

Lions, Bylaws, and Conservation Metrics

MONIQUE BORGERHOFF MULDER, JONATHAN LUCAS KWIYEGA, SIMONE BECCARIA, SYLVESTER SADOCK BWASAMA, EMILY FITZHERBERT, PETER GENDA, AND TIM CARO

African lions are a significant threat to pastoralists, triggering both retaliatory and nonretaliatory killings that represent a high-profile example of human–wildlife conflict. In the present article, we report on a grassroots campaign to reduce such conflict by shifting agropastoralists' attitudes toward lion killing and the central role of bylaws in its apparent success. Insofar as all of East Africa's principal protected areas still harboring lions are surrounded by pastoralist populations, the vast majority of which persecute lions, this novel strategy is of considerable wide-scale and practical significance. We report on an estimated 59%–69% reduction in the number of lions killed since the implementation of bylaws and use our experiences to highlight the need for fresh dialog among project managers, conservation organizations, and their funders in crafting appropriate conservation success metrics. In the context of human–wildlife conflict, changes in peoples' norms and attitudes are of greater significance over the long term than simplistic tabulations of the number of individuals saved.

Keywords: community, Katavi, Tanzania, donors, felidae

Growing agricultural and pastoral populations moving in search of unoccupied land create huge challenges for conservationists (e.g., Joppa et al. 2009, Laurance et al. 2014), especially when migrants settle in remote areas of low population density surrounding protected areas, as in Tanzania (Salerno et al. 2014) and other steppe and savannah locations. Where such migrants bring with them traditions for dealing with human–wildlife conflict, such as the retaliatory killing of lions (*Panthera leo*), tensions with protected area managers quickly develop. To address this pervasive problem across Africa, new approaches to conservation interventions and funding are needed. Although multiple approaches to reducing human–wildlife conflict are being tried (box 1), we report in the present article on the use of a hitherto unexplored community-driven means of conserving lions, the establishment of village bylaws, and its role in contributing to conservation success. In addition, and controversially, we question the appropriateness of the metrics of success that conservation funders increasingly require.

All of East Africa's principal protected areas still containing lions are surrounded by pastoral communities (table 1; see also Bauer and Van Der Merwe 2004 for West Africa), and human–wildlife conflict is rife. In addition, lion killing for material rewards and prestige, so deeply engrained in traditional culture (Wilson 1953, Spencer 1988), remains pervasive (Hazzah et al. 2009, Dickman et al. 2011, Eustace and Tarimo 2019), making community-focused interventions essential. In the present article, we examine a novel

grassroots strategy to reduce illegal lion killing among such populations, focusing on an ethnic group (Sukuma; see box 2) that has recently expanded to almost every region of Tanzania (Salerno et al. 2017). The implications of this investigation into how to stop lion killing form a case study in how to reduce human–wildlife conflict involving dangerous predators (Woodroffe et al. 2005).

We introduce the novel strategy of supporting a community initiative to establish bylaws that ban the killing of lions and rewarding of lion killers. Bylaws (*sensu stricto*) for conservation are typically deployed in industrial nations to solve landscape and urban planning dilemmas (Hawkins 2014, Curran et al. 2016), but within developing nations, their use is primarily limited to the participatory forestry sector (e.g., Khatun et al. 2017). Indeed, despite widespread support among international conservation organizations for community-based conservation, there is little acknowledgment that local conservationists (who these organizations empower) themselves need institutional means of furthering their objectives. Bylaw establishment offers an effective bottom-up community-driven institutional process that can change behavior and attitudes, as we will show.

Most strategies designed to reduce human–carnivore conflict demand continuous external funding (Dickman et al. 2011), but success in the funding arena rightly requires rigorous evaluation of project outcomes (Sutherland et al. 2004). Evaluation, most effective when conducted by independent parties, is expensive, however. In addition, it can

BioScience XX: 1–11. © The Author(s) 2019. Published by Oxford University Press on behalf of the American Institute of Biological Sciences. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted reuse, distribution, and reproduction in any medium, provided the original work is properly cited.
doi:10.1093/biosci/biz114

Box 1. Strategies to reduce human–lion conflict.

Free-ranging African lions are perceived as problems by pastoralists (Woodroffe et al. 2005, Riggio et al. 2013) because lions threaten livestock and humans; indeed, predator depredation can amount to two-thirds of a household's annual cash income (e.g., Holmern et al. 2007). Consequently, killing lions in retaliation for livestock loss is commonplace in many parts of the lion's range (Ogada et al. 2003, Holmern et al. 2007, Hazzah et al. 2009, Dickman et al. 2014, Hazzah et al. 2017), and retaliators garner significant economic and cultural rewards among human populations that rely heavily on livestock (e.g., Fitzherbert et al. 2014). In the face of this human–lion conflict, various approaches encourage coexistence between people and predators (Dickman et al. 2011). These include compensation for livestock losses (MacLennan et al. 2009, Bauer et al. 2017), safer husbandry practices (Ogada et al. 2003, Kissui 2008, Lichtenfeld et al. 2014), individual lion protection (Hazzah et al. 2014), fencing (albeit contraversially; Packer et al. 2013), setting up community conservancies whereby income from tourism replaces that from livestock (Blackburn et al. 2016), and village bylaw implementation (e.g., the present study).



Figure 1. Male lion feasting of a dead hippopotamus in Katavi National Park with crocodiles in attendance (photo Tim Caro).

impose considerable burdens on both interviewed households and project personnel, because, to be useful, it must cover multiple aspects of people's lives potentially affected by the intervention (Woodhouse et al. 2015, Brooks 2017). Without extensive and transparent discussions of realistic metrics between conservation funding organizations and their donors, local organizations now face daunting challenges in providing independently collected and sufficiently broad evidence-based success metrics when applying for renewed funding (Baylis et al. 2016).

Using village bylaws to limit lion killing

A novel approach to reducing negative impacts of humans on lions lies in the grassroots implementation of village bylaws that prohibit lion killing. The WASIMA campaign (*Watu, Simba, na Mazingira*, "People, Lions, and Environment") focused on establishing such bylaws at a site (Mpimbwe District) adjacent to Tanzania's third largest national park, Katavi (KNP) and the Rukwa Game Reserve (RGR). WASIMA is predicated on the assumption that locally driven institutional change (bylaws) could influence

Table 1. Principal protected areas in East Africa containing lions and the primarily pastoralist populations living adjacent to these areas.

