Earthwatch 2017 Field Report

Elephants and Sustainable Agriculture in Kenya

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LETTER TO VOLUNTEERS

Dear Earthwatch Volunteers,

The team would like to extend our gratitude for your assistance on the inaugural season of Earthwatch's *Elephants and Sustainable Agriculture in Kenya* project. Thanks to you, we have made significant progress towards the goals of the project. We have welcomed teams from across the world with a wide variety of skills. We have been impressed by the diversity of backgrounds and motivations for participating but the common denominators were a love of elephants and other wildlife, a concern for people, and the desire to conduct solid science with a conservation component. Each team member brought welcome advice and valuable abilities as we laid the ground work for this long-term project. We successfully constructed and deployed four different types of mitigation measures to test which were best at preventing elephant crop raiding in our experimental blocks at the farming community of Sasenyi, and documented crop raiding by several species. Two hundred and forty elephant-favored trees were tagged and measured to determine how elephant foraging changes over time, and our wildlife transects spotted over 3,000 individuals from 68 species, allowing us to further document the biodiversity on Rukinga ranch and evaluate how composition changes with season and elephant presence. The team catalogued over 70 individual bull elephants and 20 family groups. Further analysis of photographs taken by the field cameras at the experimental plots showed that eight of the identified bulls were crop-raiders. In addition, we are analyzing the biodiversity and photographic data to determine potential indicator species that will help give farmers an early warning as to when crop raiding may be eminent. With new projects, it is especially helpful to obtain insight from different viewpoints on ways to improve our experimental methods and analyses, and all the groups were excellent at giving us feedback. We met you as volunteers and we are now fortunate to count you as friends. Thanks to your efforts we have laid the groundwork for a project that will continue to investigate solutions to improve conservation of elephants and assist the people that live amongst them.

Asante Sana!

SUMMARY

Volunteers and the field team successfully deployed crop raiding mitigation measures at a local farming community and acquired data on over 300 individual crop raids by several species, and an apiary was established to incorporate bee hive fences in future growing seasons. Over 70 bulls, and 20 family groups of elephants were identified, with eight bulls confirmed as crop raiders. 240 elephant-favored trees were tagged and measured to be monitored for elephant damage. Weekly wildlife transects have quantified 68 species from 989 sightings and 3343 individuals.

GOALS, OBJECTIVES, AND RESULTS

Objective 1: *Developing the applied science of sustainable intensification using CSA (Climate Smart Agriculture)*

As the soil expert on the team, Dr. Urbanus N. Mutwiwa spent time at the field site with one of the early teams to evaluate the fields, examine the soils, and assess the crops grown. In terms of agricultural practices, we are awaiting results from our deterrent studies before making recommendations on agricultural practices in light of CSA and sustainable intensification.

Objective 2: *Applying the ecosystem approach to biodiversity conservation in agricultural landscapes*

Floral and faunal species richness is considered an indicator of the ability of an environment to provide ample ecosystem services (Maestre et al., 2012), such as carbon cycling. The area of the project, Rukinga ranch, was once a cattle farm and is still recovering from overgrazing. The ranch borders a farming community which sometimes illegally obtains firewood for personal use or charcoal manufacturing. These two factors in addition to elephant foraging may have an impact on the ability of this recovering forest to provide some vital ecosystem services. To observe the impact that elephants foraging has on native trees, we identified six driving transects throughout Rukinga ranch (Figure 1), and selected four sites from each transect that would be in a high transit area for elephants, such as water points. At each location 10 different elephant-favored trees were identified. This resulted in 240 different trees of 32 species (Table 1). For each tree, we measured height, canopy cover, and the amount and types of elephant damage, such as bark stripping (Figure 2), branch breaking, main stem breaking, uprooting, felling, or no damage. All trees were tagged with a unique physical ID, as well as a GPS waypoint. We re-visit the trees to assess when damage occurs across the rainy and dry seasons and see if crop raiding is correlated to changes in tree damage. We will determine if the trees in this area are especially vulnerable to elephant foraging since the area is still recovering from overgrazing and competing with the community for firewood, which directly impacts the ability of the trees to absorb CO_2. This also lays the foundation for future potential experiments, such as tree wrapping to prevent elephant damage.

