



Evaluating the impact of Warrior Watch: Behaviour change to promote human-lion coexistence

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ABSTRACT

Promoting human-wildlife coexistence is one of the most complex and pressing global conservation challenges faced today, particularly for large carnivore species. Effective conservation of large carnivores rests on interventions fostering coexistence in human-dominated landscapes, across the large ranges on which they depend. However, there is a paucity of research evaluating such interventions, and impact on the social determinants of behavioural outcomes. To bridge this evidence gap, we evaluate the impact of Warrior Watch, a grassroots intervention established in 2010 that draws on the traditional social structures and roles of Samburu pastoralists in northern Kenya to mitigate human-lion conflict peacefully. Using a novel approach blending elements of theory-based methods and traditional impact evaluations, and tailored to local resources and capacities, we evaluate the impact of Warrior Watch on a) attitudes towards lions and b) killing intentions as a proxy for tolerance. We show that warriors in the intervention site reported significantly more positive attitudes towards lions and were significantly less likely to indicate intentions to kill lions than their counterparts in the comparison conservancy. Furthermore, respondents in the intervention site were significantly more likely to report positive changes in their attitudes and tolerance towards lions since the inception of Warrior Watch, and to attribute these changes to the intervention. Our study demonstrates how evaluations tailored to local capacities and resource-limited situations can produce robust insights to support the adaptive management of interventions and increase the evidence-base to guide conservation practice.

1. Introduction

Promoting human-wildlife coexistence is one of the most complex and pressing global conservation challenges faced today. This is particularly true for large carnivore species which, owing to their large home-ranges and dietary requirements, are especially vulnerable to conflict with humans (Macdonald and Sillero-Zubiri, 2002). Human-carnivore conflict, which can trigger retaliatory or pre-emptive killing of carnivores (e.g. Kissui, 2008; Hazzah et al., 2009), often arises in response to actual or perceived threats to people's livelihoods or personal safety (Dickman et al., 2013; IUCN SSC Human-Wildlife Conflict Task Force, 2020). With human population growth and encroachment into wildlife habitat, interactions between people and large predators are becoming increasingly common, exacerbating conflict, and driving range contractions and decline of numerous large mammalian carnivore species worldwide (Dickman et al., 2013; Wolf and Ripple, 2017). Many

'big cat' populations rely heavily on human-dominated landscapes, outside formal protection (Riggio et al., 2013; Bauer et al., 2018). These communal lands are vital for maintaining connectivity between protected areas, which alone may not be sufficient to sustain viable large mammalian carnivore populations (Woodroffe and Ginsberg, 1998), and can be plagued by poor management and deficient funds (e.g. Lindsey et al., 2017; Lindsey et al., 2018). Effective conservation of large mammalian carnivores, therefore, necessitates a landscape-scale approach, incorporating protected areas and fostering human-wildlife coexistence across communal lands (Dickman et al., 2018a).

However, the underlying drivers of human-wildlife conflict are notoriously complex and multi-faceted, encompassing diverse socio-psychological and cultural factors (Dickman, 2010; Dickman et al., 2013). Although studies of human-wildlife conflict often frame human behaviour as a rational response to perceived costs and benefits of human-wildlife interactions, it is usually indirect impacts that shape

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people's attitudes to damage-causing wildlife (Kansky and Knight, 2014). As such, it is increasingly recognised that fostering human-carnivore coexistence requires effective, multi-faceted strategies combining measures to mitigate the negative impacts of living with large carnivores while promoting positive attitudes and tolerance (Dickman et al., 2018a; Glikman et al., 2019; Western et al., 2019). Whilst technical solutions aimed, for example, at reducing livestock predation (e.g. reinforced livestock enclosures, predator deterrents or real-time GPS data from collared animals) are often an important step in conflict-mitigation efforts, these measures alone are unlikely to be sufficient to promote coexistence with large carnivores (Dickman et al., 2018a; Western et al., 2019). To that end, collaborative approaches focusing on community empowerment to foster a sense of ownership in the process of conservation are increasingly seen as fundamental for engendering local support for large carnivore conservation (Bhalla, 2017; Redpath et al., 2017; Dickman et al., 2018a). Such holistic approaches to conservation tailored to specific socio-cultural contexts are expected to foster positive attitudes and social norms towards wildlife and ultimately tolerance. However, despite an almost exponential increase in journal publications on human-wildlife conflicts and coexistence, evidence-based evaluations of the effectiveness of conservation interventions to promote coexistence with carnivores remain scarce (Nyhus, 2016; Lozano et al., 2019).

Furthermore, although robust evaluation of conservation success should cut across ecological, economic, and socio-political dimensions, existing evaluations of interventions designed to promote human-carnivore coexistence are often narrowly framed around direct economic impacts (e.g. livestock depredation; Bauer et al., 2010; Tumenta et al., 2013; Lichtenfeld et al., 2015; Miller et al., 2016), or conservation outcomes (e.g. frequency of carnivore killing; Ogada et al., 2003; Hazzah et al., 2014; Bauer et al., 2017). Fewer studies explore the social determinants of behavioural outcomes (including attitudes, behavioural intentions, or programme support) meaning key mechanisms underpinning impact can be missed (although see Dyson, 2015; Hazzah et al., 2017; Sibanda et al., 2020). The Theory of Planned Behaviour (Ajzen, 1991) has been applied as a conceptual framework to investigate conservation behaviour (e.g. Beedell & Rehman, 2000; Williams et al., 2012) and may be a particularly useful framework to explore carnivore killing (Marchini and Macdonald, 2012). It predicts that the most proximate determinant of behaviour (e.g. lion killing) is behavioural intention, which in turn is governed by personal attitudes, social norms, and perceived behavioural control (i.e. the perceived ability to carry out the act). Understanding these factors is key to attribute impact to actions (Dyson, 2015; Sibanda et al., 2020), design effective conservation strategies (Hazzah et al., 2017; Broekhuis et al., 2020; Sibanda et al., 2020), and adaptively manage and learn from interventions (Kleiman et al., 2000).

To address this gap, we evaluate the impact of Ewaso Lions' flagship programme, Warrior Watch, focusing on the programme's influence on attitudes and tolerance towards lions in Samburu, northern Kenya (see: www.ewasolions.org). Among large carnivores, the African lion (*Panthera leo*) has experienced one of the greatest range contractions (94%; Wolf and Ripple, 2017), with the most recent IUCN Red List assessment estimating a 43% overall population reduction in the past 21 years, with sharp declines in Western, Central, and East Africa (Bauer et al., 2016). Conflict with humans is ranked as the greatest threat to the species' survival outside protected areas, including across their range within East and Southern Africa (Funston et al., 2016; IUCN SSC Cat Specialist Group, n.d). Lions rely heavily on human-dominated landscapes, with approximately 44% of their range lacking any official protected area status (Lindsey et al., 2017). As with numerous other large carnivores, conflict is also compounded by habitat loss and wild prey depletion, further compromising the viability of wild populations (Funston et al., 2016). Lions thus represent a strong case study species for further examining the effectiveness of interventions designed to promote coexistence between humans and large carnivores.

Launched in 2010, Warrior Watch seeks to protect lions by engaging a group formerly neglected in conservation: the Samburu warrior. Whilst the traditional 'protection' role played by the warrior age-class has historically manifested as pre-emptive or retaliatory lion killing, Warrior Watch seeks instead to fulfil of this role by increasing warriors' ability to protect communities from livestock depredation and to mitigate conflict peacefully. The intervention is thus designed to mesh with traditional social structures and roles. Involving a peer-to-peer network of carefully selected and trained warriors stationed in their home villages, the intervention combines conflict mitigation strategies with conservation education aimed at fostering recognition of the multiple values of carnivores, and broader biodiversity conservation (e.g. ecological, cultural, and economic) among the warrior demographic and the wider Samburu community (see: Theory of Change, Fig. 1). The involvement of warriors is also a strategic approach to leverage their wide-ranging presence in lion habitat for lion monitoring, as well as other wildlife.

