

Evaluating the Effects of a Conservation Intervention on Rural Farmers' Attitudes toward Lions

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Data availability statement

Data supporting the results presented in the paper can be obtained by emailing lovemore.sibanda@zoo.ox.ac.uk

Disclosure statement

We declare no conflict of interest.

Abstract

Using an experimental approach, we analyzed the self-reported changes in farmers' attitudes towards the African lion (*Panthera leo*) and a community-based lion conservation program (i.e., the Long Shields Community Guardians), before and after implementation. This program protects livestock and mitigates lion depredation through non-lethal means, with the aim of promoting human-lion coexistence. Results indicated a significant positive shift in attitudes of lions by farmers in the treatment group. This was also the case for farmers in what was recognized as a second unplanned treatment group, called the intermediate group, who learned about the program through communication within their peer network. This article contributed to the growing literature on conservation evaluation and demonstrates that people's attitudes are valuable for assessing the impact of conservation programs.

Keywords: conservation, *Panthera leo*, human-lion coexistence, intervention, Long Shields Community Guardians program, impact evaluation

Introduction

Three-quarters of the world's large carnivore species are under threat due to habitat destruction, prey depletion and persecution by humans (Inskip & Zimmermann, 2009). These pressures will only intensify with an ever-increasing human population (Wolf & Ripple, 2016). A species prone to conflict with humans is the African lion (*Panthera leo*), a keystone species in the African savannah, and both economic (e.g., tourism) and cultural values (IUCN, 2016). These values alone, however, are often insufficient to provide widespread protection, and the world's lion population has been severely reduced (Bauer et al., 2016).

A primary threat to lion populations is direct persecution by farmers in retaliation for real or perceived livestock loss (IUCN, 2016). Livestock are an important source of income, food, and cultural significance (Sibanda et al., 2020). If carnivore depredation occurs retaliatory killing can ensue (IUCN, 2016). Lions are killed by farmers using wire-snares and poison (Bauer et al., 2016). This is true for lions in Zimbabwe's Hwange-Matetsi Protected Area Complex (HMPAC), which hosts one of six remaining lion populations numbering over 1,000 (IUCN, 2016).

The impacts of humans on lions have been studied in the HMPAC. Most lion attacks on livestock occur at night when livestock are left to freely graze instead of being secured in protective enclosures (Kuiper et al., 2015). Between 2008 and 2016 lions killed over 1,000 domestic animals and farmers killed at least 50 lions in response to attacks on livestock (Loveridge et al., 2017). This presents an opportunity to develop and implement locally relevant conservation interventions that raise awareness of these impacts and build knowledge and skills to reduce negative impacts on livelihoods.

Methods to protect livestock from wild carnivores have ranged from protective enclosures (Sutton et al., 2017) to livestock guarding dogs (Marker et al., 2005). There is, however, no universally applicable solution to reducing human-carnivore conflict. For example, Heberlein and Ericsson (2008) predicted that hostility towards large carnivores can

increase over time with an increase in individual reports, stories and negative experiences.

Houston et al. (2010) suggest that familiarity with large carnivores can reduce negative sentiments. It is crucial that the impact of wild carnivores on humans are adequately addressed, through locally targeted and culturally appropriate interventions, recognizing that a solution that is effective in one area might have undesirable effects in another (Dickman & Hazzah, 2016).

Theoretical Background

Evaluation is a process that critically examines the extent to which the intervention's intended outcome has been achieved (Gertler et al., 2011). Evaluation enables conservationists to show which interventions work and which ones do not so that limited resources can be best used for maximum benefits (Ferraro & Pattanayak, 2006).

Conservationists can learn from their mistakes and not to waste time on ineffective interventions (Gunaryadi et al., 2017). However, most conservation interventions designed to mitigate the conflict between humans and wild animals, have not been evaluated scientifically (van Eeden et al., 2018). Identified reasons include limited financial resources and difficulties related to study design (Baylis et al., 2016). According to Sutherland et al. (2004), the lack of evaluation has slowed progress towards evidence-based conservation.

Most published articles on impact evaluation have largely focused on measuring decreases in livestock loss to illustrate effectiveness (Miller et al., 2016), rather than quantifying changes in human attitudes or adoption of desired behavior. The latter are often more meaningful measures of success, having a positive impact on the former (Hogg & Vaughan, 1995). Perception refers to how a person observes, interprets and evaluates an experience, object, action or other social entity (Pickens, 2005). Attitudes 'represent a positive or negative evaluation of an object (e.g., a program), and can influence how an individual behaves toward a wildlife species or conservation action (Bennett 2016, p. 588).

Attitudes influence behaviors and are invaluable for conservation evaluation (Manfredo & Dayer, 2004).

In 2012 in collaboration with the local community, we developed the Long Shields Community Guardians program (hereafter: the *Long Shields program*), a non-lethal, community-based, human-lion conflict intervention that encouraged local subsistence farmers to learn about, and adopt proactive behaviors that reduce the risk of livestock depredation. The Long Shields program was modelled on the Lion Guardians program in Amboseli, Kenya, which aims to provide non-lethal solutions, from educational outreach to actively deterring lions, to reduce human-lion conflict and promote coexistence (Hazzah et al., 2014).