Kenya		Tanzania		Uganda	
Protected area	Adjacent population	Protected area	Adjacent population	Protected area	Adjacent population
Aberdare NP	Maasai	Katavi NP	Sukuma	Kidepo NP	Karimajong
Amboseli NP	Maasai	Lake Manyara NP	Maasai	Murchison Falls NP	Karimajong
Lake Nakuru NP	Maasai	Mahale Mountains NP	Sukuma	Queen Elizabeth NP	Nyankole, Hima
Masai-Mara NR	Maasai	Mikumi NP	Barabaig, Maasai		
Meru NP	Borana and others	Mkomazi NP	Maasai		
Nairobi NP	Maasai	Ngorongoro CA	Maasai		
Tsavo East NP	Maasai, Orma	Ruaha NP	Barabaig, Maasai, Sukuma		
Tsavo West NP	Maasai	Saadani NP	Barabaig, Maasai, Sukuma		
		Selous GR	Maasai		
		Serengeti NP	Maasai		
		Tarangire NP	Maasai		
		Udzungwa NP	Sukuma		

Note: The data are from various sources, primarily Enghoff (1990) and Homewood (1995). Abbreviation: CA, conservation area; GR, game reserve; NP, national park; NR, nature reserve.

lion numbers by shifting the cost:benefit ratio of killing lions. The theory of change (White 2009) underlying this campaign is that attitudes and practices surrounding lion killing would change as a result of new bylaws making illegal both the visits of lion dancers to Mpimbwe and the material rewards of their feats of courage.

Sukuma began arriving in Mpimbwe in the mid 1970s, bringing with them the cultural practice of killing lions that endanger people and their livestock and rewarding lion dancers for their bravery in protecting the common good (box 2). Capitalizing on evidence that householders were tiring of rewarding lion killers who increasingly seek trophies inside the national park (Fitzherbert et al. 2014), WASIMA project staff, with local input, adopted the use of bylaws. First, they introduce the idea informally in a village, working closely with a motivated core group of individuals. Next, a draft bill goes to the village natural resource committee (figure 3) and, finally, to a full village assembly. If accepted, the bill moves to the district council. After approval, training is conducted with the *Sungusungu*, a grassroots and strongly locally endorsed policing organization (Paciotti and Borgerhoff Mulder 2004). At these training workshops, the political, legal, and social aspects of implementing bylaws within the framework of state law are fully discussed, working from a manual designed by WASIMA's first project manager (PG) in conjunction with *Sungusungu* and local government leaders. Additional ancillary WASIMA campaign activities accompany bylaw motivation events and include environmental film showings, tours for students and village leaders into KNP, tree planting programs, and wildlife clubs. WASIMA currently operates in 22 villages across Mpimbwe District (Katavi Region), with bylaws fully adopted in 18 villages and with another 4 currently approaching ratification.

Assessing impact. To determine the effectiveness of this intervention on perceptions of lion killing, the results of a household survey ($n = 150$) conducted in 2010 in Mpimbwe were compared with a second crowd-funded survey ($n = 212$) conducted in August 2016 and February 2017, using identical methods and survey instruments. The second survey identified a parallel sample to that of the original survey: rural Sukuma households scattered across a growing number of subvillages on the flood plains adjacent to the protected areas (see the supplement 1).

In answer to a question regarding how often the interviewee sees lion dancers in Mpimbwe these days (supplement 2), the percentages of respondents answering "often" changed from 43% to 3%, and those answering "never" from 10% to 60%. Asking more specifically about lion dancers' visits to the interviewee's household since 2005 ($n = 132$ dancer visits), 75 of 97 (77%) of the visits were reportedly rewarded in the first survey, but only 18 out of 35 (51%) in the second survey ($\chi^2 = 7.88$, $df = 1$, $p < .01$; figure 4). Although almost half of the visits were still rewarded, the payment components changed over time ($\chi^2 = 10.39$, $df = 2$, $p < .005$, $n = 93$ rewarded visits). Most notably, the highly preferred gift (cattle or multiple sheep or goats) declined from 44% to 11% of all rewarded visits between the first and second surveys, whereas the presentation of small gifts (nominal cash payments or a hen) increased from 11% to 39%.

Turning to attitudes, the interviewees' responses to hypothetical lion killing by their sons have changed since WASIMA began. Household heads claim to be far less tolerant of killings both adjacent to Sukuma settlements and inside the protected areas (figure 5); a father's approval is critically important in highly gerontocratic pastoralist societies, where sons depend heavily on their fathers for access to land and livestock.

Box 2. Sukuma and lions: An uneasy relationship.

Sukuma communities arrived in Mpimbwe in the mid-1970s after abandoning their heavily degraded homelands in northern Tanzania (Galaty 1988). As agropastoralists, they typically settle on seasonal flood plains for rice cultivation and keep large herds of cattle and small stock. Human–wildlife—and, particularly, human–carnivore—conflict occurs across much of their range, promoting a cultural practice of retaliatory lion killing. According to Sukuma contemporary practice, a lion killer has informal license to visit the households of relatives and clan members, both in their own neighborhood and in other regions of the country, perform a traditional lion dance, and demand rewards (livestock or cash) for both bravery and ridding the community of a predator.

Research conducted in 2010–2011 in Sukuma communities bordering KNP and RGR showed that the cultural practice of lion killing had altered in response to new conditions in which livestock depredation was no longer a problem. In Mpimbwe, the retaliatory killing of lions that attack livestock on village lands (by “avengers”) was being replaced by the pursuit of lions within the national park (by “hunters”; Fitzherbert et al. 2014). From Mpimbwe, Sukuma men were increasingly entering protected areas to kill lions for profit. Because lions are now, in this part of Tanzania, rarely encountered outside protected areas and pose little threat to livestock, Fitzherbert and colleagues (2014) concluded that lion killing is now driven by the attraction of financial and reputational awards rather than the protection of livestock.

In interviews in 2010, many householders conveyed dismay at this shift in Sukuma custom (Fitzherbert et al. 2014). *Wafeki* (Ki-Swenglish for “cheater” or “faker”) had become a common epithet for men who hunt lions in a protected area and then dance as if they had provided a public good. Accordingly, a grassroots campaign, WASIMA (for *Watu, Simba, na Mazingira*; in Kiswahili, “People, Lions, and the Environment”) was established in 2011 to halt the prevalence and the spread of lion killing in Mpimbwe (Genda et al. 2012), a heavily human dominated landscape (Caro 1999).