Although randomised control trials and quasi-experimental designs are widely regarded as the 'gold standard' in impact evaluation, they are challenging to implement (Margoluis et al., 2009; Woodhouse et al., 2016). Factors such as resource capacity (e.g. financial, human, organisational), complexity and ethics can make these methods infeasible or inappropriate (Margoluis et al., 2009; Pynegar et al., 2021). Under these circumstances, alternative methods to evaluate impact, or the mechanisms underpinning it, may be more appropriate, although additional scrutiny is required in drawing inferences. For example, theory-based approaches, like process tracing, can be harnessed to compare the results of an intervention to theoretical predictions (e.g. a theory of change), examining and confirming or discounting alternative hypotheses based on empirical evidence (Intrac, 2017). Whilst not designed to estimate the magnitude impact, such approaches provide crucial insights into how and why the impact occurred, with important implications for adaptive management (Woodhouse et al., 2016).

Here, we develop a tailored approach to evaluating the impact of Warrior Watch, blending elements of theory-based approaches and traditional impact evaluations. In doing so, we aimed to guide future intervention expansion while demonstrating a pragmatic approach to programme evaluation under limited resources. First, we co-constructed a theory of change with the Ewaso Lions team (Fig. 1) to highlight the hypothesised mechanisms underpinning impact. The theory of change makes explicit how changes in attitudes and killing intentions, two core components of the Theory of Planned Behaviour, should ultimately lead to higher tolerance and reduced lion killing. The focus on attitudes, and killing intentions is supported by the Ewaso Lions team's understanding that in the study area, lion killing primarily occurs through a planned process to prevent, or following, livestock depredation. Second, to evaluate the impact of the intervention on attitudes and killing intentions, we measure how these vary between Westgate, a conservancy where the Warrior Watch programme is established, and Meibae, a comparable conservancy where the programme was not rolled out but earmarked for expansion (see Methods). Lastly, in the absence of a quantitative baseline, we use a participatory approach to evaluate reported changes in attitudes and killing intentions.

Our hypotheses are:

1. Attitudes are more positive, and killing intentions lower, in Westgate than Meibae, with the difference between conservancies more pronounced for warriors than for elders because warriors are the direct target of the programme.
2. Significantly more respondents report positive changes in attitudes over time in Westgate than in Meibae because the programme is running in Westgate, and this difference is more pronounced for warriors than elders.
3. Respondents attribute positive changes in attitudes and tolerance to Ewaso Lions, and specifically, to Warrior Watch.

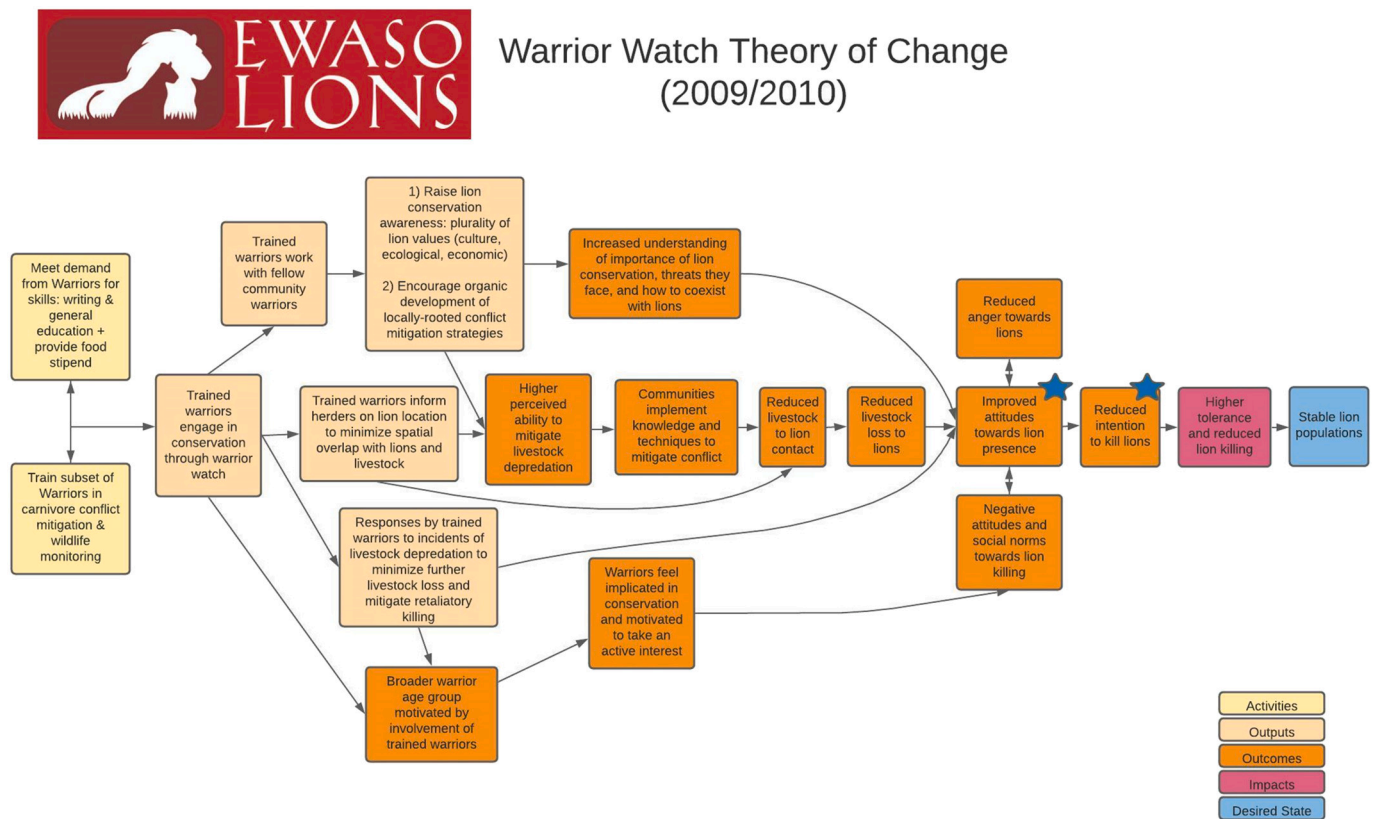


Fig. 1. Warrior Watch Theory of Change (ToC). The ToC was designed post-hoc in consultation with Ewaso Lions staff members (see supplementary material). Blue stars show indicators reported in this analysis. Note - the food stipend provided to participating Warrior Watch warriors at the time this study was conducted was replaced with full-time salaries in 2014. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

2. Methods

2.1. Study area

The study area comprised two community conservancies, Westgate and Meibae, located within the Eastern Constituency of Samburu County (Fig. 2). Samburu County in northern Kenya encompasses private, public, and communal lands, covering a total area of 21,000 km², and is bordered by the Counties of Marsabit, Isiolo, Laikipia, Baringo and Turkana. This semi-arid region, with a total population of 310,327 (Government of Kenya, 2019), is predominantly inhabited by Samburu pastoralists whose main economic activity is based around livestock (Karanja Ng'ang'a et al., 2016). Westgate and Meibae were formed in 2004 and 2006, respectively, from community-owned group ranches collectively managed by communities for pastoralism and wildlife conservation (Low et al., 2009). Westgate covers an area of 36,671 ha, inclusive of a core conservation area and buffer zone, and borders the Samburu National Reserve. Meibae Conservancy covers an area of 101,385 ha, bordering Westgate along its south-eastern side. Most people across both conservancies rely on livestock for subsistence or earn their living through the sale of livestock or associated products, or small business ventures. At the time of the study, the two conservancies differed primarily on the level of investment in wildlife-based tourism and conservation, with a higher activity in Westgate in part due to the influence of Warrior Watch, and Westgate's proximity to Samburu National Reserve. Some Westgate residents derived income from casual or permanent employment through the Conservancy, NGOs, or tourism. In contrast to Westgate, wildlife killings for meat have happened on occasion in Meibae for giraffe. Additionally, although camels are also now herded as livestock in both conservancies, they were introduced in Meibae prior to Westgate (circa 2006). The introduction of camels in

Meibae is believed to have generated strong animosity towards lions and retaliations following camel killing.