We used the Theory of Change (ToC), a methodology following a logical, ordered sequence to designing a program or evaluation (Woodhouse et al., 2015), to illustrate the inputs, activities, target audiences, and desired outcomes of the Long Shields program (Figure 1). The ToC conceptual framework is useful in collecting baseline data and prioritizing the activities and goals of future programs (Morehouse et al., 2020). ToC is flexible and has been used in different conservation contexts such as evaluating the impacts of illegal wildlife trade (Biggs et al., 2017), public awareness campaigns (Howe et al., 2012) and human-wildlife conflict mitigation efforts (Morehouse et al., 2020).

Using ToC, we hypothesized that: (a) a reduction in livestock loss to lions (both perceived and actual); (b) reduction in human safety risk; and, (c) awareness of and demonstrated effort by the Long Shields Community Guardians, would positively shift farmers' attitudes towards lions, and motivate adoption of this program (Figure 1). Our efforts should result in positive attitudes of the Long Shields program itself.

In this article, we sought to establish whether the Long Shields program was effective in influencing a positive shift in attitudes towards lions. We utilized a quasi-experimental design to estimate the effects of an intervention in situations where random allocation of subjects to treatment and control groups is not possible (DiNardo, 2008). Researchers use

quasi-experimental design because of ethical considerations, difficulty in randomizing subjects, and small sample sizes (Woodhouse et al., 2015). We chose this design to avoid ethical issues associated with random assignment of subjects to treatment (DiNardo, 2008).

More specifically, (a) we examined attitudes towards lions before and after the implementation of the Long Shields program, and compared the changes between farmers that participated in this program (i.e., treatment group) and those that did not (i.e., control group). We hypothesized that the program would lead to a significant positive shift in attitudes towards lions for participating farmers compared to non-participating farmers. We also explored farmers' attitudes of the Long Shields program compared to other lion conflict mitigation strategies (i.e., electric fence, livestock herding, compensation, canvas mobile bomas¹, lethal control). This article contributed to the impact evaluation literature and demonstrated that attitudes are useful for assessing the impact of conservation programs.

[Insert Figure 1: Theory of Change model for the Long Shields program]

Methods

Study Area

This case-study was conducted in 82 villages across three rural communities alongside the boundaries of HMPAC. Two communities bordered Hwange National Park: Tsholotsho (Matupula and Siphoso Chieftainships, 2,171 km², 42 villages) and Mabale (Nelukoba-Dingani Chieftainship, 480 km², 11 villages), while Victoria Falls (Mvuthu and Shana Chieftainships, 655 km², 29 villages) bordered Zambezi National Park (Figure 2). The smallest unit was a farmstead (a group of individuals related by blood or marriage living together), several farmsteads of up to 25 (range: 6 - 86 farmsteads) made up a village. Each village was administered by a village head and several villages made a community (range 11 - 42 villages). The three communities were selected based on their: (a) proximity to protected

¹ a novel method that uses polyvinyl chloride (pvc) curtains to house and protect livestock against wild carnivores at night

areas; (b) differences in ethnic groups; (c) financial losses to depredation; and (d) benefits from Communal Areas Management Program for Indigenous Resources (CAMPFIRE). The study area is semi-arid with an average annual rainfall of 550-600mm (Loveridge et al., 2017). Livestock included cattle (*Bos taurus*), donkey (*Equus asinus*), sheep (*Ovis aries*) and goat (*Capra hircus*). Methods used to guard livestock against wild carnivores included herding during the day and penning livestock at night (Kuiper et al., 2015). Electric fences and compensation were currently not in use, although farmers mentioned that these methods existed in the 1970s and 1980s (Sibanda et al., 2020).

[Insert Figure 2: A map of our study area in northwestern Zimbabwe]

Case-Study: Long Shields Program

In setting up the Long Shields program, we followed six key stages. First, we conducted a baseline survey to understand the attitudes of farmers towards lions and factors influencing these attitudes (Sibanda et al., 2020). In consultation with the local traditional leaders, we used the Theory of Change framework to develop a logical model of behavioral change. Thereafter, we recruited our Community Guardians ($n = 14$), residents in the area and recommended by local traditional leaders and the wider the community. We selected candidates based on previous direct experience with lions (e.g., people who had physically chased a lion), literacy, residency within the local area and good standing in the community. Community Guardians were then trained by the Trans-Kalahari Predator Project (WildCRU) in lion tracking and the use of radio-telemetry, Global Positioning System (GPS) data collection protocols (e.g., livestock depredation assessment) and conflict mitigation techniques (e.g., herding, enclosure fortification). Community Guardians assisted their peers to: (a) recover missing livestock; (b) build strong livestock enclosures; (c) warn farmers of approaching lions; and (d) haze or chase problem lions back into the park. We piloted the program in Mabale communal area for six months (August - December 2012) before expanding the program to Tsholotsho communal land in January 2013 and Victoria Falls in

June 2016. Between 2013 and 2017, we identified 21 lions (males = 14; females = 7) (Mabale = 6; Tsholotsho = 9; Victoria Falls = 6) and fitted them with (satellite) GPS collars to monitor their movement. We selected lions for collaring based on their home ranges overlapping local farming communities outside of the protected areas and whether the animals were likely to disperse (e.g., young males). Each satellite collar took one location every two hours. Whenever lions were within three kilometers of a protected area boundary, a warning message was sent via Community Guardians to a network of farmers within treatment villages. Lions that crossed the park boundary and approached human settlements would be hazed (chased) by the Community Guardians plus volunteers within the treatment villages using a ‘vuvuzela’, a plastic horn that produces an irritating sound of about 127 decibels (dBA) (Petracca et al., 2019).

