International Elephant Foundation Interim Report

HEC Abatement: Deterrents, ecological correlates, and climate smart agriculture practices

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Start: January 2017

Field Completion Phase I: January 2018

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2. Conservation Needs of Project

The Kasigau Corridor REDD+ (Reduce Emissions from Deforestation and forest Degradation) Project Area includes 14 Group Ranches covering an area of ca. 2000 km^2 that is part of the Kasigau Wildlife Corridor between the Tsavo East and Tsavo West NP (Figure 1). These ranches are conserved under a REDD+ scheme that aims to provide financial incentives by tapping into the carbon market to help protect forests. Wildlife Works has pioneered practical REDD+ solutions that are acceptable to both the rural communities and the marketplace. The biological component of the study involving the elephant surveys and monitoring will mainly be undertaken within Rukinga Wildlife Sanctuary (30,000 ha).

Human encroachment and agricultural development have compressed and fragmented the ranges for African elephants. Negative encounters with people result in human elephant conflict (HEC) with consequences that represent the major conservation needs of this project:

(1) Crop raiding is the major form of HEC, and losses to elephants can severely influence livelihoods. Thus, there is a great need to identify sustainable and affordable means to reduce crop raiding by elephants. The study area at Rukinga Ranch has no permanent residents but community owned ranches and villages surround it; thus, negative encounters with wildlife are common. Farmers would benefit from means of deterring elephants that approach their crops and being warned of elephants at a distance but heading in the direction of their fields.

(2) Poor attitudes of people towards elephants reduces the effectiveness of conservation initiatives and practices, ultimately resulting in a decline in elephant populations. People often attribute crop raiding to any elephants in the area, but it is possible only particular individuals are the culprits. Many bull elephants we catalogued in the project area have one or more large scars, likely the result of negative encounters with the local people. By determining which elephants crop raid, we can target solutions and enhance human attitudes towards elephants in general.

(3) Elephant presence in confined areas, such as the wildlife corridor at our study site, can result in extensive damage to canopy trees. Bark striping that results in girdling a tree can lead to mortality. These trees provide habitat (e.g., nesting sites) and cover for other species. In addition, humans use these trees as a resource for lumber, medicinal products, food, and fuel. The project site was formally a cattle ranch and faunal diversity is still recovering from years of overgrazing. Thus, there is a need to maintain these trees in the habitat for elephants, wildlife, and humans.

(4) Elephant activities can facilitate biodiversity and enhance ecosystem services. However, elephants confined by human presence or enclosed by fences can overuse a particular habitat resulting in a drop in biodiversity. Elephants and their activities can facilitate enhanced biodiversity but not all species are favored by elephant presence. Thus, highly mobile yet easy to locate species such as larger mammals and predatory birds may be indicators of elephant absence or presence.

(5) Crop raiding by elephants needs to be put in perspective of overall crop yield. Previous studies have shown that farmers will attribute crop losses to elephants even when elephants are not the primary reason for crop loss. In order to improve human livelihoods we need to know the relative importance of various factors on crop survival as well as have good data on the overall prevalence of elephant crop raiding.

3. Goals and Objectives of Project

(1) We are testing **deterrent fences** to reduce elephant intrusion into crop fields. We are experimentally testing chili pepper and new metallic strip fences singly and in combination, as well as a traditional acacia fence. We should see a direct benefit to elephants by reducing conflict with local farmers and discovering data and techniques concerning deterrent methods that can be applied wherever HEC may occur.

(2) We are creating an **elephant identification database** and using trap cameras to identify elephants that crop raid our experimental plots. We also are making visits to the local primary school to facilitate a good relationship with the local community. As part of the larger project, Wildlife Works conducts surveys with people in villages in the study area to examine their attitudes on wildlife, elephants, and sustainable practices to maintain a viable livelihood.

(3) We are assessing **damage caused by elephants to tree species** in the study area. This information will be used to assess the timing and degree of damage relative to crop raiding. We will test the hypothesis that tree damage could be used as an indicator of impending crop raiding. In the future, we will wrap some trees of value with wire to determine if this wrapping reduces tree mortality from elephants (such mortality is primarily the result of bark stripping).

(4) We are using **surveys of mammals and higher trophic level birds** (primarily raptors) to assess biodiversity. In addition, we will be testing the hypothesis that one or more of these species could serve as indicators of elephant presence and degree of activity, such as impending crop raiding. Thus, such species could provide a biotic early warning system.