2.2. Theory of change

We co-constructed a theory of change with senior members of the Ewaso Lions team (Fig. 1) to make explicit how the intervention was assumed to deliver outcomes and contribute to wider impact. We drew on documents produced prior to the start, or in the very early stages, of the intervention to ensure that the theory of change aligned with the team's initial vision (see supplementary material for details). Although drawing a theory of change prior to implementation is preferred, such as to guide actions, make assumptions explicit, and support baseline data collection (Simister and Smith, 2010), devising a theory of change post-hoc still offers several benefits (Woodhouse et al., 2016). First, it allows articulation of assumptions underpinning the intervention. Second, it allows articulation of a shared understanding of conservation aims and prerequisites for success to guide prospective evaluations. Together, these support more effective targeting of limited conservation resources (Sutherland et al., 2004).

2.3. Sampling and survey instruments

To evaluate the impact of Warrior Watch we sampled 10 locations in the study area: 4 in Westgate where the programme has been running without interruptions since 2010, and 6 in Meibae where the programme had not yet been established (Fig. 2). Meibae locations were strategically selected to be in proximity to a lion corridor connecting Westgate and Meibae; Ewaso Lions was scoping the area for future expansion. We were unable to use propensity score matching to guide our selection of a control, and hence Meibae should not be considered a

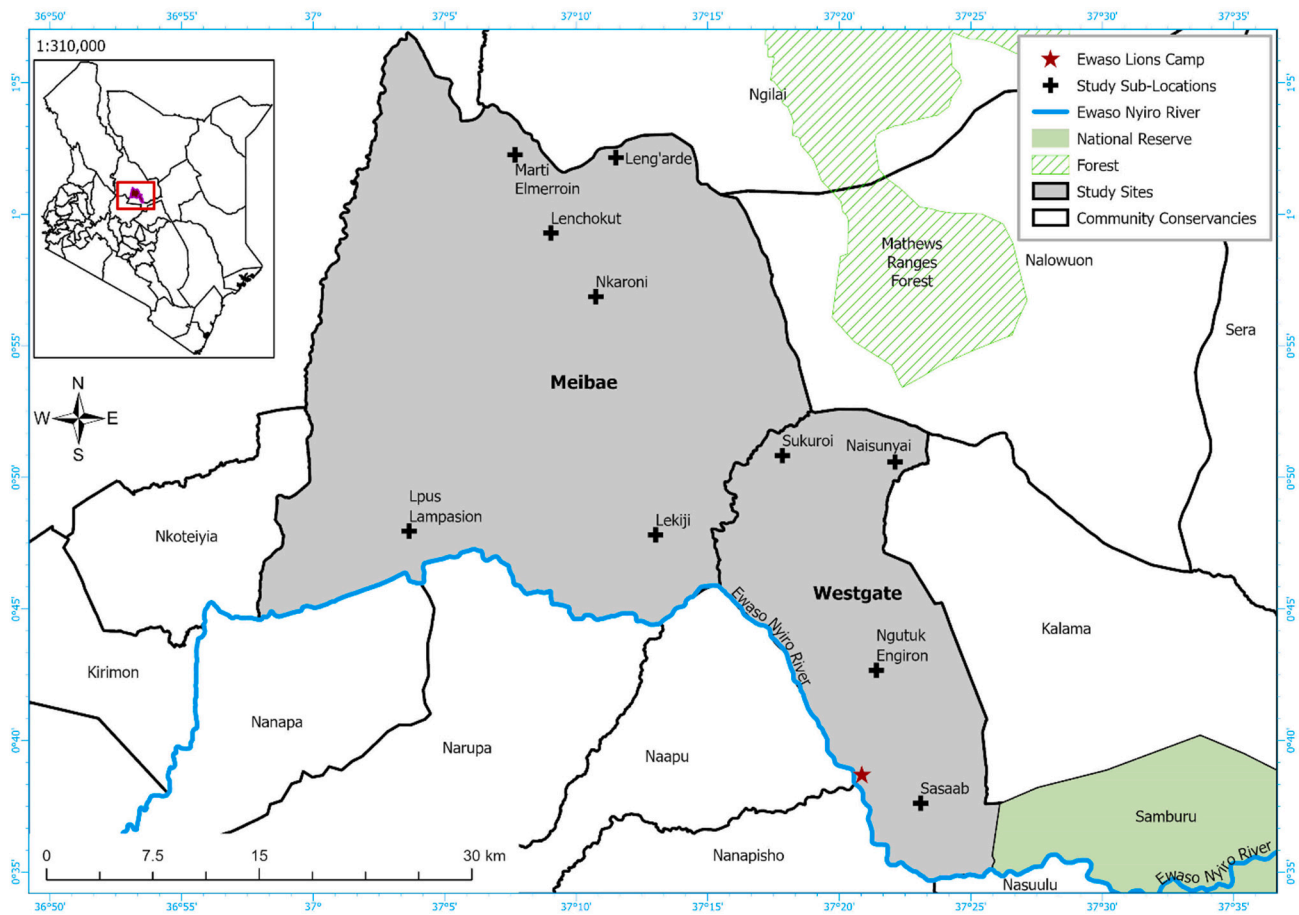


Fig. 2. Study area map showing the location of the study area in Kenya, and the sampling locations across both conservancies (Meibae, Westgate) in grey.

control group. However, our comparator, Meibae, was carefully chosen, representing a similar socio-cultural context, with no reason to assume that the intervention in Westgate had influenced its inhabitants' attitudes to, or intentions concerning, lions. We explore how socio-cultural differences between the two conservancies (see [Study Area](#)) may have influenced attitudes towards lions and killing intentions in the [Discussion](#).

Data collection took place between May and June 2017. A semi-structured, household-level questionnaire (see supplementary material) was used to assess attitudes towards the presence of lions, attitudes towards the killing of lions, and behavioural intentions, namely whether the respondent would try to kill a lion following a livestock depredation event (hereafter “killing intentions”). The questionnaire was administered in Samburu Maa by two local research assistants (BL, and PL), the native language for all respondents. To check translation accuracy, the research assistants orally back translated the question items from English into Samburu Maa and back to English. Piloting was conducted in two separate locations in Westgate. The questionnaire content, question order and wording were progressively refined through the course of piloting to ensure contextual relevance, and that the questions were socially and culturally salient.

The research assistants surveyed 140 men from separate households in Westgate and 127 in Meibae, representing 40–50% of the adult male population in each location. We focused on men because the Warrior Watch intervention targets men, and because women do not directly engage in the killing of lions in this area. In the study area, a household comprises one male head with one or more wives, and their children. The research assistants interviewed one male respondent per household, either a warrior or an elder, and excluded anyone who had lived in the locations for less than a year (see [Appendix 2](#) for the sampling

approach). A few respondents (12) refused to be interviewed, stating they either had no time to participate in the survey or were not interested. Another 12 interviews were omitted because they were incomplete. The mobile nature of the population made probabilistic sampling across households challenging. Drought conditions during the sampling period forced a proportion of herders (predominantly warriors) to spend extended periods of time away from village locations. As such, sampling may have been biased towards individuals herding less and spending more time within homesteads.

