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Tracking the Elephant (*Lexodonta africana*) Corridor and the Human-Wildlife Conflict in Selela Village

Nicole Chlebek
Illinois Wesleyan University, SIT Study Abroad, nchlebek@iwu.edu

Laura Stalter
University of Vermont, SIT Study Abroad, laura.stalter@uvm.edu

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ABSTRACT

The beastly journey of long-distance migration for the African Elephant (*Lexodonta Africana)* is important for upholding their connections between diminishing protected areas, especially in northeastern Tanzania. However, human development is encroaching into these corridors, creating a human-elephant conflict, which can ruin livelihoods of villagers, depending on the extent of conflict. This study focused on exploring the hypothesized human-elephant conflict on the Selela corridor, specifically in Selela village, as well as GPS (Global Positioning System) mapping evidence of elephant travel along the projected Selela elephant corridor connecting Ngorongoro Conservation Area (NCA), to Selela Forest Reserve (SFR), and finally to Manyara Ranch. 61 interviews were conducted in the Selela village that consists of about 7,000 Maasai and Wambulu people. The village is adjacent to the SFR, which backs up to the Rift Valley Escarpment. Opportunistic interviews were conducted along the corridor with pastoralists, agriculturalists, Askari gaurds, and one key-informant interview. Furthermore, the corridor was physically mapped by using Global Positioning System to mark each piece of evidence (dung, tracks, browsing, scratching, and wallowing). We found that, after compiling interviews and GPS waypoints of elephant evidence, we can conclude the Selela elephant corridor is currently used for migration during the rainy season. We support our hypothesis that elephants currently travel during the rainy season from NCA to SFR and from Manyara Ranch to Losimangori Mountains (LM), and possibly from LM to SFR, but there was not enough elephant evidence to confirm that area is still connected to the SFR. There is a large human-elephant conflict in Selela village, where elephants often kill humans and destroy farmland. Elephants might travel to the SFR in order to escape dangerous ants in NCA, to eat crops, and for the high phosphorous levels in the forest for lactating females. We hope that this study can be used to help conserve this vital elephant corridor and assist in resolving the human-elephant conflict in Selela village in the wake of increasing human development.

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INTRODUCTION

One of the world's wonderful natural phenomenon is large mammal migration. Migration can be defined as the movement of wildlife during a specific season away from their original habitat and eventual return. Long-distance migration may be defined as an event in which a species travels over 10-12 one-way kilometers (Fuller & Keith, 1981; Sandgren & Sweanor, 1998). Wildlife usually use a routine pathway during migration (Viljoen, 1989), otherwise known as a corridor. A wildlife corridor is usually defined as a path that is taken to and from "islands", or patches of suitable habitat (Hilty et al., 2006). Corridors can connect different populations of a species. The interbreeding of these populations is essential for genetic variation (Keyghobadi et al., 2005), sustainable populations (Brown and Kodric-Brown, 1977; Hanski, 1998), and has other important ecological implications including interactions with other species (Soulé et al., 2003).

When a corridor exists near an area of development, human-wildlife conflicts arise, affecting millions of people across corridors around the world (Madden, 2004). Almost 13% of the earth's surface is part of the global network of wildlife protected areas, which has safeguarded many large and threatened mammals (World Database on Protected Areas, 2012). However, several of these mammals do not permanently remain in these protected areas, and therefore cause conflicts when they come into contact with humans, particularly in areas throughout the developing world (Inskip and Zimmermann, 2009; Woodroffe et al., 2005). The human-wildlife conflict occurs "when the needs and behavior of wildlife impact negatively on the goals of humans or when the goals of humans negatively impact the needs of wildlife" (Madden, 2004, p. 248). Large mammals tend to cause the most severe conflict with humans (Inskip and Zimmermann, 2009; Liu et al., 2011; Marchini and Macdonald, 2012). These conflicts include farm and livestock destruction, and injury or death (Lamarque et al., 2009). These can be considered 'visible impacts'—immediate, direct conflicts that an animal causes to a human. They can also cause 'hidden impacts', which are indirect effects that the conflicts have on people, usually of low socioeconomic status, and are often temporarily delayed. These hidden impacts include a weakened state of psycho-social wellbeing, the loss of opportunity, poor nutrition and health, and costs to request compensation (Barua et al., 2013).

African elephants (*Lexodonta africana*) are one of the greatest threats of the human-wildlife conflict, especially in Africa. They are identified as one of the biggest concerns to farmers due to crop raids (Parker et al., 2007). Consequentially, up to 10-15% of the total agricultural output may be lost in African communities due to elephants (Lamarque et al., 2009; Madhusudan and Sankaran, 2010). Crops raids, disturbance to people, infrastructural damage, and injury or death are all part of the human-elephant conflict. In Tanzania, most of these conflicts occur between the corridor boundaries and places of human development and residence (Galanti, 1997). Although elephants are important for tourism and ecosystem services (Caro et al., 2009), most of the time the people residing along corridors don't receive any of its benefits (Jones, 2012).

Additionally, humans also affect the African Elephant significantly. The massive journey of long-distance migration has been cut short for this species (Waithaka, 1994). Tanzania holds the second largest elephant population in all of Africa (Tanzania Elephant Management Plan 2010-2015). African Elephants have a vulnerable status, meaning that they are "considered to be facing a high risk of extinction in the wild" (IUCN Red List, 2008). The elephants' range once covered 49% of the country's surface area, but has decreased to an estimated 39% between 1998 and 2009. However, in 2009, the national census estimated the total abundance of elephants in Tanzania was 109,051 individuals, which increased since the late 1980s population of 55,000 individuals. This was likely due in part to anti-poaching actions (Tanzania Elephant Management Plan 2010-2015).

While Tanzania's wildlife protected area's network encompasses about 36% of its total land area, with 4.38% as National Parks, 0.88% as Ngorongoro Conservation Area, 12.98% as Game Reserves and 5.54% as Game Controlled Areas, and another 12% of the total surface area protected as Forest Reserves (MNRT, 2007), very few of these protected areas are 'closed systems'. This means that elephants regularly travel outside of these areas in search, food, water (Tanzania Elephant Management Plan 2010-2015), and nutrients. Specifically, they often travel in search for calcium and phosphorus from mineral deposits in the soil, which are essential for the health of lactating females (McNaughton, 1990; Galanti, 1997).

There are 31 corridors in Tanzania that elephants use to find these resources (Jones 2012), and according to an assessment by Caro et. al in 2009, most of them are estimated to

disappear in less than five years. Because of increased development, such as agricultural practices, the building of roads, local immigration, and population growth, corridors are becoming unusable to the wildlife that need them for migration (Caro et al., 2009; Jones, 2012). As human development is encroaching on the boarders of protected areas in northern Tanzania, corridors are becoming increasingly important for the connectivity of these wildlife habitats. The removal of these corridors changes elephant behavior and ecology and is expected to reduce several of Tanzania's elephant populations to an unfeasible state (Tanzania Elephant Management Plan 2010-2015).

One important known corridor is the Selela corridor between Ngorongoro Conservation Area and Lake Manyara National Park (Mangewa, 2007). It is considered a "land connection plus movements" corridor, which is a semi-continuous land between two protected areas (Caro et al., 2009). It was 'confirmed active' in 2009 (Tanzania Elephant Management Plan). The section that leads from NCA to the Selela Forest Reserve (SFR) was declared an NCA nature reserve in 1978 in order to maintain the wildlife migration corridor (Mangewa, 2007). The land surrounding these protected areas is quickly being converted to agriculture, leaving a few isolated habitats and little in between for connectivity (Newmark, 1996; Lama, 1998). It is considered in critical condition and is one of the corridors that was projected to have been taken over by human development by 2014 (Caro et al., 2009; Mangewa, 2007).