Figure 2. *Lion dancer visiting a household. Photograph: Emmanuel Stephens.*

How many lions were saved? Of the 132 dancer visits, 105 (80%) involved killings in KNP and RGR (areas not differentiated by Sukuma and referred to in the present article as Katavi); the remaining 20% of killings occurred in other western and central regions of the country; some Sukuma lion dancers travel far to celebrate their feat. We determined that the visits from lion dancers represented the deaths of between 55 and 72 Katavi lions (using the lower and upper bounds of independence, table 2). To identify the change in lion killings between 2005–2010 and 2011–2016, the same analysis was conducted on visits recorded in the 5 full years preceding each survey. We recorded that 42–55 lions were killed in Katavi between 2005 and 2010 (inclusive) and 13–17 lions

between 2011 and 2016 (table 2), representing a decline of 59%–69%. Put another way, the number of lions saved during the WASIMA campaign (2011–2016) lies between 29 and 38 individuals (or 4.8–6.3 lions per year over 6 years). On the basis of the only accurate estimate of lions ever made in KNP (Kiffner et al. 2009), that gave a figure of 168 (range, 77–439) lions in 2005; this represents 2.9%–3.8% of the 2005 lion population saved per year (table 2).

What have we learned?

In this study, we used a before and after design to show a major decline in reported lion killing and lion dancing in Mpimbwe and in social approval of the lion killing tradition,



Figure 3. WASIMA staff facilitating a village council meeting in Mpimbwe. Photograph: Jonathan Kwiyegea

which resulted in saving an estimated 29–38 individual lions between 2011 and 2016. These changes are coterminous with the establishment of the WASIMA campaign and likely contingent on the institution of bylaws and associated WASIMA activities. Because of both widespread internal migration of people across remoter areas of Tanzania (Salerno et al. 2014) and the continuing prevalence of human–lion conflict where (agro)pastoral populations live adjacent to protected areas (Salerno et al. 2017), these results are of considerable relevance to East Africa and beyond. We recognize the limitations of relying on reported data and of estimating demographic outcomes from lion dancer visits (both discussed below), but we use this apparent success story to reflect on the broader challenges and opportunities facing community organizations in evaluating their performance according to the metrics of international funders. These include the difficulty in counting lions saved; the tricky dynamics among the behavioral, attitudinal, and ecological impacts of their programs; and the challenge of convincing donors of the role of bylaws in institutionalizing conservation objectives.

Difficulties in counting lions saved. Increasingly and for good reason (Sutherland et al. 2004), funders ask programs that are designed to ameliorate human–wildlife conflict to

provide measures of success. They often request a precise estimate of the effect of the program on the target species' numbers, effectively asking, "How many individuals has your initiative saved?"

To be credible, such estimates require not only accurate independent data on overall population trends in the target species but also careful apportionment of (often multiple) causes of population change. Regarding the first, for WASIMA, this would entail comparing the current population of lions in KNP to that estimated in 2005 by Kiffner and colleagues (2009) to see if there has been an increase in the population coterminous with the founding of WASIMA. This was not feasible because of a delayed nationwide lion census and a more general political sensitivity to counting species classed as "vulnerable" (Riggio et al. 2013). Furthermore, such a donor-demanded census, had it occurred, could still not unequivocally attribute a change in lion numbers to WASIMA's actions.

This is because ascribing population changes to particular ecological and social drivers demands intensive research on prey populations, disease, and rainfall, as well as on anthropogenic drivers, including habitat fragmentation and different forms of exploitation acting simultaneously, and even the best studies (e.g., Blackburn et al. 2016) rely in part on

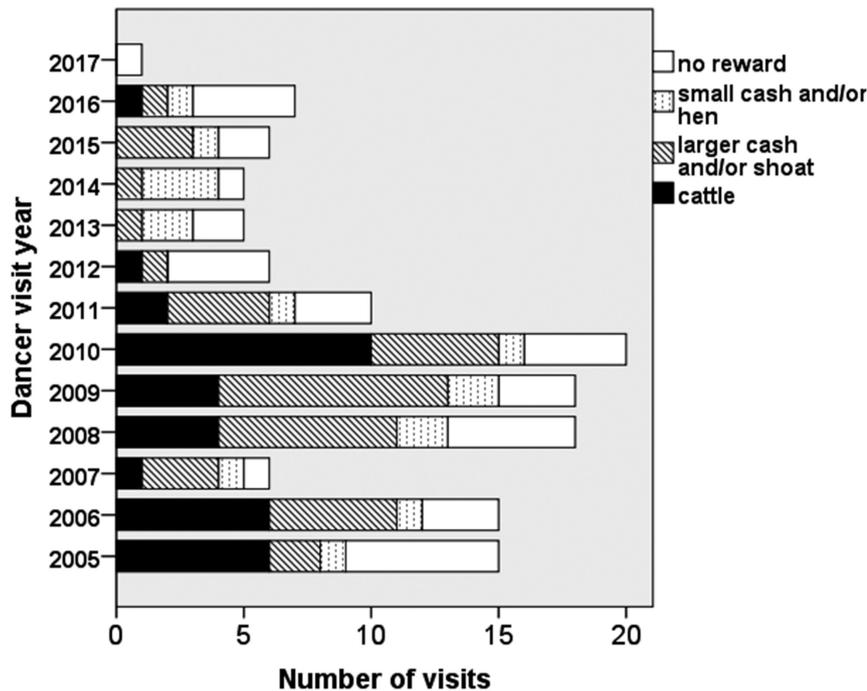


Figure 4. The distribution of visits made by lion dancers since 2005, and the proportion of those visits rewarded with different gifts, based on 5-year recall in 2010 and 2016–2017 surveys ($n = 132$). WASIMA was initiated in 2011 and became fully active in 2012.

inferences. With respect to the current case, lions are killed by expatriate hunters (Packer et al. 2011, Nelson et al. 2013) in five hunting blocks that surround KNP (Caro 2008), but there is no accurate picture yet of the relative importance of illegal and legal hunting of lions in Tanzania. Obtaining lion legal offtake records from local and central government is often difficult (Riggio et al. 2016), and, coupled with a reticence about conducting lion surveys nationally, the overall significance of changes in local hunting pressure are hard to assess. Furthermore, a declining prey base within KNP may also be exerting an effect (Caro 2008), mirroring that occurring throughout the lion's range (Sandom et al. 2017). The data-intensive investigations required to unpack the precise impact of a community initiative such as WASIMA are far beyond the scope and capacity of most grassroots conservation projects.