To mitigate livestock loss exaggerations, respondents were first asked to report separately on the number of cattle and sheep or goats (‘shoats’) lost from the household herd over the past 12 months, to specific causes (drought, disease, theft, carnivores, and other). Once the respondent reported the number lost to carnivores, they were asked to report on the number lost to lions. We measured attitudes towards the presence of lion (13 questions) and killing of lions (4 questions) using 5-point Likert-type response scales, primarily following the agree-disagree format but also incorporating instrumental (e.g. useful/useless) and affective (e.g. like/dislike) aspects of attitudes towards the presence of lions and towards the killing of lions ([Ajzen, 2006](#)). Killing intentions were operationalized based on an index of tolerance designed by [Romanach et al. \(2007\)](#) to assess propensity to kill predators among various groups including Samburu and Maasai pastoralists in central Kenya. Respondents were grouped into two categories: those who would or would not kill a lion following livestock depredation.

Given the lack of quantitative baseline data in the study area, we used a participatory approach to account for temporal changes in attitudes and killing intentions. Specifically, we used reflexive baseline recalls ([Woodhouse et al., 2016](#)) to evaluate temporal change as perceived by warriors, and elders. Respondents were asked if their

attitudes or killing intentions would have been the same before a notable drought event, well engrained in the memories of the respondents throughout the study area, which preceded the implementation of Warrior Watch. Respondents who said 'yes' were then asked the extent to which their attitude/killing intention changed on a 5-point scale. To understand how change is perceived to be operating, we also assessed which conservation organisations were most salient to targeted stakeholders in relation to expressed changes in attitudes or killing intentions. Specifically, respondents were asked if the activity of any organisation in this period contributed to any change in their answer, and if so to list the group(s). Although other conservation organisations operating in the study area at the time did not specifically aim to change attitudes towards carnivores, their activities may have influenced attitudes towards wildlife and conservation in general. Organisations mentioned first by more respondents, are assumed to have higher salience (Papworth et al., 2013). Because Ewaso Lions was operating more than one intervention, respondents mentioning Ewaso Lions were then asked to specify the intervention(s). Average salience scores for organisations and Ewaso Lions interventions were calculated using the following equation for a given organisation/intervention i (Quinlan, 2005):

$$\text{Salience}_i = (1 + \text{list length}_i - \text{organisation position}_i) / \text{list length}_i$$

2.4. Ethics statement

Interviews were not pre-arranged. Verbal informed consent was secured from all respondents prior to each interview. The research assistants informed the respondents that they were conducting a survey on behalf of Ewaso Lions to understand the interactions between people, livestock, and lions in the community. They ensured that respondents were aware that certain questions may be sensitive and full anonymity was assured. The research assistants were careful to remain neutral, and were trained on questionnaire administration, including recognising, and mitigating potential social desirability biases. They emphasised that there are no right or wrong views on lions or conservation prior to the administration of the attitude scales. If respondents brought up the issue of livestock compensation the research assistants clarified that their responses would have no impact on compensation, and that Ewaso Lions has no control over compensation. Sensitive questions pertaining to the topic of lion killing were asked at the end to reduce potential influence on other answers. The procedure was reviewed and approved by the Social Sciences and Humanities Inter-divisional Research Ethics Committee (IDREC) of the University of Oxford (Ref #: R50459/RE001).

2.5. Scale uni-dimensionality and reliability

The statistical validation of the item questions was carried out through factor analysis using the *factanal* function in the *psych* package in R (Revelle and Revelle, 2015) to test for uni-dimensionality of the attitude scales. We ran Exploratory factor analyses (EFA) using maximum likelihood. For uni-dimensionality to hold, all items should load on the same factor, indicating that each question measures the same construct (De Vaus and de Vaus, 2013). The factor analyses revealed one factor with an eigen value above 1 for both scales, with all items loading strongly on this factor (i.e. > 0.7) (Table A1). Only factor was extracted for both scales and therefore no rotation of the solution was performed. The Kaiser-Meyer-Olkin measures of sampling adequacy were 0.960 and 0.857 for the scales representing attitudes towards the presence of lions and killing of lions, respectively, and Bartlett's test of sphericity was significant for both scales indicating sufficient correlation in the data for factor analysis ($\chi^2(78) = 2831.232, p < 0.001$, and $\chi^2(6) = 1119.916, p < 0.001$ respectively). For attitudes towards the killing of lions, communalities were above 0.5. However, for attitudes towards the presence of lions, 3 items had communalities below 0.5. Factor scores for attitudes towards the presence of lions and attitudes towards the killing of lions were significantly correlated, so results are only given for the

former. Internal consistency (reliability) for the scales measuring attitude towards the presence of lions, and attitudes towards the killing of lions was assessed with Cronbach's alpha separately for Westgate and Meibae (Table A2). There was strong internal consistency for scales across both conservancies (Cronbach's alpha ≥ 0.7 ; De Vaus and de Vaus, 2013), and no items were removed.

2.6. Statistical analyses

Statistical analyses were run in R version 3.6.1 (R Core Team, 2020). Linear and binomial logistic regression mixed-effects models were run with the *lme4* package (Bates et al., 2014), using the functions *lmer* and *glmer*. To test for group-level differences, Bonferroni-corrected post-hoc contrasts were computed with the *lsmeans* function (Lenth, 2018). We do not report p values from mixed-effects models, as the package *lme4* does not provide these in model summary outputs (Bates et al., 2014). For statistical inference, we report parameter confidence intervals (profiled) and the standard error of parameter estimates for which 95% confidence intervals do not cross 0.

2.7. Factors associated with attitudes towards the presence of lions and killing intentions

We tested associations between attitudes towards the presence of lions (thereafter attitudes) and household-level livelihood, demographic group, and cattle depredation using linear mixed-effects models with factor scores as the response and a random intercept for location nested within conservancy. Where specified in the text, group means for attitudes reflect mean of the factor scores – lower values reflect lower attitudes, and *lsmean* differences indicate difference in group mean factor score. For associations with killing intentions, we ran binomial logistic regression mixed-effect models with a logit-link function, specifying a random intercept for location within conservancy. We used the *inv.logit* function in the *boot* package (Ripley, 2021) to convert log-odds to probabilities for group-level comparisons in killing intentions where significant. Table 1 presents the predictors and explanations for each.

Because the transition from warriorhood to the elder age-set does not depend on marriage, some heads of households were still in the warrior age-set and did not self-identify as elders. As such we categorized respondents into 3 demographic groups – Warriors, Head of Household Warriors, and Elders, to test for group level differences. Respondent residency time (number of years lived in the location) was not incorporated in the model as it did not influence the relationship between demographic group and attitudes or killing intention (results not shown).

We did not include the number of cattle lost to predators, as it was significantly associated with the number of cattle owned by the household ($b = 0.007, SE = 0.002, t = 4.114, p < 0.001$). Age was not included as a predictor as it overlaps with demographic group (warrior or elder), and we were interested in the latter to test our hypotheses. We included a binary factor denoting if the respondent reported household-level income from conservation or tourism livelihoods to test the hypothesis that respondents in this group would report more positive attitudes. Because of small sample size, we excluded this factor from subsequent logistic regression models and all contrasts calculations (differences between demographic groups). For households reporting cattle loss, we included the proportion of cattle losses attributed to depredation, as a study in a similar context found that this was associated with killing intentions (Hazzah et al., 2009). In a separate model on the whole dataset, including households not reporting cattle loss, we tested for an association between whether a household reported cattle loss in the past 12 months, and attitudes and killing intentions (separately). We tested the variance inflation factor (VIF) and checked the variance decomposition proportions; both tests confirmed that there was no collinearity between the predictors.