Evaluation Design

To evaluate the changes in attitudes towards lions, we used a quasi-experimental design with Before-After Control-Intervention (BACI) measurements. We surveyed treatment and control groups of farmers simultaneously before and after the introduction of the Long Shields program. Of the 82 villages, 50% ($n = 41$ villages) were selected to participate in the Long Shields program while the remainder ($n = 41$) villages were not exposed to any treatment. The selection of villages in the program was *not* random given the objective of this program was to solve a real-world problem. We selected villages that previously sustained significant livestock depredation to be part of the program.

Data Collection and Sampling

Data were collected before and five years after the Long Shields program was implemented, hereafter designated the pre-program and post-program surveys. Prior to program implementation, data were collected between 2010 and 2012 preceding the introduction of the Long Shields program. Data were collected using a face-to-face semi-structured interview format. The survey protocol was pilot-tested in Mabale, on 20 randomly

selected farmers of varying age and gender. We included their responses in the final analysis. For full-scale evaluation, we used a systematic sampling approach to select every fifth household in each of the 82 villages and interviewed one adult male or female (i.e., self-identified ‘head’ of farmstead) in each home, attempting to interview males and/or females over 18 years as equally as possible. We used this approach to avoid a clustered selection of respondents. In total, we interviewed 632 farmers [Mabale = 124, Tsholotsho = 234 and Victoria Falls = 274; response rate = 100%]. The sample was proportionate to the total farmer population at each site. We explained the study’s purpose before each interview; all interviewees consented to voluntarily participate (Brittain et al., 2020). Interviews were conducted in the farmer’s language of choice (i.e., *isiNdebele*, *chiNambya* or *chiTonga*) and responses were transcribed in English.

Measuring Attitudes

The interviewer asked: ‘How much do you like or dislike lions and why?’ Farmers selected a response from a five-point scale: ‘5 = strongly like’, ‘4 = like’, ‘3 = neither like nor dislike’, ‘2 = dislike’ and ‘1 = strongly dislike’ and explained why. We also asked farmers their views on what they would ‘like to see happen to the current lion population, around your village, in the future and why?’ Responses included: ‘increase’, ‘decrease’ and ‘stay the same’ and also explained why. Questions we used to assess farmers’ familiarity, level of participation and attitudes towards the Long Shields program are listed in Table 1.

[Insert Table 1: Statements used to measure attitudes and tolerance towards lions]

In August 2017, we repeated the same face-to-face interviews with the same farmers, to determine the impacts of the program after implementation. We also added new questions to assess the farmers’ awareness of the program, level of participation, and overall attitudes towards the program itself. To help minimize possible interviewer and respondent bias, data were collected by four independent interviewers (woman = 1, men = 3) different

from those in 2010-2012. The trained interviewers were not aware of which villages had participated in the program previously to avoid bias in recording responses.

During post-program surveys we found evidence that treatment and control groups exchanged information about the Long Shields program, including lion warnings provided to participating villages. As such, in addition to the treatment and control group, we found we needed to include a third analysis group (an intermediate group). We defined the intermediate group as farmers who were originally assigned to the control group but exchanged information about lions and the intervention with farmers in the treatment group.

Data Analysis

We used linear regression models to examine whether demographic and socio-economic characteristics of farmers that participated in the Long Shields program were similar between groups. Dependent variables included: (a) age, (b) household size, and (c) livestock holdings, while treatment status and communal area were independent variables.

Changes in Attitudes towards Lions

To test for changes in lion attitudes between treatment, control and intermediate groups, we first calculated the difference-in-difference (Abadie, 2005) score by coding from 1 (“strongly dislike”) to 5 (“strongly like”) and subtracted the score ‘before’ from the score ‘after’ the introduction of the Long Shields program. The scale for ‘change in attitudes’ ranged from -4 to +4 where the extremes represented a shift from ‘strongly like’ to ‘strongly dislike’ and from ‘strongly dislike’ to ‘strongly like’ respectively; 0 represented ‘no change’. Logistic regression models were fitted with a cumulative-link function (“*clmm*”) (Christensen, 2015). We tested if the changes in attitudes of farmers participating in the Long Shields program were significantly different from those in the control group. The calculated difference-in-difference scores were included in the candidate model as the dependent variable while the: (a) treatment status (control, intermediate and treatment) and (b) area (Mabale, Tsholotsho, Victoria Falls) were included as categorical independent variables. We

controlled for possible clustering of similar responses between study villages by adding the variable ‘village’ as a random-effect to the model. We used the ‘*sure*’ package (Liu & Zhang, 2018) to scrutinize model diagnostics using surrogate residuals. To test for significant ($p \leq .05$) differences in attitudes between the treatment, control and intermediate groups, we performed Likelihood Ratio Tests (LRT) comparing models with and without the effect of interest. All analysis were conducted in R statistical software (R Core Team, 2019).

During our post-program surveys we found evidence that treatment and control groups of farmers exchanged information, as a result, we calculated the ‘effective communication range’ (i.e., the distance between farmers in the treatment and intermediate groups where communication channels influenced a change in attitudes). To determine this, we used the function ‘*variog*’ in R-package ‘*geoR*’.

Results

We interviewed 338 subsistence farmers; we excluded nine interviews from the analysis because of missing responses to key questions. The remaining 329 interviews used in analysis included farmers from the Mabale ($n = 64$), Tsholotsho ($n = 125$) and Victoria Falls ($n = 140$) communal areas. Of these, 55% were men and 45% were women, with an average age of $59.73 \pm (SD = 14.78)$. Fifty-three percent of the farmers were part of the treatment group, 19% in the intermediate group, and 28% in the control group.