In this study, we will map the elephant pathways through and look at the conflicts with the Maasai and Iraki people living in Selela village in Tanzania. We hypothesize that there is a human-elephant conflict in Selela village, and that the corridor leading from Manyara Ranch to Selela and Ngorongoro Conservation Area to Selela is still being used by elephants during the rainy season. The question flow we will use within our interviews is stated as follows: Do the people living in Selela village have conflicts with wildlife? If so, with which animals and what do they have the most conflict with? What is that conflict specifically? What do the villagers do to deal with the conflict? If there is an elephant conflict, where are they coming from and going to? Why are they travelling through this area? How many elephants and what is their family dynamics, including age and sex? Does the population of elephants travelling through the area seem to be increasing, decreasing, or staying constant? What time of year do

they travel through the corridor? And, do the villagers of Selela have suggested solutions to the conflict with elephants?

STUDY AREA

Maasai Steppe of Northern Tanzania

The Maasai Steppe of Northern Tanzania encompasses Lake Manyara National Park, Tarangire National Park (TNP), Ngorongoro Conservation Area (NCA), and six districts that include the Monduli and Simanjiro Districts. It is on the eastern rim of the Rift Valley Escarpment (Shem, nd). The area is defined by the movements of wildlife that extends through the Steppe to Kenya, including the elephant corridor. It lies between 3° 40' and 4° 35' South Latitude and 35° 50' and 36° 20' East Longitude (Lamprey, 1964). The Maasai Steppe encompasses a vast area estimated variously at between 20,000 and 35,000 square km (Borner, 1985; Prins, 1987). Lake Manyara is recognized internationally as a Biosphere Reserve. Tarangire and Manyara National Parks are acknowledged as keystone components of Tanzania's tourism industry. Tarangire and Manyara are two of the highest grossing of Tanzania's 12 national parks in terms of revenue generated and visitor numbers (Shem).

This area is mostly a tree savannah and arid land with Accacia and Commiphora (Ludwig, 2001; Shem, nd). 75% of the area is flatland, 22% is rolling, and 3% is hilly (Shem). The rainfall is bi-modal with short rains occurring between November to December, followed by a dry period, and then by a longer rainy season from March to May (Shem, nd). Rain averages to about 650mm per annum, but can vary widely (TANAPA, 2001). The Rift Valley seems to influence the increased rainfall in nearby areas. The mean maximum temperature is 27˚C and minimum temperature is 16˚C. The extreme minimum is 4˚C in July and the highest maximum is 40˚C in January. Humidity in October falls to 35%, showing that there are very dry conditions during that time (OIKOS, 2002b; Shem, nd).

Ngorongoro Conservation Area to Selela Forest Reserve

The Lositete village resides on the edge of the Upper Kitete highland forest and is protected by the Ngorongoro Conservation Society. This village consists of Wambulu and Waarusha tribes. These people are mostly agriculturalists, with few pastoralists.

Losimangori Mountains

There is a Laiboni Maasai village that lies on the edge of the Losimangori Mountains. The Maasai village consists of around 90 people. They are mostly pastoralists. The Losimangori Mountain area holds a boy's secondary school and is controlled by a Tanzanian army base.

Selela Village

Selela village is 3° 10'-3° 20' S and 35° 50'-36° 00' E, which is about 40km from Arusha, Tanzania. The forest's vegetation is mostly lowland and montane forest strata, or a broadleaf groundwater forest (ICCA, nd; Kajembe, 2005). The forest is 1190 hectares (ICCA, nd). Its biodiversity consists of large mammals, including elephant, buffalo, and leopard (ICCA, nd). We also observed several monkeys, such as blue monkey and baboon, and a fairly large population of hornbills.

Selela is a Village Land Forest Reserve, declared in the Forest Policy and Statutory changes of 1998 and 2002, respectively. Under the decentralization of forest management from the Participatory Forest Management program, Selela has a Community Based Forest Management approach. This means that Selela forest is managed by the entire community (Kajembe, 2005). The forest is a surveyed village land (Village Land Act No. 5, 1999). The full responsibility of the forest is placed on the villagers and elected officials (Blomley et al., 2007). They are exempted from tree harvesting regulations and do not have to share payments with any local or central government (Blomley et al., 2007).

The total population in the villages adjacent to Selela Forest Reserve (SFR) is 7,315 with a total of 984 households (URT, 2003). Its residents consist mostly the Maasai and Wambulu tribes. A majority of the economy comes from agriculture and pastoralism of cattle, goat, and sheep (ICCA, nd; Kajembe, 2005). The majority of families living in Selela own and cultivate their own small farm plots adjacent to the SFR ranging from banana, rice, maze, lettuce greens, and tomatoes. Villagers mostly extract water for drinking and farm irrigation, and timber for firewood and development from the forest (ICCA, nd; Kajembe, 2005).

The village is becoming increasingly more developed, with a few more-permanent building structures and will gain electricity by June 2015 (Leboy pers. comm., 2015). Its population is growing rapidly, as indicated by the Tanzania National Bureau of Statistics within

the past 15 years (NBS, 2003). Tourism is also entering the village economy, where the Cultural Tourism Program based in Mto Wa Mbu has recently begun taking tourists up the escarpment wall through the recently discovered elephant corridor (Wesley, pers. comm., 2015). There is one unpaved road that leads out of Selela and connects to route B-114. Selela households earn a monthly income of the equivalent to 61.4 US dollars (Kajembe, 2005).

We chose Selela village because of its unique intersect with the elephant migration corridor that leads through the forest adjacent to it. The wildlife conflict is important to understand as the development of Selela will continue to expand into important wildlife habitats, especially Selela Forest Reserve.

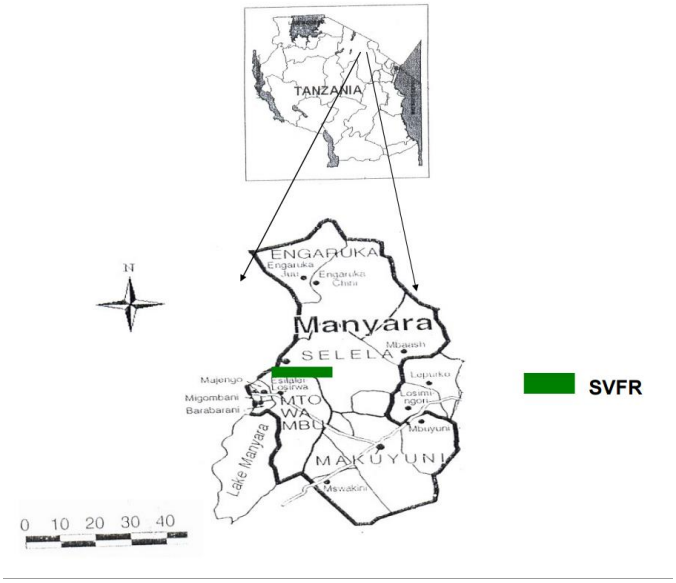

Figure 1. Map of the Maasai Steppe of Northern Tanzania. Selela Forest Reserve resides to the Southwest of Selela.