As an alternative to focusing on the population dynamics of predators, conservationists can use more directly measured outcomes. For example, interventions focused on good husbandry quantify *reductions in lion attacks on livestock* (Ogada et al. 2003, Kissui 2008, Lichtenfeld et al. 2014), or experience of livestock depredation can influence *individual propensities toward lion killing* (Hazzah et al. 2009). Some programs track the *number of lions killed*. For example, on a southern Kenyan “group ranch,” compensation combined with a broader set of interventions incentivizing lion conservation is associated, most likely causally, with an extraordinary 99% decline in the number of lions

killed (Hazzah et al. 2014) and, similarly, an 80% decline around Tanzania's Ruaha National Park (www.bbc.com/news/magazine-40261039). Although such measures offer, in one sense, a gold standard, it is of course possible that individuals inclined to kill lions hunt elsewhere (an issue of leakage we address below), such that inferences to overall lion numbers are still problematic.

WASIMA cannot directly count the number of lions killed, because these events occur deep inside the national park and game reserve, but they can make estimates on the basis of lion dancer visits. This method has limitations. First, there are exogenous reasons that estimates may be biased up (or down) in both surveys (see table 2). Second, the data are based on *recalled* visits of lion dancers; the number of visits may be inflated because of their saliency or, alternatively, may be forgotten or concealed. Third, illegal lion killing may be underreported to the second survey enumerators, who were (albeit indirectly) associated with WASIMA, although insofar as the first

survey was conducted by an expatriate researcher (EF) working with a broader long-term conservation activities in the area (Borgerhoff Mulder et al. 2007), an underreporting bias might be expected there too. We raise the relationship between independent evaluation and funding later.

In short, when grassroots lion conservation program managers are asked to show (e.g., on funding application forms) how many lions they have saved, they should ideally conduct fully controlled before and after studies with counterfactuals to accurately infer causality (e.g., Ferraro et al. 2019). This is rarely feasible for small organizations. Insistence on this point will stifle—and even halt—many worthwhile local conservation initiatives.

Collaborative development of appropriate metrics of success. Our experiences with identifying metrics of success for WASIMA highlight the need for what Baylis and colleagues (2016) called “mainstreaming” project evaluation through long-term partnerships between funders and projects in both the design and funding of interventions. We encourage this for several reasons.

First, in considering the shortcomings of our estimates of lions saved, we recognize that not all men who kill lions in Katavi dance in Mpimbwe. Indeed, it is quite possible that lion killers leave Mpimbwe to dance elsewhere. This is a classic spillover dynamic, often referred to as *leakage* (Baylis et al. 2016). It is, effectively, the displacement of unwanted

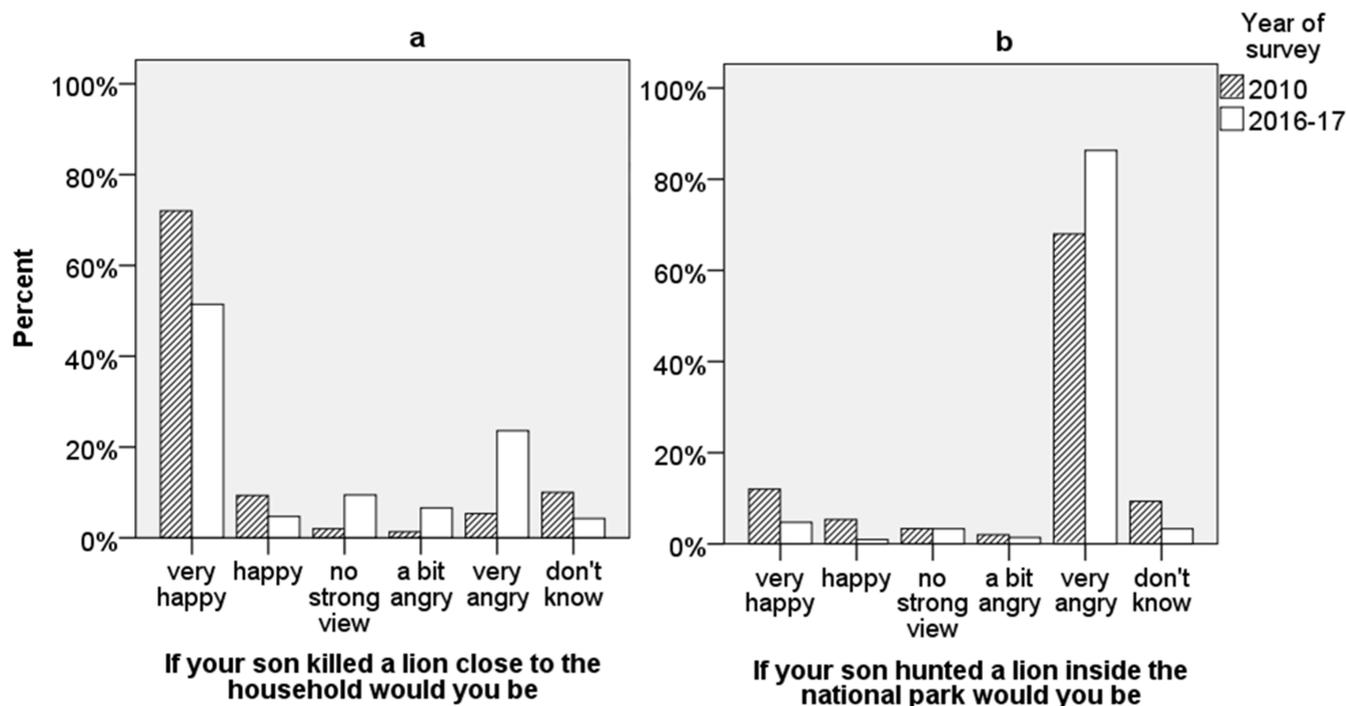


Figure 5. Attitudes toward the killing of lions within (a) the community and (b) the national park as compared between before and after WASIMA that started in 2011. ($\chi^2 = 33.68$, $df = 1$, $p < .001$, $n = 338$; $\chi^2 = 13.44$, $df = 1$, $p < .01$, $n = 341$, respectively).

behavior elsewhere, and indeed, project managers often hear that lion killers now fear dancing in Mpimbwe because of contravening village bylaws. This is undoubtedly a problem for the estimate of lions saved (effectively overestimating the metric of success). However, at the same time, it is, ironically, a sign of the success of the WASIMA campaign and provides a strong rationale for expanding the program across adjacent Sukuma-dominated areas, such that dancing no longer becomes an option anywhere, thereby avoiding leakage and rather promoting what has been called a “halo” effect (Baylis et al. 2016). This raises the question of how much attention funders should pay to the number of lions saved as opposed to alternate impact metrics of novel institutions.

