Conservation Biology

Special Section: *Moving from Citizen to Civic Science to Address Wicked Conservation Problems*

Conservation and monitoring of a persecuted African lion population by Maasai warriors

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Abstract: *Although Africa has many threatened species and biological hot spots, there are few citizen science schemes, particularly in rural communities, and there has been limited evaluation of existing programs. We engaged traditional Maasai warriors (pastoralist men aged 15 to 35) in community-based conservation and demographic monitoring of a persecuted African lion (*Panthera leo*) population. Through direct engagement, we investigated whether a citizen science approach employing local warriors, who had no formal education, could produce reliable data on the demographics, predation, and movements of a species with which their communities have been in conflict for generations. Warriors were given benefits such as literacy training and skill enhancement and engaged in the monitoring of the lions. The trained warriors reported on lion sign across an area nearly 4000 km^2. Scientists worked together with the warriors to verify their reports and gather observations on the lion population. Using the verified reports and collected observations, we examined our scientific knowledge relative to the lion population preceding and during the citizen science program. Our observations showed that data quality and quantity improved with the involvement and training of the participants. Furthermore, because they engaged in conservation and gained personal benefits, the participants came to appreciate a species that was traditionally their foe. We believe engaging other local communities in biodiversity conservation and monitoring may be an effective conservation approach in rural Africa.*

Keywords: carnivore, *Panthera leo*, participation, traditional ecological knowledge, wildlife monitoring

La Conservación y el Monitoreo de una Población de León Africano Perseguida por Guerreros Maasai

Resumen: *Aunque África ha tenido muchas especies amenazadas y hot spots biológicos, existen pocos esquemas de ciencia ciudadana, particularmente en las comunidades rurales, y ha habido una evaluación limitada de los programas existentes. Involucramos a guerreros Maasai tradicionales (pastores entre 15 y 35 años) en la conservación basada en la comunidad y en el monitoreo demográfico de una población perseguida de león africano (*Panthera leo*). Por medio del involucramiento directo, investigamos si una estrategia de ciencia ciudadana que emplea a guerreros locales, los cuales no tienen educación formal, podría producir datos fiables sobre la demografía, la depredación y los movimientos de una especie con la que sus comunidades han estado en conflicto durante generaciones. A los guerreros se les dieron beneficios como alfabetización y mejoramiento de habilidades, además de la participación en el monitoreo de los leones. Los guerreros entrenados reportaron cada león a lo largo de un área de casi 4, 000 km^2. Los científicos trabajaron junto con los guerreros para verificar sus reportes y recolectar observaciones de la población de leones. Con los reportes verificados y las observaciones recolectadas examinamos nuestro conocimiento científico en relación con la población de leones antes y durante el programa de ciencia ciudadana. Nuestras observaciones mostraron que la calidad y la cantidad de los datos mejoraron con la participación y el entrenamiento de los participantes. Más allá, ya que participaron en la conservación y obtuvieron beneficios personales, los participantes llegaron a apreciar a esta especie que tradicionalmente fue su rival. Creemos*

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que involucrar a otras comunidades locales en la conservación y en el monitoreo de la biodiversidad puede ser una estrategia efectiva de conservación en el África rural.

Palabras Clave: carnívoro, conocimiento ecológico tradicional, monitoreo de vida silvestre, participación, *Panthera leo*

Introduction

Scientists have been conducting ecological studies and conservation projects in Africa for decades, but local communities have rarely participated in the research other than as rangers or laborers (Trinkel et al. 2008). Although the traditional ecological knowledge (TEK) (Usher 2000) of local people has often been ignored in developing countries, many researchers emphasize the need to involve them in wildlife research and conservation (Huntington 2000; Woodroffe et al. 2005; Trinkel et al. 2008; Pearce 1991), particularly for species, such as elephants and large carnivores, that are inherently in conflict with human interests.

Species that are in competition with people are unlikely to persist in close proximity to humans unless local people take an interest in their conservation (Mech 1995; Stander et al. 1997). Ultimately, the conservation of such species depends on the decisions of local communities because they are the ones who bear the costs of coexisting with wildlife (Treves & Karanth 2003; Dickman et al. 2011).

