Received: 17 June 2020 | Accepted: 2 September 2020

DOI: 10.1002/pan3.10154

RESEARCH ARTICLE

PEOPLE AND NATURE | BRITISH ECOLOGICAL SOCIETY

Ranger perceptions of, and engagement with, monitoring of elephant poaching

Timothy Kuiper[1] | Francis Massé[2] | Nobesuthu A. Ngwenya[3] | Blessing Kavhu[3] | Roseline L. Mandisodza-Chikerema[3] | Eleanor J. Milner-Gulland[1]

[1]Interdisciplinary Centre for Conservation Science, Department of Zoology, University of Oxford, Oxford, UK

[2]Department of Geography and Environmental Sciences, Northumbria University, Newcastle upon Tyne, UK

[3]Zimbabwe Parks and Wildlife Management Authority, Harare, Zimbabwe

Correspondence
Timothy Kuiper
Email: timothykuiper@gmail.com

Funding information
Commonwealth Scholarship Commission, Grant/Award Number: ZACS-2017-648; ERC Horizon 2020, Grant/Award Number: # 694995

Handling Editor: Sarah Crowley

Abstract

1. Ranger-based monitoring has enormous potential to inform conservation globally, with hundreds of thousands of rangers patrolling extensive areas and recording observations of illegal activities and biodiversity. Much quantitative research has demonstrated the pitfalls and potential of data collection by rangers, but little work has considered its human dimensions. Yet poor engagement with, and ownership of, monitoring by those undertaking it may compromise data quality and thereby limit evidence-based conservation.
2. We interviewed rangers and supervisors involved in a programme for monitoring and managing elephant poaching in the Zambezi Valley, Zimbabwe. We assess the importance that rangers ascribed to data collection within their broader occupation, and their level of engagement with data management and use.
3. We found that rangers saw the collection of biodiversity data as a routine duty that helped guide patrol strategy. Reporting these data was perceived as a primary way of demonstrating fulfilled responsibilities to their supervisors. Rangers did not, however, engage actively with data management and use. Ranger sentiment was evenly divided between those who said feedback on how the data they collected were used would motivate more engaged data collection, and those who said they would continue collecting data regardless, out of duty.
4. Three elements of the occupational culture of rangers at our site—a strong sense of duty, deference to authority and knowing their defined responsibilities within the organizational hierarchy—were identified as key drivers of their engagement with monitoring.
5. Building on these findings, we develop a theory of change to develop more meaningful engagement of rangers with monitoring. We argue that more effective and sustainable monitoring can be achieved by building on existing ranger culture while also fostering rangers' appreciation of data collection and utilization. Addressing key challenges around ranger well-being, and resource and capacity needs, is also essential.

KEYWORDS
adaptive management, elephant, job satisfaction, law-enforcement monitoring, motivation, observational data, occupational culture, poaching, ranger-based monitoring

1 | INTRODUCTION

Monitoring changes in biodiversity and threats within protected areas is essential for understanding their status and evaluating conservation interventions. Collecting systematic, robust data on features like wildlife distribution or poaching levels requires technical capacity and resources, as do later analytical stages in the adaptive management cycle (Canessa et al., 2015). Therefore, when resources for management are scarce, more direct interventions (like anti-poaching operations) may be prioritized over baseline monitoring (Nuno et al., 2017). Rangers across the world spend large amounts of time patrolling extensive areas and are therefore well-placed to make observations of illegal activities and biodiversity. Ranger-based monitoring is thus a valuable management resource, providing a cost efficient alternative to skill and resource intensive ecological surveys (Gray & Kalpers, 2005; Kuiper et al., 2020). Rangers must, however, balance collecting data with other patrol-based activities such as direct law enforcement and anti-poaching (Moreto & Matusiak, 2017; Stokes, 2010). Ranger-collected data may also be subject to systematic bias because patrols are seldom consistent over space and time, and favour certain areas and species over others (Dobson et al., 2018).

We use the term 'ranger' to refer to 'a field-based operative whose regular work involves surveillance, protection and maintenance of species and ecosystems' (Belecky et al., 2019). We define ranger-based monitoring as the collection of data by rangers, which may include evidence of illegal activity, animal sightings and behaviour and vegetation status (Gavin et al., 2010). The global programme for the Monitoring of the Illegal Killing of Elephants (MIKE) is a prominent example of the value of ranger-based monitoring. Rangers across 90 MIKE sites in 30 African and 13 Asian countries report elephant mortality data from regular patrols. The resultant data is used both for local protected area management and to inform international wildlife trade policy (CITES Secretariat, 2019). The large information potential of ranger-collected data has encouraged quantitative research into understanding and overcoming biases inherent in these data, such as effort-adjusted indices (Dobson et al., 2019) and hierarchical statistical models (Critchlow et al., 2015). Furthermore, quantitative models have been developed for translating biased data into future patrol strategies (Fang et al., 2017). Significantly less work, however, has investigated the social and human dimensions of ranger-based monitoring, such as ranger occupational culture, and how these intersect with the day-to-day realities of being a ranger. Thus an important prerequisite for understanding the mechanisms underlying the process of ranger-collected data is missing; modelling alone cannot provide the insights required for more effective protected area management.

A recent survey of over 7,100 government rangers across 28 Asian and African countries revealed that 50% of rangers lack access to clean water, one in three contracted malaria in the preceding year and less than a fifth of the 74% who are married are able to live with their spouses (Belecky et al., 2019). Rangers' salaries are often low and they feel under-equipped, while 81% of rangers believed their jobs were dangerous. Seminal qualitative work on ranger perceptions has provided rangers' insights into poacher motivations (Moreto & Lemieux, 2015), the occupational stresses they face (Moreto, 2016a), their relations with local communities (Moreto et al., 2017) and their understanding of professionalism and misconduct (Moreto et al., 2015). These studies are unified in their demonstration of the value of meaningfully engaging rangers in conceptualizing and tackling conservation problems, rather than seeing them as passive nodes through which conservation strategies are enacted. The well-being and perceptions of rangers are important both ethically (they are at the frontline of conservation management), and practically (the sustainability and rigour of ranger-based monitoring relies on commitment from rangers).

Drawing on these insights, we argue that understanding the value that rangers ascribe to data collection requires understanding the context of their broader occupation, and specifically ranger occupational culture. Occupational culture encompasses the shared norms, values, beliefs and priorities of members of a particular occupation (Van Maanen & Barley, 1982). The culture developed among a group of people in the same occupation defines what is valued, emphasized and accepted in this community, and therefore influences behaviour and conduct (Christensen & Crank, 2001; Schein, 1990). Occupational culture focuses on human behaviour and social processes through the lens of occupational communities, rather than the lens of the organization, to help explain social behaviour and performance in the workplace (Van Maanen & Barley, 1982). Glomseth et al. (2007), for example, identified four dimensions of occupational culture amongst police officers in Norway, finding that the extent and nature of 'team culture' had a significant influence on knowledge sharing amongst officers during police investigations. Importantly, occupational culture has a direct bearing on performance at work. Occupational culture is thus a useful lens to understand how members of an occupation (rangers) engage with a particular aspect of their work (data collection and monitoring), in order to identify pathways to more effective organizational practice.

Using a case study of rangers involved in a long-term programme for monitoring and managing elephant poaching in the Zambezi Valley, Zimbabwe, we draw on insights from occupational culture as well as existing work on ranger perceptions and culture to examine

and understand a core aspect of rangers' work, namely data collection and monitoring. We ask the following questions:

1. How do rangers perceive their occupation: what values and motivations typify their work?
2. What importance do rangers ascribe to data collection within this broader occupation?
3. Are rangers involved/aware of how the data they collect are used for conservation management?
4. What influences how engaged rangers are with ranger-based monitoring?

Finally, we discuss how rangers' level of engagement with monitoring might affect data quality and the evidence-based management that depends on it.