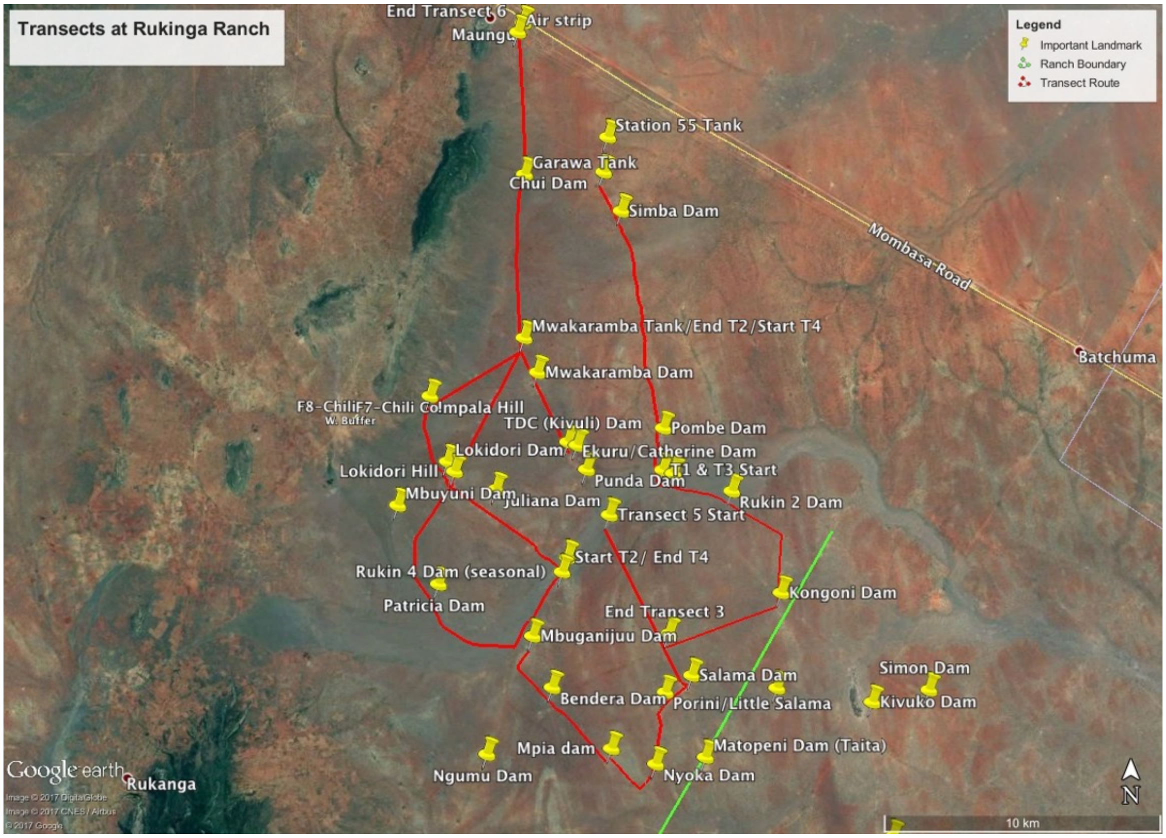

Figure 1: Transects established by Earthwatch project team for wildlife and tree transects

Table 1: The 32 tree species identified and tagged on Rukinga ranch assessed for elephant impact.

Genus (14)	Species (25)
Acacia	*bussei, etbaica, hockii, nilotica, robustica, tortillis, zanzibarica*
Albizia	*anthelmintica*
Balanites	*aegyptiaca*
Boscia	*coriiacea*
Boswellia	*neglecta*
Carissa	*edulis*
Cassia	*abbreviate*
Combretum	*apiculatum, exalatum*
Commifora	*africana, campestris, confusa, edultis,*
Cordia	*monoica, sinesis*
Delonix	*elata*
Diospyros	*mespiliformis*
Grewia	*bicolor, mollis, similis*
Lannea	*alata, rivae, schweimfurthii*
Manilkana	*moschisia*
Platycelyphium	*voense*
Sterculia	*africana*