Many rural people have observed wildlife extensively, and their observations provide insight into species' behaviors that can inform their conservation (Huntington 2000). They often decide the fate of threatened species and can contribute to knowledge about animals that are hard to study and conserve with standard scientific methods. In particular, local people can affect the conservation and study of threatened large carnivores, such as African lions (*Panthera leo*), which in the last century have lost over 80% of their historic range (Riggio 2011). Carnivore research is typically difficult due to rough terrain and the nocturnal habits, wide-ranging movements, and wariness of the animals (Loveridge & Canney 2009; Pangle & Holekamp 2010; Crooks et al. 2011). This is particularly true of heavily persecuted lions on the livestock-producing rangelands of southern Kenya (Mogensen et al. 2011; Dolrenry 2013; Hazzah et al. 2014), where pastoralism has been practiced for millennia (Marshall 1990). Local human communities have generations of experience with lions due to their tradition of hunting them to protect livestock, and they know the region intimately because they move their herds seasonally over a very large area. Thus, they have extensive environmental knowledge on a wide geographical and temporal scale. Due to communal land ownership and shared living space, pastoralism in these communities facilitates strong continuity of knowledge, sharing of experience, and maintenance of TEK (Usher 2000).

In 2007 we created a citizen science approach to lion research and conservation in which we employed local Maasai warriors (traditional pastoralist men aged 15 to 35) with no formal education to collect data on the demographics, predation, and movements of African lions with which their communities have been in conflict for generations. We examined the changes in data and knowledge about the lion population and the benefits of the program to the participants, the broader community, and lion conservation.

Ecological monitoring is necessary for the conservation and long-term management of threatened species (Yoccoz et al. 2001; Holthausen et al. 2005). Although developing countries have many threatened species and biological hot spots, there are few wide-scale monitoring schemes, primarily due to high costs and lack of skilled professionals (Danielsen et al. 2003; Danielsen et al. 2005; Danielsen et al. 2007). Yet, there are many examples in developed countries of broad-scale citizen science monitoring programs that involve nonscientists gathering reliable data for use by scientists (Silvertown 2009; Dickinson et al. 2012; Shirk et al. 2012; Bonney et al. 2014).

Participatory monitoring is defined as monitoring of wild flora and fauna carried out on a local scale by individuals with little or no formal education (Danielsen et al. 2005). More generally, participatory monitoring within the citizen science discourse engages average citizens in direct experiences (Jakubowski 2003; Conrad & Hilchey 2011). Even though citizen science projects are primarily focused on scientific objectives, they can also achieve social and behavioral changes that improve conservation (Conrad & Hedin 1982; Fazey et al. 2006; Bonney et al. 2014; Wals et al. 2014).

Some studies in developing countries show that investment in monitoring that combines conventional scientific methods with TEK can be more effective in producing positive outcomes than a similar level of investment in scientific monitoring alone (Reed et al. 2008; Anadón et al. 2009; Danielsen et al. 2009). However, some scholars express concerns over the quality of data produced by citizen science programs (Penrose & Call 1995; Gilchrist et al. 2005; Uychiaoco et al. 2005) and emphasize the necessity for evaluating the accuracy of data collected and conservation effectiveness. We examined the involvement of informally educated Maasai warriors as citizen

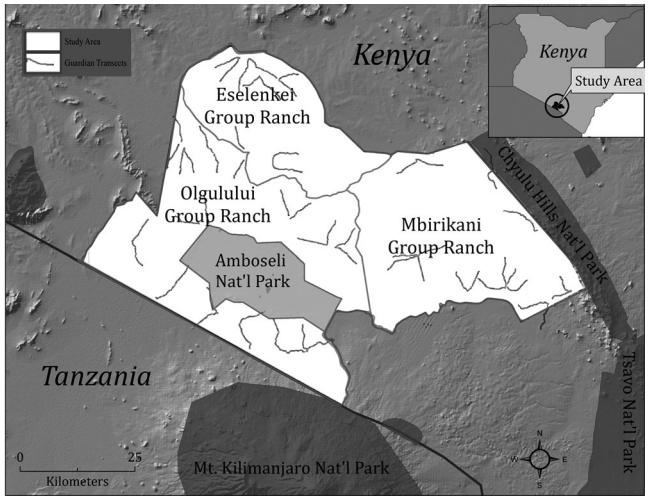

Figure 1. Location of group ranches (land owned communally by Maasai pastoralists) within the Amboseli-Tsavo Ecosystem, Kenya. The white areas are the group ranches where the Lion Guardians program operated. The guardians' transects (gray lines) are shown to illustrate spatial coverage of the guardians across the 3 group ranches.

scientists and whether the integration of their TEK with scientific knowledge could improve understanding of a lion population with which they are inherently in conflict.