2 | METHODS

2.1 | Study area and field work

The first author conducted research in two adjacent protected areas in the Zambezi Valley, Zimbabwe: Chewore Safari Area and Mana Pools National Park, both managed by the state wildlife authority. Together with Sapi Safari Area, these form the Mana-Chewore World Heritage Site (Figure 1). The elephant population in the broader Zambezi Valley has declined from *c*. 20,000 in 2003 to *c*. 11,000 in 2014, mainly due to poaching (ZPWMA, 2015). Chewore, Mana and Sapi are MIKE (Monitoring of the Illegal Killing of Elephants) sites, with large numbers of poached elephant carcasses detected by rangers in recent years (CITES Secretariat, 2019). Rangers encounter elephant mortalities (poached and natural) while on regular patrols, with data from these sites reported annually to MIKE offices at regional and global levels. The lead author visited two ranger bases in each of Chewore and Mana, between the 1 and 24 August 2018, living in ranger accommodation in close proximity to rangers themselves. This allowed for many informal conversations with rangers, supervisors and observation of their daily activities (recorded using field notes). The lead author also accompanied rangers on 2-day-long patrols to have a first-hand observation of how rangers collect data.

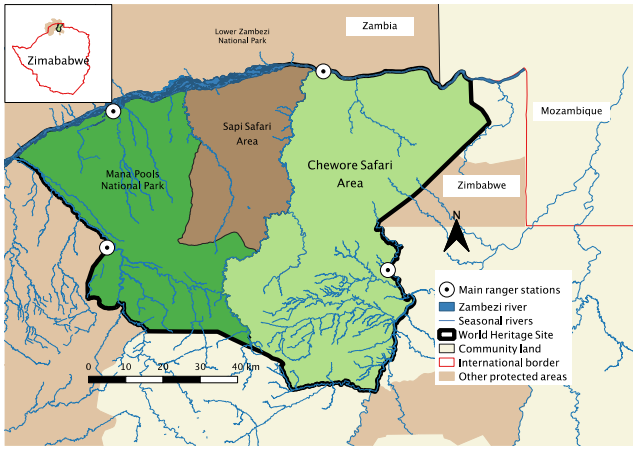

FIGURE 1 The Mana-Chewore World Heritage Site, showing the four ranger bases at which interviews were conducted. Non-poached elephant carcasses (natural and management-related mortalities) for Chewore and Mana for the years 2016 and 2017 are shown for illustrative purposes

2.2 | Interviews, respondent recruitment and thematic analysis

The first author conducted individual semi-structured interviews with park rangers and their supervisors (Table 1). The semi-structured format helped balance the need to stimulate discussion rather than elicit particular answers, while also maintaining focus on our research questions (Newing, 2010; Young et al., 2018). Two types of respondent were interviewed: rangers ($n = 23$) and their immediate on-site supervisors ($n = 8$), out of a total of *c*. 94 rangers and 11 supervisor across the two protected areas. Each respondent was interviewed individually in a private room. At each of the four ranger stations, rangers were randomly selected for interview from those available in camp and not out on patrol (rangers take a few days off between extended patrols). We continued sampling until saturation was achieved, that is, the point where more interviews yielded minimal new information (Ritchie et al., 2013; Table 1). Rangers are directly involved in the collection and reporting of monitoring data, while supervisors are responsible for planning patrol deployments and supervising data collection. Both groups are employed by the Zimbabwe Parks and Wildlife Management Authority (ZPWMA). Each ranger interview comprised several broad areas of discussion (working conditions, the nature of patrols, perceptions of the value of data collection and involvement in data management and analysis), with several questions in each section (an interview guide is included in the Supporting Information). Supervisor interviews focussed on the extent to which elephant carcass data were used for

TABLE 1 The number of rangers and their supervisors interviewed at each of four ranger stations in the Zambezi Valley, Zimbabwe

Site and ranger station	Rangers interviewed (mean # of years working at site)	Supervisors interviewed (mean # of years working at site)
Chewore Safari Area		
Mkanga ranger station	9 (4.2 ± 2.2 years)	2 (1.5 ± 0.7 years)
Kapirinhengu ranger station	5 (10.3 ± 5.0 years)	2 (4.6 ± 6.0 years)
Mana Pools National Park		
Mana Pools ranger station	7 (9.4 ± 4.0 years)	3 (5.63 ± 5.1 years)
ZAVARU ranger station	2 (9 ± 3.2 years)	1 (9 years)

management (analysed elsewhere), but also included questions on ranger supervision and monitoring (analysed here).

Based on triangulation among interviews, personal observations and the general impression given by respondents, the first author judged that responses were honest and did not find evidence for any strong social desirability bias. The first author established rapport with respondents by approaching them as a young student with no ulterior agenda, emphasizing that he was not affiliated with any NGOs operating in the area or with the MIKE programme, such that respondents were willing to candidly share their frustrations. All respondents were male Zimbabwean nationals, except for two female rangers (there are very few female rangers overall). The families of the majority of respondents lived in towns outside the Zambezi Valley region.

We analysed interview responses using thematic analysis to identify patterns of meaning in the data and then developed a narrative account of key themes in relation to the research questions (Braun & Clarke, 2006). Analysis started with a period of immersion in the data followed by the generation of flexible notes and annotations (Newing, 2010). Nvivo software (QSR International Pty Ltd, 2018) was then used for thematic analysis, using a combination of deductive (focussed on our prior research questions) and inductive (bottom-up) coding (Braun & Clarke, 2006). The importance of a theme was judged either by its prevalence (repeat occurrence across and within respondents) or by how informatively it spoke to the research questions (Braun & Clarke, 2006). This process was repeated once to check for reliability. We also categorized ranger respondents based on whether or not greater knowledge of how the data they collected are used would motivate more engaged future data collection. This involved coding the responses of each respondent (across a number of questions) that spoke directly to this theme, and then making a categorization assessment that reflected their overall sentiment. A conservative approach was taken to increase reliability, by including 'mixed sentiment' and 'uncategorised' categories for cases where the sentiment of the respondent was not clear. Responses were kept confidential and anonymous, and each respondent gave prior and informed consent for their participation. All procedures were granted ethical approval by the Human Research Ethics Committee at Oxford University (CUREC REF: R58336/RE001).

3 | RESULTS

3.1 | Overview of ranger-based monitoring in the Zambezi Valley

Rangers described having diverse duties, including patrols, law enforcement, fire management, road maintenance, monitoring trophy hunts and office duties (amongst others). Their primary responsibility was routine multi-day patrols. Typically, four rangers are deployed by a vehicle to a particular area of the park, either at a temporary or permanent camp, and remain for 7 days. Each day is spent patrolling the surroundings in different directions (4–8 hr per day, within 5–10 km of the base). A secondary patrol strategy involves rangers changing base every night or two, covering a more linear area. Less common patrol types include day-long foot patrols from the main station, and 1- to 3-day vehicle patrols. Patrol areas are chosen based on expected illegal activity, animal distribution, water availability and accessibility (Table 2). Monitoring illegal activities (elephant poaching, fish poaching, subsistence bushmeat hunting, gold panning, livestock encroachment and others) is the main purpose of patrols. Rangers record evidence of illegal activity, large animal sightings and water and vegetation status using notebooks (Table 2). Handheld *Cybertracker* devices for recording observations and patrol routes have recently been introduced but are not yet widely used. After patrol, rangers share results with their supervisors in a debrief session, and discuss future patrol strategies. The patrol leader then compiles a handwritten report, describing the routes used each day and all notable observations (Figure 3).

A review of patrol reports showed that the directions of daily patrol routes and notable observations were consistently reported, with variation among stations in the detail provided (Figure 3). GPS records of observations and patrol locations were inconsistent, however. Some patrols are not recorded, evident from comparing entries in patrol books to ranger interview accounts of recent patrols. Some patrols included future patrol recommendations. Detailed recording of elephant mortality is conducted at all stations as part of the MIKE

TABLE 2 A typology of data types collected by rangers in the Zambezi Valley, ZImbabwe. Data types are listed in order priority as judged by their frequency in rangers' responses

Type of data collected	Purpose
Evidence of illegal activity (carcasses, poacher camps, poacher spoor, snares)	Guide future patrol deployments. Measure anti-poaching effort and performance
Key animal species sightings (elephant, buffalo, lion, leopard, various antelope)	An area of higher animal abundance requires more frequent patrolling
Water status (whether rivers and springs are dry or active)	Water points attract animals and are targeted by poachers. Rangers may also depend on water access during patrols
Vegetation status	Seasonal vegetation change is large and affects animal distribution and hence patrol strategies
Animal behaviour	Distress can indicate poacher presence
Animal trophy quality	Discern potential hunting trophies
Animal health	Poor health can indicate water scarcity, disease or the need for supplementary feeding

programme (Figure 4), leading to significantly more detail and consistency (e.g. GPS locations, times and dates, auxiliary information) in reporting of elephant mortalities compared to other illegal activities and animal sightings.