Figure 2: A freshly bark-stripped tree, which was tagged by Earthwatch teams

Towards assessing the faunal biodiversity in the project area, wildlife transects were performed three times per week along the same established transects as used for tree assessment. At least two persons are required, and each visually surveys their designated area while the driver stays at 20 KPH or less. Birds of prey and all mammals are included in the survey, and when an animal is spotted the driver pulls parallel to the area the animal was initially seen. The GPS coordinate, time, species, age category, and distance from the vehicle are recorded. As elephants are the focus of this project, pictures are taken of them for ID purposes, along with additional notes. To date, over 80 transects have been performed, with 3393 individuals observed, representing 68 species (Table 2), some of which are listed as endangered. Data assessment is ongoing to determine if any fluctuations in population numbers might reveal species that indicate when crop raiding rates are expected to change. Our data complement a more expansive study in the area (Williams et al. 2017) that ran transects well beyond Rukinga ranch. The focus of our study was to narrow both geographic and temporal scales to see how biodiversity varies in the protected space of Rukinga ranch over the ebb and flow of elephant presence and crop raiding incidents. One of the co-PIs (Githiru) and one of the field assistants (Amakobe) are authors on cited publication from this larger study.

Table 2. Biodiversity transects with 989 sightings of 3343 individuals from 68 species.

Sightings	**Common name**
>150	Kirk's dik-dik
50-100	Giraffe, Eastern chanting goshawk, zebra, lesser kudu
20-49	Elephant, warthog, impala, buffalo, ostrich, oryx, Grant's gazelle, buff-crested bustard, baboon, secretary bird
10-19	Hartlaub's bustard, gerenuk, black-bellied bustard, white-bellied bustard, hartebeest, unstriped ground squirrel
1-9	A range of 50+ species of ground birds, raptors, and mammals

Objective 3: *Investigating how elephant ecological research and monitoring can contribute to mitigating for HEC, especially as an early warning system*

At the start of this study, limited data existed on the identity of elephants using the Rukinga ranch area as part of the Kasigau Wildlife Corridor and the Tsavao National Park ecosystem. McKnight (2015) established an elephant identification database for parts of the Tsavo National Park area, but it was not known if these elephants used Rukinga ranch. Williams et al. (2017) used ranger data to determine the use of the Kasigau Wildlife Corridor by elephants from 2012-2015. In their data, 2,011 elephant encounters involved 21,250 individual elephants but no attempts were made to determine elephant identity (i.e., how many unique elephants were sighted). For the present study, teams and staff encountered elephants in transit to other areas of the ranch, when conducting wildlife transects, and during specific sessions to locate elephants. When this occurred, the type of group, ages, sexes, and associations were recorded. When possible, photos of individuals were taken and processed with volunteers at camp to create catalog entries for the individuals (see sample Figure 3.) New sightings were checked against the existing database to determine if these were new individuals or re-sightings of already identified elephants. Catalog entries were also compared with camera trap footage in crop raiding experiments (see below) to determine individuals who are repeated crop raiders. This information can provide insight into the demographic composition of elephants that visit farms to crop raid. Currently, over 70 bulls have been individually identified with the majority being observed multiple times. Family groups on the ranch can be evasive when spotted, so while almost 30 groups have been partially identified, only two have been observed enough at close enough proximity to identify each individual. The catalog continues to grow, and comparing it with those of nearby conservation groups in the future may reveal even more information on elephant movements.

Original Date Sighted: 7/23/17
Original Location: Salama Dam
Original Group Size: 1

Individual	Age Class	Age	Notes
Ernest	Adult	25	Left tusk slightly sheared off

Additional Sightings

Date	Location	Group Size	With Whom?
8/9/17	TDC	1	N/A
8/21/17	TDC	4	Arnold, Mandela, & Jo
8/29/17	TDC	4	Shamba, Vuli, & Woltmann