Second, conservation interventions must operate on multiple scales. The estimated 29–38 lions saved represent the reduced hunting pressure only from Mpimbwe, lying to the south of Katavi. To the north of the protected areas lie traditional lands of the WaBende and, to the east, the WaKonongo (Mgawe et al. 2013); both zones are now heavily populated by Sukuma migrants (whose settlements are now also permanent, Salerno 2016). Because there is no evidence that Sukuma youth in those areas have reduced their customary lion killing, the impact of illegal lion killing may be considerably greater than estimated in the present article. Funders, in collaboration with local communities, should consider whether funds are better spent evaluating local success for lion numbers or expanding bylaw adoption elsewhere. Are funders willing to consider that leakage is sometimes best

countered through promoting institutional halos around successful interventions, effectively scaling up their intervention (e.g., Andrews and Borgerhoff Mulder 2018)?

Third, funders typically support only activities directly related to stopping lion killing, not longitudinal ecological and social monitoring. Organizations such as WASIMA must therefore turn to crowd-funding platforms. In this particular case, evaluation was facilitated through links to a US academic institution (and a secondary network of conservation-minded donors)—an advantage unfortunately largely unavailable to most local conservation organizations. A related problem is that, even if funders are willing to support evaluation, resources are rarely sufficient for hiring independent personnel. The WASIMA surveys were not entirely independent (see supplement 1), raising important credibility issues for community-based grassroots organizations that clearly worry funders.

Finally, although no funding agency has raised this issue, WASIMA recognizes that dismissing the cultural value of virtuoso lion dance performances would be counterproductive. Projects should be evaluated on multiple criteria, not least cultural integrity. Campaigns should be balanced with programs that encourage maintenance of (dance) traditions, similar to the emphasis on cultural continuity in a comparable grassroots program in Kenya (Hazzah et al. 2009, Dolrenry et al. 2016). Other examples already exist in Africa, such as PANTHERA’s promotion of fake leopard skins in Zulu cultural dancing.

Table 2. Lion dancers' visits to households in Mpimbwe between 2005–2016, where the location of incident was identified as “Katavi.”

Date	Lion dancer visits	Proportion of visits judged independent ^a		Estimated number of lions killed	
		Lower bound (less stringent estimate)	Upper bound (more stringent estimate)	Lower bound	Upper bound
2005–2010	75	0.723	0.560	55	42
2011–2016 ^b	22	0.773	0.591	17	13
2005–2016	97	0.742	0.567	72	55

^aTo determine number of lions saved, the *independence* of 97 cases where households reported a visit from a dancer who announced having killed a lion in “Katavi” must be established. Using two sources of data—year of reported visit and place of origin of the dancer—lower and upper bounds of independence were identified. *Lower-bounded* (or less stringent) independence was determined for paired records with shared year and shared place of dancer's origin; in other words, if dancer from the same area of origin danced in multiple households in 2008 he was considered as a single case (one lion killed). Using this method for the full set of observations ($n = 97$) yielded a judgement that 74% of lion dancer visits were made by independent dancers celebrating *distinct* incidences, or 72 killings. *Higher-bounded* independence was determined more stringently, insofar as adjacent years were considered as equivalent (i.e., the same year), perhaps reasonable given that many Sukuma estimate the passing of a year on an agricultural rather than a Julian calendar; therefore, dancers from the same place of origin dancing in 2008 and 2009 were considered as a single case (one lion killed); this yielded an estimate of 55 independent killings for the full sample of observations. The estimates of number of lions killed may be overestimated if lion killers are “sharing” spoils with others (for profit), or underestimated if lions are being killed for purposes other than dancing—for example, to provide traditional medicines both within Africa and internationally (Riggio et al. 2013). (We assume, following ethnographic reports, that lions are killed by a single hunter or dancer).

^bThere are two reasons our comparisons in the text are conservative with respect to inferring the effects of WASIMA: The first survey captures 68 months retrospectively, the second 68–74 months, and WASIMA was not fully implemented until midyear 2012.

We have raised several thorny conservation issues. First, what is the appropriate relationship between behavioral or attitudinal measures of change (negative views on a lion-killing son, reduced gifts for dancers) and ecological outcomes (number of lions saved)? Should the latter necessarily take precedence? Second, what to do when the institutional success of a campaign such as WASIMA may have driven the behavior undercover and may therefore have interfered with more standard measurements of success (in this case, the frequency of lion dancer visits)? The very fact the behavior might be hidden to other community members (including researchers) actually points to an important norm change! Third, how to deal with scalar effects in success metrics? Campaigns that successfully change peoples' attitudes have within them, when there is leakage of conservation actions beyond the project area, the very seeds of their own expansion or destruction (Baylis et al. 2016). If WASIMA in Mpimbwe is prompting lion killers to dance elsewhere, WASIMA must be extended to adjacent areas. Consequently, donors need to consider far more carefully whether evaluation funds might be better spent focusing on appropriate metrics and examining what is going on outside of the project area for both positive and negative spillover effects; this is particularly important for wide-ranging target species.

Ultimately, funders demanding evidence-based evaluations should recognize the financial and logistic challenges in conducting those evaluations and should think beyond simplistic endpoints. Clearly, there is no one size fits all solution, such as the number of individual animals saved. As was recently concluded by Blackburn and colleagues (2016), changing human perceptions and attitudes toward lions most likely play a key role in successful conservation outcomes in Kenya's Masai Mara, even though the authors were unable to measure this. WASIMA, on the other hand,

chose to measure attitudes but not outcomes, but these too would be considered as clear flags of success in any theory of change (White 2009). Indeed, as Cowling (2014) implored, as conservationists, “let's get serious about human behavior” (see also Hazzah et al. 2017).