3.2 | Rangers' appreciation for the broader value of monitoring data

Interviews revealed several possible reasons for poor ranger engagement with monitoring, including the time it takes to record data in the field, limited capacity to use devices like GPSes and the feeling that data recording devices were tracking ranger performance. A deeper, and perhaps more prominent, reason for poor engagement is a low level of appreciation for the broader purpose of data collection. Whilst rangers value data collection as an important duty to their supervisors, they tended not to value data for its own sake and tended not to see its broader importance for management. Rangers stated that they received minimal feedback on how the data they collect was used by site supervisors. '*I can't lie to you…Since 2014 I have not had any feedback*' (ranger 1). Yet many rangers were eager to know more about how their data were used: '*We are the ones who collect, so we want to know, the data we are collecting, where is it going and how it helps us?*' (ranger 9). This desire for knowledge and feedback might be explained by the need for rangers to feel that their work is important and that they are doing it well: '*Feedback is very very important; it shows that you are doing something very nice…it will show that the information I am bringing is vital*' (ranger 16). Rangers described how being more actively involved in managing and using the data they collected would motivate greater effort in data collection:

> It's good to also know how to enter the same data into the computer…this will give you a passion to, you know, do it [field data collection] very very accurately since you will be the one who will enter the data. Also, that ranger who provides the information should be able to analyse, to explain what is happening pointing on the map, not just the supervisors. At the end of the day…you will see [understand] what you were doing in the jungle [field]…so your effort will be more (ranger 23).

> Rangers should know these things [how data are used]…so that they do it in a good way…if they don't have that information, one can leave the carcass without recording (ranger 21).

Nevertheless, out of deference to their supervisors, some rangers did not expect feedback: '*On that one I don't mind… that is all up to him [my supervisor]… I can't say to him "why you are not using my information"*' (ranger 12). Overall, rangers appear to face a tension between simply fulfilling data collection as a duty, and a desire to know more and be involved in the full data cycle:

> Now for me I am OK… I collect exact data from patrol and give to our officers here, I am happy to just collect the data. And also to know everything also, from the computer and how to send the data… I just want to know, I am interested (ranger 20).

Although most rangers expressed mixed sentiments, a fair proportion expressed the sentiment that they would be more engaged with their data collection duties if they knew more about how the data they collected were used (Figure 5). Many rangers desired more involvement in the full ranger-based monitoring and management cycle. '*They [supervisors] must teach us that information we keep for the reason A, B, C [management procedure]. So then I know when I see another carcass I can come and report with a punch because I know what I am doing*' (ranger 17). The potential gains from a greater awareness of the value and use of data amongst rangers may be significant. Rangers variously said that greater awareness would lead to '*more precise and more focussed*' monitoring (ranger 18), '*with a punch*' (ranger 17), that is carried out '*very very accurately*' (ranger 23). Supervisor interviews suggested, however, that they themselves do not always buy into data-driven adaptive management and may prefer to use personal intuition and institutional memory as a guide: '*Graph or no graph, I know my area*' (supervisor 1).

The strategic use of individuals can help catalyse an ethos of ranger ownership of data collection and monitoring. During the research, we identified several individuals that we refer to as 'data champions', who we define as those who took active ownership of monitoring and had the potential to engender a greater appreciation for the value of data among the wider ranger group. Feelings of ownership of ranger-based monitoring and management must start at higher levels, however, as one supervisor remarked: '*Without them [supervisors] being interested, I don't think the rangers will be. You cannot force someone to do what you are not doing*' (supervisor 9). Another supervisor with significant previous experiences as a ranger demonstrated a particularly deep appreciation for the value of data:

> Some rangers do not appreciate the use of data…so when you tell them to collect data in the field, they end up compromising the whole lot because they don't see the value of the data. They don't understand the actual essence of data collection. We need to involve them [rangers] in whatever we do so they can start to appreciate the data collection (supervisor 9).

As an example of a data champion, this supervisor organizes weekly individual sessions with rangers to train them in data entry and show them maps and graphs of the data they collect. Rangers may also have an important role as data champions. One ranger was given responsibility for managing the *SMART* data management system at his station and he felt strongly about the value of data for management, an attitude he wanted to inspire among other rangers:

> When new things come into place [SMART]… there is that resistance… but if someone of their rank is doing it and then explains to them, they really understand. If you know the importance of the data, then you have to be more precise and more focussed. When we started this SMART thing, rangers thought these guys wanted to monitor their movements, but then I explained that we need this data for us to get donor funding and for us to go to CITES to argue for the process of selling ivory… and now they [rangers] are starting to appreciate it (ranger 18).

Another ranger had experience with patrols and monitoring for 11 years and had recently become involved with data management. His experience suggested rangers may become apathetic about data collection if they do not see tangible outcomes:

> If you send someone to do data collection at the end of the day you have to come back and say, 'Oh with that data you have collected I have come up with such and such..'. If they don't see a tangible outcome, they will focus only on law enforcement and leave this monitoring (ranger 21).

Next we examine how ranger occupational culture might intersect with this mixed engagement and appreciation for monitoring.

3.3 | The occupational culture of rangers

We identified three specific elements of the broader occupational culture of rangers that influenced ranger engagement with monitoring: (a) a strong sense of duty and service, (b) deference to authority and (c) rangers understanding their defined role in the organizational hierarchy. These are interconnected; rangers see their duty as fulfilling their defined roles within the organization and as a way of serving their supervisors. These three elements permeated interview responses. While they do not comprehensively describe the occupational culture of rangers at our site, they did have a significant bearing on rangers stated motivations and behaviours (especially in relation to monitoring but also more generally; Table 3).

3.3.1 | Rangers have a strong sense of duty

Rangers demonstrated a strong sense of their responsibilities within the organization, and a desire to fulfil them: '*I will do any duty assigned to me*' (ranger 8). The most commonly reported motivation for rangers' work could be summarized simply as '*That is our duty*' (ranger 9).

> I have a feeling that I need to finish my goal. I need to catch the poacher… I'm just interested in doing my job, the results I get motivates me (ranger 22).

Rangers described their dominant duties as (a) monitoring and reporting on illegal activities: '*I will keep on collecting data for them [supervisors], that is my job*' (ranger 10) and (b) defending wildlife from poachers: '*We are here to conserve, so that no one is going to disturb our animals*' (ranger 20). Rangers saw their duty as to their supervisors, their organization, their country, to future generations and to their God (Table 3). A sense of duty repeatedly emerged in a variety of discussions, from the purpose of patrols and data collection, to the challenges and motivations of being a ranger (Table 3). The notion of duty was closely tied to deference to authority, particularly that of on-site supervisors. This points to the second identified dimension of ranger occupational culture: A strong motivation for rangers to fulfil their duties is by pleasing their supervisors and others above them in their organization.

> I make sure everything is in order on behalf of my supervisor…I do good things for my supervisors, for the department, and for the country. If I do wrong, I do wrong for everyone up the ladder (ranger 14).

3.3.2 | Rangers defer to authority

Questioning supervisors may occasionally happen, but is mostly considered inappropriate: '*According to the military… it says that the seniors come first, and the juniors follow… if you say jump, I will jump*' (ranger 9). Rangers were mostly content with occupying the base of the organizational hierarchy: '*We are the foundation of the organisation as rangers that makes me enjoy my job*' (ranger 14). While supervisors were often authoritative and commanding, there was variation among camps in the ranger–supervisor relationship. One supervisor, for example, espoused service leadership: '*To be a leader does not mean you know everything… I am happy to learn from junior staff*' (supervisor 4). Rangers perceived this supervisor as exceptionally kind, and were motivated by his consideration. The role of the character of supervisors in influencing ranger motivation was more generally evident: '*The sort of response we get from the management team whenever we have got some problems… that gives me more appetite, that motivates me for my duty*' (ranger 16). Some rangers, however, complained of negative judgement from their supervisors, '*We need a leader not a judge… who listens to us, who asks, "Give us your point of views". Not just someone who says, "do this"*' (ranger 1). While ranger responses indicated a respect for and deference to hierarchy, rangers themselves sought respect and recognition by their supervisors: '*The bosses must appreciate and say, "ah guys you are doing a good job"… we need thanks each and every time. For example, if you are staying with your children, when the children doing nice for you, we say "thank you very much"*' (ranger 17).