(5) We are measuring the damage to our experimental plots from all causes (elephants, other wildlife, domestic animals, insects, and lack of water). We are also **tracking incidents of elephant crop raiding in the farming area** of our experimental plots.

4. Specific Actions Taken to Achieve Objectives

(1) Deterrent Fences. Our research design established four agricultural blocks measuring 16 m x 310 m. Each block was leased from one or more farmers and planted with maize, and lentils and/or cowpeas. We have eight (8) fields in a block each measuring 16 m x 32 m. Thus, each block is a replicate with all treatments contained within each block. Between each field and at the ends of each block we have unfenced transit areas (hereafter referred to as alleys) 16 m x 6 m. For each field, fence posts were erected at 8 m intervals. Within each block, we assigned our treatments with a paired control randomly without replacement. The treatments are acacia fence (unfenced control), chili pepper fence (used motor oil fence control), metallic strip fence (metal wire fence control), and a chili + metallic strip fence (motor oil + metal wire fence control). Acacia branches from trees that were trimmed along roadsides were placed around the perimeter of one field per block. An adjacent field had only the fence posts. The chili pepper fence was constructed by grinding chili peppers and mixing them in used motor oil. This mixture was soaked into ropes that were tied between fence posts at heights of approximately 1.5 m and 2.0 m from the ground. A 0.5 m x 0.5 m cotton cloth was soaked in the mixture and tied to the top and bottom rope at the mid-point between fence posts. An adjacent field had the same construction except the ropes and cloths were soaked only in the used motor oil. We constructed the metallic strip fence by cutting metallic strips (ca. 5 x 20 cm) out of corrugated iron sheets locally used as a roofing material, punching a hole near the top, and stringing the strips onto a

metal wire. Strips were placed in sets of three or four and the wire crimped every 50 cm so that a set could only slide between the crimps. The 11-12 m lengths of fence were tied to the posts approximately 1.4 m from the ground. The control metal fence consisted of the metal wire crimped but without any metallic strips. The chili + metallic strip fence was a combination of the above two treatments with an adjacent field having the complementary control fence. The front line of each block had a short layer or acacia to prevent livestock from entering. Because of drought, only two of the blocks sprouted after the long rains during the first growing season of trial one (June – August). After the short rains in the second growing season of trial two (November-February), all blocks survived and produced a harvest. The remainder of the deterrents were deployed in the two remaining blocks, and the established blocks maintained. Twenty-seven camera traps were erected and monitored; one on the road to the farms and the remainder in strategic positions near viable crops. We employed locals to assist with fence construction and maintenance, and four Earthwatch teams helped with all phases of the process.

(a) First Trial: 6/28/17-9/28/17. Due to drought only two of the four blocks had viable crops and deterrents were only deployed in these areas. Some individual fields within those blocks did not survive as well. Thus, we lacked replication in this tial. However, over 300 individual approaches by wildlife to fields or transit areas (hereafter referred to as alleys) in the surviving blocks were noted by fence attendants or camera trap images. In addition, belt transects around these blocks were performed, checking for signs of tracks or dung, which gave insight into which animals were near the area that were not captured by cameras. The fields were assessed numerically for viable crops (maize and lentils or cowpeas) and a system of condition scores was established to rate the stage of growth of each plant type. These scores were updated weekly, and we will these measures to examine if crops were more likely to be raided at different stages. Each fence pole was numbered so that attendants and field staff could report the exact entry and exit points of animals into the fields. Along with field visits by experienced trackers, this information gave insight into the exact movement patterns by elephants. We have recorded incidents of intrusion into the crop fields by other species as well, including dik-dik, duiker, eland, giraffe, goats, gerenuk, hyena, and lesser kudu. After crops were harvested, cameras remained in place to quantify how long wildlife was still present in the area, and after no presence was detected for a week, they were removed. Some unique observations were made: eland were commonly crop raiders and were doing significant damage to crops, and the metal control treatment (a simple crimped wire surrounding the field) was not visible in the dark and seemed to startle and deter elephants that came into contact with it.