Table 1
Predictors included in the GLMM models for factors associated with attitudes towards the presence of lions and killing intentions.

Predictors	Explanation	Variable type	Hypothesised direction of effect
# Children	The number of children in the household, as a proxy for household size.	Count	
# Cattle	The number of cattle owned by the household	Count	Negative; the greater the number of cattle owned, the more negative the attitudes towards lions, and the greater the killing intentions
Cattle loss experience	Whether or not the respondent reported losing cattle in general in the past 12 months. This variable was not included in the same model as the proportion of cattle loss attributed to carnivores.	Binary	Negative; respondents reporting cattle loss will report more negative attitudes towards lions, and greater killing intentions
Proportion of cattle loss attributed to carnivores	Among those reporting cattle loss, the reported proportion of cattle killed (at the household-level) in the past year by carnivores, relative to the overall number lost to other factors (drought, disease, theft, other).	Proportion of count	Negative; the greater the proportion of cattle loss attributable to carnivore, the more negative the attitudes towards lions, and the greater the killing intentions
Conservation or tourism livelihoods.	Whether or not the respondent reported household-level income derived from wildlife conservation or tourism)	Binary	Positive; respondents reporting income from conservation or tourism will report more positive attitudes towards lions, and a lower the killing intentions
Demographic group	Respondent demographic group, warrior or elder, with the former split according to whether the warrior identified as head of household or not (HH vs. non-HH)	Categorical, three level.	Warrior that are not head of household will report more positive attitudes towards lions, and lower killing intentions, in comparison to warriors that are heads of household, and elders

2.8. Impact evaluation models

We compared attitudes and killing intentions between Westgate and Meibae using mixed-effects models (linear mixed-effects model and mixed-effects binomial logistic regression, respectively). We specified conservancy and demographic group as fixed effects, an interaction between both, and a random intercept for location. We did not nest location within conservancy because our aim was to test the effect of conservancy. We tested if there was a difference between a model including location nested within conservancy, and a model with both factors as separate random intercepts. There was none; model AICs were the same. We ran additional diagnostic tests to check for outliers and identified outliers for attitudes towards the presence of lions and attitudes towards the killing of lions (z scores >2.53). Additionally, in both

the Meibae and Westgate datasets, high influence cases (i.e. leverage values greater than 3 times the average leverage; (Stevens, 2012) were detected in the logistic regression models for killing intentions. Inspection of these cases revealed no justification for removing them.

To compare reported change in attitudes and killing intentions since the inception of Warrior Watch between Meibae and Westgate for each demographic group, we ran a mixed binary binomial logistic regression model specifying a random intercept for location. We compared respondents reporting no change, and those reporting improvements in attitudes or killing intentions because only 4 respondents indicated negative changes. Respondents too young to own livestock (18.7% in Westgate and 23.5% in Meibae) when Warrior Watch was launched in 2010 were not asked how their killing intentions had changed.

3. Results

3.1. Sample description

Respondents in Meibae and Westgate had similar socio-demographic characteristics (Table A3). Most respondents (75% in Westgate, 83% in Meibae) did not receive formal education. Across both conservancies, more elders were interviewed than warriors (59% of interviewees were elders in Westgate, and 57% in Meibae). A greater proportion of warriors in Westgate identified as heads of household than in Meibae (47% vs 26%). All respondents owned livestock, and most depended on livestock for their main livelihood, primarily for subsistence in both Westgate and Meibae (63% and 77% respectively). Average household-level livestock holdings were comparable between both conservancies, and overall, 95% of households owned cattle. A higher proportion of respondents reported income derived from either conservation or tourism in Westgate (25%) than in Meibae (6%), reflecting in part the greater number of conservation organisations and the one tourist lodge operating in Westgate. There was widespread awareness of conservation activities in Westgate, whereas in Meibae very few respondents indicated awareness of conservation action. Among households holding cattle, the proportion of households reporting carnivore depredation was significantly higher in Westgate (39%) than in Meibae (25%) ($\chi^2 = 4.56$, $df = 1$, $p = 0.0326$). Among these, there was no significant difference in mean number of cattle depredated per household in Westgate ($\bar{x} = 1.37$), and Meibae ($\bar{x} = 1.43$) ($t = 0.298$, $df = 42.652$, $p = 0.767$).

3.2. Factors associated with attitudes and killing intentions

There was a significant association between attitudes towards the presence of lions and demographic group (Table 2, Model 1). Elders had significantly more positive attitudes towards the presence of lions than warriors (elders vs household head warriors: mean attitudes = 0.341 vs -0.258; SE = 0.172, DF = 238, $t = 3.488$; elders vs non-household head warriors: mean attitudes = 0.341 vs -0.075; SE = 0.127, DF = 237, $t = 3.284$). Attitudes towards the presence of lions did not, however, differ between warriors that were household heads and those that were not (mean attitudes = -0.258 vs -0.075, respectively; SE = 0.202, DF = 238, $t = -0.903$). We therefore combined the two warrior classes for subsequent impact evaluation models. The probability of indicating killing intentions varied between demographic groups (elders = 44%, household head warriors = 58%, non-household head warriors = 53%), but not significantly so (SE = 0.503, $z = 0.416$) (Table 2, Model 2).

Neither household size nor cattle herd size were associated with attitudes or killing intentions (Table 2). Respondents reporting household revenue from conservation or tourism livelihoods reported significantly more positive attitudes than respondents who did not (mean attitudes = 0.381 vs -0.376, respectively; SE = 0.151, DF = 240, $t = 5.028$). Among respondents reporting cattle loss, we found no association between the proportion of livestock loss attributed to depredation and either attitudes or killing intentions. There was no significant difference in attitudes or killing intentions between respondents who reported losing

Table 2

Results of GLMM for factors associated with attitudes towards the presence of lions (Model 1) and killing intentions (Model 2) across Westgate and Meibae combined. Demographic group is significant when compared to elders as the base level. Parameter estimates for which 95% confidence intervals do not cross 0 are highlighted in bold.

Predictors	Model 1: attitudes towards the presence of lions				Model 2: killing intentions			
	Regression estimate	Lower CI (95%)	Upper CI (95%)	t-value	Regression estimate (logit)	Lower CI (95%)	Upper CI (95%)	Z-value
intercept	0.142	-0.618	0.898	0.426	-0.419	-1.326	0.505	-1.061
# children	0.010	-0.023	0.044	0.583	0.008	-0.090	0.074	-0.183
# cattle	0.004	-0.009	0.001	-1.428	0.003	-0.010	0.016	0.491
Proportion of cattle loss attributed to carnivores	-0.463	-1.192	0.286	-1.217	0.593	-1.296	2.501	0.619
Conservation or tourism livelihood	0.816	0.521	1.127	5.253				
Demographic group (HH Warriors)	-0.616	-0.974	-0.251	-3.318	0.511	-0.404	1.439	1.092
Demographic group (non-HH Warriors)	-0.352	-0.616	-0.098	-2.644	0.385	-0.262	1.035	1.167

Model 1 $R^2_m = 0.128$, $R^2_c = 0.382$; Model 2; Model 2 $R^2_m = 0.0150$, $R^2_c = 0.0674$.

cattle for any reason in the past 12 months ($n = 232$) and respondents who did not ($n = 35$) (Tables A4 and A5).