3.3.3 | Rangers understand their defined role within the organizational hierarchy

Rangers had a strong sense of their defined place in the organizational hierarchy, as distinct from their supervisors. This is tied to their

TABLE 3 Interview quotes illustrating (A) three elements of the occupational culture of rangers emerging from the interview responses, and (B) how these influence the level and nature of engagement of rangers with monitoring

Duty and service	Deference to authority	Knowing their defined roles
(A) As key elements of the occupational culture of rangers		
When you come here, you forget to think about everything else, I just focus on doing my work (R9)	*I don't want to lie. I want to tell my bosses exactly what I did on patrol* (R20)	*We don't choose as rangers…we are given areas to go by supervisors* (R3)
If I conserve elephants, I do it for the whole country, and for younger generations (R14)	*If the big bosses are here…we are not alone, we are not lost…his presence makes a very good motivation to rangers…we can follow that* (R5)	*They [rangers] are the ones who are always on the ground, they are the ones I send on patrol to gather information about any illegal activity* (S3)
We have to protect our heritage…that's what I know…that's what I feel (R1)	*I make sure everything is in order on behalf of my senior ranger* (R14)	*It is their [supervisors] duty to compile reports for station level and report to higher levels* (R14)
[I can do] any duty that arises (R23)	*I cannot tell him [supervisor] what to do… It is only I need to do what he wants me to do* (R12)	*We have to learn from somebody, some people are strong, I need to follow them* (R12)
Adam was given a duty by God to take care of everything… this is the same job we as rangers were given to look after our wildlife (R23)	*I have my own notebook, then for the bosses I write patrol reports* (R12)	
(B) As key factors influencing ranger engagement with ranger-based monitoring		
We are happy to bring back the information [data from field] because that is our duty (R2)	*I want to play my side and give my bosses exact information I get from patrols* (R20)	*We collect the data and we pass it onto our supervisors. Then they send it to their superiors at the regional level* (R10)
That is an operating procedure… whoever is in the bush will be looking for those things [signs of illegal activity]… and informing the office (S1).	*I don't know… the information will help them to supervise us…the supervisors know more…I am not sure how they use that information* (R19)	*I have never seen those MIKE carcass forms… maybe our seniors do that…what we do is just give them the loc stats [GPS location of elephant carcass]* (R10)
Both sides is so good, monitoring and also some anti-poaching. Both is important, because we are here for that purpose (R17)	*We sit down, and I tell them to make sure they collect the correct carcass information* (S4)	*It [data] will help us to know even the hotspots, then this will make our superiors decide how to do our patrols, where to deploy* (R23)
Yes it [ranger-collected data] helps management, it is our duty (R20)	*During briefings I always emphasize to guys [rangers] to collect as much information as possible* (S5)	*Monitoring carcasses is a big part of my job… because I have to see everything that is happening in my area* (R2)
That is our duty to monitor and report [poached] carcasses for management use (R22)	*If we come back from the bush with no results, the supervisors can say 'Ah…that guys not going for the bush, just going to the bush and sleeping'* (R17)	

sense of duty; rangers understood that they were responsible mainly for patrolling and reporting findings, and their supervisors were responsible for planning deployments and anti-poaching strategies. '*I do my part, he [the supervisor] has got his part, each one has got his role*' (ranger 6). Whilst rangers actively participate in verbal patrol brief and de-brief meetings, sharing their opinions and concerns, they are generally content with leaving to supervisors the development of management strategies. One ranger used a powerful analogy, comparing the separate roles of rangers and supervisors to separate roles within a family:

> Like in your family there are some things like "this is for father, this is for mother, this is for children"… if I play my role [collect data from the field] it is enough (ranger 14).

The defined role of rangers, and their responsibility to their supervisors, is reinforced by on-site supervisors: '*I am a senior ranger; my duty is to instil discipline. Before deploying I sit with the rangers and then I will tell the guys the role they should play in field. What they should do and what they must not do. Then we sign a form, so that we agree that the guys will do their duty*' (supervisor 7). We now examine how the above aspects of ranger work and culture influence data collection practices.

3.4 | Key elements of ranger occupational culture shape engagement with monitoring

The three elements of ranger occupational culture identified above help explain how rangers approach and perceive data collection, the importance they ascribe to it and their level of awareness of and involvement in stages after data collection (Table 3; Figure 2). We began this work with the expectation that the level of understanding and appreciation of the value of data amongst rangers would correlate with their level of engagement with ranger-based monitoring. A notable

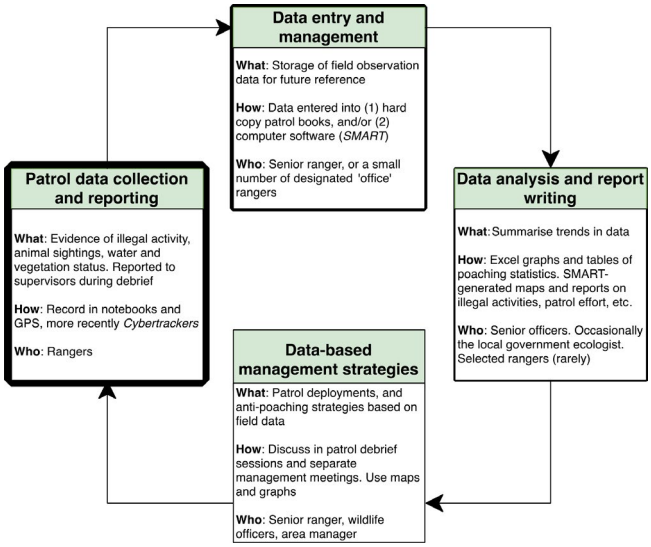

FIGURE 2 The data cycle for the ranger-based monitoring and management system, showing four distinct stages. Line thickness around each stage represents the level of engagement of rangers in that stage

outcome of interviews is the strong theme of data collection as a duty, together with the above-mentioned calls for more active ownership of the data management and use cycle.

Rangers perceive data collection as a fundamental duty, to which they ascribed a high level of importance. The majority of rangers' time is spent on patrol, with rangers describing the monitoring of illegal activities as the main purpose of patrols. In this context, a sense of duty is central: '*Whilst you are in patrol you specialise on finding animals and illegal activities, I enjoy it because it's part of my job… I have to*' (ranger 9). Rangers also take pride in their role as the 'ears and eyes' on the ground: '*They use our information… because we are the right people on the ground*' (ranger 12). Relatedly, rangers considered data collection to complement their anti-poaching role: '*When I am collecting data it can lead me into apprehending a poacher or knowing how the poachers are moving*' (ranger 13). Reporting data collected on patrols to their supervisors, especially illegal activities, is a primary way that rangers demonstrated fulfilled duty: '*As a duty as a ranger, you would go out on patrol and bring something from the field to show you have done your job*' (ranger 12). This attitude is re-enforced by supervisors:

> We have standard operating procedures for anti-poaching and data collection. We came up with standing orders… it will force rangers to love data collection…everyone who goes on patrols, they have to collect data… when they come back they have to tell us what they collect (supervisor 7).

While the ranger-based monitoring and management cycle involves multiple stages after data collection—office data entry, reporting of data to regional and national levels, data analysis and finally the use of data to inform management and patrol strategies (Figure 2)—rangers' involvement in this cycle is limited, and tends to end with data collection. Rangers nonetheless have a good basic understanding of why they are required to collect data (Table 2):

> Data collection is needed in the field. It will be used for management purposes. If I go out and don't collect information, [the supervisors] won't know what is there. So, data collection is very important. You can't keep deploying people to where there is no animal sightings (ranger 22).

The most commonly mentioned reason for collecting data was to identify poaching hotspots: '*The carcasses within the area are the indicators of hot areas*' (ranger 13). A few rangers described the value of data as a tool for measuring anti-poaching performance: '*By looking at the carcass numbers you can see this year we have received a defeat… and look at the factors which have contributed to your failure, was it a shortage of manpower?*' (ranger 16). Yet rangers tend not to know the details of how their supervisors use monitoring data: '*I just pass the data through to my supervisors. Maybe they are the ones who do that [manage the data]*' (ranger 10). Rangers generally see the management of data, and its use for future deployments, as the responsibility of supervisors: *'We can give the information to our bosses, so they know where to deploy us*' (ranger 2). Whilst rangers did have a good basic understanding of why animal sightings and illegal activities were important to report for anti-poaching purposes, they generally did not know the details of how supervisors used these data and tended to see stages after collection as beyond their remit. Yet, even though many rangers were not aware of how the data they collected on patrol were used by their supervisors, they were still engaged with monitoring as a fundamental duty. The duty and deference elements of occupational culture identified here are crucial in explaining this discrepancy. Recording illegal activities and animal sightings while on patrol was seen by rangers as an important duty to fulfil, and reporting such observations to their supervisors was one of the main ways they demonstrated a job well done.