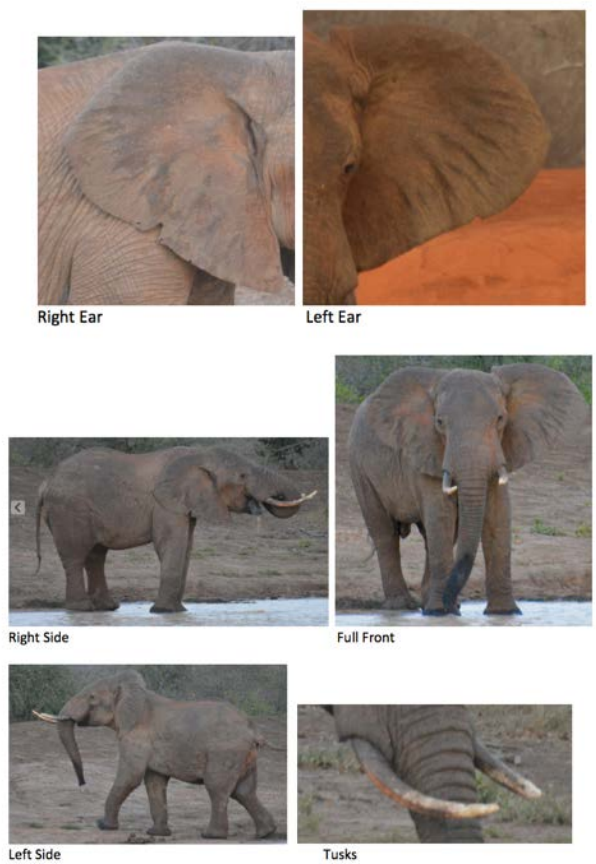

Figure 3: Example of a catalog entry for bulls, showing original sighting information, description, additional sightings, and photos of key identifying features.

Objective 4: *Evaluating how various deterrents work to reduce probability of elephant crop-raiding*

To assess and compare the efficacy of a variety of crop raiding deterrent methods, the team conducted an experiment in the Sasenyi area which borders Rukinga ranch. Four different blocks of farms were identified and leased from eight different families. Each family was compensated from the use of their land, and allowed to keep any remaining crops. This resulted in a direct impact on their livelihood, as they were compensated regardless of the status of their crops thus, farmers were eager to participate. In this region of Africa, crops are planted and harvested twice a year for the long rains and short rains. The beginning of the project occurred towards the end of the long rains, but farms were secured in hopes of more rain for the initial trial. Only one of the blocks mostly survived the drought. Each of the four blocks were divided into 8 fields, with an alley in between to prevent bleed over from deterrents. To maintain congruency each end had an additional buffer. All four blocks were measured out and had fence poles erected by local hired workers. Four different types of deterrent methods with matching controls were randomized and set up in the two blocks which survived.

Volunteers assisted with constructing all components of the deterrent methods. The first technique, a metal strip fence was invented by co-field team leader Simon Kasaine. Strips of metal are cut out from a locally available metal sheet by local workers and then volunteers use hammer and nail to punch holes in the tops of the metal pieces and string them along a sturdy binding wire, twisting the wire at intervals to prevent the strips from sliding too far. This fence is then erected in panels around the perimeter of the poles to enclose the field. The fence is an obvious physical barrier for elephants, and when a breeze blows, the fence acts like a giant wind chime. Since the sound is intermittent (and varies according to the strength of the wind) it could prevent habituation by elephants. The control for this method is a simple wire with periodic twists. (*This technique is not published yet so we have not provided photographs and would like this information kept general for any Earthwatch publication*).

The next technique tested was an acacia fence, which is commonly used for deterring goats and cows in the area from grazing in unwanted places (Figure 4). Local acacia trees are cut (sometimes illegally from the ranch) and their sharp thorns prevent easy entry into fields. The hypothesis for this deterrent was that it would not affect elephants' ability to forage in these fields, and the control was no deterrent method at all. This provided a way to have one large control to measure the elephants and other animals' interest in the crops and an area that we could replace with a different deterrent in future trials (see below). A short layer of acacia was placed in front of all the active blocks to prevent livestock foraging.

Figure 4: Acacia fence used to deter livestock and other animals from entering farms.