Figure 2. Map of study area, including Selela village where interviews were conducted. Corridor mapping took place in the adjacent forest of Selela, as well as in and around the Ngorongoro Conservation Area and the Losimangori Mountains.

METHODS

The Human-Elephant Conflict

In order to test our hypothesis that elephants travel through the Selela corridor and create conflicts with the people living along the elephants projected path, we interviewed a sampling frame that consisted of people who resided along the projected corridor. We first interviewed 61 Maasai and Wambulu villagers living in Selela. We interviewed 31 Mama's and 30 Baba's in the village, who were fathers and mothers that had property and/or farmland in Selela. We choose to select interviewees in this manner because people who are often in charge of a family and property either do not know their age or vary greatly in age from under 16 to 70 years. We conducted our interviews in Selela by using 2 translators, one who translated directly from English to Kiswahili, and English to Kimaa with villagers who could not speak Kiswahili, as well as one who translated directly from English to Kiswahili with villagers who were able to speak Swahili, or Kiwambulu if villagers preferred that language. Our sampling was opportunistic, where we individually interviewed anyone that we came by and who was willing to talk in the village. We spent 5 days performing interviews. Each interview began by stating that we were students with the School for International Training and that we were there to study the human-wildlife conflict in Selela. Then, the interviewee had the opportunity to accept or decline the interview. No compensation was given. The questions we asked started off by first addressing whether there is a general wildlife conflict and which animals they thought cause the most disruption to the village. From there, we followed with our interview questions (see appendix B).

Furthermore, we had multiple opportunistic interviews conducted outside of Selela village. While following the projected pathway gathered from the interviews in Selela, we interviewed Tanzanians who we came across. In a Laiboni Maasai village on the edge of the Losimangori Mountains, we interviewed a group of 5 Maasai Baba's. In Lositete village on the edge of the Upper Kitete forest protected by the Ngorongoro Conservation Society, we interviewed a group consisting of two Askari guards in charge of protecting the forest and three Baba's. We asked them if they have seen elephants pass through the area, where they

come from and where they go, when they see them, how many they see, and if there is a conflict with elephants in the area.

We also conducted one key-informant interview with the Wesley, the Director of the Cultural Tourism Program in Mto Wa Mbu. From him, we learned of the future development and tourist attraction plans for Selela village and the elephant corridor leading from the village up the Rift Valley Escarpment.

Lastly, we performed opportunistic interviews while walking the corridor. We came across 5 small groups of villagers—2 groups of Maasai leading from SFR to Losimangori Mountains, 2 groups of Wambulu in the Upper Kitete, and one group in the Losimangori Mountains—in which we asked the direction of the corridor, when they have seen elephants, the population dynamic of elephants they have seen, and if they have conflicts with them.

Mapping the Selela Elephant Corridor

By using a Global Positioning System (GPS), we marked the Universal Transverse Mercator (UTM) coordinates of each trace of elephant evidence that we come across. Evidence includes dung, broken branches from browsing or passing by, footprints, and scratching marks on trees. We roughly marked the timeline of the dung by placing them into categories of “new” (1-7 days) and “old” (two weeks or more).

We walked for 6 days to map the corridor that we expected elephants to travel through. Our projection came from a compilation of our 61 interviews in Selela village, the opportunistic interviews while on the corridor, and through our hired guides that walked us through the corridor. The corridor was expected to extend from Ngorongoro Conservation Area, down through the Rift Valley Escarpment, into the forest in between the Rift Valley Escarpment and Selela village, to the Losimangori Mountains, and into Manyara Ranch.

We would travel in one line if the corridor was clearly marked with a pathway with under 10 meters wide, with evidence less than 10 meters apart. When we did not have a direct, clear path with evidence of elephants greater than 10 square meters apart, we spread out with 4 people in a line and 10 meters in between each person and walked in the projected corridor direction. One person held the GPS tracker in the same position on the line, marking each piece of evidence found from each of the 4 people without travelling off their position to the exact location of evidence.

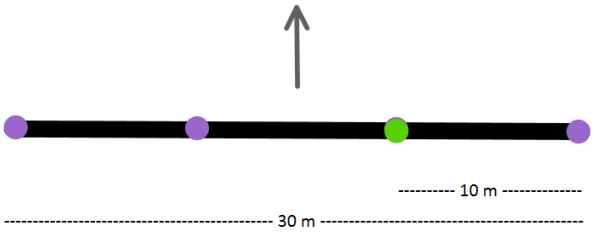

Figure 3. Methodology of mapping the corridor with GPS points when a clear path was not visible. Each dot on the line represents a person, while the green dot represents the GPS point plotter. Direction walked was based off of the projected corridor route. Each piece of evidence was recorded on the line.

CORRIDOR MAPPING RESULTS

Elephant evidence was mapped in three specific sections along the Selela corridor. Based off the interviews, we can connect these sections into a corridor that leads from Ngorongoro Conservation Area (NCA) to the Selela Forest Reserve (SFR) to the Losimangori Mountains to Manyara Ranch Evidence was recorded on April 10, 14, and 19, 2015 starting on April 10 from the Selela Forest Reserve and ending on April 19 at the NCA forest. The entire corridor leading from the SFR was dispersed with old dung. The majority of new dung was concentrated on the Rift Valley Escarpment and near the NCA forest. The elephants travel in a path that doesn't overlap farms, however, the corridor is surrounded by farmland from the north and south. The corridor leading from Manyara Ranch to the Losimangori Mountains was recorded on April 13, 2015. This corridor is more evenly dispersed with old and new dung.

The section of the corridor leading from the SFR to the Losimangori Mountains recorded on April 18, 2015 had evidence which was old and spread apart, and one trace of old dung was found. The recorded data that shows where the corridor is expected to be is based off of the 61 interviews with Selela villagers, opportunistic interviews on the corridor, and our guide, Abubakar Leboy.