This suggests that data collection would continue even in the absence of a deeper appreciation among rangers of its broader purpose, as long as supervisors provide clear imperatives and instructions for it. Indeed, the greater consistency in the reporting of MIKE elephant carcass data versus regular patrol data (Figures 3 and 4) might reflect a clearer imperative and set of instructions to rangers in the case of MIKE data. Nevertheless, a fair proportion of rangers reported a desire to know more about how the collected data were used, saying it would motivate more focussed and enthusiastic data collection (Figure 5). The insights of the 'data champions' also suggested that a greater appreciation amongst rangers for the value of data was crucial to engaging them more effectively in monitoring, and highligted the possibility of compromised data collection in the absence of such an appreciation. On balance, our results suggests that whilst a sense of duty can motivate data collection to a certain extent, the quality (consistency, detail, etc.) of data (though not measured here) is likely to be improved when rangers appreciate the purpose of these data.

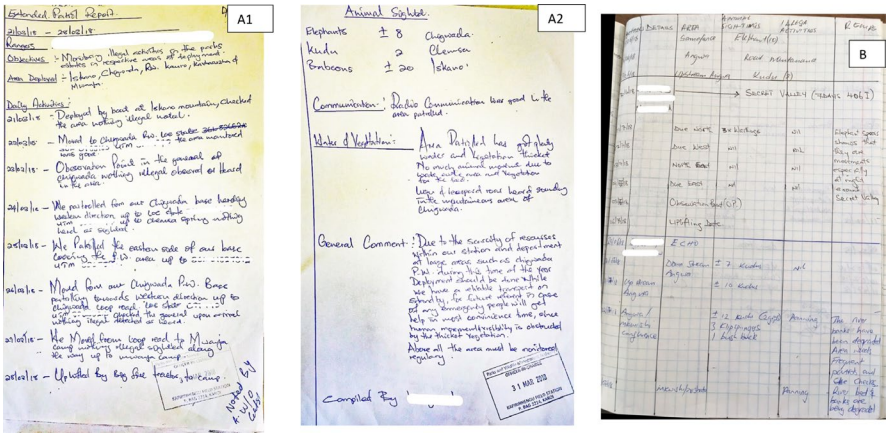

FIGURE 3 Example of extended patrol reports from two different ranger stations in Chewore (2018). A1 and A2 constitute one patrol report (8-day patrol), while B shows data from three separate 7-day patrols (only the middle report is shown in full). Ranger names and GPS locations have been removed

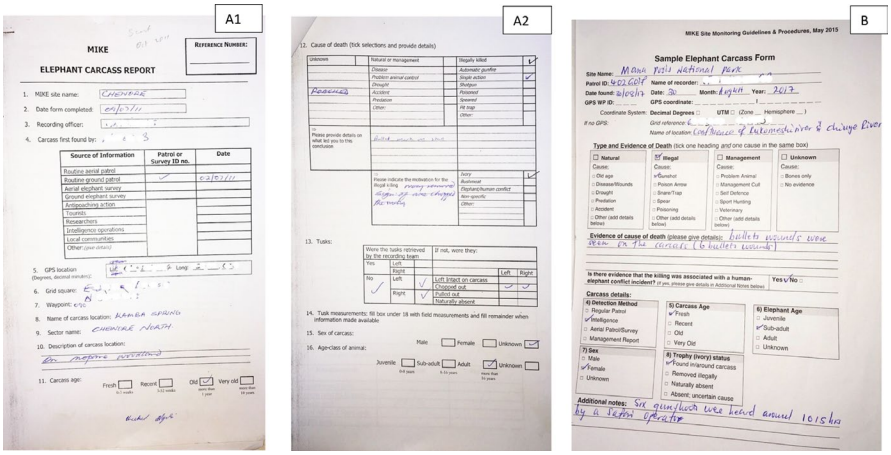

FIGURE 4 Examples of completed MIKE forms used by rangers in Mana Pools and Chewore to record elephant mortalities. A1 and A2 constitute the older form style (used 2009–2016), while B shows the condensed version (used from 2017). GPS locations and ranger names have been removed

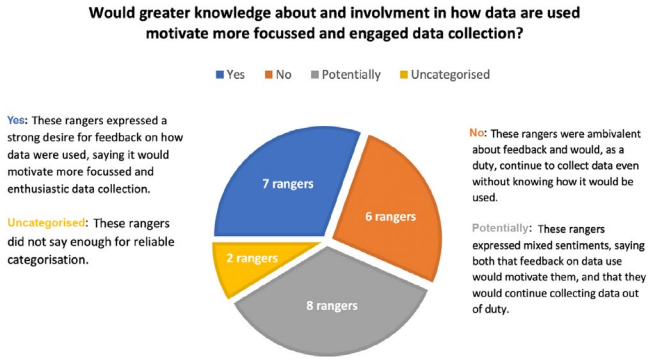

FIGURE 5 Based on their answers to several interview questions, the 23 ranger respondents were assigned to four categories based on whether greater involvement or knowledge of how data were used for conservation management would likely motivate more engaged data collection

3.5 | Creating an enabling environment: Ranger job-satisfaction and resource/capacity needs

In addition to these three elements of ranger culture at our study site, our interviews and observations highlight how the work and living conditions of rangers also help shape engagement with monitoring. For example, rangers spoke extensively about job satisfaction and well-being. A love for nature was the most common reason rangers cited for enjoying their jobs: '*My love for these wild animals motivates me to be a ranger*' (ranger 7). While this motivated a desire to protect nature, for many rangers it also had a strong intrinsic element of enjoying nature for its own sake:

> To start with I love nature… that's the drive that can motivate me. Spending nights in the bush… the sounds of the birds… the sounds of lions… to live with nature, I like that (ranger 15).

Tied to this love of nature was an eagerness to learn: '*I enjoy mountain climbing…discovering hot springs, new type of trees and stones…everything is fascinating*' (ranger 10). '*I like to be a ranger because I learn lots from what I do, you can learn that long back people used to live here, you can see pieces of clay pots*' (ranger 20).

This love for nature and fascination with learning contrasted with the many challenges rangers faced. The most commonly described challenge was living away from family. The ranger stations are far from the nearest towns, and the need for schooling means that most families live away from rangers, some in distant parts of the country. Family separation had clear negative psychological effects, such as stress and worry:

> I want to share with my [spouse] or share with my children when there is a problem, but we are living apart so sometimes I get stressed and a high blood pressure (ranger 17).

> Sometimes you get bored, you need your partner to be close to motivate you… and see your child growing up. You get stressed… your mind will be centred there [with family], so your duties will be very difficult (ranger 18).

Living in remote areas means limited leisure opportunities: '*It is quite challenging to stay in the bush… if you go out there [trips to town] you can meet friends and you will be happy and when you come back you will be ready to do your work*' (ranger 16). Having no respite from the workplace also had implications for rangers' perspectives and relief from work duties: '*If we had a vehicle to play a soccer match in the community, it could help us take our mind off patrols*' (ranger 18).

Harnessing the parts of their work that rangers enjoy, while minimizing the challenges they face, is likely to lead to a more enabling environment in which rangers work more effectively (Belecky et al., 2019; Moreto, 2016a; Spira, Kirky, & Plumptre, 2019).