Chili pepper fences have experienced varied success across areas where crop raiding is an issue (Chang 'a et al., 2016; Hedges & Gunaryadi, 2010; Karidozo & Osborn, 2015) and a variation on these fences was previously attempted at the Sasenyi community. Our experiment followed the construction manual provided from an experiment of Chang 'a, which resulted in a 100% success rate (Chang'a et al., 2015). Volunteers helped make sisal rope bundles and tie cloth flags, which when dipped in a mixture of used engine oil and crushed chili peppers result in a fence panel that emits a noxious odor (Figure 5). The control for this method was an identical fence, but with only motor oil saturated on the cloths and ropes.

Figure 5: Chili pepper fence panel deployed after soaking in motor oil and crushed chili peppers.

The last deterrent method was a combination of the chili pepper fence and metal strip fence. The control for this method was the motor oil soaked flags and ropes with the wire metal control placed beneath it. *(Again, no photographs are provided)*. In addition to placing the deterrent methods, staff and volunteers placed and monitored 27 camera traps which took a variety of images (Figure 6). After harvest, elephants continued to visit the farms and monitoring continued with the volunteer teams. For the second trial, beginning in November, one farmer elected not to participate, and the last volunteer team assisted with moving the deterrents to an adjoining plot.

(a) Duiker

(b) Male bull" Shamba"

(c) Eland

(d) Family group of elephants

(e) Giraffe just outside the farming community

(f) Male elephant deterred my metal strip fence

Figure 6: A variety of camera trap images retrieved from the experimental blocks at Sasenyi of animals' crop raiding

The first trial had little replication, and crops only survived in certain areas, providing a variety of levels of attraction to the wildlife. Thus, no conclusions can be inferred on which method performed best, but over 300 separate occurrences of animals in the proximity of fields were recorded, with elephants successfully crop raiding 29 times and being deterred 12 times. However, these numbers can be misleading as the successful crop raids included acacia and acacia control, and some fields such as the chili + metal were never raided because they had no crops. In the second, ongoing trial, all blocks have been at least partially successful with an even distribution of crops, thus analysis will be more telling. One surprising outcome was that the metal control fence deterred animals (mostly elephants) nine (9) times in the first trial. This method turned out to be very difficult to see, even by the field staff during the day. Thus, it may be undetectable by elephants at night, and when an elephant contacts it, might flee thinking it has encountered an electric fence. Therefore, an unexpected deterrent treatment might be quantifiable from this study. (NO PICS, NOT PUBLISHED YET) Elephants only disrupted the metal strip fence four (4) times during the entire first trial, which shows promise, since elephants were in the proximity of the fields over 70 times.

One of the deterrent methods the project hoped to incorporate was beehive fences. Towards that goal, we initiated a collaboration with Dr. Lucy King of the Elephants and Bees Project from the NGO Save the Elephants in nearby Sagalla. An apiary has been erected in Sasenyi (Figure 7) to attempt colonization of our beehives, so that they can be incorporated into active beehive fences. If colonization is high, the acacia fences can be replaced by bee hive fences in one or more blocks in the third trial in the long rains for 2018. Several teams also visited the Elephants and Bees Center in Sagalla.

Figure 7: Apiary shelves constructed by the workshop team at Wildlife Works which now house 24 beehives at Sasenyi.

PROJECT IMPACTS

1. Increasing Scientific Knowledge

a) Total citizen science research hours

Typical volunteer day:

Training at camp or on site: 30 min
Transit to work areas: 30 min
Working on site or at camp: 4-5 hours
Data processing or in camp work: 1 hour
Game drives/ Elephant ID: 2 hours
Total typical work day: 8 hours X 10 days= 80 volunteer hours per person per team

b) Peer-reviewed publications

Githiru M, Mutwiwa U, Kasaine S and Schulte B (2017) A Spanner in the Works: Human–Elephant Conflict Complicates the Food–Water–Energy Nexus in Drylands of Africa. *Frontiers in Environmental Science* 5:69. doi: 10.3389/fenvs.2017.00069

c) Non-peer reviewed publications:

Technical reports, white papers, articles, sponsored or personal blogs

Bilski, K (2017) Elephants and Sustainable Agriculture in Kenya: An Earthwatch Expedition. *Journal of the Elephant Managers Association.* 28(3). http://fliphtml5.com/bulu/lfrr/basic