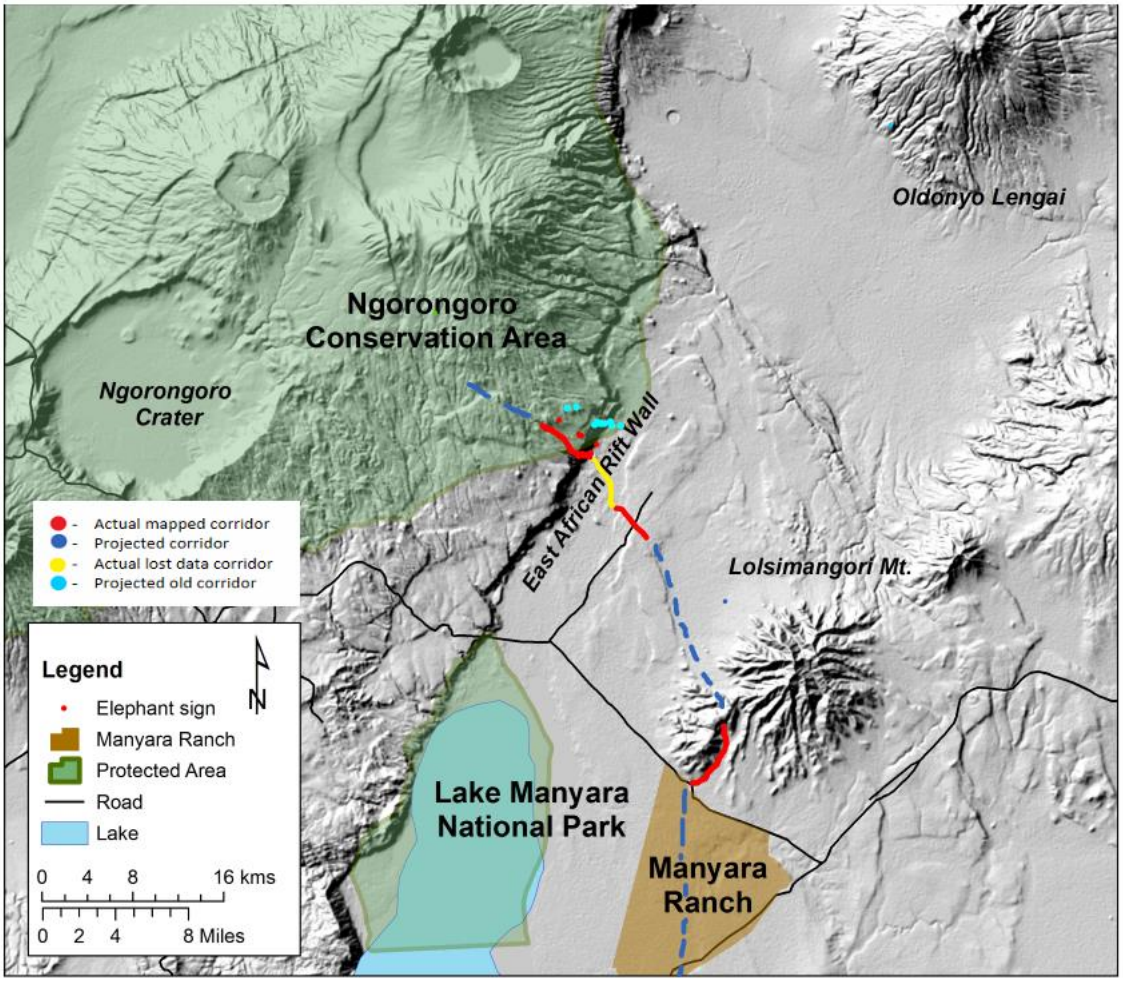

Figure 4. The Selela elephant corridor route leading from Ngorongoro Conservation area to Manyara Ranch. The corridor was compiled with data from actual GPS coordinates of evidence, a projected route from interviews, actual track without GPS points of evidence because of lost data, and the corridor that has not been used in 4 years, based off of interviews.

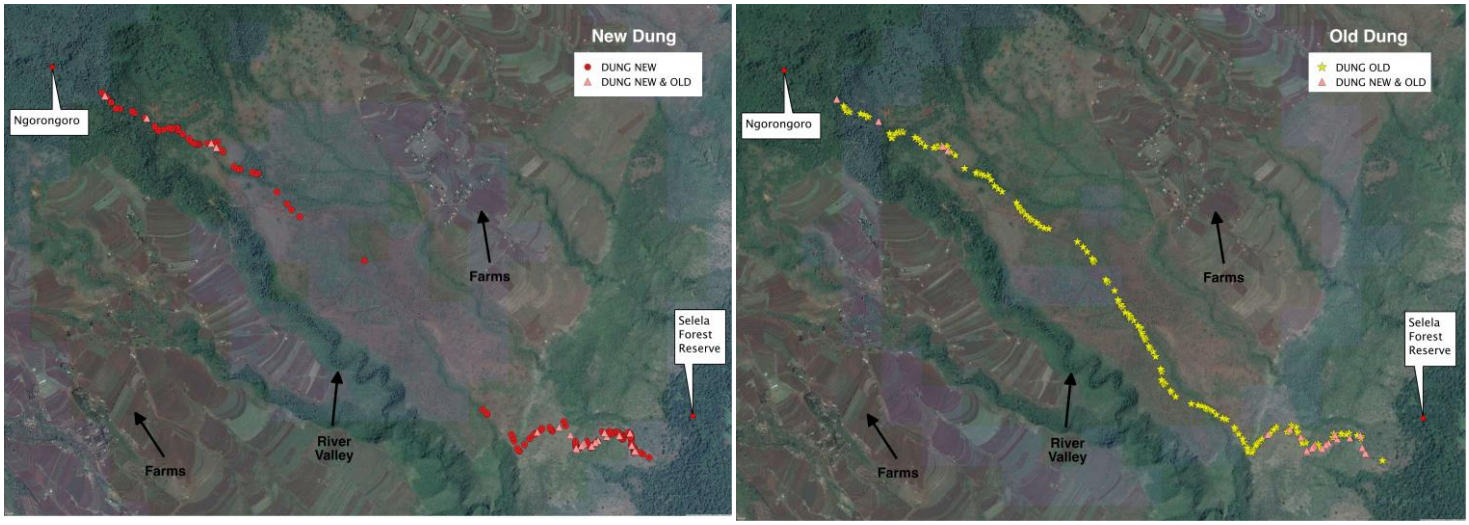

Figure 5. New dung (left) and old dung (right) from the Selela Forest Reserve to the Ngorongoro Conservation Area recorded on April 10, 14, and 19, 2015.

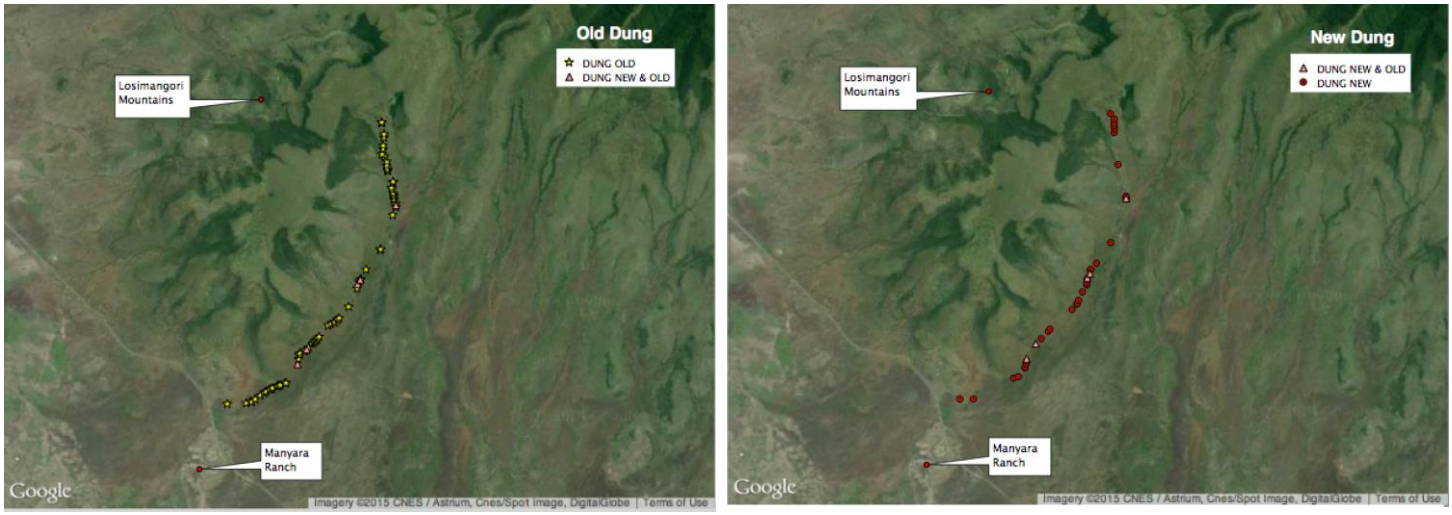

Figure 6. New dung (left) and old dung (right) recorded in the Losimangori Mountains on April 13, 2015.