(b) Second Trial: 11/30/17-2/18/18. All four blocks were secured and planted as with the initial trial. One farmer elected not to participate, and deterrents were moved to the other end of an existing block. Farmers were requested to only plant maize so that field contents would be more consistent. One farmer did not understand the request and added cow peas and lentils. Crops in all blocks and individual fields and alleys survived, and the remaining blocks had their deterrents erected, with the help of local labor and Earthwatch teams. Maintenance was performed on the two existing blocks which already had deterrents. Cameras were redistributed throughout the four blocks and monitoring continued as it had in the first trial. Each experimental block had crops till harvest, so the lack of replication as seen in the first trial was not a factor. 204 visits to fields by various animals (mostly elephants) were recorded, and final data are being transmitted from the field for statistical analysis.

In an effort to use beehive fences in future trials, an apiary of 24 hives was established near the home of one of the fence attendants. Structures were built to house the beehives in three different locations, each maintained with a supply of sugar and water, honey badger deterrents, oil to prevent insect infestation, and a ring of acacia to prevent access by livestock or local children. A relationship was established with Save the Elephants' Dr. Lucy King and her team, which will facilitate the relocation of the beehives into fences when the hives are established. At the time of this report, five hives were already occupied.

(2) Elephant identification database. During animal surveys, other drives on the property, and through the cameras traps, we have compiled an elephant identification database. Each elephant is photographed and sketches made when time allows, to note distinguishing features such as ear tear patterns and the shape of tusks. Sex, age, GPS location, and group composition are all noted. Family groups are notoriously skittish in this area, and bulls were much easier to locate and track, with some individuals observed up to 20 additional times. As of mid-February 2018, 22 family groups and 89 bulls have been catalogued. In addition, bulls had their associations recorded. Eight of the bulls in the catalogue were identified as crop raiders, with two of those individuals as repeat crop-raiders. Four additional bulls had clear camera images from crop raiding incidents, but have not been identified in the catalogue yet. One of the known bulls in the catalog was later collared by Save the Elephants.

(3) Tree damage. We assessed tree damage to large trees along our animal survey routes (see #4) and at waterholes. We photographed each tree, identified the species, recorded the coordinates using GPS, and measured diameter at breast height, total height, and canopy dimensions. We assessed damage as bark stripping (proportion of trunk girdled), branch breaking (percentage of intact canopy with broken branches), felling, and uprooting. During 2017 we successfully located and tagged 240 trees spread over six transects. Each had proper metrics and photographs recorded into a database, and each tree will be revisited in the next field season to see how the damage has changed over time.

(4) Mammal and bird surveys. We created six driving transects along roads that cover the majority of the Rukinga Ranch wildlife corridor. Transects were driven three days per week by each of the Earthwatch teams and scientific personnel. Graduate student R. Lynn Von Hagen and assistants conducted 90 transects from 6/17/17 to 1/10/18. We recorded species, age and sex, number of individuals, perpendicular distance from the road, and any relevant notes. Seventy-five species were recorded and 3343 individuals. Of special note were several sightings of endangered Grevy's zebra and vultures. These data will be analyzed to look for trends that correlate with elephant activity.

(5) Crop raiding incidences and causes of crop damage. Two Wildlife Works employees are the dedicated fence attendants who live in the village near our experimental plots and daily acquire information on crop raiding in the area. Mr. Kasaine and the attendants work closely with the community to gather information and maintain a positive working relationship. The livelihood of the community has suffered greatly in the past due to drought and frequent crop raiding. Since the community is adjacent to an area of refuge for wildlife, crop raiding is common especially on the boundary farms. Some of these farmers have abandoned their fields altogether, and elephants and other wildlife then come to their residences. Farmers have traditionally planted crops that elephants favor such as maize and cow peas, and can rarely afford to invest in protection for their crops other than scavenging acacia from the ranch, making their fields prime targets for crop raiding. Between both trials, wildlife has been noted 513 times in areas near our experimental areas, representing 1015

observed individuals. Records have been kept of visits that were elsewhere in the community as well. Elephants have often been observed using the front-line farms as areas to pass through to reach other farms further into the community. In the second trial, locals in the community attempted to scare away elephants and other raiders from the farms, coming dangerously close to elephants. Data analysis is preliminary, but deterrents were circumvented or alleys passed through almost 300 times while monitoring was occurring, with elephants representing over a third of these incidents. Wildlife approached and was successfully deterred over 200 times. The location of these farms coupled with the frequent presence of wildlife have made this an ideal data collection location and statistical analyses should provide insight into which of our deterrent methods was the most effective.

