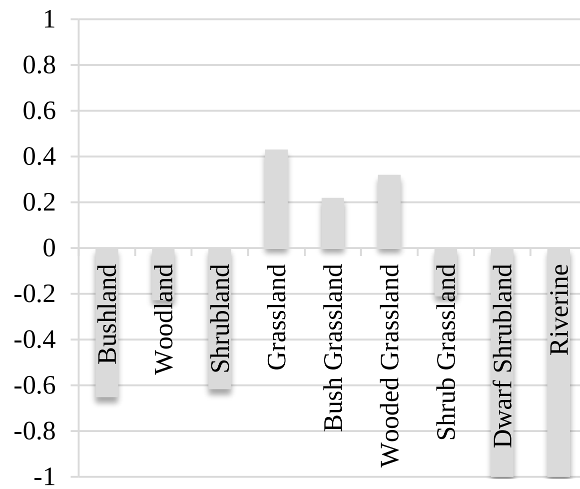


**Fig 14** Jacob's Index for habitat preference in Kimana

During the dry season of 2012, Kimana had a wildlife density of 47.02 individuals per km$^2$ and contained fifteen of the twenty-two overall observed wildlife species. Kimana had the greatest diversity of habitat types. The most common was bush grassland (37%); the eight additional habitats individually fell below 20% of the sanctuary (Fig 13). Woodland, shrubland, bush grassland, dwarf shrubland, and riverine were avoided or considered impartial/neutral – meaning the habitat types fell between –0.5 and +0.5, thus neither preferred nor avoided – by grazers (Fig 14). Bushland was preferred by the Common reedbuck (+1), grassland by the Common waterbuck (+0.82), and wooded grassland by the Maasai giraffe (+0.88) and Grant's gazelles (+0.79). None of the other grazers had any strong preferences (≥ +0.75), but the African elephant came close with a preference for bush grassland (+0.72).

*Motikanju*

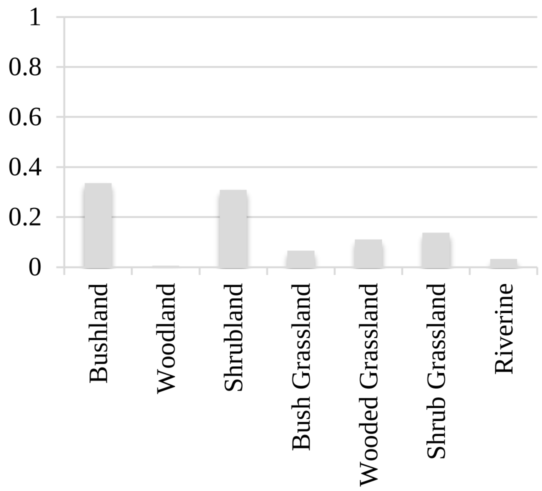


**Fig 15** Habitat proportion in Motikanju

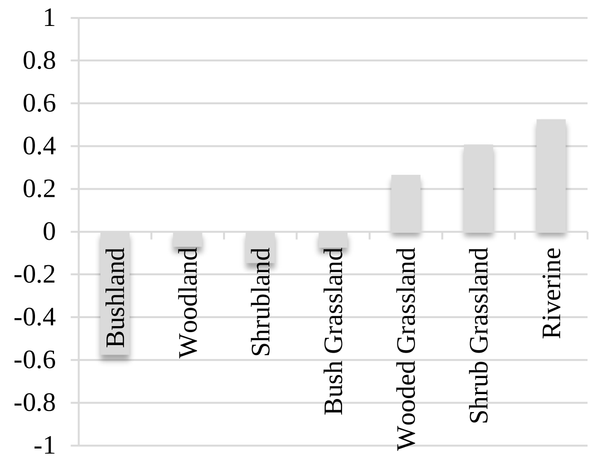


**Fig 16** Jacob's Index for habitat preference in Motikanju

Motikanju is composed primarily of bushland (34%) and shrubland (31%) (Fig 15), yet wooded grassland, shrub grassland, and riverine habitats had the highest preference by wildlife (Fig 16). Woodland was avoided completely by every grazer. Bushland was highly preferred by the Lesser kudu (+1), shrubland by the Common reedbuck (+1), and shrub grassland by the Thomson's gazelle (+1). Wooded grassland was used by Maasai giraffe (+0.62) and Grant's gazelle (+0.51) and shrub grassland by the Burchell's zebra (+0.51), Grant's gazelle (+0.60), and Kirk's dik-dik (+0.61). Riverine habitat was utilized by the Burchell's zebra (+0.66) and Maasai giraffe (+0.73).