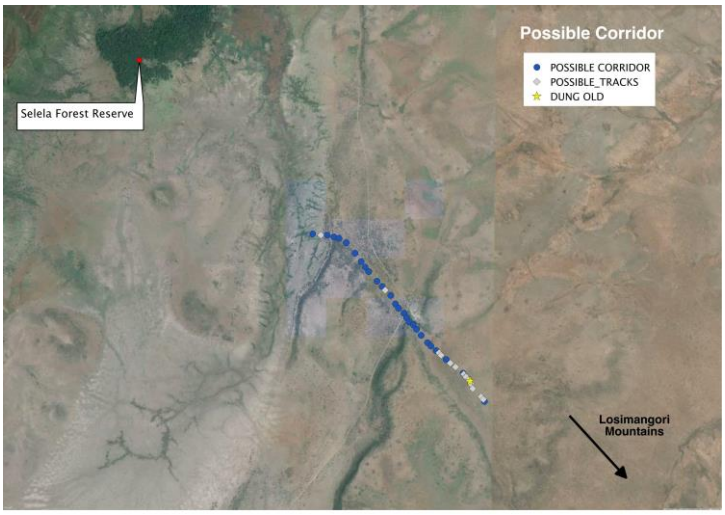

Figure 7. The projected corridor (blue), possible tracks (grey) and old dung (yellow) recorded on April 18, 2015 between the Selela Forest Reserve and the Losimangori Mountains.

CORRIDOR MAPPING DISUSSION

Because old dung was prevalent along the entire corridor leading from the Ngorongoro Conservation Area (NCA) forest, we can say that elephants have traveled from the NCA forest to the Selela Forest Reserve (SFR) around the months of March and April. The two separate areas of new dung concentrated near the SFR and near the NCA forest suggests that two different groups of elephants might have been traveling within the week of April 10, 14, and 19—one group that had already arrived at the SFR, and another that was still traveling at that time to the SFR. Overall, the prevalence of old and new dung, tracks, browsing, and scratching show that the corridor from the NCA to the SFR is frequently used in the beginning of the rainy season. The old and new dung, which was evenly dispersed from Manyara Ranch leading to the Losimangori Mountains, suggests that the corridor is also frequently used during the rainy season. Because little physical evidence was found on the corridor that leads to the Losimangori Mountains from the SFR, we can say that migrating elephants do not frequently use this corridor during the beginning of the rainy season. By combining the interviews and actual GPS plotted data, we can conclude that elephants travel from the NCA to the SFR, and from Manyara Ranch to the Losimangori Mountains, and possibly to SFR, though less frequently (Figure 4).

CHARACTERISTICS OF CORRIDOR RESULTS AND DISCUSSION

Perceived time of travel

The majority of responses mentioned that elephants travel to the Selela Forest Reserve (SFR) during the rainy season in the months from March to May (Figure 8), while only a few responses mentioned that elephants migrate to Selela during the dry season or any other time during the year. As seen in Figure 4, there was physical elephant evidence, showing that elephants were travelling during the rainy season to and around the SFR. Furthermore, along the corridor leading from Selela to Losimangori Mountains, Maasai pastoralists mentioned that they had seen elephants travel to the forest from the direction of Manyara Ranch in March. Furthermore, elephants are known to travel outside of protected areas during the rainy season (Borner, 1985; Newmark et al., 1994).

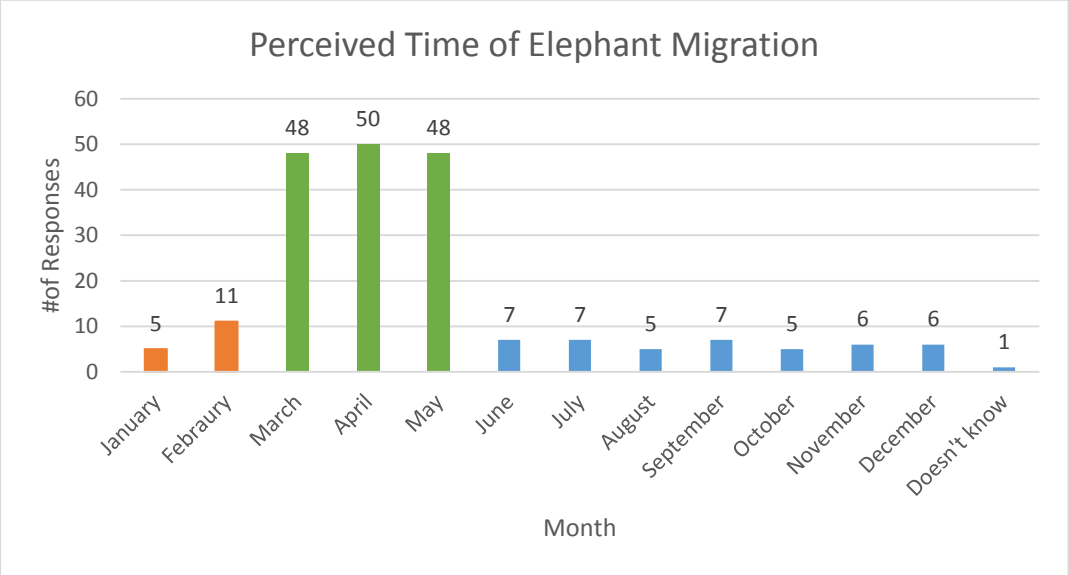

Figure 8. Selela villager's perceived time that elephants migrate to Selela Forest Reserve (n=60). Individuals could list multiple months. Orange bars represent dry season, and green represents long wet season. If individuals generally stated dry or wet season, their answers were recorded in the respective months.

Perceived Purpose of Elephant Migration to Selela

Out of the 61 interviews performed, 60 individuals stated that a conflict with wildlife does exist in Selela (Table 3). Therefore, the one individual who stated there was not a conflict

was excluded from all other questions. 95 answers were provided for the perceived purpose of elephant migration to the SFR (n=60) because there were often multiple stated reasons for elephant migration to Selela. From the answers provided by the villagers in Selela, 41.67%, 25:60 of people stated that the reason elephants migrate to Selela Forest Reserve is because they leave the Ngorongoro Conservation Area (NCA) when the ant (Siafu) populations increase in the rainy season. This was the most common answer stated. It is important to note that this answer was the only one specific to a location the elephants were travelling from. Villagers stated that ants bother the elephants by crawling up trunks, sometimes injuring or even killing them, so elephants leave NCA to take refuge in SFR. Siafu, otherwise known as driver ants or safari ants, attack and consume any animal that is not able to escape the swarm. It is possible that these ants might be the most polyphagous of all predators on earth (Franks 2001), eating most anything in their path. They are considered voracious generalist carnivores (Gotwald 1995, Hepburn & Radloff 1998).

40.00%, 24:60 of the villagers stated that generally, elephants migrate to eat the crop fields (banana, maze, rice, and beans) outside of the Selela Forest Reserve. 30.00%, 18:60 stated that the forest has all the resources for them, including water, food and a warmer temperature than the reserves they come from. Overall, the forest can sustain the elephants with enough resources. Elephants may feel unsafe leaving the protected areas and moving into more agricultural and open areas, and likely use more dense areas with greater cover for protection (Foley, 2002). The Selela Forest Reserve could serve as a possible safe base for the elephants to reside in and then use it to makes forages in the villager's farmland that are close to the forest. We noticed that the villagers who had farms closer to the part of SFR that elephants were known to reside in had conflicts with elephants feeding from their farm more often than those who had farmland farther away from the forest. Therefore, elephants seem to remain near the comfort of the Selela forest they resided in.