Farmer Characteristics

The average age of the farmers ($Z = -.35, p = .72$), livestock holdings ($Z = .36, p = .72$) and household size ($Z = .77, p = .44$) were similar for the treatment and the control group, with intermediate group calculation included here in the control group. Sources of human livelihoods remained the same over the study period, both before and after introduction of the Long Shields program. Crop farming and livestock rearing were listed as the primary livelihood sources.

Changes in Attitudes towards Lions

Compared to before, results indicated a positive shift in self-reported attitudes towards lions after the introduction of the Long Shields program, for farmers in both the treatment and intermediate groups (Figure 3). This before-after change was influenced by participation in the Long Shields program ($F = 2.95$, $df = 2$, $p = .05$). The change in attitudes was significantly different to the control group (Table 2). No evidence suggested these changes were affected by the communal area that farmers lived in ($F = 1.91$, $df = 2$, $p = .36$).

[Insert Figure 3: A bar plot illustrating changes in self-reported attitudes towards lions]

[Insert Table 2: Parameter estimates of an ordinal regression model]

We also found that since the introduction of the Long Shields program, farmers' opinions of lion population status have changed, with more farmers indicating they would like to see either stable or increasing lion populations across the area (Table 3). However, their participation in the Long Shields program had no detectable effect on desired lion population trends ($F = 1.13$, $df = 2$, $p = .34$), nor did the communal area in which a farmer lived ($F = .41$, $df = 2$, $p = .66$).

[Insert Table 3: Farmers' desired lion population trends before and after the program]

Attitudes towards the Long Shields Program

Of the farmers that participated in the Long Shields program (i.e., treatment and intermediate groups), 87% agreed with the statement that lions have the right to exist, with 32% indicating they are now less fearful of lions because of the Long Shields program. Over half (52%) of participating farmers indicated that because of the program they were less concerned about lions attacking livestock at night, and 64% strongly agreed that depredation incidents had decreased as a result of the Long Shields program. Since 2013, over 100 livestock enclosures had been reinforced, and over 2,200 messages warned farmers of approaching lions. Over ninety percent (91%) of farmers agreed the early-warning messages

helped them avoid direct livestock losses to lions (Figure 4). No evidence suggested these attitudes were affected by the area that farmers lived ($F = 2.39$, $df = 2$, $p = .09$).

[Insert Figure 4: A bar plot of Likert-scaled statements regarding the program's ToC]

Ninety percent of farmers in Long Shields program felt the program was important. Perceived benefits of the program included the early-warnings of approaching lions (52%), the program physically deterring lions off village lands (15%), collating livestock depredation reports (11%), and educating farmers on building lion-proof livestock enclosures (7%). Upon receiving warning messages 78% of the farmers more closely monitored their livestock and avoided areas of high lion risk, and 8% of farmers in the treatment group had assisted Community Guardians to physically deter a lion back into the park.

In contrast to other human-lion conflict interventions (i.e., electric fence, livestock herding, compensation, canvas mobile bomas, lethal control), 21% of farmers perceived electric fences as the most effective technique to protect against lion depredation, followed by traditional livestock herding (19%) and canvas mobile bomas (18%). Seventeen percent of farmers believed the Long Shields program was the most effective technique; lethal removal (15%) and financial compensation (10%) ranked fifth and sixth respectively.

Fourteen percent of farmers shared lion warning messages with neighboring farmers across other villages. The effective communication range was 177.82 m (Figure 5). Conceivably, this is how a proportion of the farmers in the control group, which we in turn categorized as the intermediate group, became aware of the Long Shields program.

[Insert Figure 5:

An omnidirectional variogram illustrating the effective communication range]

Discussion

We evaluated farmers' attitudes towards lions, before (2010) and after (2017) the Long Shields program was implemented. Surveys conducted before the Long Shields program was introduced revealed that a majority (>90%) of farmers in our study area largely

held negative attitudes of lions, with perceived livestock depredation cited as the primary reason influencing this negativity (Sibanda et al., 2020). This work informed both the design of the Long Shields program and evaluation, hypothesizing that a decrease in (real or perceived) lion-caused livestock depredation would result in a positive shift in farmer attitudes and result in adoption of proactive mitigation techniques (Figure 1).

As expected, farmer participation in the Long Shields program, and even familiarity with the program, resulted in a positive shift in attitudes of participating farmers (treatment and intermediate groups) towards lions compared to those in the control group. This included farmers' opinions regarding the desired state of future lion population in the area, dropping from 93% to 65% of those wanting to see the population decrease. Farmers part of the program thought the current lion population could be managed with the help of the Community Guardians. These findings were comparable to those of a study conducted in southern Kenya, where attitudes of Maasai warriors towards lions improved following the implementation of the Lion Guardian program (Hazzah et al., 2017).

Nearly two-thirds (63%) of farmers that were part of the program reported livestock depredation had decreased, attributed to the Long Shields program. This perception by farmers is supported by our preliminary analysis on livestock depredation, which showed a 40% drop in livestock losses for farmers directly involved in the Long Shields program, which is larger than the drop experienced by farmers who were not part of this program. The majority of participating farmers were largely responsive to early-warning messages about lions in their vicinity, delivered through the WhatsApp system (> 2,200 messages sent to farmers in 5 years). This enabled farmers to monitor their livestock and avoid grazing in areas of high lion risk, thereby reducing the threat of depredation. Over 90% of the farmers stated this was the most important activity of the Long Shields program. Similarly, a study in northern Botswana showed that warning people of approaching lions is an effective tool against lions because it encourages active risk management (Weise et al., 2019).