Bylaws as keys to success. As was noted above, WASIMA's theory of change lies in the assumption that attitudes and practices regarding lion killing and lion dancing would change as a result of shifts in the cost:benefit ratio of lion killing and lion dancing contingent on new bylaws. At a superficial level, the intervention has worked. There has been an apparent increase in disapproval among household heads of lion killing by their sons, a reported reduction in rewarding lion dancers, and a substantial drop in the number of lion dancers reported visiting households. It is unlikely that this results from reduced conflict with lions, because the levels of livestock depredation were very low in both surveys (4% and 3%, respectively). (Also, if attitudinal change simply tracked declining incidences of human-wildlife conflict, we would expect only a reduction in tolerance of sons killing as “avengers” and not as “hunters,” but this was not the case.) WASIMA staff sense bylaws are working as deterrents rather than punishments. For example, village governments working with the *Sungusungu* exert fines of 100,000 TSh (US\$45) for infringements but rarely now encounter dancers. Notably, in 2016, villagers informed on an incident of 10 youths planning to hunt lions inside KNP.

How can all these changes be explained? We look briefly at this question from the perspective of householders, potential lion killers, and, finally, the communities accepting new bylaws to determine broader lessons for lion conservation in areas dominated by pastoralists with lion killing traditions, as are found particularly in East Africa.

Precipitating factors that have motivated Sukuma householders—typically elders—to first suggest and later embrace the goals of WASIMA likely include resentment of the financial gains being made, not only by the *wafeki* themselves but also the local doctors (*waganga*), who reportedly sell lion body parts delivered to them by lion killers in exchange for potions. Also likely important was “gifting fatigue” (Fitzherbert et al. 2014) and annoyance among householders who see lion dancers as no longer providing a *public* good but simply private benefits. In their words, dancers are “stealing twice, once from us [through our gifts] and once from KNP” (village meeting August 2014). Finally, *Sungusungu* support was critical, given their respected status in Mpimbwe (Paciotti et al. 2005).

Turning to lion dancers, the anticipation of smaller (or no) gifts or of the threat of censure or fines clearly reduces the motivation both to kill lions and to dance in Mpimbwe. The logic in the present article seems straightforward, insofar as the costs of lion hunting have increased (because of WASIMA fines) and the benefits declined.

What is more puzzling is why the people of Mpimbwe, in their various roles as members of village assemblies, recipients of dancer visits, or potential victims of lion attacks agree to bylaws at all. There are three possibilities. First, community members might perceive increased benefits from conserving lions. Tourism is commonly identified as a source of compensation, but in Mpimbwe, there are effectively no significant financial benefits to local communities from lion conservation. Tourism is restricted to luxury camps, typically staffed by personnel from other regions and supplied by air; furthermore, employment opportunities in KNP are meager. Second, perhaps project interventions have shifted wildlife values through WASIMA’s ancillary activities? These, however, are, as yet, quite limited. Consistent with Dickman and colleagues (2011), we note that resources devoted to alternative livelihood programs or other inducements for coexistence with predators are inadequate. In short, there are no perceived benefits to living with lions. Furthermore, although the costs are currently low (cases of cattle depredation are rare; Fitzherbert et al. 2014) these may climb as populations grow (Salerno et al. 2017) and herders seek pasture inside of protected areas, thereby exposing their livestock to greater risks of predation.

A third possibility is that people want to develop their own regulations regarding their interactions with wildlife after a history of top-down state-led initiatives. The people of Mpimbwe, as in some other parts of East Africa, have suffered harassment from centralized law enforcement; most recently, they were relocated with the expansion of KNP in 1998 (Borgerhoff Mulder et al. 2007) and targeted by violence (in the Tokomeza campaign’s burning of their houses; Salerno et al. 2017). It is just possible that these grievances stimulated grassroots action.

In summary, we cannot pinpoint *exactly* why communities in Mpimbwe were open to the adoption of bylaws, but we have some suggestions that may guide

initiatives elsewhere in Africa where human–wildlife conflicts abound (Woodroffe et al. 2005). First, heterogeneity within communities with respect to support of the custom of lion killing can be profitably leveraged without infringing on individual rights. Second, local institutions must be involved from the very start in both the design and implementation stages (as was shown to be important globally; Brooks et al. 2012). Third, given that benefits from tourism may be a vain hope (at least in the short term), alternative stabilizing institutional mechanisms, such as mutually agreed on fines, are needed. Locally initiated bylaws may not be a panacea, but they are worth considering more broadly, if local activists are to be empowered. In short, conservationists should encourage the endogenous emergence of institutions.

Conclusions

Internal migration in Tanzania is heaviest in areas with lower (preexisting) population densities, areas that typically lie close to protected areas (Salerno et al. 2014) and that are the focus of the Sukuma expansion of the last 40 years (Salerno et al. 2017). Lion-killing traditions cause considerable lion population offtake (between 55 and 72 individuals in KNP since 2005). Bylaws, in conjunction with ancillary educational and entertainment activities, offer effective tools to reduce illegal lion killing, as is evidenced in the present article. This has implications for national strategy, especially in East Africa but potentially wherever retaliatory killing occurs. Interestingly, although there is some use of village bylaws in the participatory forestry sector, we are not aware of this as conservation strategy for wildlife. There is a tendency to glamorize community-based conservation, but communities are not single-willed entities (Agrawal 1997). The conservation-orientated community members that outside nongovernmental organizations attract (and empower) need institutional means (such as bylaws) of furthering their objectives. Establishing bylaws has proved a novel (as far as we know) and effective (as we have shown) solution. Furthermore, bylaws are not, by definition, top-down impositions—a strategy so contested in the conservation literature—but promote self-regulation.

Ongoing grassroots initiatives require basic operating costs and, therefore, donor support, necessitating the evaluation of outcomes and impacts. This can be problematic for small organizations with limited budgets, unable to outsource the process to an independent agent; WASIMA’s evaluation was supported entirely through crowd funding. With social media and a few well-connected friends, this might prove appropriate for small organizations in the developing world that do not, at least in their early years, have the human capital to apply for large conservation grants.