5. Modifications of Actions

The major modification that has occurred is that we did not test the beehive fence in 2017 as one of our deterrents. Because of the extensive drought in the region, bees moved to higher, moister habitats. In a meeting with Dr. Lucy King, she informed us that they have acquired no honey this year because of the absence of bees. To alleviate this issue, we have established and apiary (see deterrent fence subsection) and are attempting to attract bees so they may be moved to fences after the long rains of 2018 for trial number three.

In addition, the large number of elephants in the area late in the year created problems for collecting data on tree damage. For safety reasons, we often could not leave our vehicle to tag and inspect trees. Eventually, we complete all transects but our process was slowed and thus we did not re-visit tagged trees in 2017.

Local farmers were defending fields and burning fires in the experimental area during trial two. We had to adjust our data collection methods to note when elephants were chased away from farms so that we could differentiate when natural behavior was occurring or when it was modified by human interference.

6. Conservation Outcomes to Date

To date, our data analysis is ongoing as the second trial is still concluding and information is being transmitted from the field. While we have no final numerical outcomes at this point, we have strong indicators that our analyses will reveal which of the deterrents was the most effective. Observations reveal that the metal fence control had a strong effect on elephants, which could result in testing the efficacy of this measure independently. The metal strip fence, which has been tested for the first time, was rarely circumvented; thus, it is likely that not one, but two new deterrent techniques will result from this study. Our four Earthwatch teams had very good experiences and they were quite helpful in the construction of our experimental fields. Earthwatch has expressed interested in continuing their support of this project. We visited the school near our experimental fields three times and the teachers and students were enthused, and appreciative of our presence in the community. We employed local farmers to assist with the construction of our experimental fields and maintenance of the chili fences, and all were eager to participate and extremely appreciative of the additional income. In addition, we have initiated all of our objectives as explained above. The elephant ID database grew quickly, and is the first time elephants have been catalogued in the project area. Long term, this may

provide interesting information as to how elephant populations are responding to the presence of the new railroad adjacent to Tsavo East National Park. Our teams worked well together and we have managed the logistical details efficiently and in a cost effective manner.

A Facebook page was established so that individuals who had been on the Earthwatch expedition or other interested parties could follow the progress of the project. It is updated frequently and provides a means to thanks supporters of the project and direct them to places (such as the IEF donation page) where they can contribute to our efforts.

7. Numerical Impact on Humans and Elephants

Based on the 2009 National Census, the human population in Buguta sub-location was ca. 7,000 in 1,200 households. This is the area closest to our experimental fields. The region around the Wildlife Works wildlife corridor has a population of some 90,000 people. Tsavo National Park has an estimated elephant population of 12,000 (ca. one-third of the Kenyan population). Hundreds of elephants are known to move through the Kasigau wildlife corridor but reliable population estimates have not been determined prior to the present study; however, during the November-December months of 2017, the population of the elephants on the ranch from aerial surveys conducted by Wildlife Works pilot Keith Hellyer, was estimated at 700-800. The four blocks at the project had eight different families benefit from the leasing of their farms and the protection of their crops.

8. Problems during the Project Period

The greatest concern was drought in the first trial, but the second trial was fortunate enough to have plentiful rain, which resulted in the first successful harvest local farmers have experienced in some time. Some expenses were hard to predict as far as maintenance of the fences. Elephants have uprooted and/or broken several poles, and torn cloths from chili fences, resulting in early replacement. The project vehicle experienced a few days of being down due to mechanical issues, resulting in slightly higher maintenance costs, but is now running smoothly. Eight cameras have been stolen over the length of the project. We have worked with the village elders to determine why this has occurred and we believe it may be due to locals who are incorrectly assuming we are attempting to monitor their grazing activity. We are working closely with community leaders to alleviate this perception, and have put in additional security measures. In the second trial, guarding and fire burning was initiated by local people to defend the harvest, but we were able to request that our experimental areas be not guarded as closely, or that animals are only chased away after encountering the deterrents. This created the concern that data would not be acquirable, but elephants still visited almost nightly. Though many were chased away, we noted such in our data. There have been no major issues which the team was not able to adapt and overcome, or that should prevent the continued success of the project.