Adequate resources and capacity for monitoring also emerged as an important theme. Regardless of rangers' interest in data collection and use, if they are not appropriately resourced it can be challenging for them to fulfil their duties. Where the three elements of occupation culture identified here have deeper implications for ranger-based monitoring, resource and capacity challenges had more direct, immediate, implications. Patrol and camping equipment, communications tools and vehicles were all limited at the case study site. '*So far, we have got shortage of equipment, like tents, GPSes, Cybertrackers, batteries…*' (ranger 8). Notably, a number of rangers reported having to purchase their own tents and resorting to cheap options: '*We have to buy our own tent because of the economic situation. I had to pay $40. I bought one with bright colours…poachers, they will see it*' (ranger 14). This had consequences for morale: '*If we can get these things [equipment and vehicles] our morale will be more*' (ranger 5). One supervisor felt strongly about this: '*I think the best motivator is to equip the ranger with enough apparatus to use in data collection*' (supervisor 7). A lack of equipment may also compromise data quality: '*If the information is to be clear…needs lots of equipment on the ground*' (ranger 14). Both field and office resources are necessary for proper data management, as one supervisor highlighted:

> We need batteries, GPSes, computers in order for MIKE to be moving smoothly. There are no batteries for the GPSes… how can I collect data? (supervisor 4).

Vehicles were identified by rangers and supervisors as the most important resource for general operations, yet most stations had only one vehicle and small fuel budgets. Rangers also said that vehicle limitations significantly reduced patrol coverage, and hence the accuracy and breadth of data collection. Rangers commonly said they felt they did not have adequate capacity for monitoring and that they would like more training, specifically in data collection (e.g. how to properly record elephant carcass data, how to use mobile devices such as *Cybertrackers*) and data management (e.g. the use of *SMART* software). '*I have to be educated to enter the data on the computer*' (ranger 1). '*I feel we need more and more training*' (ranger 5). While SMART training workshops are offered through local NGOs, these are infrequent and involve few rangers. Those that did attend training reported that they found these mostly useful. However, some complained that training sessions were difficult to follow: '*I didn't understand what was the database and what was the data model…it was short period over which he did all these things….I was entering data but not completely understanding*' (ranger 5). One older ranger was not keen on learning how to use a computer, however, saying '*[I will] leave for the younger guys to play with the computers*' (ranger 16).

4 | DISCUSSION: A THEORY OF CHANGE FOR IMPROVING ENGAGEMENT OF RANGERS IN DATA COLLECTION AND MONITORING

Drawing on our results and existing literature, we develop a theory of change for engaging rangers more meaningfully and effectively in data collection. A theory of change describes how an initiative or intervention achieves its stated goal, or the particular assumptions, steps and outcomes between the particular initiative and the final goal (Stein & Valters, 2012). Our theory of change identifies two *drivers of engagement* and two *enabling conditions* for achieving the overall goal of more meaningful engagement of rangers in monitoring. We see the achievement of this goal as itself contributing towards more effective species and habitat conservation through adaptive protected area management (Figure 6). We first discuss two main drivers of ranger engagement with data collection. These are:

1. *The occupational culture of rangers at our site*: particularly a strong sense of duty, deference to authority and knowing their defined role within the organizational hierarchy.
2. *Seeing the value of data*: understanding the broader purpose of data (how it is used) motivates data collection.

These two drivers may be thought of as distinct sources of motivation for effective data collection, and we argue that both are important to understand and engage if the goal of effective and sustainable ranger-based monitoring is to be realized. The importance of each of these motivations, and how they might be encouraged, is discussed below.

4.1 | Engaging ranger culture

The elements of ranger occupational culture identified here are crucially important because of how embedded we observed them to be

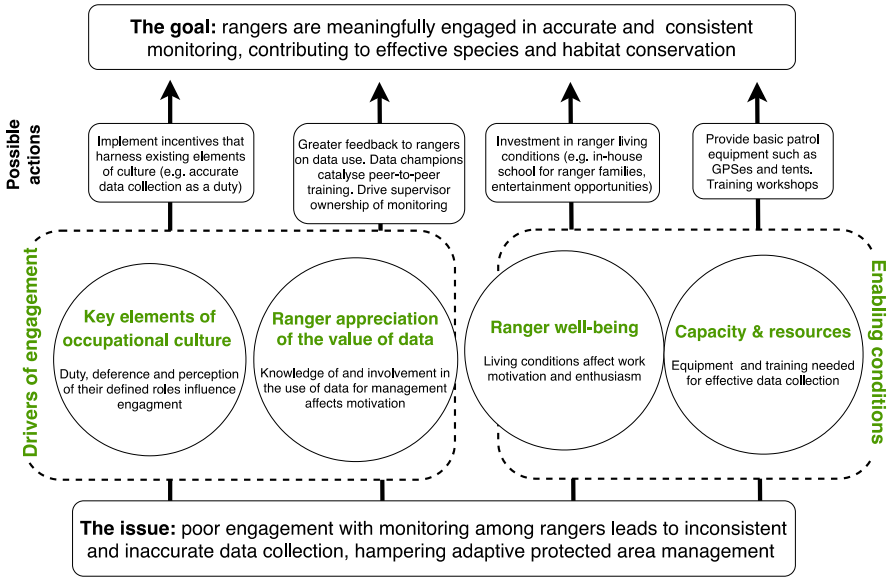

FIGURE 6 A theory of change for more meaningful engagement of rangers in ranger-based monitoring, highlighting key drivers of engagement and additional conditions that enable/disable such engagement. Possible actions to leverage these drivers and enabling conditions and achieve the overall goal are also indicated (these are only illustrative and more focussed action development is recommended)

within the ranger community in the Zambezi Valley. Interventions to better engage rangers with ranger-based monitoring will work best if they are sensitive to these aspects of existing occupational culture, and have incentives that work with and not against them (Figure 6). An important implication of the strong themes of duty and deference is that recognition of the work that rangers do, particularly from their superiors, is essential for their motivation. Results indicate that rangers were eager to work well for their supervisors, and hence were encouraged when their good performance was valued and rewarded. This may be as simple as a 'well done' from the supervisor. A survey of 570 rangers across 60 sites in Africa, for example, demonstrate that '*little or no recognition as a professional*' was one of the most commonly cited answers to the question of what the worst aspect of rangers' jobs was (Moreto, 2016b). A key strategy for engaging rangers more effectively in ranger-based monitoring is to recognize good practices, such as a high volume or quality of raw data collected, consistent GPS recording of patrol routes or a clearly written patrol report. This might be in the form of simple verbal affirmation and encouragement, the award of a good service certificate, notching towards promotion or even recognition in the form of monetary incentives.

The themes of duty and deference identified here begin to shed light on rangers' attitudes towards, and practices of monitoring, as well as what motivates rangers to work, how they perceive their occupation and what is and is not important within it and how they see themselves within their broader organizational hierarchy. Rangers in our case study knew their place within the organizational hierarchy. We see this in other conservation contexts as well. Clear hierarchies and authority structures are common within the law enforcement and conservation agencies that rangers work for globally. In a study of ranger occupational stress in a Ugandan protected area, Moreto (2016) found that rangers felt the pressure of needing to please supervisors: '*Even you get pressurized, eh? And think that if they* (*management*) *come and find illegal activity near my area, then they might think that I am not doing […] work*'. A multi-site study in South Africa similarly describes an organizational hierarchy of a section ranger at the top, who 'has command' over rangers in the rank of corporal and sergeant, through to lower level field rangers (Warchol and Kapla (2012). One of the authors of this current study (FM) confirms similar working dynamics in Mozambique (unpubl. obs.), while others describe similar working hierarchies in the USA (Charles, 1982). Dynamics of authority and deference can likely be traced to the paramilitary training that many rangers receive at our site (2 weeks of such training was mandatory for all rangers at our site). Such training is becoming increasingly common for rangers (Duffy et al., 2019).

4.2 | Fostering a greater appreciation of the value of data

We find the rangers' appreciation for the value of the data they collect to be important for two main reasons. First, most rangers interviewed expressed a desire for feedback on how the data they collected were used, with seven expressing clearly that this would create strong incentives for engaged data collection in the future (Figure 5). Of these seven, three 'data champions' expressed the desire (and showed the potential) to influence other rangers to appreciate the broader value of data, through peer-to-peer training (Figure 6). Secondly, interview responses suggested a deeper level of appreciation of the value of data is likely to affect the accuracy and consistency of data collection, where ranger culture alone may not. While our data does suggest a sense of duty alone can motivate data collection, data also suggest that this will not guarantee consistency and accuracy in data recording. If the requirement is simply to report data, there may be no incentive to report accurate, consistent and comprehensive data (e.g. rangers may become selective in what they record and how they record it). Furthermore, such an approach may not be sustainable because it relies on supervisors continually enforcing the imperative to collect data. Authority structures and division of duties mean that the ranger-based monitoring and management cycle itself is divided, with little interaction and

feedback between the collection of data by rangers and the use of these data by supervisors. Data champions were the rare exception. There is a danger that rangers will not take ownership of data collection if they do not understand its broader purposes. This might lead to rangers prioritizing other duties for which the broader purpose is clearer, such as anti-poaching operations and less on biological monitoring (see e.g. Warchol & Kapla, 2012).