Conventional standards of success dictated by Western donor organizations may be inappropriate or may, at least, distract attention from other meaningful indices. Project managers, evaluators, conservation funders, and (most

importantly) their donors need to enter into constructive dialog over appropriate indices of success. They must consider the relative merits of monitoring developments inside and outside protected areas; determine how to weight attitudinal, behavioral, and ecological measures as informative flags of success; and recognize the considerable financial and logistic constraints that grassroots programs face.

Acknowledgments

We thank Amisa Msago, the late Oska Ulaya, and Salum Ayubu for logistical support. The evaluation of WASIMA was funded via Experiment.com; we are enormously grateful to the contributors. Furthermore, support for WASIMA (cash or kind) came from the National Geographic Society Big Cats Initiative, WildCru, PANTHERA, Nomad Trust, Nature Picture Library, Sacramento Zoo, Nomad Trust, Cleveland Zoo, Tusk Trust, and UC Davis. We also acknowledge the Interdisciplinary Centre for Conservation Science (Oxford University) for investing in evaluation in Mpimbwe. Research was conducted under ethical clearance from UC Davis IRB 436682.

Supplemental material

Supplemental data are available at *BIOSCI* online.

References cited

- Agrawal A. 1997. Community in Conservation: Beyond Enchantment and Disenchantment. Gainesville. Conservation and Development Forum, Florida.
- Andrews J, Borgerhoff Mulder M. 2018. Cultural group selection and the design of REDD+: Insights from Pemba. *Sustainability Science* 13: 93–107.
- Bauer H, Van Der Merwe S. 2004. Inventory of free-ranging lions *Panthera leo* in Africa. *Oryx* 38: 26–31.
- Bauer H, Müller L, Van Der Goes D, Sillero-Zubiri C. 2017. Financial compensation for damage to livestock by lions *Panthera leo* on community rangelands in Kenya. *Oryx* 51: 106–114.
- Baylis K, Honey-Rosés J, Börner J, Corbera E, Ezzine-de-Blas D, Ferraro PJ, Lapeyre R, Persson UM, Pfaff A, Wunder S. 2016. Mainstreaming Impact Evaluation in Nature Conservation. *Conservation Letters* 9: 58–64.
- Blackburn S, Hopcraft JGC, Ogotu JO, Mattiopoulos J, Frank L. 2016. Human–wildlife conflict, benefit sharing and the survival of lions in pastoralist community-based conservancies. *Journal of Applied Ecology* 53: 1195–1205.
- Borgerhoff Mulder M, Caro TM, Msago AO. 2007. The role of research in evaluating conservation strategies in Tanzania: The case of the Katavi–Rukwa ecosystem. *Conservation Biology* 21: 647–658.
- Brooks JS. 2017. Design features and project age contribute to joint success in social, ecological, and economic outcomes of community-based conservation projects. *Conservation Letters* 10: 23–32.
- Brooks JS, Waylen KA, Borgerhoff Mulder M. 2012. How national context, project design, and local community characteristics influence success in community-based conservation projects. *Proceedings of the National Academy of Science* 109: 21265–21270.
- Caro TM. 1999. Densities of mammals in partially protected areas: The Katavi ecosystem of western Tanzania. *Journal of Applied Ecology* 36: 205–217.
- Caro TM. 2008. Decline of large mammals in the Katavi ecosystem. *African Zoology* 43: 99–116.
- Cowling RM. 2014. Let's get serious about human behavior and conservation. *Conservation Letters* 7: 147–148.
- Curran D, Krindle E, Hulse M, Kirkby J. 2016. Green Bylaws Toolkit for Conserving Sensitive Ecosystems and Green Infrastructure. Report no.
- Dickman AJ, Hazzah L, Carbone C, Durant SM. 2014. Carnivores, culture and “contagious conflict”: Multiple factors influence perceived problems with carnivores in Tanzania's Ruaha landscape. *Biological Conservation* 178: 19–27.
- Dickman AJ, Macdonald EA, Macdonald DW. 2011. A review of financial instruments to pay for predator conservation and encourage human–carnivore coexistence. *Proceedings of the National Academy of Sciences* 108: 13937–13944.
- Dolrenry S, Hazzah L, Frank LG. 2016. Conservation and monitoring of a persecuted African lion population by Maasai warriors. *Conservation Biology* 30: 467–475.
- Enghoff M. 1990. Wildlife conservation, ecological strategies and pastoral communities. *Nomadic Peoples* 25–27: 93–107.
- Eustace A, Tarimo DB. 2019. Maasai and lion killings in the Tarangire–Manyara ecosystem. *African Journal of Ecology* 57: 140–143.
- Ferraro PJ, Sanchirico JN, Smith MD. 2019. Causal inference in coupled human and natural systems. *Proceeding of the National Academies of Sciences* 116: 5311–5318.
- Fitzherbert E, Caro T, Johnson PJ, Macdonald DW, Borgerhoff Mulder M. 2014. From avengers to hunters: Leveraging collection action for the conservation of endangered lions. *Biological Conservation* 174: 84–92.
- Galaty JG. 1988. Pastoral and agro-pastoral migration in Tanzania. Pages 163–183 in Bennett JW, Bowen JR, eds. *Production and Autonomy: Anthropological Studies and Critiques of Development*. University Press of America.
- Genda P, Borgerhoff Mulder M, Caro T, Fitzherbert E, Ballard H. 2012. Launching Watu, Simba na Mazingira project in Katavi–Rukwa. *Kakakuona* (October–December): 55–56.
- Hawkins CV. 2014. Landscape conservation through residential subdivision bylaws: Explanations for local adoption. *Landscape and Urban Planning* 121: 141–148.
- Hazzah L, Bath A, Dolrenry S, Dickman A, Frank L. 2017. From attitudes to actions: Predictors of lion killing by Maasai warriors. *PLOS ONE* 12 (art. e0170796).
- Hazzah L, Borgerhoff Mulder M, Frank L. 2009. Lions and warriors: Social factors underlying declining african lion populations and the effect of incentive-based management in Kenya. *Biological Conservation* 142: 2428–2437.
- Hazzah L, Dolrenry S, Naughton L, Edwards C, Mwebi O, Kearney F, Frank L. 2014. Efficacy of two lion conservation programs in Maasailand, Kenya. *Conservation Biology* 28: 851–860.
- Holmern T, Nyahongo J, Røskaft E. 2007. Livestock loss caused by predators outside the Serengeti National Park, Tanzania. *Biological Conservation* 135: 518–526.
- Homewood K. 1995. Development, demarcation and ecological outcomes in Maasailand. *Africa: Journal of the International African Institute* 65: 331–350.
- Joppa LN, Loarie SR, Pimm SL. 2009. On population growth near protected areas. *PLOS ONE* 4 (art. e4279).
- Khatun K, Corbera E, Ball S. 2017. Fire is REDD+: Offsetting carbon through early burning activities in south-eastern Tanzania. *Oryx* 51: 43–52.
- Kiffner C, Meyer B, Muhlenberg M, Waltert M. 2009. Plenty of prey, few predators: What limits lions *Panthera leo* in Katavi National Park, western Tanzania? *Oikos* 41: 52–59.
- Kissui BM. 2008. Livestock predation by lions, leopards, spotted hyenas, and their vulnerability to retaliatory killing in the Maasai steppe, Tanzania. *Animal Conservation* 11: 422–432.
- Laurance WF, Sayer J, Cassman KG. 2014. Agricultural expansion and its impacts on tropical nature. *Trends in Ecology and Evolution* 29: 107–116.
- Lichtenfeld LI, Trout T, Kisimir EL. 2014. Evidence-based conservation: Predator-proof bomas protect livestock and lions. *Biodiversity and Conservation* 24: 483–491.