26.67%, 16:60 individuals stated that the elephants migrate to Selela for the salt/alkaline available in the forest's soil. We assume that this is phosphorous in the soil that female elephants seek out when they are lactating. Elephants are known to need these phosphorous "hot spots" (McNaughton, 1990; Galanti, 1997), but many conserved areas surrounding Selela, including Tarangire National Park, Manyara Ranch, Lake Manyara National Park, and Ngorongoro Conservation Area are absent of a phosphorous-rich zone.

Therefore, elephants need to migrate outside of the parks in order to find these areas. Selela Forest Reserve seems to be an area that elephants travel in search of phosphorous. 5.00%, 3:60 of villagers also mentioned that the elephants travel to the forest specifically because it was the birthing ground for calves. Therefore, the mention that the forest might be high in phosphorous and elephants have been known to have birth here supports the need for elephants to travel to the Selela area.

Game reserves and protected areas seldom contain the full range of natural resources necessary for the survival of a large mammal population, and therefore migration beyond the reserve boundaries must occur (Fryxell & Sinclair 1988a). As a result, some elephant populations risk migrating to adjoining private or public lands, despite the lack of protection and considerable human pressures. This interface, the spatial overlap of humans and wildlife, is leading to an escalating human-elephant conflict in many places in Africa and Asia. Planted crops attract elephants, which can devastate a farmer's annual food source and supplementary income overnight, and may also lead to a confrontation where the farmer's personal safely is at risk. Crop-raiding is becoming a problem wherever elephants occur in close proximity to humans; reports from Asia include Malaysia (Stuwe et al. 1998), Sumatra (Nyhus et al. 2000), Nepal (Smith & Mishra 1992), and India (Sukumar 1990). Extensive complaints are also reported in Africa by Barnes (1999).

Table 1. Selela villagers' perceptions on the elephants' purpose for migrating to Selela. Individuals could list more than one reason. Salt/Alkaline was the provided answer, however this is actually the phosphorous in the soil that elephants travel to during birthing season. Villagers also stated that increased ant populations in the NCA during the rainy season drive elephants away because the ants may kill or injure the elephants.

Reasons elephants travel to Selela	Perceptions of Individuals
Ants in NCA	25
Eat Crops	24
Forest Resources/Water/Warmer Temperature	18
Salt/Alkaline	16
Doesn't Know	5
Birthing Place	3
In Route	2
Past Experience	1
Protected from Poachers	1

Elephant Family Dynamics

The perceived elephant family group dynamics showed that both matriarchal family groups with and without calves, as well as lone male adults have been seen in Selela Forest Reserve, with 8.33%, 53:60 of villagers stating they've seen family groups, and 55.00%, 33:60 of villagers stating they have seen lone males. However, in our data collection of elephant evidence while mapping the corridor, we found very little evidence of calves present on the corridor, with only two calf tracks, one calf old dung and one calf new dung. Based on interviews in Selela village, the Selela Forest Reserve might be a birthing site for the elephants that migrate there (See Table 4). Therefore, evidence would not be present until after the elephants have reached the forest and gave birth. We mapped the corridor during the beginning of the rainy season when elephants are projected to begin travelling to Selela and out of the Conservation Area and National Parks (Figure 8). This may be a reason why we recorded very little evidence of calves present on the corridor, where there may be more evidence at the end of the rainy season.

Table 2. Selela villagers' perceptions of types of elephants that they have seen travel through the corridor. Family groups consist of multiple elephants and sometimes calves. It was assumed that more than 2 elephants together were female family groups and 1 or 2 elephants were lone males. Some villagers had never personally seen elephants, but knew of them from destroyed farmland and footprints. 28 Individuals listed that they saw both lone males and family groups.

Elephant dynamics	Perceptions of Individuals
Lone Male	33
Family Group	53
Never seen	3

Population Change over Time

Within the people interviewed, 43.33%, 26:60 stated that there has been an increase in elephant populations over time, while 38.33%, 23:60 of villagers interviewed stated that there has been a decrease in elephant populations over time (Figure 9).

Therefore, it is unclear whether or not there has been a change in elephant populations traveling to Selela. However, it's interesting to note that some 8.33%, 5:60 of the villagers mentioned that overpopulation was a factor in what they saw as decreasing elephant populations. While generally Tanzanians view children as "gifts from God", so wealth of children is a blessing, a few have noticed that Selela's population is growing and encroaching on the adjacent forest, and that it does affect the elephants.

In addition, 13.33%, 8:60 of villagers noted that they believe elephant populations are decreasing because park rangers and villagers scare away the elephants, which is the highest stated reason for perceived decreasing elephant populations in Selela Forest Reserve. This stated reason is also a result of the increasing population in Selela. A contradiction in our interviews was that 15%, 9:60 of villagers stated that more elephants have been coming to Selela because there has been an increase in farms from development in the area. Even with this contradiction, it is interesting to note that whether there was a perceived increase or decrease in elephant populations in Selela, many of the reasons given were of human influence. Thus, the villagers understand that they have an impact on the presence of elephants in the Selela Forest Reserve.

Furthermore, from a key-informant interview with the Director of the Cultural Tourism Program (CTP) in Mto Wa Mbu, it is projected that tourism will soon increase in Selela village and SFR. The CTP is planning to take more "cultural walking tours" through the village, into the forest, and up the Escarpment wall by way of the currently used elephant corridor. While

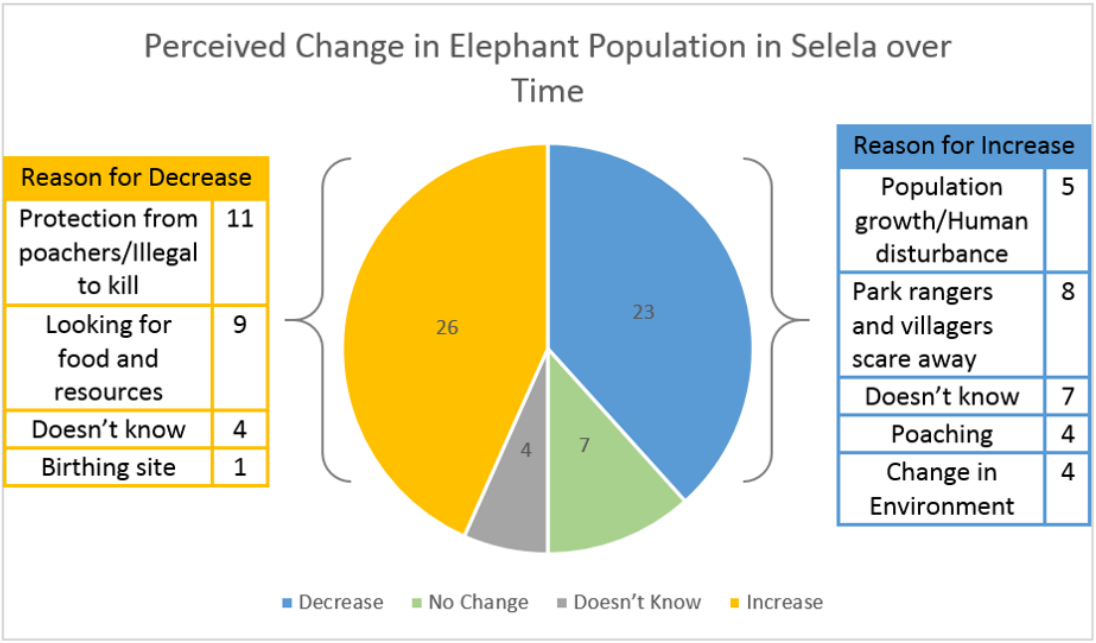

Figure 9. Selela villagers' perceptions on the change over time in overall elephant populations that migrate to Selela Forest Reserve. Individuals interviewed provided a reason or multiple reasons if they mentioned an increase or decrease over time.

this can be a positive influence on the village, bringing in capital, this potential human disturbance may negatively influence the elephant migration through the corridor.