In contrast, fewer than 50 farmers approached the Community Guardians for assistance recovering lost livestock, despite the program offering this to farmers needing help. These low numbers suggest this activity may not be needed or relevant to farmers or may not be well known or understood. Similarly, we found that farmer participation in helping Community Guardians track and haze or chase lions was generally low, with fewer than 10% participating. This is in contrast to other evidence indicating that hazing lions in large groups is effective against livestock depredation (Petracca et al., 2019). In future, the Long Shields program should consider checking with farmers to see if these activities are relevant and desired, and if so, crafting and communicating clear information about these activities, recruitment process and related benefits.

Some factors may be attributed to influencing positive changes in lion attitudes, aside from directly decreasing livestock depredation. Working with trusted and respected community members, to develop the relevant solutions they wanted, helped pave the way for shifting attitudes towards lions. Working with communities to develop locally-relevant conservation solutions is not a new concept. It ensures that the aims, actions and outcomes of intervention programs are relevant across stakeholders and aligned with the interest of the community. It also increases levels of trust and fosters a sense of stewardship towards carnivores and certainly warrants future use, albeit careful consideration for feasibility, sustainability and appropriateness (Morehouse et al., 2020).

Normative social communication, such as the discourse shared between farmers about the Long Shields program, has the potential to influence not only farmers' attitudes of the program but also of lions and decisions to change their behaviors (Hill, 2004). Some degree of social influence apparently affected our control group farmers, as 41% had awareness of the Long Shields program from other farmers (14%) sharing lion early-warning messages. Farmers indirectly benefiting from the program, via information communicated from their peers (social spillovers), has the potential to influence their attitudes of lions. This result also

demonstrated that the positive impacts of the Long Shields program were extended beyond our target audience, suggesting that the diffusion of such information across different people or villages can bode well for lion conservation elsewhere (Rogers, 2004). When resources are scarce, staggering treatment and non-treatment across villages may be effective, given the role of social spillover. It would be interesting to explore if other farmers outside our study area voluntarily choose to change their behaviors and adopt conservation practices based on information shared through farmer social networks (Wallen & Daut, 2017).

With regards to how the Long Shields program ranks relative to other human-lion conflict interventions; results indicate that farmers ranked the Long Shields program as the fourth most (perceived) effective technique against lion depredation after electric fences, traditional herding and canvas mobile bomas (a novel method that uses moveable polyvinyl chloride curtains placed over crop fields to house livestock against predators at night). However, the advantage of the Long Shields program relative to other conflict tools is that it combines several mitigation techniques such as assisting farmers reinforce their corrals, education programs, direct deterrence of lions and an early-warning system, which add to its effectiveness as an effective tool against livestock depredation by lions. The Long Shields model is flexible, with careful adaptation, the model can be scaled up to mitigate different human-carnivore conflict situations. By collaborating with local farmers, this program may increase a sense of community, improve communication and stimulate local communities to be directly involved in lion conservation which is not always the case with other techniques.

Although the results of our evaluation are informative and encouraging, we acknowledge there are some limitations. The allocation of villages to the Long Shields program was not random. We introduced the program in villages that had sustained higher livestock depredation in the past. Critics suggest that non-random treatment allocation could result in regression-to-the-mean, a statistical phenomenon that makes natural variations in data appear like genuine change (Barnett et al., 2005). This is less likely to be a problem in

this study because the high impact villages have been in that category for some time, meaning they did not just happen to be experiencing high impact from lions at the time of the study. Additionally, 47% percent of the farmers that participated in the ‘pre-intervention’ survey did not participate in the ‘post-intervention’ survey due to absence, sickness, death or relocation. While unfortunate, this large drop-out rate is not uncommon in long-term studies that involve human participants (Lugtig, 2014). We had sufficient participation to provide evidence of the impacts of the Long Shields program.

Conclusion

Conservation scientists increasingly emphasize the need to evaluate the effectiveness of human-wildlife interventions across different contexts (Baylis et al., 2016). However, impact evaluation is no easy task and often not the principal objective when interventions are conceived and implemented (Woodhouse et al., 2015). Our study utilized a Theory of Change (ToC) to both plan our program’s activities and outcomes, and evaluate its impact on farmers. ToC was a useful conceptual guide and suggested future conservation activities adopt this approach. Specific to farmers, both the treatment and intermediate groups held positive attitudes for the Long Shields program and had a positive shift in their lion attitudes. However, we acknowledge this positive shift in attitudes may not translate into desired conservation action, and that the effects of interventions like these on lion population trends will require long-term engagement and evaluation. Our results highlighted the importance of considering human attitudes in conservation programming, to help provide evidence about human-animal relations as well as the effect of conservation activities on people (Bennett, 2016). Information on attitudes can be useful in behavioral models. The positive impact of the Long Shields Community Guardians program for farmers demonstrated an important first step for contributing baseline knowledge of interventions in this area, and practically supporting farmers to coexist with lions.