## Discussion

<u>The Corridor Undivided</u>

The fact that data were collected in only one month of the dry season (April 2012) limits inference about general corridor viability. But nonetheless it allows for many useful observations. And comparing this study data to previous research enriches the analysis.

The community wildlife sanctuaries' collective ability to act as a corridor is additionally assessed in this research. Proximity to Amboseli National Park did not play as large a role as was expected. Kilitome was the community wildlife sanctuary closest to the reserve, and while it had the second highest animal density (20.91/$km^2$; 9 species) it was Kimana that had the greatest number of species (15) and highest density (47.02/$km^2$). The fact that Kimana is the fifth farthest sanctuary from the reserve, suggests that the corridor is successful in providing animals a useable trail away from Amboseli.

The size of sanctuary did not appear to predict wildlife density. Elerai-Rupet is the largest of the six sanctuaries, and yet it had the second fewest species present (8) and very low densities (3.22/$km^2$). Nailepo, which is less than half the size of Elerai-Rupet had more species present, six of which were large grazers. Insofar as width, all six community wildlife sanctuaries ought to be used by all of Amboseli's mammal species based on their home ranges and the sanctuary widths. Elerai-Rupet has the widest distance across (7.875 km) and Osupuko has the smallest (2.875 km). The total average estimated width of the corridor was found to be 4.68 km. In Osupuko, the widths at the southernmost and northernmost ends of the sanctuary bottleneck to approximately 0.75 km at the bottom and essentially 0 km at the top. This bottleneck may also limit large populations of animals from migrating due to the lack of habitat needed to assist their movement. Moreover, because human settlements surround the community wildlife sanctuaries, light, noise, air, water pollution, poaching, and human wildlife conflicts may occur in greater instances around the edges of the sanctuaries with slim widths and higher edge to interior ratios (Bennett, 2003). The bottom portion of Osupuko is thus not conducive to many of the focal species. Potentially, both of these areas of Osupuko are currently unsuitable for the majority of corridor dwellers and have greater adverse effects for migratory species. Osupuko is used by both the Grant's gazelle and Thompson's gazelle, but as species with larger homeranges they are most likely just quickly passing through.

Of the six community wildlife sanctuaries analyzed for habitat heterogeneity, Kimana, Kilitome, and Motikanju had the most even distribution of habitats and the highest number of habitats. The fact that these three community wildlife sanctuaries had the highest observed density of wildlife (Kimana with the most, followed by Motikanju, then Kilitome) appears to corroborate Cromsigt *et al.*'s (2009) hypothesis that a diverse mosaic of habitat patches is important for sustaining wildlife populations, particularly for grazer species in savanna systems (Cromsigt *et al.*, 2009). The fact that the wildlife density was higher in the sanctuary fifth most distant from the Park was unexpected, however its habitat heterogeneity is a strong indicator of wildlife presence, and Kimana had the most varied landscape.

Habitat quality appeared to be less influential in where animals were found than habitat heterogeneity. Elerai-Rupet had the lowest (i.e. best) overall habitat score; Motikanju and then Nailepo had the highest or most exhausted overall habitat score. Paradoxically, Motikanju had the second highest species richness, thus habitat heterogeneity proved more influential that habitat quality. The only positive correlation found was between the overall observed vegetative health and the overall density of wildlife found in the habitats in Kimana. It has been suggested that diversity of habitat use, like in Kimana, is indeed related to habitat resource quality, especially for ruminant grazers (Cromsigt *et al.*, 2009). Therefore, sanctuaries with an overall higher degradation of habitats were expected to have lower densities of wildlife; however, the results did not support this assumption. This inconclusive result may be due to limited timeframe of study and the fact that wildlife habitat use may vary temporally, even for similar habitats (Tews, 2004). Water availability and predation can also influence herbivore distribution on a landscape. For example, lions are presumed to focus on areas in which there is a high chance of catching prey rather than areas of high prey abundance, therefore, herbivores will often avoid dense-cover habitats even though they may be suitable otherwise (Cromsigt *et al.*, 2009). Other factors include the animals studied, measurement procedure of vegetation structure, and the temporal and spatial scale of the study (Tews, 2004). These dynamics may have influenced animal distribution on degraded habitats, causing more animals to be seen in poorer habitats. As a note, this study was conducted at the end of the dry season and the overall quality of the corridor was especially poor as a result. The results concerning the relationship between livestock and wildlife densities and habitat conditions are inconclusive.