Methods

Study Area and People

This study was conducted on the group ranches, land owned communally by Maasai pastoralists, of the Amboseli-Tsavo Ecosystem in southern Kenya, a 6000-km² patchwork of protected and unprotected areas. The protected areas include Amboseli, Tsavo West, and Chyulu Hills National Parks (Fig. 1). Our research was conducted on Mbirikani (MGR, 1320 km^2), Eselenkei (EGR, 769 km^2), and Olgulului (OGR, 1595 km^2) group ranches, all of which have been highly affected by humans and their livestock.

The group ranches support the full range of native predators, including lion, spotted hyena (*Crocuta crocuta*), leopard (*Panthera pardus*), cheetah (*Acinonyx jubatus*), and wild dog (*Lycaon pictus*), and prey species, including plains zebra (*Equus quagga*), blue wildebeest (*Connochaetes taurinus*), Maasai giraffe (*Giraffa camelopardalis tippelskirchi*), common eland (*Taurotragus oryx*), and lesser kudu (*Ammelaphus imberbis*) (Okello 2012; Groom & Western 2013). The group ranches are important dispersal areas and corridors for wide-ranging wildlife species (Ntiati 2002; Okello et al. 2008), particularly because the adjoining protected areas are not fenced and are too small to support the wildlife of the ecosystem (Okello & Kiringe 2004). Despite a rapidly growing human population of approximately 60,000 and nearly 150,000 head of livestock (Kenya National Bureau of Statistics KNBS 2009; Kenana et al. 2013), there is more wildlife on the group ranches than inside the protected areas (Western et al. 2009).

The county-wide literacy rate is 55.4%, but among the Maasai warriors in the study area, the literacy rate is about 7% (Hazzah 2011). There are few educational or employment opportunities for the young warriors other than herding livestock. From their years of herding, warriors are familiar with vast tracts of the landscape. To help protect their livestock, warriors have tracked and killed lions for generations. Successful hunters gain immense prestige in their community, and the act of hunting provides warriors with knowledge of lions' movements and behaviors (Spear & Waller 1993; Hazzah et al. 2009). Prestige and honor are paramount to a Maasai warrior and were traditionally earned from killing a lion or human enemy, actions that helped his community (e.g., protecting livestock). Today prestige and honor are gained through employment and education. Although most have never been to school, their bush skills serve them well as citizen scientists in wildlife research (Ellul et al. 2013).

Background of Lion Guardians

In response to the high level of lion killing (over 160 lions in 8 years period [Hazzah et al. 2014]), we initiated a conservation program, called Lion Guardians, in which traditional warriors (henceforth guardians) were employed. Prior to being appointed as guardians, many of these warriors were renowned lion killers. During the program, the guardians lived and worked from their home communities (Hazzah et al. 2014). They took pride in their abilities to track lions on foot and to protect their communities (e.g., alerting herders to lion presence to proactively prevent attacks on livestock and assisting in better husbandry practices [Hazzah et al. 2014]). Guardian jobs were in high demand because warriors worked in their home communities and could use their specialized tracking skills and their confidence working near large wild animals.

The program began in January 2007 on MGR, where a separate project was underway that compensated people financially for livestock killed by predators (Hazzah et al. 2014). In 2009 Lion Guardians and accompanying lion research was expanded to EGR and OGR. Lion Guardians still operates in these 3 areas. From 2007 to 2009, 9 guardians were employed on MGR. By the end of 2010, 33 additional guardians had been recruited from across the 3 group ranches.

When initiating the program in a new area, prospective guardians were interviewed. The warrior's skills and

experience (lion killing, herding, tracking abilities, etc.) were discussed, and his ability to recognize carnivore tracks from pictures was tested. Promising candidates were selected from each zone and asked to report on lions within their home communities over the next few weeks or months. A scientist responded and verified these reports through a standardized protocol to gauge bush skills and knowledge, personality, and community standing of the individual. Based on final protocol scores, one candidate from each area was chosen to become a guardian and then began formal training.