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Table 1

Statements regarding affective attitudes, tolerance towards lions, familiarity of the Long

Shields program

Questions	Answer options
How much do you like or dislike the lion?	1 = 'strongly dislike': 2 = 'dislike', 3 = 'Neutral', 4 = 'like', 5 = 'strongly like'
What would you like to see happening to the current lion population in the future?	1 = 'increase', 2 = 'decrease' or 3 = 'stay the same'
Are you familiar with the Long Shields Community Guardians program?	Yes/No
Do you have Community Guardians in your village?	Yes/No
If yes, what is the role of the Long Shields Community Guardians program?	Open ended
Do you receive warning messages from your Community Guardians?	Yes/No
If yes, what do you do when you get these warning messages?	Open ended
Personally, how do you perceive the Long Shields Community Guardians program and why?	1 = 'very unimportant'; 2 = 'unimportant'; 3 = 'neither' 4 = 'important', 5 = 'very important'

Table 2

Parameter estimates of an ordinal regression model used to determine whether or not the before-after changes in attitudes of farmers in the control group were significantly different to those in the treatment or intermediate groups.

	Estimate	Std. Error	z-value	Pr(> z)
<i>Reference= Control group</i>				
Intermediate	.71	.34	2.11	.03*
Treatment	.67	.28	2.39	.02*

Table 3

Farmers' desired lion population trends before and after the introduction of the Long Shields program in the treatment, control and intermediate group. The values represent percentages

	Treatment (<i>n</i> = 175)		Intermediate (<i>n</i> = 65)		Control (<i>n</i> = 88)	
What would you like to see happening to the current lion population in the future?	Before	After	Before	After	Before	After
Increase	0	5	0	2	2	5
Decrease	94	66	89	72	95	65
Stay the same	5	29	8	26	3	30
No clear opinion	2	0	3	0	0	1

Figure 1: Theory of Change model for the Long Shields Community Guardians program, illustrating the Community Guardians' activities and expected outcomes