9. Evaluation of Success to Date

To date, the project is moving along very well. Since all experimental blocks were successful in terms of crop production in trial two, the results should demonstrate which of our deterrents was the most successful if we had enough visits for statistical power. As we continue to build the tree and the animal transect databases, we will investigate the relationship between these data sets and the presence of

elephants and the prevalence of crop raiding. One of the goals of 2017 was to successfully identify all the trees for the experiment, which was accomplished. We will analyze whether damage to trees or the prevalence of particular birds or mammals can serve as indicators of elephant presence and activity and the transects performed gathered a considerable amount of information, towards this goal. The elephant identification catalogues grew very quickly, and we were very satisfied with the number of elephants we were able to confirm as crop raiders within the first field season. At the qualitative level, our relationships with the local people is positive and we hope to help facilitate greater awareness (and action) on how to deter elephants, and whether their perceptions of elephants improve over time (i.e., we can also examine this quantitatively through surveys conducted by Wildlife Works in conjunction with this study). Each Earthwatch team was extremely satisfied with their expedition and all have expressed interested in staying current on developments within the project.

10. Next Step

There is unlikely to be an affordable, sustainable, and ecologically friendly 'silver bullet' to reduce or eliminate crop raiding by elephants. Field experiments are time and energy consuming, but they are the only means to demonstrate scientifically that a particular deterrent or set of deterrents is successful and economically viable for rural farmers, who must contend with elephants and other forms of crop depredation. A clear benefit of a continued presence and commitment to reducing HEC is the conservation pay-off. People who live with elephants often see little value to elephants. By working with these people and their children and by incorporating a climate smart agriculture approach, we can change them from opponents to proponents of elephant conservation.

Our next goal will be to test the deterrent fences after the long rains in trial three and incorporate bee hive fences, and possibly a new deterrent, dependent on results from our data analysis. We will continue to grow the elephant ID database and determine if there are elephants that repeatedly crop raid into our experimental blocks. As we continue to build the tree and the animal transect databases, we will investigate the relationship between these data sets and the presence of elephants and the prevalence of crop raiding. Our experiments in trial two, showed that it is possible to evaluate the efficacy of these deterrents, and one of the next steps as we progress through our statistical analyses towards quantitatively assessing the outcomes, is to determine which factors contribute towards elephants being attracted to crops and how we can mediate this effect. If we confirm that our metal strip fence and its control show deterrence power, we hope to combine them with other deterrent measures to seek optimal success rates, as well as disseminate the information on construction to other communities that could benefit from it. Incorporating beehive fences into trial three, investigating an early warning system, and working with climate-smart agricultural practices will be some of our main priorities, as well as improving our experimental techniques and data collection. Over the longer term, we are building a collaboration with Dr. Lucy King of Save the Elephants and may have access to some of the data from a recent collaring of 20 elephants in the area, exploring the movements of crop raiding elephants

11. Human Interest Story

Our second Earthwatch team was comprised of mentors from the LA zoo and students from the zoo magnet school. The students were all entering their senior year of high school or were graduating

soon and going onto college. Many of them were interested in ecological careers and several had already been accepted into a university, and only one had been to Africa previously. The enthusiasm of the group was boundless, and for the adults getting to watch the student experience animals in the wild that they might have cared for in captivity, it was simply magical. They were fortunate to have several encounters with elephants and other wildlife including the only spotting of the year of a striped hyena. They assisted us with setting up and activating one of the blocks at our experimental site and were especially affected by the local children who they had a chance to play with. The students also developed a special bond with the staff at Kivuli, by helping in the kitchen and having a game of football (soccer in Kenya). The staff were obviously affected by their kindness and the positive impact they had on their impression of the project. A listening session was initiated in which the students could ask the scientists questions about career and academic advice. Our team was able to share their individual journeys in the hope it would inspire and inform. The female students were especially keen to have an example of a female scientist working abroad, as STEM fields have been traditionally male-dominated. Each student kept a journal of their experiences and the group compiled individual presentations that would be given to the sponsors of their fellowships that they received to come on this expedition. After hearing those presentations, and how their two weeks in Kenya had changed their impression of the world there was hardly a dry eye, and our team was especially thankful to have been a part of their experience.