Training

At time of hiring, 86% ($n = 57$) of the guardians could not read or write even at a basic level. We determined this based on their ability to hold a pen or pencil, write their name, numbers, the time, and name of their home area or zone. The remainder had attended a few years of primary school. Program managers, field coordinators, and tenured guardians coached the new guardians in reading, writing, and Swahili (the local language is Maa, but Swahili is necessary to communicate with scientists and other East Africans). These skills allowed them to collect and report accurate data and instilled them with a sense of prestige and accomplishment (Stein 1995). The guardians were also taught radiotelemetry, methods of identifying individual lions (Pennycuick & Rudnai 1970), and systematic survey methods (Stander 1998; Gusset & Burgener 2005). The initial guardian training was 5 d and taught participants basic skills (e.g., how to hold a pen or pencil and write their name and numbers). After preliminary training, the guardians returned to their home communities, where a field coordinator visited a minimum of 2 d/month (approximately 10 h/month/guardian) for continued training in reading, writing, and language skills to reduce data-collection errors. Once a year, the entire Lion Guardians team came together for a 1-d refresher training. During this annual event, guardians were asked to describe Lion Guardians in a sentence. This was done to gauge their perception of what it means to be a participant in the Lion Guardians program.

Monitoring and Reporting Methods

A lion ecology study commenced in May 2004 on MGR. One scientist conducted the work until December 2006 (Maclennan et al. 2009). In January 2007, guardians began collecting data and reporting to the scientists on lion sign, sightings, and livestock depredation within their home communities. We were particularly interested in increasing lion sightings over those obtained by scientists alone and in the changing proportion of individually identified to unknown lions (i.e., lions we did not have records of seeing previously, based on our systematic records of vibrissae patterns for each sighted lion [Pennycuick & Rudnai 1970]). With increased lion sighting and knowledge of individual lions, we could identify dispersers, migrants, individuals' home ranges, and change in known lion numbers.

We emphasized to the guardians that the lions were theirs to find, study, and protect. To foster ownership and stewardship of the lions by the guardians, they gave identified lions Maasai names based on their perceived character or unique characteristics.

Each guardian looked for lion sign and lost livestock, reinforced weak corrals, helped herders move livestock away from predators, and stopped lion hunting parties within roughly 100 km^2. Every week he systematically walked a 10- to 12-km predetermined transect within his zone and counted tracks of lions, other large carnivores, and major prey species (Stander 1998; Gusset & Burgener 2005) (Fig. 1). Guardians reported by mobile phone fresh ($\leq$ 24 h) lion sign, number of lions detected, age and sex of lions as interpreted from the tracks, the names of the lions believed to be present, lion predation on both wild and domestic animals. Each report was recorded in full by a scientist and repeated to the guardian to ensure accuracy and clarity. A scientist and the guardian would then follow the lion tracks and verify the number, age, and sex of the lions. The guardian's report was recorded as accurate or inaccurate. Scientist and guardian followed tracks until a positive identification of the individual lion or lions could be made by either picking up a radio signal from a collared lion or seeing and individually identifying each lion on the basis of its vibrissae spot pattern. Due to inaccessibility of some areas and secretive behavior of lions, visual verification was not always possible.

Each month throughout the study (May 2004 to December 2013), we recorded the number of guardians employed and the current number of known (i.e., individually identified) lions within the study area (Figs. 2 & 3). Using systematic field verifications with multiple observers, we analyzed the accuracy of reports from the warriors over 5 years. The number of accurate reports were compared with the total number of verified reports, and inaccurate reports were further examined to determine the reasons for the errors. When a lion was sighted, a geographic positioning system (GPS) location was taken and used to calculate each individual lion's total range. We used the 100% minimum convex polygon (MCP) to determine range because our objective was to detect change in the size of home range relative to home ranges obtained solely by scientists using radio tracking (Mohr 1947). Data were collected on each lion kill observed either by the scientists (before initiation of Lion Guardians) or by the guardians. The number of lion sightings and kills found were totaled monthly and divided into 2 periods, May 2004 to December 2006 (before Lion Guardians [before LG]) and January 2007 to December 2013 (during Lion Guardians [during LG]) (Fig. 4). Building on earlier studies done in the area (Hazzah et al. 2009; Maclennan