*Comparing 2012 Wildlife Data to Previous Studies in the Corridor*

Professor Shem Mwasi and the students from previous years at the School for Field Studies – Kilimanjaro Bush Camp, have systematically measured wildlife in the same area with same methods, but cross-year comparisons are constrained by the fact that data was not collected every year in both the dry and wet season.

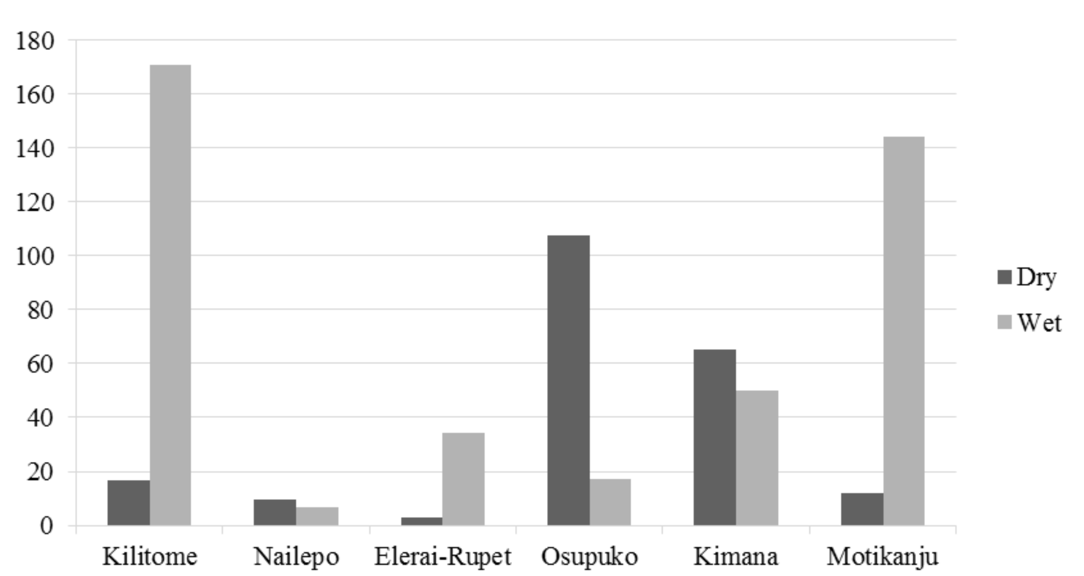


**Fig 18** Compiled wildlife density data from 2010, 2011, and 2012 mean densities in wet and dry season in each wildlife sanctuary. The sanctuaries arrayed from left to right according to proximity to reserve (Kilitome is adjacent).

Using a t-test, there has been seasonal variation of wildlife densities among the sanctuaries

($t$ = –2.196, $p$ = 0.05). There are higher mean wildlife densities in the dry (5.81) versus the wet (158.73) seasons among the sanctuaries (Fig 18). A one-way ANOVA revealed no significant difference in the annual variation of wildlife densities among the sanctuaries ($F$ = 3.887, $p$ = 0.035).

*Individual Community Wildlife Sanctuaries Effectiveness – Considered with Multi-Season Data*

The Kilitome sanctuary has the highest density of all the sanctuaries in the dry season and has for the past two years (2010 and 2011). Kilitome borders Amboseli National Park, thus it has a high likelihood of being on the migratory path of wildlife from Amboseli National Park. Its location may contribute to its high dry season density, because it is the last sanctuary the animals would encounter upon returning to Amboseli National Park. However, in the wet season it has a high prevalence of livestock use, which may discourage the wildlife from utilizing the sanctuary then – which is typically when wildlife leave park confines (Okello 2010). If livestock are using resources within the sanctuary boundary during the wet season, wildlife may be finding more adequate food and cover reserves in the park or in the other wildlife sanctuaries. Okello (2010) found that wildlife kept the greatest distance from cattle, compared to other livestock possibly because cattle compete with bulk grazers for forage. Eight herbivorous grazers and the Maasai giraffe were all observed within the sanctuary. The most preferred habitats by these grazers in increasing order are:  bush grassland, dwarf shrub grassland, and shrubland, which made up less than 17% of the total sanctuary. Consequently, wild grazers are concentrated in these three habitat types, which could lead to resource competition. Competition for forage resources between two species is unavoidable if (1) their habitats overlap, (2) their diets overlap, and (3) their resources are limited (Sitters, 2008). Livestock can displace wildlife through competitive exclusion (Okello, 2010). At the time this research was conducted there was little preferred habitat available by the grazers, so the wild grazers may refuse to enter the sanctuary if the proliferation of grazing pressure continues.