12. Project Progress Summary (500 words)

Human encroachment and agricultural development have compressed and fragmented the ranges for African elephants. Negative encounters with people result in human elephant conflict (HEC) with consequences such as loss of biodiversity, damage to canopy trees, poor relations between local peoples and wildlife officials, loss of livelihoods, and injury or death to people and elephants. The most common form of HEC is crop raiding, which is often devastating for subsistence farmers. Our project has five main objectives: 1) experimentally test the effectiveness of specific deterrents for reducing crop raiding by elephants; 2) create an elephant identification database to determine which elephants are raiding crops; 3) measure the damage to trees in the Rukinga wildlife corridor as a means to assess elephant presence and activity, and for future protection of trees that have high wildlife and human value; 4) perform animal surveys from vehicles driving along dirt roads in Rukinga to measure biodiversity and evaluate if any species can serve as indicators of elephant presence or activity; 5) document levels of crop raiding in the community and causes of crop damage to our experimental blocks of crops. This project is part of a larger Earthwatch study on climate smart agriculture practices for sustainable farming and the perpetuation of wilderness in the Kasigau corridor between Tsavo East and West National Parks, Kenya. In year one, we established four experimental blocks of eight fields each with deterrent fences and corresponding controls in each block. The blocks serve as replicates. All four blocks had crops in the second trial. We had four Earthwatch teams of volunteers. Team 1: was comprised of eight women and one female Earthwatch employee; team two had both males and female comprised of seven students from the Los Angeles Zoo magnet school with three mentors and one Earthwatch employee. These volunteers helped us set up the fields during June and July for blocks one and two. Two additional teams assisted us in August and October, with one Earthwatch employee joining us in August. Each was comprised of six women and one man from the US and UK, from a variety of backgrounds. Their assistance was essential in preparing the materials for blocks three and

four, and changing camera traps during the crop raiding season, as well as processing the images. All four teams had valuable input towards the project, and each also assisted with animal transects, elephant identification, and tree identification. We have made excellent progress on all five objectives, and WKU graduate student R. Lynn Von Hagen returned from the field in January 2018 with considerable data. Dr. Schulte has spoken about the project at several venues and Ms Von Hagen is giving a talk in March at the WKU Student Research Conference and she will be conducting a seminar at her alma mater, Austin Peay State University in the fall. Based on our results, experimental protocol and treatments will be modified for a second year of study to begin in May 2018.

13. Project Progress Summary (50 words)

Elephant crop raiding is the most pervasive and economically damaging interaction between humans and elephants. We experimentally tested several deterrent methods for effectiveness while also creating an elephant database, assessing tree damage caused by elephants, measuring biodiversity, and tracking crop raiding incidents in the Kasigau wildlife corridor of Kenya.

14. Organizations involved

The International Elephant Foundation (https://elephantconservation.org/), the Richard Lounsbery Foundation (https://www.rlounsbery.org/), the Earthwatch Institute (http://earthwatch.org/), Save the Elephants', Elephants and Bees Project (http://elephantsandbees.com/),Western Kentucky University (https://www.wku.edu/), Wildlife Works (http://www.wildlifeworks.com/saveforests/forests_kasigau.php), and Jomo Kenyatta University (http://www.jkuat.ac.ke/).

15. Financial Report to Date (January 31, 2018)

Item	Budget	Expenditures	Cost
Travel	$10,000 (adjusted to $11,350)	Airline ticket Board Room Vaccinations Visa	$ 1,283.26 $ 5,962.90 $ 3,960.00 $ 91.31 $ 52.53
Field Vehicle	$1,500 (adjusted to $250)	Gas	$ 250.00
Permit	$500 (adjusted to $400)	MS Research Permit Kenya	$ 400.00
Total	$12,000		$12,000.00

16. Digital Images

1. An elephant warily reaches underneath the control for the metal strip fence to eat corn rather than going through

2. Ahadi, one of the elephants in the catalog of bulls in Rukinga Ranch

3. Wildlife Works Fence attendants and Ranger after helping set up one of three bee apiaries

4. A *Lannea alata* exhibiting bark stripping damage by elephants which was tagged and measured by teams

5. A chili fence damaged by elephants at the experimental site in the farming community of Sasenyi

17. Video Clip

A family group drinking and bathing at Salama Dam

18. Presentation / Publication Plans

Githiru M, Mutwiwa U, Kasaine S, Schulte B. 2017. A spanner in the works: Human-elephant conflict complicates the energy-food-water nexus in drylands of Africa. Frontiers in Environmental Science, doi.org/10.3389/fenvs.2017.00069.