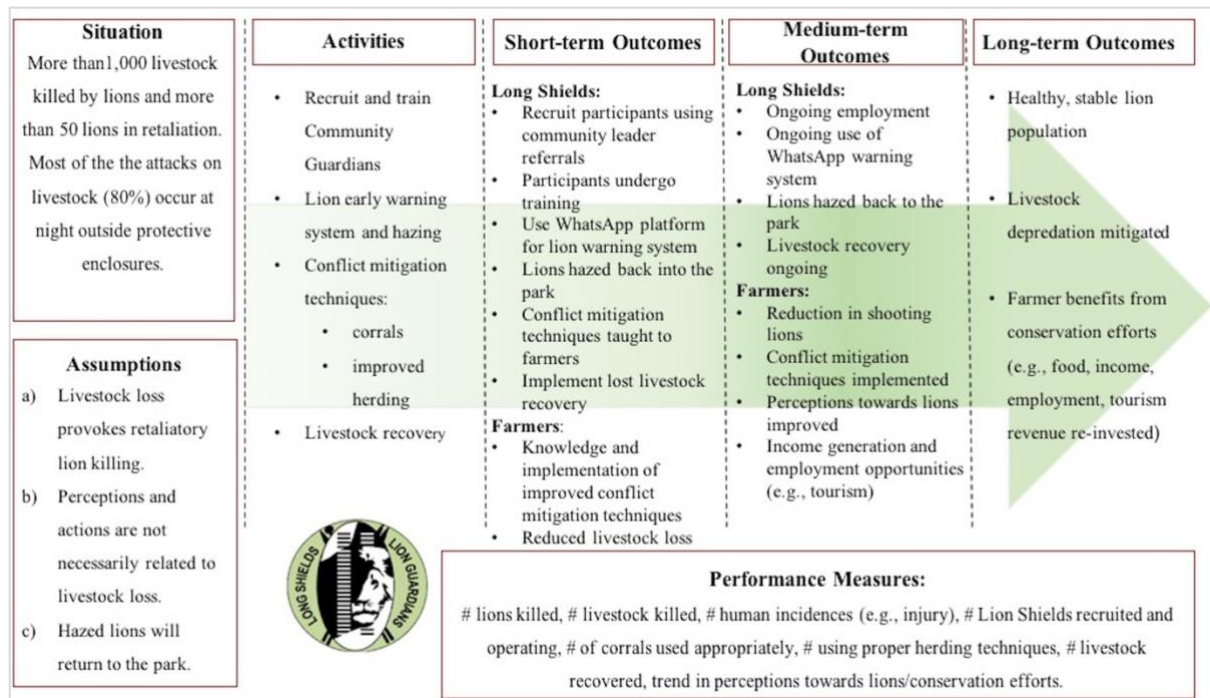


Figure 2: The map of our study area in northwestern Zimbabwe

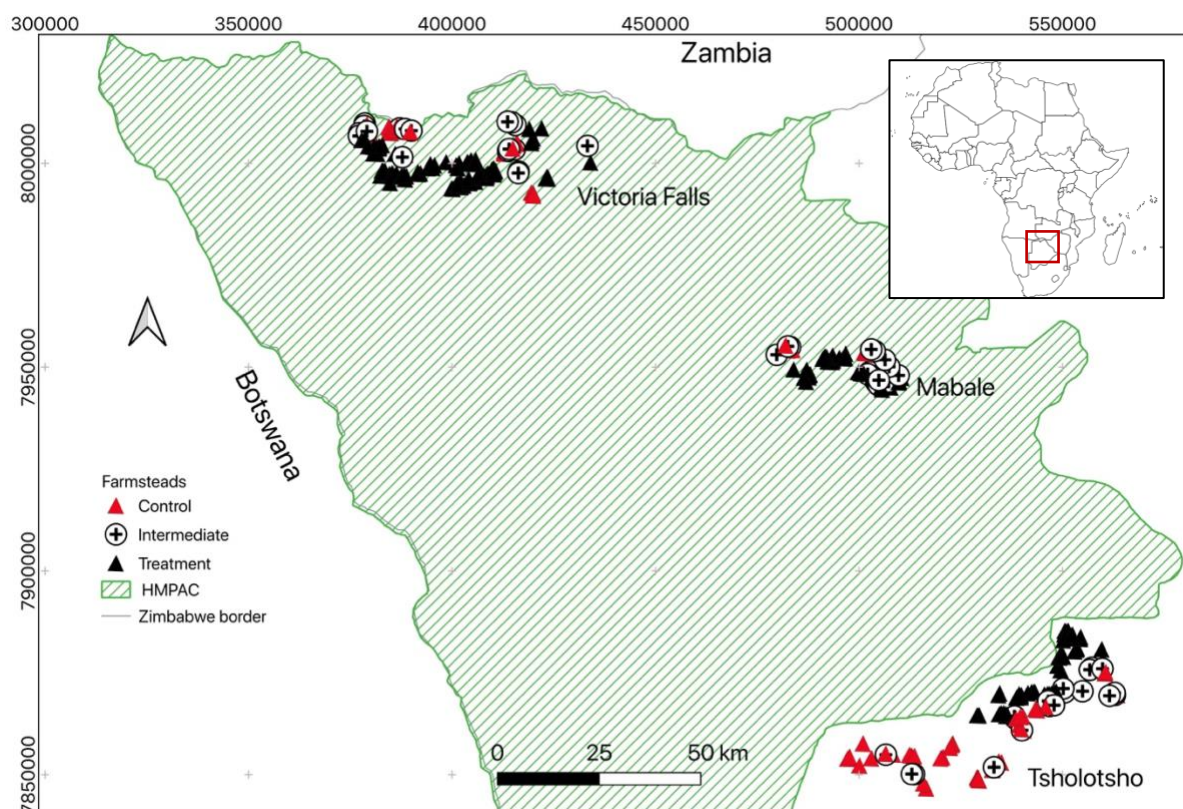


Figure 3: Perception changes towards lions before and after the introduction of the Long Shields Community Guardians program