Nailepo had the highest (most damaged) overall score for vegetative health. The habitats seemed divided amongst the species present. Several factors interact to have an influence on habitat selection for an individual such as competition, cover, and predation (Krauman, 1999). The Burchell's zebra had exclusive use of the bush grassland habitat, and it had a very high preference for the habitat as well, in this way Nailepo is a good fit for this grazer species. The Grant's gazelle and Thomson's gazelle are commonly found together in species associations, this proved true in Nailepo where both species were found in bushland. The other grazer present in the sanctuary was the gerenuk that occupied shrubland. The distribution of grazers in dissimilar habitats means there was little likelihood for resource competition. In this sense the animals will most likely enter the Nailepo habitats and with the high available resources in their preferred habitats they will have a suitable experience through the sanctuary. It was observed that Nailepo is closely surrounded by human settlement, not 100 meters from the sanctuary boundary there were a number of *bomas* or Maasai homes. These human settlements do not seem to strongly effect on the wildlife yet, but human presence, children playing noisily and even smoke emission from cooking also displaces wildlife according to Okello (2009). Human presence is threatening to wildlife because the density of *bomas* will inevitably increase with the increasing human population further displacing wildlife.

Elerai-Rupet, despite being 40% bigger than the second largest sanctuary (Motikanju), had a low total animal abundance across the seasons sampled. Some of this may be attributed to the presence of the twenty-nine African elephants observed during the transects within the sanctuary boundaries. Elephants put more pressure on grazing resources due to their excessive size and accordingly excessive eating habits. However, elephants also facilitate grazers by modifying woodland to grasslands, so their presence may someday encourage the presence of these animals (Mwasi, 2012). Elephants require the largest home range of all observed species; therefore the size of Elerai-Rupet serves as a needed corridor for this keystone species. Another reason for the low abundance may be the location of Elerai-Rupet. It is the southernmost sanctuary in the corridor. Although it is positioned less than ten kilometers from the southeastern tip of Amboseli it may not be on a habitual migration route. The establishment of corridors in areas that have not been traditionally used by a species may lead to a less effective corridor (Newmark, 1993). There are no sanctuaries adjacent to Elerai-Rupet therefore the animal has a higher probability of encountering areas of human presence, and many species are reluctant to use dispersal areas that have been altered by human settlement – making such areas undesirable for wildlife (Okello, 2010).

A minimum of five herbivorous grazing species were present in every sanctuary excluding Osupuko, in which only the Grant's gazelle and Thomson's gazelle were present.  This lower prevalence of grazers may be associated with the presence of agriculture within the sanctuary. According to wildlife density data in 2010 and 2011, Osupuko has had higher wildlife densities in the dry season, however during the dry season of 2012 it had experienced a significant decline in wildlife density. In the dry season of 2011, Osupuko had a wildlife density of 51.8 and in the following year's dry season the density had fallen to 3.6. The reduction in wildlife density between the 2011 dry season and the 2012 dry season may be attributed to the increasing agricultural landscape within the sanctuary. The sanctuary was once a wholly protected area, but over the years local agriculturalists forwent the principle of a sanctuary unblemished by cultivation. The animals are thus confined to bushland and shrubland. Wildlife-related losses to agriculture can rise to 35-45% of total production costs in wildlife areas (Emerton, 1998). As such, agriculture often displaces wildlife through increased human-wildlife conflict: farmers spear, poison, or snare wildlife in retaliation for crop damage (Okello, 2010). Grazers like the eland, Greater kudu, and Lesser kudu are sensitive to human presence (Newmark, 1993), so without an adequate buffer to the human presence these species are not likely to inhabit this sanctuary. Grant's gazelle and Thomson's gazelle are less avoidant of human presence, hence their appearance in the sanctuary.

Kimana experiences the highest wildlife density of all the sanctuaries. For the past two years (2010 and 2011) Kimana has had higher wildlife densities in the wet season. It serves as a temporary home for eight grazing species including the African elephant. Grassland, wooded grassland, and bush grassland are the preferred habitats, in descending order, by wild grazers. These habitats compose just over half the sanctuaries landscape. These habitats received scores between 4.97-5.25 for vegetative health – note that the study occurred at the end of the 2012 dry season and it is probable that vegetative cover will rejuvenate with the rains, if this stands true the score would be brought down accordingly. As a community wildlife sanctuary, Kimana provides adequate habitat availability and quality for migrating wildlife despite its 22.9 $km^2$ dimensions.