Planned for 2018:

Conferences

- 2018 International Elephant Foundation
- 2018 Animal Behavior Society (if not in field)
- 2018 Student Research Conference (R. Lynn Von Hagen)
- 2018 International Society for Behavioral Ecology (August, Minnesota) or Society for Conservation Biology (July, Toronto)

Publications

- MS Thesis by R. Lynn Von Hagen
- One publication on human-elephant conflict (peer-reviewed)
- One 'popular' article

19. Website, Blogs, Social Media Accounts

https://www.facebook.com/ElephantsandSustainableAgricultureinKenya/

https://wkunews.wordpress.com/2017/02/08/elephant-research-kenya/

http://www.bgdailynews.com/news/wku-professor-gets-funding-to-study-human-elephant-conflict/article_c65bfb09-dfa3-5e3a-b21a-c978229dbe10.html

https://www.facebook.com/permalink.php?id=108627465679&story_fbid=10155055396185680

https://elephantsinkenya.wordpress.com/

http://earthwatch.org/expeditions/elephants-and-sustainable-agriculture-in-kenya

http://wkuherald.com/news/professor-to-research-elephants/article_195bd418-35eb-5a07-ba30-a701a6ceea93.html

http://targetednews.com/nl_disp.php?nl_date_id=833129

http://www.epagepub.com/publication/index.php?i=419814&m=&l=&p=42&pre=

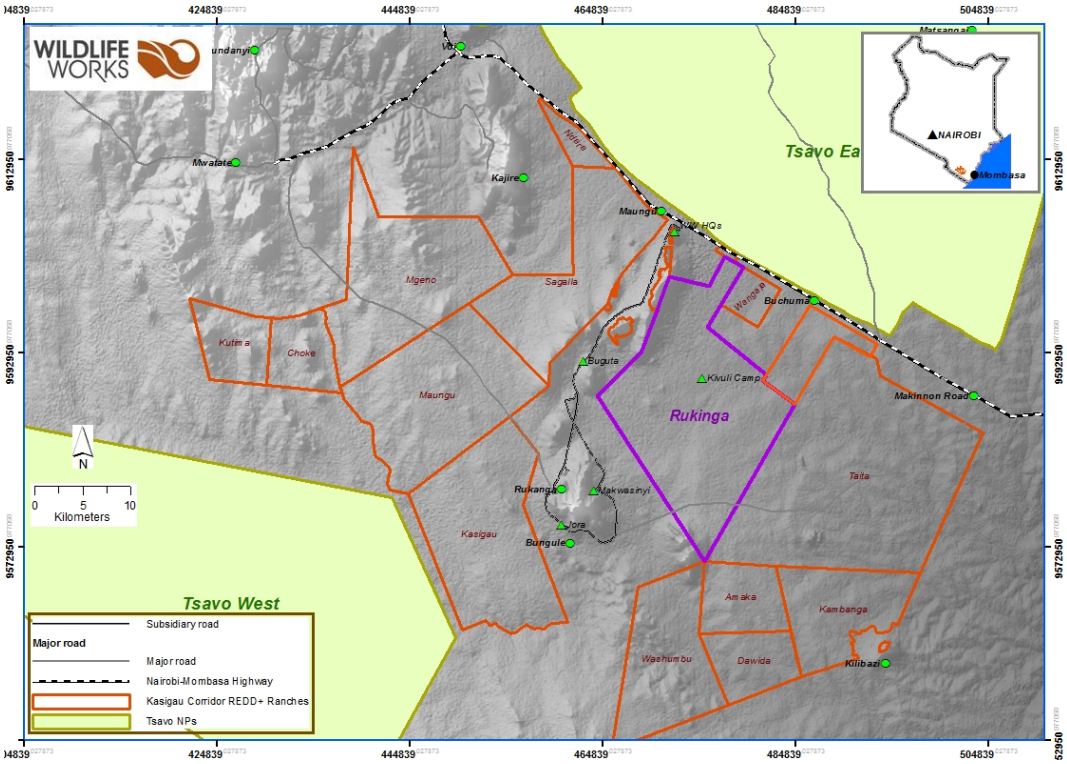

Figure 1. Map of project site location showing Rukinga Ranch as well as the rest of the Kasigau Corridor ranches in the REDD+ Project. (NB: Kivuli Camp will be Earthwatch project's main base.)