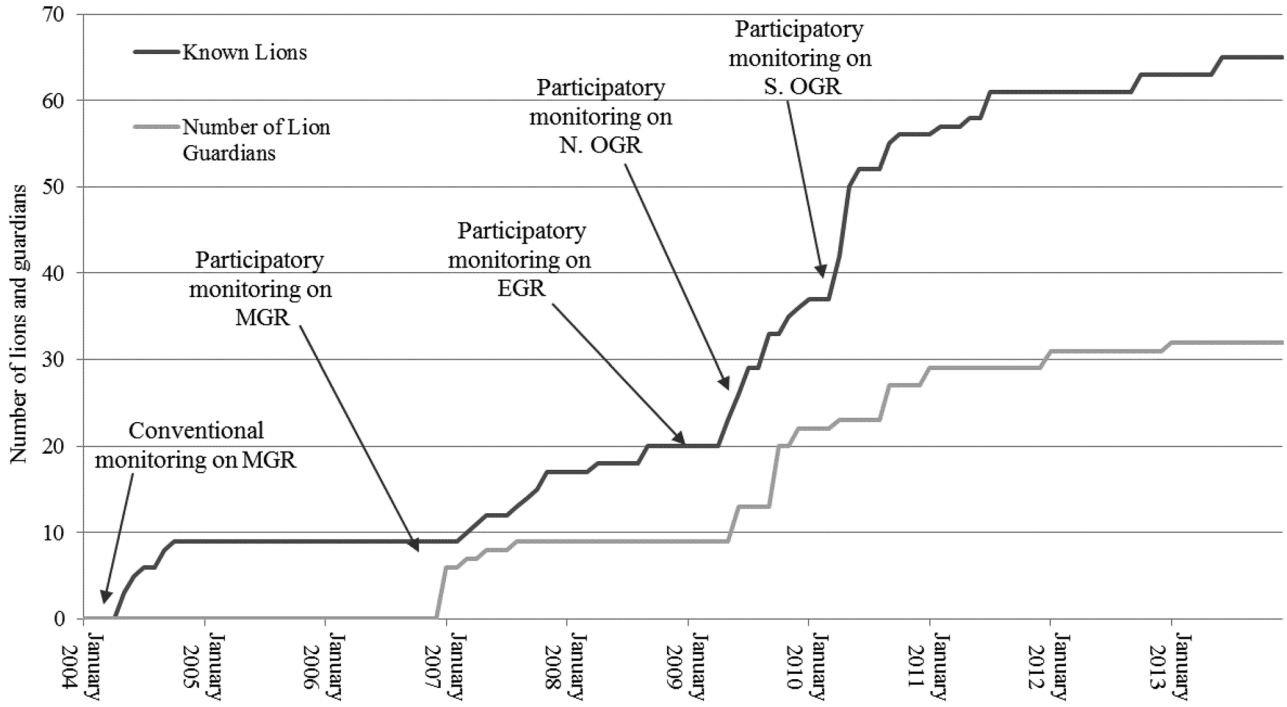

Figure 2. Number of individually identified lions (i.e., known lions) and number of local participants in a participatory monitoring program (Lion Guardians) in the Amboseli-Tsavo Ecosystem, Kenya, from May 2004 to December 2013 (MGR, Mbirikani Group Ranch; EGR, Eselenkei Group Ranch; OGR, Olgulului Group Ranch).

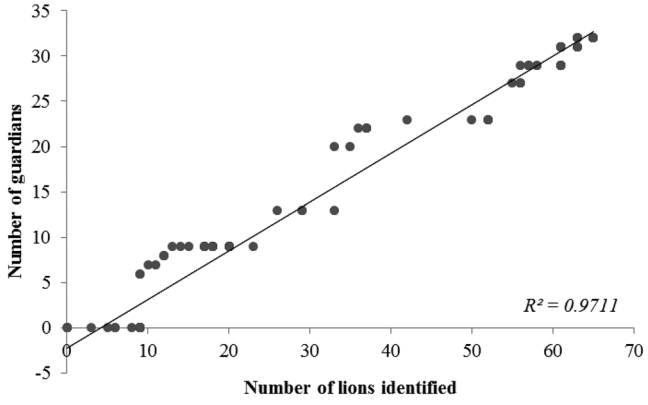

Figure 3. Correlation of number of participants in the Lion Guardians program (citizen science monitoring of lions) to the number of known lions (i.e., individually identified lions) in the Amboseli-Tsavo Ecosystem, Kenya.

et al. 2009; Hazzah et al. 2014), we compared our findings with those previously reported to further ascertain the guardians' contributions to knowledge of the lion population and to broader conservation. This research was conducted under research permit MOEST 13/C689, University of Wisconsin-Madison human-subjects protocol SE-2005-0222, animal-use protocol L400, and University of California-Berkeley animal-use protocol R191.