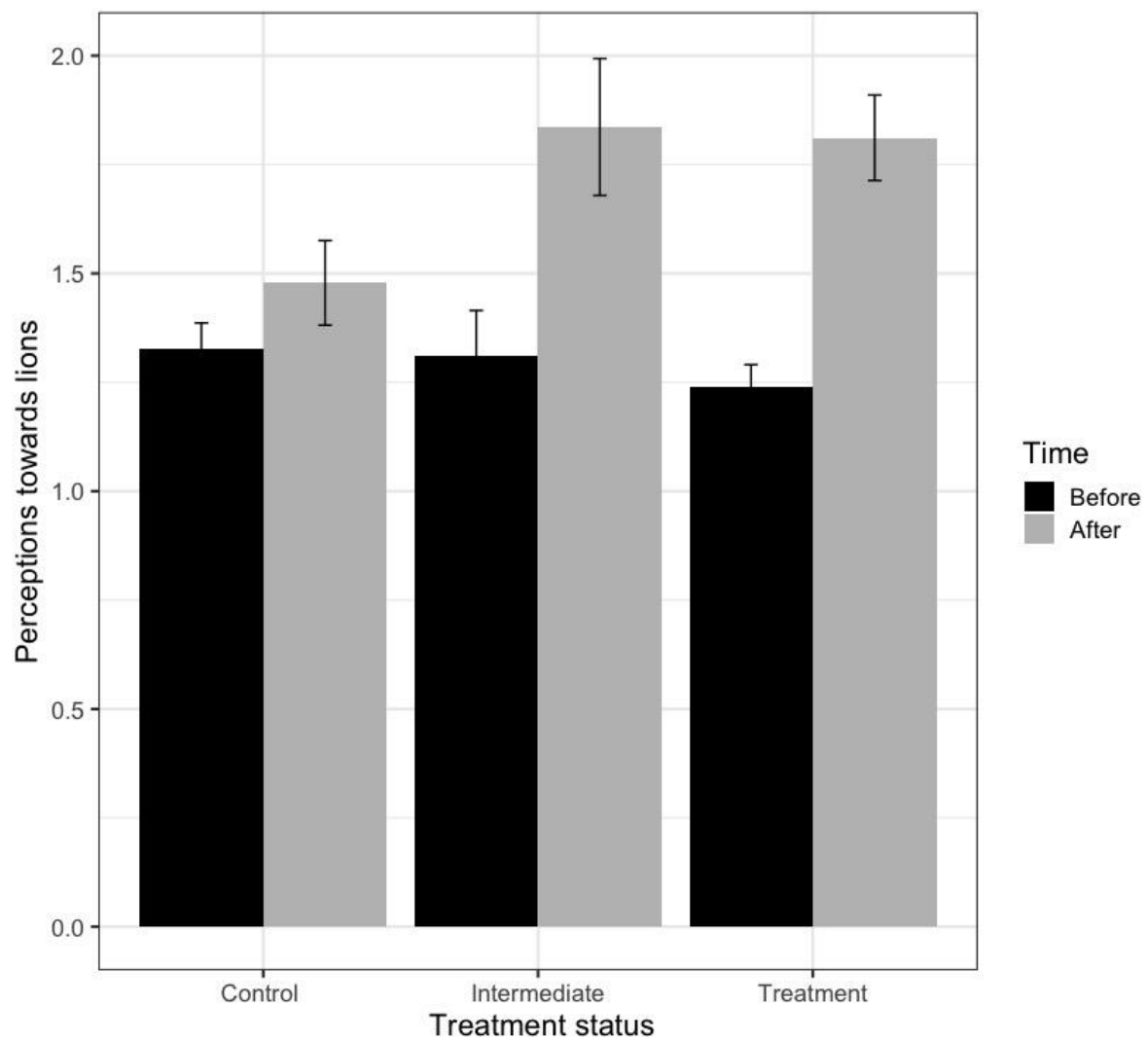
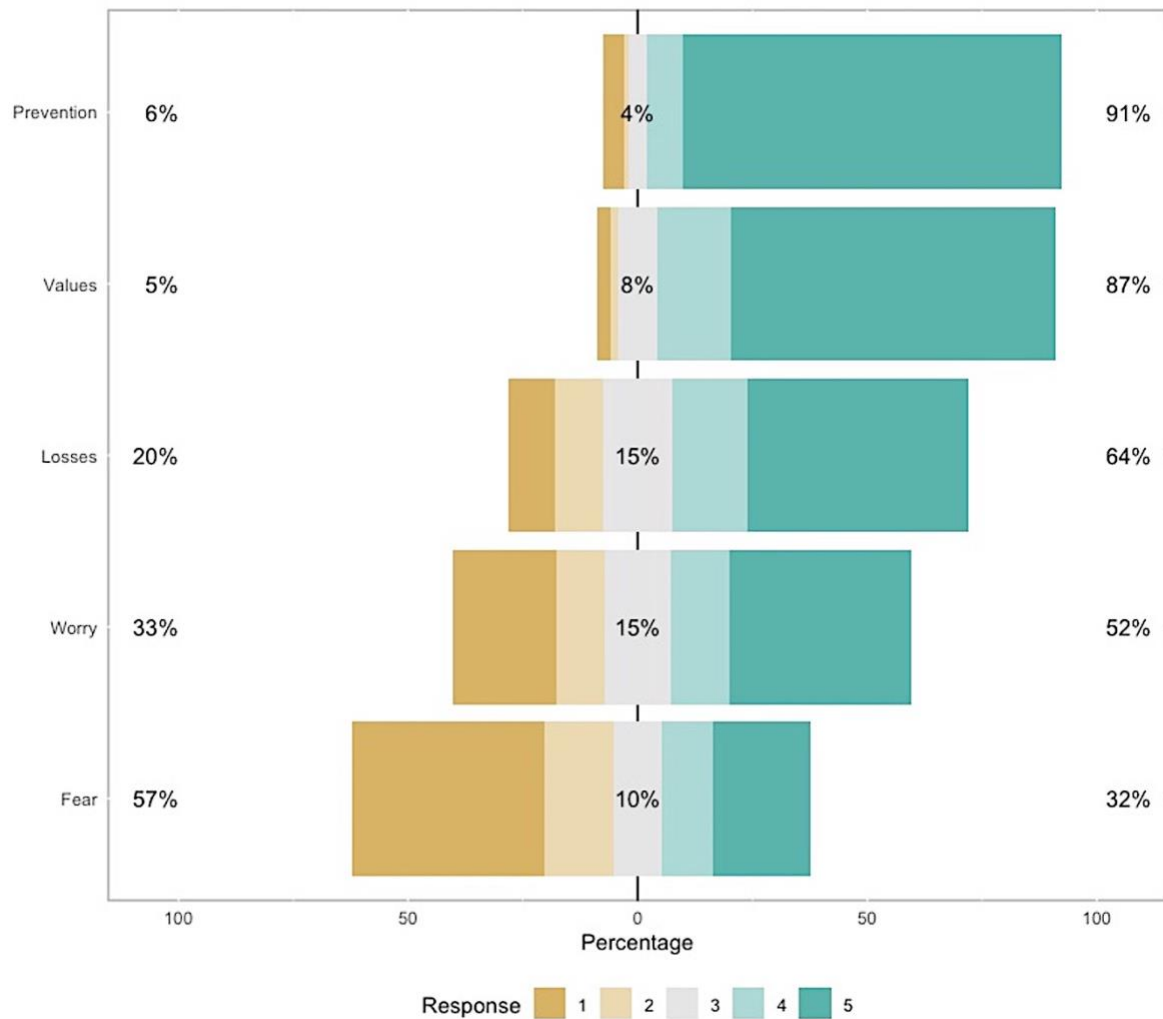


Figure 4: A bar plot of Likert scaled statements (below the figure) regarding the Long Shields program Theory of Change (ToC)



* **Prevention:** Warning messages from the Long Shields program have helped (you) avoid impact from lions;

Values: Lions have the right to exist; **Losses:** Depredation incidents have decreased as a result of the Long

Shields program; **Worry:** You are less worried of lions attacking livestock inside corrals at night as a result of the Long Shields program; **Fear:** You are now less fearful of lions as a result of the Long Shields program (1= strongly disagree: 5 = strongly agree).

Figure 5: An omnidirectional variogram used to determine the effective communication distance/ range between farmers part of the Long Shields program and those who were not. The found the effective range to be approximately 200 meters (actual = 178.82 *m*), this means farmers in the control group that were within this range had their attitudes influenced by the treatment neighbor.