The appreciation for data might also drive higher levels of engagement in the international MIKE programme. Office hardcopy and computer records of patrol observations at each station show that data on elephant carcasses were the most clearly and consistently recorded (compared to other illegal activities and animal sightings). With the MIKE programme, rangers are given specific instructions for what to record when encountering an elephant carcass and are then required to report this for data storage. Moreover, rangers are aware of how this data fit into and contribute towards a bigger objective at the local, national and even global level. One senior ranger highlighted the excitement of rangers when he told them how the elephant carcass data they collect are used to make international decisions concerning ivory trade. Research on ranger-based monitoring across eight sites in India similarly emphasizes that data collection has potential to empower and motivate rangers if regular feedback on monitoring results is given (Stokes, 2010). One strategy that could contribute towards fostering greater data appreciation is active feedback workshops in which managers (or representatives of external bodies like MIKE) explain to rangers how field data are used, thereby giving rangers the sense that their data are making an important contribution.

Knowing how data are used not only ties into sentiments of wanting to be recognized as a professional, but to a sense of pride among rangers in fulfilling their various services to society. Our observations of this are mirrored amongst rangers in other contexts as well (Charles, 1982; Spira et al., 2019). In a study of the job satisfaction of rangers in Uganda, for example, Moreto et al. (2016) found that rangers saw their work as serving future generations and supporting national development by conserving wildlife. This sense of service was a key factor determining their job satisfaction. Helping rangers understand how their day-to-day data collection and monitoring fits into a bigger local, national and even global picture and decision-making, such as is the case with MIKE, can help foster a greater appreciation for data collection and more effective collection and monitoring practices.

Engaging the elements of ranger occupational culture identified here, and fostering a greater appreciation for the value of data amongst rangers, will depend on good site-level leadership from supervisors. Indeed, our results indicate that good leaders have the potential to motivate rangers. Interventions and innovation should therefore be directed at both rangers and their supervisors.

4.3 | Enabling conditions for ranger-based monitoring

In addition to understanding the drivers of engagement in monitoring, our results highlight the importance of both ranger well-being and the availability of capacity and resources as conditions that enable effective monitoring. Moreto (2016a) showed how a challenging work environment for rangers in Uganda contributed to occupational stress, with implications for work enjoyment and performance. Spira et al. (2019) describe difficult living conditions, poor salaries and limited promotion opportunities for rangers in the DRC as key drivers of low job satisfaction and motivation. Our results similarly reveal significant challenges faced by rangers (such as separation from family and a lack of stimulation outside of patrols), with rangers describing direct implications for their levels of motivation and focus in fulfilling their duties. Relatedly, rangers frequently reported a shortage of basic equipment for both patrols and data collection, describing how this made their work difficult and sometimes impossible to fulfil. The aforementioned global survey of rangers found that only around half of the 7,100 rangers survey felt that they had sufficient basic equipment to carry out their duties (Belecky et al., 2019). It follows, then, that strategies to foster more effective ranger-based monitoring (e.g. by engaging the two drivers of engagement emphasized in this study) may not be successful unless the broader well-being of rangers and their basic resource and training needs are adequately addressed.

Being a case study of one area at one time, this study is limited by its temporal and spatial scope. It is thus difficult to generalize to rangers globally, or even in Zimbabwe. However, occupational culture as a way of thinking about the beliefs, values and motivations of rangers is generalizable to other contexts. Moreover, our results fit into a body of existing literature that highlights similar aspects and characteristics of ranger culture, perceptions and attitudes concerning their work. Given this congruence, we demonstrate the value of occupational culture as a lens through which we can understand the engagement of rangers in the data collection and data use stages of ranger-based monitoring. In this regard, our case study does provide analytical generalizability in the sense, described by Yin (2009), of generalizing to a theoretical position, which we summarize in the Theory of Change. Drawing on our own results and existing literature on ranger attitudes and working environments, this Theory of Change identifies key drivers of engagement and enabling conditions as levers for improving the effectiveness of ranger-led data collection and monitoring, and thus for conservation and protected area management. Further generalizability of these conclusions and the robustness of this Theory of Change require further research with rangers in other contexts.

4.4 | Conclusion

Many governmental and non-governmental initiatives seek to promote adaptive protected area management through the implementation of sophisticated data collection, management and analysis protocols (Malpas & D'Udine, 2013; Stokes, 2010). However, the on-the-ground day-to-day reality of data collection for rangers may be very different. Drawing on research with rangers in our study area and existing literature on ranger motivation, occupational culture and attitudes, we

developed a Theory of Change towards improving the implementation and outcomes of ranger-based monitoring. Specifically, we demonstrate how a more thorough understanding of key elements of the occupational culture of rangers and fostering the appreciation of the value of data among rangers and their supervisors could act as motivators for more effective ranger data collection. We also complement recent work on the lived experiences of rangers by highlighting well-being and adequate resources as necessary enabling conditions for effective data monitoring.

Our study began with the assumption that the motivations and values of rangers have significant implications for conservation interventions that depend on rangers as key actors, and are therefore worth investigating. Our findings contribute to a small but growing literature on the social dimensions of the ranger occupation (Moreto et al., 2015; Spira et al., 2019). We reveal particular elements of the occupational culture among rangers in our case study that influence engagement with monitoring—a strong sense of duty and service, deference to hierarchy and clearly defined occupational roles. As discussed above, these findings complement existing research on the topic. Understanding this culture was essential to properly contextualize and indeed assess the importance rangers ascribe to data collection and the nature and level of their engagement in the broader data-based management cycle.

Rangers are at the frontline of conservation practice and protected area management globally, in the sense that they are directly involved in the practical implementation of interventions to protect nature. This includes anti-poaching and law enforcement operations, but also extends to duties such as baseline monitoring and evaluation (Stokes, 2010), and park-community relations (Moreto et al., 2017). It follows that the success of conservation management in many contexts is closely tied to the performance and meaningful engagement of rangers. Furthermore, engaging ranger perspectives and lived experiences is necessary to ensure a just working environment, which is necessary both from an ethical and a pragmatic standpoint.

ACKNOWLEDGEMENTS

We thank the rangers of Mana and Chewore for their participation and insights. We thank the Zimbabwe Parks and Widlife Management Authority and the Research Council of Zimbabwe for authorizing this research. We thank Lynne Taylor and Richard Maasdorp for helping to facilitate fieldwork. We thank Danica Kuiper for helping with logistics during fieldwork and being an excellent research partner. We thank the Commonwealth Scholarship Commission for funding the first author's PhD research at the University of Oxford (of which this manuscript is an output). Francis Masse supported by ERC Horizon 2020 Advanced Investigator Grant # 694995. [Correction added on 16 November 2020, after first online publication: Funding information added for Francis Masse.]

CONFLICT OF INTEREST

We declare that none of the authors have any conflict of interest to declare.

AUTHORS' CONTRIBUTIONS

T.K., N.A.N., B.K., R.L.M.-C. and E.J.M.-G. conceived the ideas and designed methodology; T.K. collected the data; T.K. analysed the data; T.K., F.M. and E.J.M.-G. led the writing of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

DATA AVAILABILITY STATEMENT

Audio recordings and transcribed interview responses cannot be made public due to agreed procedures under the ethical clearance provided for this research (Human Research Ethics committee, Oxford University, REF: R58336/RE001).

ORCID

Timothy Kuiper https://orcid.org/0000-0003-2502-4028
Nobesuthu A. Ngwenya https://orcid.org/0000-0002-0152-1364
Blessing Kavhu https://orcid.org/0000-0003-2065-4485
Roseline L. Mandisodza-Chikerema https://orcid.org/0000-0001-6151-2593
Eleanor J. Milner-Gulland https://orcid.org/0000-0003-0324-2710

REFERENCES

Belecky, M., Singh, R., & Moreto, W. D. (2019). *Life on the frontline 2019: A global survey of the working conditions of rangers*. WWF Report, 1–70.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101.