Results

Reporting Accuracy

A total of 368 lion sightings and sign, reported by 50 guardians, were verified by scientists over 56 months. The guardians were accurate in 89.1% (SD 23.2) of their reports of lion sign and presence. Of the reports where sex could be determined (304), they accurately reported sex 89.8% of the time. Of the reports where the number of lions were verifiable (280), the number of individuals was accurately reported 90.7% of the time. Of the 47.0% of verified reports where scientists were able to confirm lion identity, guardians accurately predicted the lion's identity 89.0% of the time.

The inaccurate reports (40) were due miscounting of the number of small cubs (12), mistaking a female with older cubs as a male or mistaking a subadult male as a female (15), miscounting the number of males (7), misidentifying species (4), and misreporting the direction or area of a radio-collar signal (2). Five of the 40 inaccurate reports (12.5%) were incorrect because guardians relayed reports given to them by other community members without first verifying them; omitting these increased guardian reporting accuracy to over 90%.

The one scientist who worked alone on MGR from 2004 to 2006 cataloged 9 known individual lions and estimated a further 3–9 individuals, which were difficult to identify, used MGR intermittently (Maclennan et al.

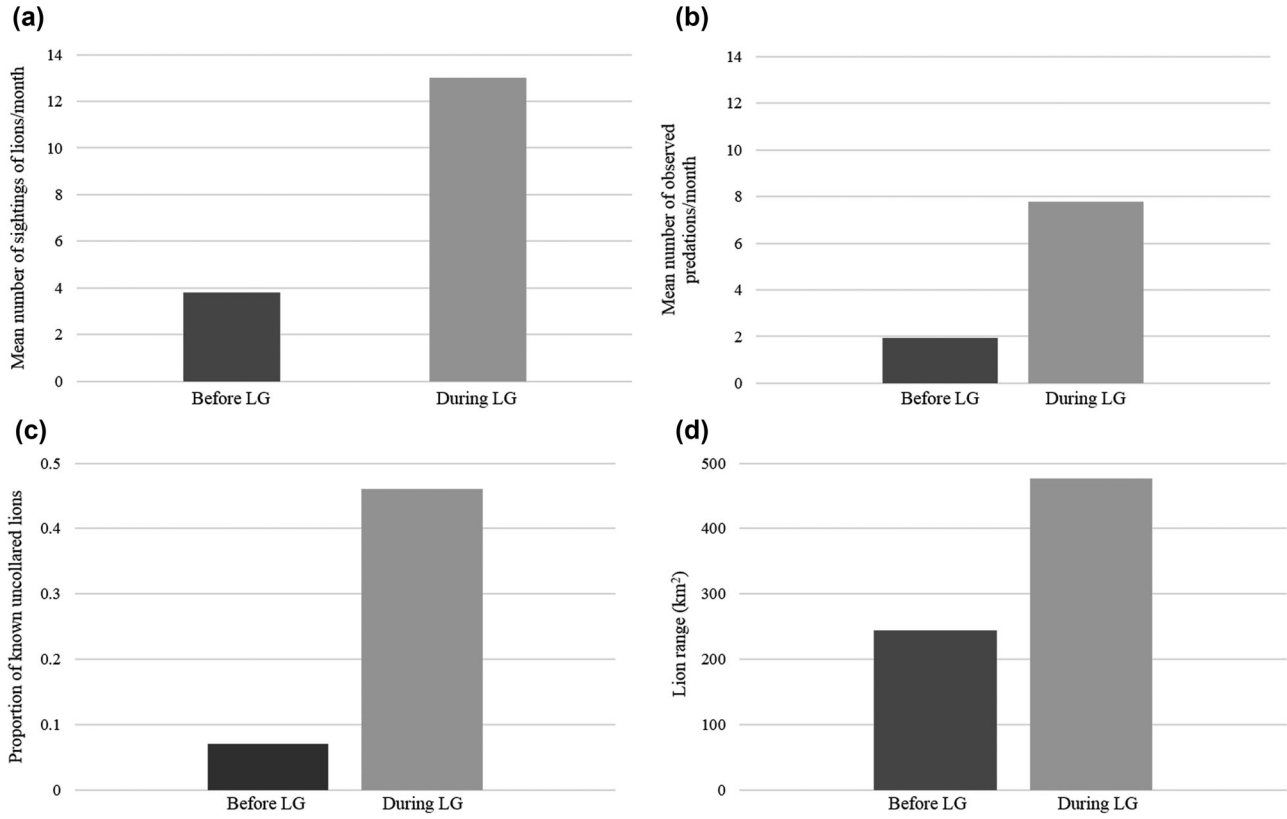

Figure 4. From May 2004 to December 2013: (a) mean number of sightings of lions per month before and during the citizen science lion monitoring program Lion Guardians (LG); (b) mean number of observed lion predations per month before and during the Lion Guardians program; (c) proportion of observed, uncollared lion population that were known (i.e., individually identified) before and during the Lion Guardians program; (d) mean lion range calculated from the 100% minimum convex polygon for individual lions before and during the Lion Guardians program.

2009). Thus, he estimated a population of 12–18 individuals. Within 18 months of initiating Lion Guardians on MGR, the number of positively identified lions doubled from 9 to 18 (Fig. 2).

The area covered by the Lion Guardians program expanded 3 times in the Amboseli Ecosystem from 2007 to 2010, from 1320 km^2 to 3684 km^2. With each expansion, the number of known lions increased and then leveled off within an average of 5.5 months (range 2–11) (Fig. 2). The relationship between the number of guardians, the area under study, and the number of known lions was strong (Figs. 2 & 3).

The number of lion sightings, the proportion of all known lions that were not collared but identified, and the observed number of lion predation events all increased (Figs. 4a-c). With the engagement of the guardians, more detailed data on movements of both collared and uncollared lions were obtained, resulting in larger mean home range size estimates (Fig. 4d).

Discussion

Improved Data Quantity and Quality