Motikanju has a heterogeneous habitat mosaic, consisting of seven of the ten overall habitat types. Maintaining habitat diversity is important because of the different requirements species have and the more habitats provide a greater number of niches (Okello, 2010). In spite of the high habitat diversity only one habitat type, riverine, was majorly preferred; it also made up only 3% of the total sanctuary. The Burchell's zebra, Grant's gazelle, and Maasai giraffe – all focal herbivorous species, used the riverine habitat. Bushland and shrubland were the two highest habitat proportions at 33% and 31%, but were avoided or considered by impartial by every species within the sanctuary, therefore neither are habitats in which a species would reside for any significant duration. Motikanju may serve as a wildlife corridor for passage species, but is not suitable for high densities of wildlife for an extended period of time because the available habitat is not the habitat type preferred by wildlife.

Insights from Interviews with Neighboring Residents

The fifty interviews carried out in the communities surrounding Osupuko, Kimana, and Motikanju sanctuaries provided some insights (below), but it seemed that most respondents were reluctant or disinterested in talking about people-wildlife interactions. The fact that I was only onsite for three weeks likely hindered quality of engagement as did the fact that I was asking somewhat sensitive questions. Finally, there may be some interview exhaustion because they have been repeatedly interviewed by School for Field Studies students.

Agriculture is the dominant land use practice evident on the landscape. It was observed that on both sides of the main road the land was used mainly for *shambas* or farms with some space cleared for houses. All of the farmers interviewed grew both onions and tomatoes, which are the staple crops of the region and are used as a cash crop. The onions and tomatoes are grown, harvested, and sold to the Nairobi region for profit. Other crops such as maize and French beans are also grown, but less frequently.

The farmers interviewed had been farming in the Kimana area from two months to ten years (the average was about three years). Those interviewed were Maasai (five interviewed with an average of five years spent farming) or Kamba (forty-five interviewed with an average of 3 years farming time), a tribe leasing farmland from the Maasai. When asked what the human-wildlife conflicts they had personally experienced or knew of were, most responded that trampling and eating crops were the main problems. The wildlife species they most often blamed for destruction are elephant, hippopotamus, buffalo, zebra, and gazelle. Birds, the farmers mentioned, are also a problem because they occasionally peck at ripe tomatoes, which then cannot be sold. The farmers also explained that occasionally the animals – usually elephant and buffalo – kill or injure people. The elephants are generally the most feared because of potential danger to people and because of their ability to damage entire fields in very small numbers. The animals, I was told, cause the most damage in the dry season when they leave the parks in search of water, which is contradictory to what researchers have noted. It is commonly understood that the animals exit the park in the wet season in search of resources (Okello, 2005). The farmers mentioned, however, that there have been fewer incidents in the past few years. During the dry season the farmers estimated they may lose anywhere from 20-60% of their profits due to crop destruction by wildlife. One farmer from outside Kimana community wildlife sanctuary estimated that he lost the equivalent of 80,000 Kenyan shillings (roughly $940 USD) after a hectare of onions was destroyed by elephants.

The farmers explained that they are rarely compensated for damaged crops even when it is significant. The Kenyan Wildlife Service, they said, is supposed to pay for damaged crops, however after filing many complaints the farmers have not seen any payouts (compensation is part of the KWS strategic plan in the KWS 2008-2012 Executive Report). Two farmers interviewed who were fairly new to the area – two months and two years, respectively – had not experienced any human-wildlife conflicts and are under the impression that compensation is a reality. However, the consensus of the other farmers was that complaints are filed and then often ignored. They explained, however, that in the instance of human death or injury 80,000 Kenyan shillings compensation is (roughly $940 USD) paid to the families. This is insufficient in the eyes of many farmers (KWS Executive Report, 2008). KWS will come to retrieve animals found in the *shambas* if reported, however without paying compensation the KWS seems to play no other role. Other than KWS there is no apparent organization involved in conflict resolution. As a note, organizations like Lion Guardians are in the surrounding area, but are not currently present or at least known by the local people in the Kimana Group Ranch, where the studied corridor is located.

The farmers often take wildlife control methods into their own hands by use of fire and loud noises. They all stated that at night flames are used to scare away the animals and in the case that this is not enough they make loud noises or gather up their neighbors to shout at the animals until they go away. Most farmers said these methods are effective. When asked if they believed there is a better solution to prevent animals from coming onto their fields they mentioned the use of an electric fence. The electric fence that was once in place between Kimana Group Ranch and Amboseli National Park is no longer in use.