Human- Wildlife Conflict

Of the 98.36%, 60:61 of villagers who stated that a human-wildlife conflict exists in Selela village, 96.67%, 58:60 agreed that elephants cause conflict (Table 3), and 71.67%, 43:60 stated that elephants cause the highest amount of conflict (Table 4). When asked what specific conflict the individual has with elephants, the most common answer was that elephants kill people (63.33%, 38:60; Table 5). As stated in several interviews, within the past few years 2 pregnant women were killed while collecting firewood in the Selela Forest Reserve. It seems that many people in the village have felt the loss of these two women and view killings as a personal problem, even if the killings were not of direct family members. Because of the recent killings many women are now afraid to go into the forest to collect their necessary firewood. One hidden impact on the death or injury of a woman of the household is that it can seriously affect children by adding new responsibilities at an early age (Lamarque et al., 2009). This may result in decreased school attendance, a negative impact on the parent-child relationships, and lead to a weakened child development (Barua et al., 2013).

Also, 55.00%, 33:60 villagers stated that elephants are eating and/or destroying their farms (Table 5). Therefore, the human-elephant conflict is affecting the livelihood of the Selela villagers. Crop raids have been known to decrease an entire family's food supply, which may cause women to eat less in order to feed their children (Ogra, 2008). This has led to weakened health in women, sometimes causing anemia, and further resulting in poor child care (Barua et al., 2013). Crop raids have also forced families to quit farming and find alternative sources of income (Choudhury, 2004 and Maïga, 1999), which may disrupt the family bonds and increase stress (Barua et al., 2013). It seems that little protection is given to the villagers of Selela by the government, though it is clear that increased safety is necessary to prevent the negative effects of elephant conflicts.

Table 3. Selela villagers' perceptions on which wildlife cause conflict. Individuals could list more than one animal.

Wildlife	Perceptions of Individuals
Elephant	58
Buffalo	33
Zebra	25
Monkeys	20
Hyena	20
Wildpig	16
Leopard	10
Gazelle	7
Warthog	6
Simba	4
Wildabeast	3
Porquipine	3
Jackle	1
Wilddog	1
Ostrich	1
Kudu	1
Rhino	1
Impala	1
No conflict	1

Table 4. Selela villagers' perceptions on which animal causes the greatest human-wildlife conflict in Selela village. Individuals could list more than one animal.

Wildlife	Perceptions of Individuals
Elephant	43
Zebra	11
Buffalo	9
Hyena	7
Monkeys	6
Wildpig	2
Warthog	1
Leopard	1

Table 5. Selela villagers' perceived personal conflicts with elephants. Even if people killed were not directly associated with individual interviewed, they associated a killing as a personal problem and/or as a fear of their own. Individuals could list more than one reason.

Elephant Conflict	Perceptions of Individuals
Eating/ Destroying farms	33
Kill people	38
None	7

Proposed Solutions

Based on personal observation, there is no action currently being taken in an attempt to resolve the conflicts in Selela. The most common proposed solution by villagers to the human-elephant conflict is better ranger security (70%, 42:60; Figure 10). While, according to several interviews, rangers from Mto Wa Mbu may be called to scare away elephants in the Selela Forest Reserve, some villagers noted that they want permanent rangers living in Selela for increased protection. One individual stated that a solution would be to have a better relationship with the rangers. Also, 36.67%, 16:60 individuals in Selela mentioned that some

form of fence should be built in order to keep wildlife out. Thus, villagers want to be separated from the wildlife by increasing security through rangers or a fence. Although 5.00%, 3:60 of individuals wanted education about elephants to learn how to live with them, and one individual wanted to create a new pathway for the elephants, the majority of individuals interviewed did not desire to work toward a more peaceful relationship with wildlife, but instead wanted separation.

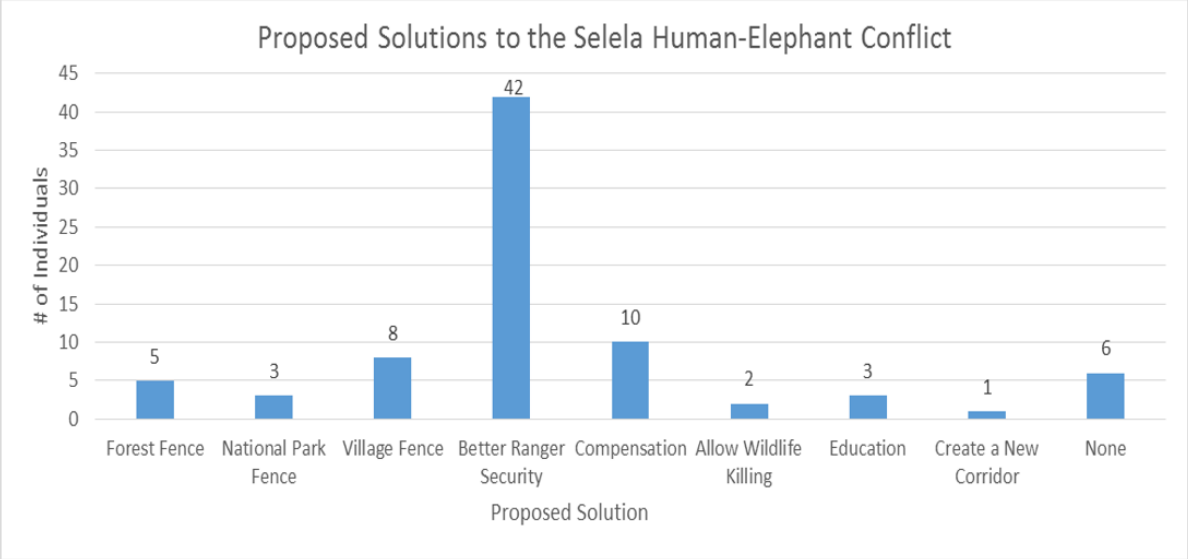

Figure 10. Selela villagers' perceptions on possible solutions to their conflicts with elephants. Education refers to teaching villagers ways to better coexist with wildlife, such as moving farms away from the elephant corridor. Better ranger security includes adding a ranger station within Selela to keep elephants out, as well as creating a better relationship with existing rangers who are called when elephant conflicts occur. Village fences include building fences around farms, bomas (Maasai houses), and animal pens. Compensation includes receiving money from the government for human killings and farm and property destruction. None doesn't necessarily mean that a solution does not exist, but that the individual could not think of one. Individuals could list more than one solution.