Because there was no change in prey numbers or water distribution during the first 18 months of Lion Guardians, we attributed the apparent increase of lions to firm identification of unverified individuals, due to involvement of the guardians, not to an actual increase in the lion population. Through the reporting efforts of the guardians and systematic identification of the sighted lions by the scientists, annual population counts were obtained. These counts of observed individuals documented an increase in the lion densities from 1.8 lions/100 km^2 in 2007 to 3.49 lions/100 km^2 in MGR (Dolrenry 2013).

Since the final expansion in 2010, 1 adult lioness with two older cubs was newly identified. She was a transient wet-season visitor from Amboseli Park that returned to the park after 1 week on communal land. The other new detections were of several young male dispersers from

outside the study area, as expected in lion populations (Hanby & Bygott 1987).

Benefits to Guardians, Community, and Conservation

Within the first year of joining the program, 98% of the guardians could read and write their name, the name of their zone and area, the time, and numerals. This lead to an increase in guardians' self-esteem, as reported by a guardian: "I am proud because the Lion Guardians program has made me literate." They could also take and record GPS locations, and most were proficient in the use of radiotelemetry equipment. One guardian stated, "The program has increased our status in the community because we are now literate. With our GPS and scientific forms, it has placed us in a different league."

Collecting systematic data on the lion population endowed each guardian with increased prestige within his community for becoming educated, employed, and engaged with a species traditionally admired for its power and charisma. The program gave previous lion killers the ability to use their skills and ecological knowledge in productive and legal ways. One guardian stated, "Lion Guardians has given us the opportunity to gain formal, gainful employment. It has helped us as individuals and known lion killers, saved us from a life behind bars." The engagement in conservation and monitoring led to a sense of responsibility for the lions as well as other wildlife. In 2013 Guardian Kisimir said, "A guardian is a wildlife protector, an indigenous conservationist."

Jobs are scarce in the region, and many young men leave. The guardians expressed gratitude at having employment while maintaining the essence of the warriors' traditional role in society. As one put it: "I love being a Lion Guardian because I am not removed from my culture and my people."

Guardians also assisted their communities in a variety of ways while improving conservation outcomes (Hazzah et al. 2014). Each year, from 2007 through 2013, guardians recovered more than $1,000,000 worth of livestock lost in the bush (and likely to be killed by predators), reinforced over 300 corrals, found an average of 20 lost child herders, and stopped an annual average of 47 lion hunts by other warriors, often going to extreme lengths to prevent "their" lions from being killed after livestock depredations (Hazzah et al. 2014).