Elephants and Sustainable Agriculture in Kenya Facebook page: https://www.facebook.com/ElephantsandSustainableAgricultureinKenya/

Blog: https://elephantsinkenya.wordpress.com/about-the-project/

Research Gate: https://www.researchgate.net/project/An-investigation-of-Mitigation-Techniques-Utilized-to-Alleviate-Human-Elephant-Conflict-HEC-in-the-Kasigau-Wildlife-Corridor-Kenya

News Items:

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

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

d) Books and book chapters: NA

e) Presentations:

Indicate if this was an invited paper, panel presentation, keynote speech, plenary address, or other.

Schulte BA. Elephants and Elephant Conservation. University of Louisville. 11/9/2017. Invited.

Schulte BA. Elephant Conservation: Hope for the most Prominent Proboscis? Science Café, Bowling Green, KY, a SKySciFestival Event. 5/29/2017. Invited.

Schulte BA. Chemical communication and social behavior of elephants with applications for conservation. Penn State University. 3/16/17. Invited.

Von Hagen RL, Kasaine S, Mutwiwa U, Githiru M. Amakobe B, Schulte BA. An exploration of chili pepper (capsicum spp.) fences as a crop raiding deterrent method to alleviate human elephant conflict (HEC) in the Kasigau Wildlife Corridor, Kenya. WKU Student Research Conference, March 2017.

2. Mentoring

a) Graduate students

List graduate students doing thesis work on the project and include student CVs and their research proposal on file with the university as an attachment when you submit your annual report

Student Name	Graduate Degree	Project Title	Anticipated Year of Completion
R. Lynn Von Hagen	MSc candidate	An investigation of Mitigation Techniques Utilized to Alleviate Human Elephant Conflict in the Kasigau Wildlife Corridor, Kenya	2018

b) Community outreach

Provide details on how you have supported the development of environmental leaders in the community in which you work.

Name of school, organization, or group	Education level	Participants local or non-local	Details on contributions/ activities
Austin Peay State University, TN	College undergraduate	Non-local	Keynote speaker at the NSF bridge program discussing how to pursue goals, perfrom research, and obtain graduate research positions
Bowling Green Christian Academy, KY	Elementary School	Local	Presentation on why elephant conservation is important
Sasenyi School, Kenya	Elementary	EW teams	Visited, interacted with children, spoke with teachers, donated items

3. Partnerships

List your current active professional partnerships that contribute to your project and indicate the type of support these partners provide

Partner	Support Type(s)[1]	Years of Association (e.g. 2006-present)
Dr. Lucy King, Save the Elephants	Collaboration	2016-present
Cara Braund, Wildlife Works	Logisitcs, cultural support, permits	2015-present
Keith Hellyer, Wildlife Works	Data-gyrocopter reporting of elephant sighting	2016-present

1. Support type options: funding, data, logistics, permits, technical support, collaboration, academic support, cultural support, other (define)

4. Contributions to management plans or policies

List the management plans/policies to which your project contributed this year

Plan/Policy Name	Type[2]	Level of Impact[3]	New or Existing?	Primary goal of plan/policy[4]	Stage of plan/policy[5]	Description of Contribution

2. Type options: agenda, convention, development plan, management plan, policy, or other (define)
3. Level of impact options: local, regional, national, international
4. Primary goal options: cultural conservation, land conservation, species conservation, natural resource conservation, other
5. Stage of plan/policy options: proposed, in progress, adopted, other (define)

5. Conserving natural and sociocultural capital

a) Conservation of taxa

i. List any focal study species that you did not list in your most recent proposal

Species	Common name	IUCN Red List category	Local/regional conservation status	Local/regional conservation status source

ii. In the past year, has your project helped conserve or restore populations of species of conservation significance? If so, please describe below.

Species	IUCN Red List category	Local/regional conservation status	Local/regional conservation status source	Description of contribution	Resulting effect[6]

6. Resulting effect options: decreased competition, improved habitat for species, range increased, population increase, improved population structure, increased breeding success, maintained/enhanced genetic diversity, other

b) Conservation of ecosystems

In the past year, has your project helped conserve or restore habitats? If so, please describe below.