Canessa, S., Guillera-Arroita, G., Lahoz-Monfort, J. J., Southwell, D. M., Armstrong, D. P., Chadès, I., Lacy, R. C., & Converse, S. J. (2015). When do we need more data? A primer on calculating the value of information for applied ecologists. *Methods in Ecology and Evolution*, *6*, 1219–1228. https://doi.org/10.1111/2041-210X.12423

Charles, T. (1982). Yellowstone ranger-the social control and socialization of federal law enforcement officers. *Human Organization*, *41*, 216–226.

Christensen, W., & Crank, J. P. (2001). Police work and culture in a non-urban setting: An ethnographic analysis. *Police Quarterly*, *4*, 69–98. https://doi.org/10.1177/109861101129197752

CITES Secretariat. (2019). Report to CITES CoP 18 on Monitoring the Illegal Killing Of Elephants (MIKE). CoP18 Doc. 69.2, 1–20.

Critchlow, R., Plumptre, A. J., Driciru, M., Rwetsiba, A., Stokes, E. J., Tumwesigye, C., Wanyama, F., & Beale, C. M. (2015). Spatiotemporal trends of illegal activities from ranger-collected data in a Ugandan national park. *Conservation Biology*, *29*, 1458–1470. https://doi.org/10.1111/cobi.12538

Dobson, A., Beale, C. M., Keane, A. M., & Milner-Gulland, E. (2018). Detection deterrence from patrol data. *Conservation Biology*, *3*, 1–60.

Dobson, A. D. M., Milner-Gulland, E. J., Beale, C. M., Ibbett, H., & Keane, A. (2019). Detecting deterrence from patrol data. *Conservation Biology*, *33*(2), 665–675. https://doi.org/10.1111/cobi.13222

Duffy, R., Massé, F., Smidt, E., Marijnen, E., Büscher, B., Verweijen, J., Ramutsindela, M., Simlai, T., Joanny, L., & Lunstrum, E. (2019). Why we must question the militarisation of conservation. *Biological Conservation*, *232*, 66–73. https://doi.org/10.1016/j.biocon.2019.01.013

Fang, F., Nguyen, T. H., Pickles, R., Lam, W. Y., Clements, G. R., An, B., Singh, A., Schwedock, B. C., Tambe, M., & Lemieux, A. (2017). PAWS—A deployed game-theoretic application to combat poaching. *AI Magazine*, *38*, 23. https://doi.org/10.1609/aimag.v38i1.2710

Gavin, M. C., Solomon, J. N., & Blank, S. G. (2010). Measuring and monitoring illegal use of natural resources. *Conservation Biology*, *24*, 89–100. https://doi.org/10.1111/j.1523-1739.2009.01387.x

Glomseth, R., Gottschalk, P., & Solli-Sæther, H. (2007). Occupational culture as determinant of knowledge sharing and performance in police investigations. *International Journal of the Sociology of Law*, *35*, 96–107. https://doi.org/10.1016/j.ijsl.2007.03.003

Gray, M., & Kalpers, J. (2005). Ranger based monitoring in the Virunga-Bwindi region of East-Central Africa: A simple data collection tool for park management. *Biodiversity and Conservation*, *14*, 2723–2741. https://doi.org/10.1007/s10531-005-8406-x

Kuiper, T., Kavhu, B., Ngwenya, N. A., Mandisodza-Chikerema, R., & Milner-Gulland, E. J. (2020). Rangers and modellers collaborate to build and evaluate spatial models of African elephant poaching. *Biological Conservation*, *243*, 108486. https://doi.org/10.1016/j.biocon.2020.108486

Malpas, R., & D'Udine, F., (2013). *Long term system for Monitoring the Illegal Killing of Elephants (MIKE) phase II final evaluation report*. CITES Report.

Moreto, W. D. (2016a). Occupational stress among law enforcement rangers: Insights from Uganda. *Oryx*, *50*, 646–654. https://doi.org/10.1017/S0030605315000356

Moreto, W. D. (2016b). *Ranger perception study Africa*. WWF Report.

Moreto, W. D., Brunson, R. K., & Braga, A. A. (2015). Such misconducts don't make a good ranger: Examining law enforcement ranger wrongdoing in Uganda. *British Journal of Criminology*, *55*, 359–380.

Moreto, W. D., Brunson, R. K., & Braga, A. A. (2017). 'Anything we do, we have to include the communities': Law enforcement rangers' attitudes towards and experiences of community-ranger relations in wildlife protected areas in Uganda. *British Journal of Criminology*, *57*, 924–944. https://doi.org/10.1093/bjc/azw032

Moreto, W. D., & Lemieux, A. M. (2015). Poaching in Uganda: Perspectives of law enforcement rangers. *Deviant Behavior*, *36*, 853–873. https://doi.org/10.1080/01639625.2014.977184

Moreto, W. D., Lemieux, A. M., & Nobles, M. R. (2016). 'It's in my blood now': The satisfaction of rangers working in Queen Elizabeth National Park, Uganda. *Oryx*, *50*, 655–663. https://doi.org/10.1017/S0030605316000387

Moreto, W. D., & Matusiak, M. C. (2017). 'We fight against wrong doers': Law enforcement rangers' roles, responsibilities, and patrol operations in Uganda. *Deviant Behavior*, *38*, 426–447. https://doi.org/10.1080/01639625.2016.1197015

Newing, H. (2010). *Conducting research in conservation: Social science methods and practice*. Routledge.

Nuno, A. N. A., Bunnefeld, N., & Milner-Gulland, E. J. (2017). Using management strategy evaluation as a framework for improving conservation under uncertainty: The case of the serengeti ecosystem. In N. Bunnefeld, E. Nicholson, & E. J. Milner-Gulland (Eds.), *Decision-making in conservation and natural resource management: Models for interdisciplinary approaches* (pp. 156–181). Cambridge University Press.

QSR International Pty Ltd. (2018). *NVivo qualitative data analysis software*. QSR International Pty Ltd.

Ritchie, J., Lewis, J., & Elam, R. G. (2013). Designing and selecting samples. In C. Seale, G. Gobo, D. Silverman, & J. F. Gubrium (Eds.), *Qualitative research practice: A guide for social science students and researchers* (pp. 111–142). Sage Publications.

Schein, E. H. (1990). *Organizational culture* (Vol. *45*, p. 109). American Psychological Association.

Spira, C., Kirkby, A. E., & Plumptre, A. J. (2019). Understanding ranger motivation and job satisfaction to improve wildlife protection in Kahuzi-Biega National Park, eastern Democratic Republic of the Congo. *Oryx*, *53*(3), 460–468. https://doi.org/10.1017/S0030605318000856

Stein, D., & Valters, C. (2012). *Understanding theory of change in international development*. Justice and Security Programming Paper, 1–21.

Stokes, E. J. (2010). Improving effectiveness of protection efforts in tiger source sites: Developing a framework for law enforcement monitoring using MIST. *Integrative Zoology*, *5*, 363–377.

Van Maanen, J., & Barley, S. R. (1982). Occupational communities: Culture and control in organizations. Interim Technical report. Sloane School of Management, Massachusetts Institute of Technology. pp. 1–127.

Warchol, G., & Kapla, D. (2012). Policing the wilderness: A descriptive study of wildlife conservation officers in South Africa. *International Journal of Comparative and Applied Criminal Justice*, *36*, 83–101. https://doi.org/10.1080/01924036.2012.669911

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Thousand Oaks, CA: Sage.

Young, J. C., Rose, D. C., Mumby, H. S., Benitez-Capistros, F., Derrick, C. J., Finch, T., Garcia, C., Home, C., Marwaha, E., Morgans, C., Parkinson, S., Shah, J., Wilson, K. A., & Mukherjee, N. (2018). A methodological guide to using and reporting on interviews in conservation science research. *Methods in Ecology and Evolution*, *9*, 10–19. https://doi.org/10.1111/2041-210X.12828

ZPWMA. (2015). *Zimbabwe National Elephant Management Plan (2015–2020)*. Zimbabwe Parks & Wildlife Management Authority.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

How to cite this article: Kuiper T, Massé F, Ngwenya NA, Kavhu B, Mandisodza-Chikerema RL, Milner-Gulland EJ. Ranger perceptions of, and engagement with, monitoring of elephant poaching. *People Nat.* 2020;00:1–14. https://doi.org/10.1002/pan3.10154