Ten of the 45 farmers interviewed believed that there is no future for humans and wildlife to coexist peacefully. These individuals feel that wildlife is causing a great deal of harm to their livelihoods and see little benefit of the wildlife. On the other hand the majority of farmers, some essentially next-door neighbors of those who do not see a future, say they see value in preserving Kenya’s wildlife. They realize that the wildlife brings tourists and money into the country, thus it needs to be protected in order to continue generating tourism revenue. The farmers explained that wildlife benefits them because the profits of tourism goes to the government, which pays for public services like schools, hospitals, and roads.

**Conclusions and Recommendations**

The six community wildlife sanctuaries have been found to act effectively as a wildlife corridor for twenty-two observed species in the dry season of 2012. The connectedness of the sanctuaries has been found beneficial to wildlife; however, the ability of disconnected sanctuaries to harbor wildlife is not hindered by the fact that they are separated. However, a weak linkage exists at the northernmost and southernmost ends of Osupuko, which may inhibit the species use of this segment of the corridor. To reduce the possible negative effects experienced by the insufficient width in Osupuko, a connecting portion on the eastern side of Nailepo could be considered, if human settlement does not conflict. Furthermore, a wider connection between Osupuko and Kimana should be established to facilitate secure migration for larger mammals. However, a paved road between these two sanctuaries at this point may impede the growth of either sanctuary. In this case, an underpass may be employed to facilitate the passing of wildlife and reduce the risk of death. Maintaining or planting native roadside vegetation may also be necessary in order to reduce the negative effects of roads as a barrier to wildlife migration (Bennett, 2003). Width determination for the establishment of new corridors in the Amboseli ecosystem should reflect home ranges of target species, leaving space to alleviate edge effect.

The correlation observed between habitat heterogeneity and wildlife density suggests that habitat diversity is important for the sustenance of wildlife populations, especially in corridors or small reserves. In order to improve the community wildlife sanctuaries so as to increase the capability of the area to sustain wildlife, it is recommended that management practices of current community wildlife sanctuaries encourage the preservation of multiple microhabitats to facilitate patchiness. Future sanctuary establishment should consider encompassing a high number of habitats.

Habitat quality is perhaps an area of greater concern. The upkeep of vegetative quality is suggested in order to facilitate the nourishment of wildlife populations. Previous studies have found that habitat resource quality is related positively to higher densities of wildlife, yet in this study the relationship proved inconclusive. This may include the manual removal of invasive species in areas of high concentration or replenishing plant biomass to reduce erosion by planting native species. It may also consist of stricter regulation for livestock grazing. In further research, causes of vegetation damage should be considered so that mitigation of damage can proceed and closer attention to livestock and wildlife interactions. A more comprehensive and detailed assessment of vegetation damage observed in the field should also be considered because the scoring system used in this study was possibly too vague for the desired purposes. Multiple days of observation in each sanctuary would also provide more precise data, specifically on wildlife densities. More insularized sanctuaries within the Amboseli ecosystem could also be analyzed in the future if resources are permitting, to assess the effects of insularization.

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**Appendix I**

Interview Questions

1. Name and ethnicity.
2. How long have you lived in the region?
3. Do you own the land you are working on (if not, what is the arrangement)?
4. What economic (livelihood strategies) activities do you carry out?
5. What types of crops do you grow? Subsistence or cash crop?
6. Do you have conflict with wildlife, such as with crop, livestock, or property damage?
7. What animals are involved? Rank them in order of their level of destruction.
8. Has the composition of problem animals altered over the years?
9. In your estimation, where do the animals come from?
10. Which crops are frequently affected?
11. Approximately what was your total cost of damage?
12. What has been the trend (conflict) in the last 3-4 years?
13. Describe the season/month(s) of these attacks?
14. Other than the financial implication, are there any other socio-cultural implications to these interactions?
15. What local methods have you used to prevent damage to your crops?
16. Does KWS do anything the help resolve these conflicts?
17. Are there other groups/institutions that help to resolve these conflicts?
18. Have you received (currently or in the past) any direct benefit from wildlife? If yes, what?
19. What is your attitude towards wildlife?
20. How do you think the problem of human-wildlife conflict can be resolved in your area? What is your role? The government's role? Other institutions/organizations?
21. What is the future of wildlife in your area?