They took pride in naming the lions, as well as in videotaping and photographing them to show to their communities. They told stories to the elders, women, and children using the lions' Maasai names, personalizing the lions to the broader community. No longer were lions simply anonymous enemies; they became individuals even to the community members not directly involved in their monitoring and conservation. A survey conducted in the study communities in late 2012 showed that 55% ($n = 85$) of randomly sampled respondents across the study area knew the name of at least 1 lion, an increase from an initial survey in 2007 which showed that 33% of respondents could name a lion (Lenaiyasa 2012; Dolrenry 2013).

Even though changes in local tolerance toward wildlife are difficult to measure (Bruskotter & Fulton 2012), there was a significant decrease in the numbers of lions killed over time (Hazzah et al. 2014) and a doubling of the lion density (Dolrenry 2013). Additionally, guardians regularly reported improved coexistence between themselves, their community members, and lions, for example, "The Lion Guardians program has brought peace between the Maasai and lions"; "We have a caring attitude towards livestock and lions, we act as a mitigating tool"; "The project has made a previous enemy into a friend"; and "Lion Guardians are protectors of lions and livestock – we are part of a program that develops coexistence."

Our results suggest that reliable data can be obtained by incorporating local peoples' TEK into modern wildlife monitoring techniques, even when participants have no formal education. We found that Maasai warriors can accurately monitor numbers, predation events, and movements of elusive persecuted lions that are difficult to study with standard scientific methods. Involving community members in research improves understanding of the lion population and enhances conservation outcomes and the citizen scientists' understanding of research (Bonney et al. 2014; Hazzah et al. 2014; Wals et al. 2014).

Data quality and quantity improved substantially with this approach, and the approach allowed one or two professional scientists to cover three times the area and gain much more accurate data on a low-density, secretive lion population. Guardians and scientists together tracked and individually identified an entire population of lions. The warriors' previous experiences as herders and lion hunters gave them environmental knowledge on a broad geographic and temporal scale that was central to their success in data collection. An unanticipated increase in detection of dispersing lions led to improved understanding of lions' dispersal abilities, connectivity between populations, and the broader metapopulation (Dolrenry et al. 2014*b*).

We recognize that local knowledge cannot be accepted unquestioningly (Reed et al. 2008), but the guardians were accurate in 90% of their reports. The added number of observers and consequent intensity of coverage led to a significant increase in documented lion home ranges (Fig. 4d) and the number of prey kills detected (Fig. 4b).

Lion Guardians provide an example of a citizen science program that produced positive outcomes (e.g., larger and more accurate data sets, more effective monitoring, and improved conservation of a vulnerable carnivore) primarily because it was founded on local traditions, knowledge, and culture. Even though lions posed a threat to local livelihoods, encouraging a sense of ownership, or at minimum a sense of responsibility for the lions, resulted

in a positive connection between the guardians and the individual lions. The program provided a platform for local warriors to use their skills and knowledge to save a threatened and persecuted species while gaining prestige and accolades from their community. We also observed less tangible but important societal outcomes of the program. Even basic literacy opened new opportunities in a community where these skills are difficult to obtain in other ways (Hazzah & Dolrenry 2007).

The Lion Guardians program demonstrates that citizen science utilizing TEK in rural Africa can be an effective, reliable, and productive complement to standard research methods. Our quantitative and qualitative findings suggest that citizen scientists among marginalized groups in remote ecosystems can collect reliable data on threatened species, be empowered through education and gain a greater sense of ownership of their natural environment. Additional studies that delve deeper in to the social and psychological outcomes and the cultural implications of engagement in conservation and citizen science are needed.

In an effort to improve conservation on a larger scale, the program has expanded to three additional sites across East Africa, in partnership with existing carnivore projects, and has led to larger and more useful data sets (Bonney et al. 2014; Dolrenry et al. 2014*a*) and reduction in lions killed (Lion Guardians 2015). We believe similar approaches can be transferred to other rural landscapes where local communities live alongside threatened wildlife. Engaging local community members in biodiversity conservation and monitoring can be a powerful tool for advancing conservation, science, and positive social change in rural Africa.

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