LIMITATIONS AND RECCOMENDATIONS

Limitations

Mapping

- Missed evidence along the corridor
- Having the GPS in a fixed position on the line created a 30 meter bias (Figure 3)
- Misidentification of dung age
- A day's worth of data was lost due to GPS technical problems
- The presence of dangerous animals on certain areas along the corridor was a distraction

Interviews

- Miscommunication when translating between languages
- Specific individual perceptions are lost through the compilation of data when responses are categorized to create figures and tables
- Sometimes multiple people gathered around the individual being interviewed and influenced his or her responses by stating their perceptions

Recommendations for the Current Study

- Hire an Askari when walking through the elephant corridor
- Obtain permits to walk through the Ngorongoro Conservation Area and the Losimangori Mountains (Military Base)
- Back up data after each day of research

Future Recommendations

- Map the Selela corridor during different times of the year or at the end of the wet season
- Study the development of Selela, including the newly established electricity, tourism, and how the Serengeti Road would (or has, if has been created) affected the village.
- Continue mapping the projected sections of the Selela corridor where physical evidence has not yet been collected

- Study a different elephant corridor in Tanzania: Is it still being used? Are there villages near the corridor? If so, is there a human-elephant conflict there?
- How can the human-elephant conflict be resolved in Selela?

CONCLUSION

By combining the interviews and actual GPS plotted data, we can conclude that elephants travel from the Ngorongoro Conservation Area (NCA), to the Selela Forest Reserve (SFR), and from Manyara Ranch (MR) to the Losimangori Mountains (LM), and then possibly to SFR based on interviews rather than actual GPS plotted elephant evidence. Both family groups and lone male elephants migrate to SFR during the rainy season. Elephants may migrate take refuge from dangerous Siafu in NCA, eat crops and forest resources, and to get phosphorus for lactating females. We cannot conclude whether there has been a change over time in elephant population size. However, villagers do understand that they have an influence on elephant populations. There is a clear human-elephant conflict in Selela village, in which elephants destroy farms and kill people, which can greatly inhibit the livelihood of the villagers. Villagers' proposed solutions to the HEC generally consist of separating humans from elephants, by using a fence or increased ranger security. Some also express concern for attaining compensation from the government when property is destroyed or if people are killed or injured. This study was not able to fully connect with physical evidence and GPS plot the full corridor leading from NCA to SFR, and MR to LM and to SFR. In part, this was due to restrictions on time, finances, danger, and inability to legally continue tracking on the land the corridor passes through.

This study is important to hopefully help conserve the vital active Selela elephant corridor and assist in resolving the human-elephant conflict in Selela village in the wake of increasing human development. A road is projected to travel through the Serengeti National Park and travel down the Rift Valley Escarpment, cutting right through Selela village. Also, the Cultural Tourism Program is working to bring more tourists up the elephant corridor on the Rift Valley. Selela village's population is growing rapidly and development is already occurring, with electricity on its doorstep. This current and potential development may bring jobs and opportunities for wealth to the Selela villagers; these changes also will have an imperative impact on the elephant migration to the SFR. These Elephants could lose this corridor completely and human conflicts with elephants could increase even more. It is vital that this study and future studies work toward finding solutions to a better coexistence of humans and wildlife in the future.

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Appendix A

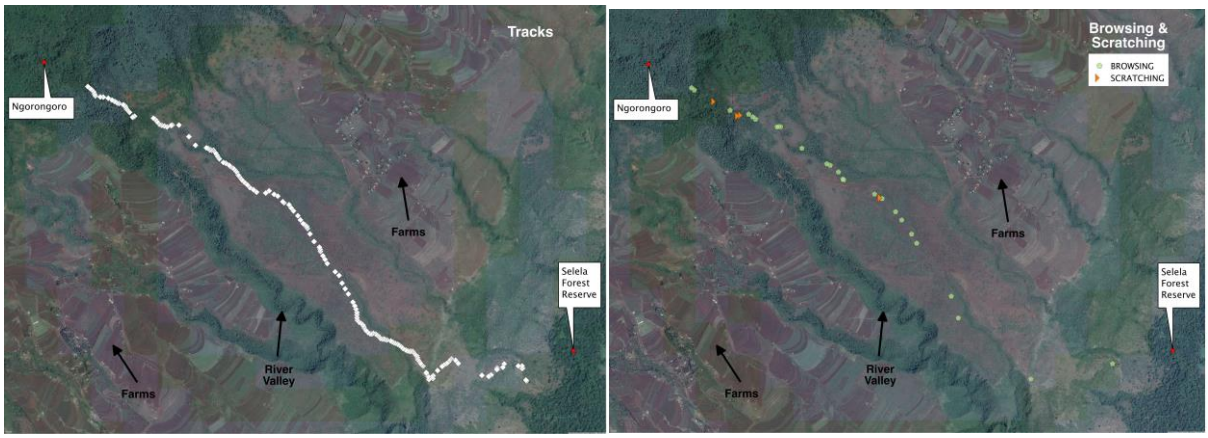

Figure 11. Track (left) and Browsing (right) from the Selela Forest Reserve to the Ngorongoro Conservation Area recorded on April 10, 14, and 19, 2015.

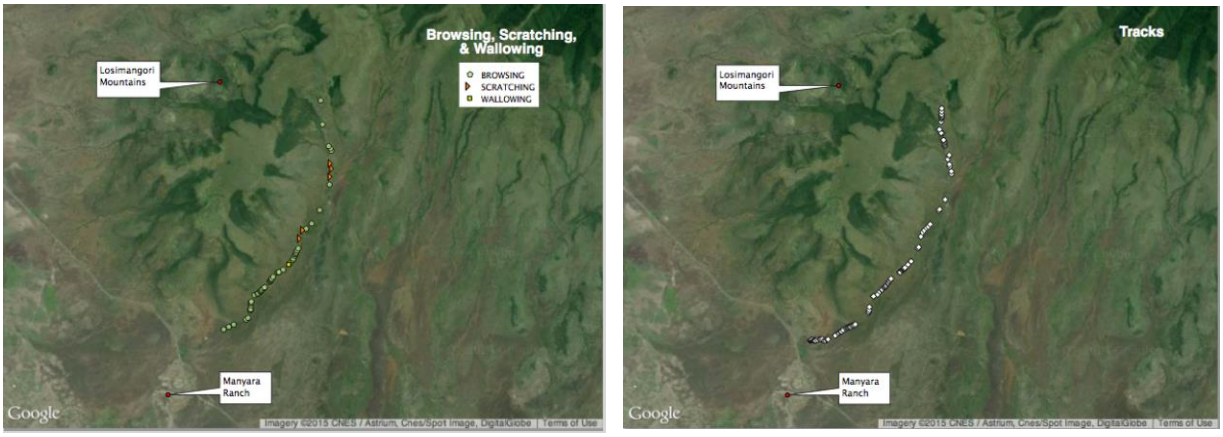

Figure 12. Browsing, scratching, and wallowing (right) and Tracks (left) in the Losimangori Mountains on April 13, 2015.

Appendix B

INTERVIEW QUESTIONS

1. Is there a conflict with wildlife in Selela?
2. If yes, with which animals? What animal causes the most conflict?
3. What specific conflict do you have with elephants?
4. What time of year do you see elephants around Selela?
5. What are the family dynamics? Do you see old, young, male, and/or female?
6. Where are the elephants coming from? Where are they going?
7. Why do you think they are coming here?
8. Over the past few wet seasons, have you noticed and recent increase or decrease in elephant populations than in the past? Why?
9. What changes would you like to see as a solution?