Habitat type	Habitat significance[7]	Description of contribution	Resulting effect[8]

7. Habitat significance options: nursery, breeding ground, feeding site, corridor, migration path, refuge, winter range, summer range, spring range, fall range or other (define)
8. Resulting effect options: extent maintained, condition achieved, restored, expanded, improved connectivity or resilience

c) Ecosystem services

Indicate which ecosystem service categories you are directly studying in your Earthwatch research and provide further details in the box below.

☐Food and water

☐Flood and disease control

☒Spiritual, recreational, and cultural benefits

☐Nutrient cycling

Details:

Crop raiding by elephants directly impact the livelihood of local people by preventing or negatively impacting crop harvests, creating human elephant conflicts. A goal of the project is to help farmers find ways to deter elephants without causing them harm, which could result in improved viewpoints towards elephant conservation and retention of their ability to secure their livelihoods

d) Conservation of cultural heritage

Provide details on intangible or tangible cultural heritage components that your project has conserved or restored in the past year.

Cultural heritage component[9]	Description of contribution	Resulting effect

9. Cultural heritage component options: traditional agriculture, artifacts, building(s), hunting ground or kill site, traditional ecological knowledge and practices, monument(s), oral traditions and history, spiritual site, traditional subsistence living

RESEARCH PLAN UPDATES

Report any changes in your research since your last proposal/annual report. For any 'yes' answers, provide details on the change in the 'Details' box.

1) Have you added a new research site or has your research site location changed? ☐**Yes** ☒**No**
2) Has the protected area status of your research site changed? ☐**Yes** ☒**No**
3) Has the conservation status of a species you study changed? ☐**Yes** ☒**No**
4) Have there been any changes in project scientists or field crew? ☐**Yes** ☒**No**

ACKNOWLEDGEMENTS

We are thankful to all the farmers who participated in our study as well as the field assistants and of course, the Earthwatch volunteers. We are also grateful for the support from the Richard Lounsbery Foundation to help launch this research project.

LITERATURE CITED

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Chang 'a A, Souza N, Muya J, Keyyu J, Mwakatobe A, Malugu L, Ndossi HP, Konuche J, Omondi R, Mpinge A, Hahn N, Palminteri S, Olson D. (2016) Scaling-up the use of chili fences for reducing human-elephant conflict across landscapes in Tanzania. Tropical Conservation Science 9(2): 921-930.

Hedges & Gunaryadi. 2010. Reducing human-elephant conflict: do chillies help deter elephants from entering crop fields? Oryx 44(1):139-146.

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Maestre FT, Quero JL, Gotelli NJ, Escudero A, Ochoa V, Delgado-Baquerizo M, Garcia-Gomez M, Bowker MA, Soliveres S, Escolar C, Garcia-Palacios P, Berdugo M, Valencia E, Gozalo B, Gallardo A, Aquilera L, Arredondo T, Blones J, Boeken B, bran D, Conceicao AA, Cabrera O, Chaieb M, Derak M, Eldridge DJ, Espinosa CI, Florentino A, Gaitan J, Gabriel Gatica M, Ghiloufi W, Gomez-Gonzales S, Gutierrez JR, Hernandez RM, Huang X, Huber-Sannwald E, Jankju M, Miriti M, Monerris J, Mau RL, Moric E, Naseri K, Ospina A, Polo V, Prina A, Pucheta E, Ramirez-Collantes DA, Romao R, Tighe M, Torres-Diaz C, Val J, Veiga JP, Wang D, Zaady E. 2012. Plant species richness and ecosystem multifunctionality in global drylands. Science 335:214-218.

McKnight BL. 2015. Relationship between group dynamics and spatial distribution of African elephants in a semi-arid environment. African Journal of Ecology DOI: 10.1111/aje.12223.

Williams HF, Bartholomew DC, Amakobe B, Githiru M. 2017. Environmental factors affecting the distribution of African elephants in the Kasigau wildlife corridor, SE Kenya. African Journal of Ecology DOI: 10.1111/aje.12442.