- MacLennan SD, Groom RJ, Macdonald DW, Frank LG. 2009. Evaluation of a compensation scheme to bring about pastoralist tolerance of lions. *Biological Conservation* 142: 2419–2427.
- Mgawe P, Borgerhoff Mulder M, Caro T, Seel SJ. 2013. *Historia ya Kabila la Wapimbwe*. Mkuki na Nyota Publishers.
- Nelson F, Lindsey P, Balme G. 2013. Trophy hunting and lion conservation: A question of governance? *Oryx* 47: 501–509.
- Ogada MO, Woodroffe R, Ogue NO, Frank LG. 2003. Limiting depredation by African carnivores: The role of livestock husbandry. *Conservation Biology* 17: 1521–1530.
- Paciotti B, Borgerhoff Mulder M. 2004. Sungusungu: The role of preexisting and evolving social institutions among Tanzanian vigilante organizations. *Human Organization* 63: 113–125.
- Paciotti B, Hadley C, Holmes C, Borgerhoff Mulder M. 2005. Grass-roots Justice in Tanzania. *American Scientist* 93: 58–64.
- Packer C, Brink H, Kissui B, Maliti H, Kushnir H, Caro T. 2011. Effects of trophy hunting on lion and leopard populations in Tanzania. *Conservation Biology* 25: 142–153.
- Packer C, Loveridge A, Canney S, Caro T, Garnett S, Pfeifer M, Zander K, Swanson A, MacNulty D, Balme G. 2013. Conserving large carnivores: Dollars and fence. *Ecology Letters* 16: 635–641.
- Riggio J, et al. 2013. The size of savannah Africa: A lion's (*Panthera leo*) view. *Biodiversity and Conservation* 22: 17–35.
- Riggio J, Caro T, Dollar L, Durant SM, Jacobson AP, Kiffner C, Pimm SL, van Aarde RJ. 2016. Lion populations are declining in Africa but not as Bauer et al. suggest. *Proceedings of the National Academies of Sciences* 113. doi:10.1073/pnas.1521506113.
- Salerno J. 2016. Migrant decision-making in a frontier landscape. *Environmental Research Letters* 11: 044019.
- Salerno J, Borgerhoff Mulder M, Kefauver SC. 2014. Human migration, protected areas, and conservation outreach in Tanzania. *Conservation Biology* 28: 841–850.
- Salerno J, Mwalyoyo J, Caro T, Fitzherbert E, Borgerhoff Mulder M. 2017. The consequences of internal migration in sub-Saharan Africa: A case study. *BioScience* 67: 664–671.
- Sandom CJ, Faurby S, Svenning JC, Burnham D, Dickman A, Hinks AE, Macdonald EA, Ripple WJ, Williams J, Macdonald DW. 2017. Learning from the past to prepare for the future: Felids face continued threat from declining prey. *Ecography*. <https://doi.org/10.1111/ecog.03303>.
- Spencer P. 1988. *The Maasai of Matapato*. Manchester University Press.
- Sutherland WJ, Pullin AS, Dolman PM, Knight TM. 2004. The need for evidence-based conservation. *Trends in Ecology and Evolution* 19: 305–308.
- White H. 2009. Theory-based impact evaluation: Principles and practice. *Journal of Development Effectiveness* 1: 271–284.
- Wilson GM. 1953. The Tatoga of Tanganyika, part 2. *Tanganyika Notes and Records* 34: 35–56.
- Woodhouse, E., Homewood KM, Beauchamp E, Clements T, Terrence McCabe J, Wilkie D, Milner-Gulland EJ. 2015. Guiding principles for evaluating the impacts of conservation interventions on human well-being. *Philosophical Transactions of the Royal Society B* 3370: 20150103.
- Woodroffe R, Thirgood S, Rabinowitz A, eds. 2005. *People and Wildlife: Conflict or Co-existence?* Cambridge University Press.

Monique Borgerhoff Mulder (mborgerhoffmulder@ucdavis.edu) is affiliated with the Department of Anthropology at the University of California at Davis, and the Max Planck Institute for Evolutionary Anthropology in Leipzig. Jonathan Lucas Kwiyege is affiliated with the Landscape and Conservation Mentors Organization, in Mpanda, Tanzania. Simone Beccaria, Sadock Bwasama, Emily Fitzherbert, and Peter Genda are affiliated with WASIMA, in Mpanda Tanzania. Simone Beccaria is also affiliated with the United Nations Volunteers Programme, in Goma, Democratic Republic of the Congo. Sylvester Sadock Bwasama is also affiliated with the Frankfurt Zoological Society, Serengeti Ecosystem Management, in Fort Ikoma, Serengeti Region, Tanzania. Emily Fitzherbert is also affiliated with WildCru Recanati-Kaplan Centre, in Tubney, United Kingdom and with the Sedbergh School, in Sedbergh, United Kingdom. Peter Genda is also affiliated with the Ruaha-Katavi Landscape Program of the Wildlife Conservation Society, in Iringa, Tanzania. Tim Caro is affiliated with the Department of Wildlife, Fish, and Conservation Biology at the University of California at Davis, and the School of Biological Sciences at the University of Bristol.