3.3. Impact evaluation results

3.3.1. Attitudes towards the presence of lions

There was a significant interaction between demographic group and conservancy, indicating that differences in attitudes between conservancies depended on the respondent's demographic group (Table 3, Model 1). In a reduced model, excluding whether the respondent indicated income from conservation or tourism due to small sample size for this variable, post-hoc contrasts showed warriors in Westgate had significantly more positive attitudes than warriors in Meibae (mean attitudes = 0.853 vs -0.374, respectively; SE = 0.286, $df = 7.53$, $t = 4.291$ Fig. 3). There was no significant difference in attitudes between elders in Westgate and Meibae however (mean attitudes = 0.398 vs -0.123, respectively; SE = 0.275, $df = 6.27$, $t = 1.938$, Fig. 3). Within Meibae, elders had significantly more positive attitudes than warriors (mean attitudes = -0.123 vs -0.853, respectively; SE = 0.154, $df = 242.58$, $t = 4.742$), whereas in Westgate there was no significant difference between the demographic groups (mean attitudes 0.398 vs 0.374, respectively; SE = 0.149, $df = 243.38$, $t = 0.159$).

3.3.2. Killing intentions

Respondents in Westgate were significantly less likely to indicate killing intentions than respondents in Meibae, but there was a significant interaction between demographic group and conservancy (Table 3, Model 2). The probability of warriors reporting killing intentions was greater in Meibae than in Westgate (73% vs 34%, respectively; SE = 0.556, $z = 2.936$). There was no significant difference in reported killing intentions between elders in Meibae and Westgate (48% vs 39%, respectively; SE = 0.488, $z = 0.733$).

3.3.3. Reported changes in attitudes and killing intentions

Overall, respondents in Westgate were significantly more likely than respondents in Meibae to report positive changes in attitudes (85% vs 40%) and reduced killing intentions (90% vs 35%). Reported changes in attitudes towards the killing of lions did not differ from reported changes in attitudes towards the presence of lions. Within conservancy there was no significant difference between demographic groups in their probability of reporting changes. The probability of warriors reporting positive changes in attitudes was greater in Westgate (83%) than in Meibae (30%) (SE = 0.657, $z = 3.767$). Results were similar for elders - the probability for reporting positive attitude changes was 87% in Westgate vs 52% in Meibae (SE = 0.610, $z = 2.982$). Results for killing intentions were also comparable; the probability of warriors reporting reduced killing intentions was greater in Westgate (89%) than in Meibae (23%) (SE = 1.026, $z = 3.190$). For elders, the probability of reporting reduced killing intentions was 91% in Westgate vs 50% in Meibae (SE = 0.814, $z = 2.829$).

3.3.4. Salience of conservation organisations

Respondents in Westgate indicating a change in attitudes or killing intentions free listed 8 organisations which had influenced this change (Fig. 4a, b). Ewaso Lions was the most salient organisation in Westgate for attributions of change in attitudes ($\bar{x} = 0.810$, S.D. = 0.239) and killing intentions ($\bar{x} = 0.389$, S.D. = 0.224). Salience scores dropped markedly for the organisations ranked 3rd and below. Salience scores for Ewaso Lions were higher for warriors (attitudes: $\bar{x} = 0.875$, S.D. = 0.235; killing intentions: $\bar{x} = 0.904$, S.D. = 0.206) than elders (attitudes: $\bar{x} = 0.766$, S.D. = 0.234; killing intentions: $\bar{x} = 0.813$, S.D. = 0.283). Respondents listing Ewaso Lions listed 5 interventions to which they attributed changes in attitudes or killing intentions (Fig. 4c, d). All respondents mentioned Warrior Watch, and overall Warrior Watch was the most salient intervention to which all demographic groups attributed changes in attitudes and killing intentions. Salience scores for

Table 3

Results of GLMM comparing attitudes towards the presence of lions (Model 1) and killing intentions (Model 2) between Westgate and Meibae. The intercept represents the base category (Elders in Meibae). Parameter estimates for which 95% confident intervals do not cross 0 are highlighted in bold.

Predictors	Model 1: Attitudes towards the presence of lions				Model 2: Killing intentions			
	Regression estimate	Lower CI (95%)	Upper CI (95%)	t value	Regression estimate (logit)	Lower CI (95%)	Upper CI (95%)	Z value
Intercept	-0.163	-0.550	0.224	-0.798	-0.0840	-0.889	0.725	-0.231
Demographic group (Warriors)	-0.743	-1.029	-0.454	-5.052	1.055	0.284	1.870	2.623
Conservancy (Westgate)	0.439	-0.078	0.956	1.606	-0.358	-1.439	0.716	-0.733
Conservation or Tourism livelihood	0.709	0.425	0.989	4.906	(variable omitted)	(variable omitted)	(variable omitted)	(variable omitted)
Demographic group (Warriors) * Conservancy (Westgate)	0.563	0.154	0.963	2.720	-1.275	-2.364	-0.219	-2.338

$R^2_m = 0.290$, $R^2_c = 0.391$; Model 2; Model 2 $R^2_m = 0.0879$, $R^2_c = 0.143$.

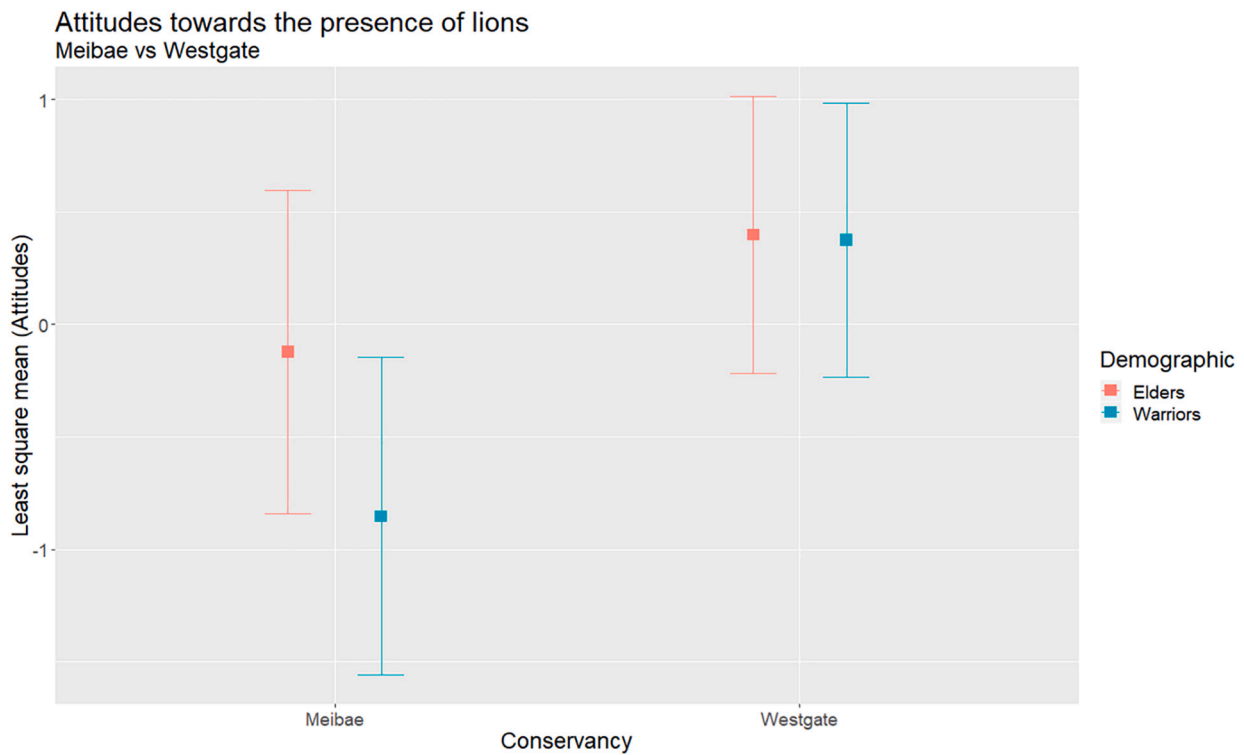


Fig. 3. Comparison of lion attitudes between conservancies. Attitudes (least-square means) towards the presence of lions (extracted factor scores) for warriors (blue) and elders (red) in Meibae, and Westgate, with bars showing 95% confidence intervals. Lower values reflect more negative attitudes. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)



Fig. 4. Salience scores. The y axis represents the average of the salience scores for conservation organisations operating in Westgate and Ewaso Lions interventions implemented at the time across the indicators for changes in attitudes towards the presence of lions (a and c) and killing intentions (b and d). Organisations other than Ewaso Lions are anonymized. EL = Ewaso Lions, WW = Warrior Watch, MS = Mama Simba, WzW = Wazee Watch, LKC = Lion Kids Camp, ELS = Ewaso Lions Scouts.

interventions other than Warrior Watch were markedly lower.

4. Discussion

Despite repeated calls to evaluate conservation programmes and disseminate knowledge on intervention effectiveness, there remains a paucity of evidence on the impact of human-wildlife coexistence interventions (Lozano et al., 2019). Yet such evaluations are not only crucial to sustain the impetus for, and investments in, these interventions, but also for adaptive management. Responding to these calls, we report a social impact evaluation of Ewaso Lion's Warrior Watch programme, operating for the past decade in northern Kenya. This represents an important contribution to the evidence base on the impact of community-based interventions for promoting human-wildlife coexistence, whilst demonstrating how impact evaluations can still be undertaken in situations where conservation interventions have not been designed for evaluation. Carrying out post-hoc evaluations such as this can bolster the evidence base on conservation interventions, and support learning towards more effective interventions.

4.1. Key findings

Theories of behavioural change suggest that behaviours are motivated by a range of underlying factors. These can include people's attitudes towards the behaviour, the social context within which they are operating, and their capacity to carry out the behaviour. In turn these constructs are underpinned by beliefs and influenced by knowledge about the system. There are several models of behavioural change, including the Theory of Planned Behaviour (Ajzen, 1991) and the Theory of Interpersonal Behaviour (Vu and Nielsen, 2022). Here we consider our key findings in the light of the constructs used in the Theory of Planned Behaviour, in particular the relationship between attitudes and killing intention.

Warriors in Westgate, where Warrior Watch was rolled out, reported significantly more positive attitudes towards lions and were significantly less likely to indicate intentions to kill lions than their counterparts in Meibae, even though a greater proportion of households in Westgate reported carnivore depredation. Although Warrior Watch ultimately seeks to promote positive attitudinal change and tolerance beyond the warrior group, and across the Samburu landscape, attitudes and killing intentions did not significantly differ between elders in Meibae and Westgate. This is not surprising, as elders in Meibae held significantly more positive attitudes towards the presence of lions, and lower killing intentions, than Meibae warriors, whereas in Westgate the attitudes of both groups were similarly positive towards conservation. The Warrior Watch strategy was to focus engagement on the warrior group because they were more negatively inclined towards lions, and hence these findings from Meibae support the programme's theory of change. The greater animosity towards lions associated with the historically greater presence of camels and their depredation by lions in Meibae may explain in part the difference in attitudes and killing intentions between the two conservancies. However, the fact that attitudes and killing intentions only differed significantly for the warrior age class suggests other influences. Importantly, both warriors and elders in Westgate were also significantly more likely to report positive changes in attitudes and tolerance in the period since the inception of Warrior Watch than their counterparts in Meibae for the same period, and to attribute these changes to Ewaso Lions and Warrior Watch specifically. Although this may be expected given that Ewaso Lions is the only conservation organisation specifically targeting lion conservation, other conservation interventions in Westgate are active in community-engagement and awareness raising. These might be expected to influence broader attitudes towards conservation and wildlife, yet they received markedly lower salience scores. Therefore, although the difference in reported attitudes towards lions and killing intentions between both conservancies may be due to an overall greater investment in conservation

efforts in Westgate, these results suggest that Warrior Watch is the main factor.

These results support our hypothesis that Warrior Watch specifically has promoted positive attitudes towards lions and reduced killing intentions where it is operating. However, even a few individuals holding negative attitudes and low tolerance can jeopardise these efforts, contributing not just to lion mortality but also potential behavioural costs to lions (Oriol-Cotterill et al., 2015). Given the large home range of lions, it is crucial for interventions like Warrior Watch to be incorporated in a broader landscape approach. Preliminary findings from our survey also highlighted the importance of social norms in shaping killing intentions (perceptions for how one should behave, and how individuals perceive others to act). This provides support for the expansion of interventions targeting other demographic groups to promote positive social norms. A previous evaluation of Warrior Watch (Gurd, 2012) found that the intervention was widely regarded as contributing towards social and political empowerment in Westgate, which may have helped Warrior Watch garner widespread community support despite only directly targeting warriors and conferring minimal financial incentives at the start. Future research should explore how the development of a coherent, synergistic set of interventions may further foster empowerment as different segments of Samburu society come together to achieve shared goals.

4.2. Factors associated with attitudes and killing intentions

We also found that respondents who reported household-level income from conservation and tourism held significantly more positive attitudes and were significantly less likely to report killing intentions. Further work is required to explore the causality of this finding - are attitudes positive because of involvement in wildlife-based tourism or conservation, or vice versa? Previous research has shown that working in ecotourism can promote positive changes in attitudes and behaviour towards focal species, and that this is not necessarily associated with economic returns (Ziegler et al., 2020). Additionally, it is not possible to rule out positive response bias from respondents in this group, who may feel pressured to report positive attitudes towards wildlife. While harnessing economic benefits can be a powerful incentive for carnivore conservation (Dickman et al., 2018b), focusing solely on financial mechanisms can 'crowd out' other values critical to promoting long-term coexistence (Rode et al., 2015). Carnivore retaliation may re-emerge if financial incentives, such as livestock compensation, disappear (Treves et al., 2009). The COVID19 pandemic has also highlighted the implications of overreliance on external finance flows, such as those linked to tourism, with pastoralist communities in northern Kenya seemingly more resilient than their southern counterparts who derive greater income from tourism (S. Bhalla, pers. obs.).

Lastly, although Hazzah et al. (2009) found that killing intentions were positively associated with the proportion of cattle losses attributable to depredation, our results do not corroborate this. Attitudes and killing intentions are shaped by a multitude of factors, beyond livestock ownership and the economic impact of wildlife on livestock. For example, attitudes towards lions may primarily be influenced by socio-psychological or cultural factors (Hazzah et al., 2009; Barua et al., 2013; Kansky et al., 2016), which may not necessarily bear a relationship with the number of livestock lost, or the proportion of the loss attributable to lions.

4.3. Study limitations

Despite a lack of comparable baseline data, we were able to elicit perceptions of change through a participatory, reflexive counterfactual approach, supporting community engagement in the conservation evaluation process. Although this approach is potentially prone to recall bias (Woodhouse et al., 2016), we were also able to assess which organisations respondents associated with that change, allowing us to

disentangle the potential influence of various conservation interventions (Dyson, 2015). Perceptions of changes in one's own attitudes and intentions, and the influence of different interventions on those changes, may ultimately be the critical factor in driving acceptance or support for an intervention and in turn may drive the desired behaviour change.

Our evaluation may have been influenced by social desirability bias. Although the research assistants had no prior engagement with Ewaso Lions, respondents may have been aware that they were affiliated with Ewaso Lions during the study period. Additionally, the survey instruments were designed to mitigate the influence of social desirability bias (Appendix 1, 2), but the research assistants reported that some respondents may have been purposely providing positive answers to attitudinal questions, driven by a desire for the social standing, food stipend or salary, and education provided by Warrior Watch. Even if true, this would demonstrate awareness of the benefits of the intervention. In addition, we also did not use indirect questioning to gauge killing intention which may have led to underreporting, as self-reports of sensitive behaviours can be prone to social desirability bias (St John et al., 2011). However, a substantial proportion of respondents in Westgate still indicated killing intentions, suggesting that social desirability may not have been strong enough to eliminate all negative responses. Alternatively, it is possible some negative responses were also strategic in nature and driven by a desire for continued or enhanced benefits derived from human-carnivore conflict interventions. Lastly, we only surveyed male respondents, and therefore cannot extrapolate our results to represent community-wide attitudes and killing intentions. Although women do not kill lions in the study area, they may influence killing intentions. In a similar context in Ruaha, Tanzania, the ritual killing of lions is a sign of bravery and winning over women may be a strong motivation to kill lions (A. Dickman, pers. comm.). While in Samburu the killing of lions primarily occurs either in retaliation for livestock killing or preventatively, and not as a cultural ritual or sign of bravery, it may be difficult to disentangle the underlying motivations for the killing of lions. Some respondents (particularly in Meibae) perceived the killing of lions as honourable, suggesting that lion killing could potentially be used for social gains (Table A7). Further research should therefore elucidate these influences.

4.4. Lessons for monitoring, evaluation, and learning

4.4.1. Evaluations tailored to organisational capacities can help overcome constraints to learning and reporting

Although recognised as crucial to support evidence-based practice, conservation programme evaluations remain under-reported in the literature, including for interventions addressing human-carnivore conflicts (Lozano et al., 2019). The lack of reporting on intervention outcomes and dissemination of practice-based lessons hinders the development of institutional memory around how to effectively address these complex issues. One key reason for this lack of reporting is that monitoring, evaluation, and learning imposes additional time, financial costs, and capacity-strengthening needs on already constrained conservation programmes (Pynegar et al., 2021). While randomised control trials or quasi-experimental evaluations are considered the 'gold standard' of impact evaluation, they can require substantial investments in money, time, and technical capacity (Baylis et al., 2016). In turn, this translates into a relatively small evidence base. Here we show that resource constraints for evaluation and learning should not be a barrier to conservation evaluation. Despite limitations (i.e. the lack of baseline data and ability to identify control sites through propensity score matching), we harnessed the principles of impact evaluation to provide a useful understanding of the impact of the intervention. This is being used to inform programme management.

Importantly, we show how eliciting a counterfactual through a participatory reflexive approach can help with evaluations in situations of social complexity, specifically by accounting for the potential confounding influences of conservation interventions operating

simultaneously. Lastly, although theories of change should ideally be developed prior to intervention implementation to support intervention design and prospective evaluations, we still encourage development of theories of change post-hoc if necessary. This helps to structure evaluations to explore why, and how interventions lead to impact (Woodhouse et al., 2016) and provides a baseline for future evaluations. However, understanding of causal relationships between activities, outcomes, and impact can evolve during an intervention. This is not an issue if the baseline is drawn for future evaluations, but for post-hoc evaluations, care should be taken to ensure the theory of change aligns with initial visions. Here, we achieve this by drawing on documents outlining the Warrior Watch vision and mode of operation, produced prior to the intervention.

4.4.2. Social evaluation is crucial to understanding the impact of conservation interventions

We did not collect data on actual reductions in lion killing, or trends in lion numbers, instead focusing on the impact of the Warrior Watch project on behavioural drivers. Evaluation of social factors is crucial to attribute impact to interventions and can improve our understanding of the mechanisms underpinning intervention effectiveness (Dyson, 2015; Sibanda et al., 2020). Although reduced killing intentions and positive attitudes may not always translate into behaviour change, research supports the link between attitudes, behavioural intention, and behavioural action (Webb and Sheeran, 2006; Marchini and Macdonald, 2012).

4.4.3. Mixed-method approaches are needed to elucidate mechanisms underpinning impact

The hypothesised intervention attributes and mechanisms underpinning how the intervention is promoting positive attitudes and lion tolerance are made explicit in the Warrior Watch theory of change (Fig. 1). Further testing of these presumed causal mechanisms will require additional, in-depth process-tracing evaluations combining qualitative and quantitative methods to provide robust empirical assessments. For example, qualitative approaches (e.g. focus group discussions, key informant interviews, ethnographic methods) are essential to provide more depth, and to examine relationships between nodes on the impact pathway made explicit in the theory of change. These methods could be harnessed to explore how the salary, education, or status of Warrior Watch members may sustain engagement of warriors in the programme, or whether the visible engagement of warriors in Warrior Watch may influence the attitudes of others towards the intervention. Rich qualitative data can also capture how the intervention may interface with participants' socio-cultural context, and in turn how that may be influencing perceptions and attitudes. Such knowledge is crucial to support formative evaluations to continuously improve and adapt interventions (Kleiman et al., 2000).

Future research should also focus on comparing the influence of the different behavioural determinants of killing intentions. This could be done by drawing on one of the various frameworks for understanding motivations, such as the Theory of Planned Behaviour (Ajzen, 1991). Such frameworks can be harnessed to assess the influence of social norms, behavioural control (i.e. perceived ability to carry out the act), and attitudes towards the behaviour of interest on behavioural intention and actual behaviours. The influence of these behavioural determinants can vary depending on the context (Armitage and Conner, 2001). As such, understanding their effect on behavioural intentions can help better target conservation efforts. For example, if social norms are found to have a large influence on behaviour, interventions harnessing the influence of recognised and respected figures in the community, such as elders, may be particularly effective to shift behaviour. Alternatively, if behavioural control is the prime determinant, interventions such as reducing the availability of weapons or promoting law enforcement may be more effective. Importantly, as landscapes are dynamic social-ecological systems, it is crucial not only to identify key behavioural

drivers of conflict, and the relationship among these, but to also understand how these may fluctuate over time. Research into human-wildlife relations should also include rigorous qualitative research on the social and ethical facets of human-wildlife relations and people's lived realities to explore coexistence in depth and expand the focus of evaluations beyond utility-based weighing up of explicit costs and benefits (Pooley et al., 2021). Establishing flexible robust monitoring, evaluation, and learning mechanisms to capture changes in the elements supporting tolerance is also crucial to sustainably manage for coexistence with large carnivores.

5. Conclusion

Expanding our understanding of which interventions are effective, how they are effective, and in which contexts, is crucial to better target conservation funds. To this end, establishing tailored monitoring, evaluation, and reporting mechanisms is essential. Here we demonstrated that Warrior Watch, a place-based, community-based intervention designed to fit the social-cultural fabric, had a positive impact on attitudes and reduced lion killing intention. Although implementing monitoring, evaluation and learning inevitably imposes additional costs on conservation programmes, it can be tailored to match organisational capacity. The success of large carnivore conservation rests on scaling-up and adaptively improving such programmes to manage for human-wildlife coexistence in rapidly changing social-ecological landscapes.

CRedit authorship contribution statement

Conceptualization: AC, HG, SB, TO, JL, and EJMG; Field work: PL, BL, TO; Data curation: AC; Formal analysis: AC, with review and guidance by JF; Funding acquisition: SB; Project administration: HG, SB, TO; Supervision: EJMG; Writing: AC and HG.

Declaration of competing interest

Study authors (HG, SB, PL, BL, TO) were affiliated with Ewaso Lions at the time. AC was contracted as an independent evaluator by Ewaso Lions to lead and undertake the evaluation. Analysis and interpretation of results was undertaken solely by AC.

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Apendixes

Supporting material and supplementary data to this article can be found online in Appendix 1, 2 and 3 at <https://doi.org/10.1016/j.biocon.2022.109571>.

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