Wildlife health perceptions and monitoring practices in globally distributed protected areas

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Abstract

The status of health monitoring practices in protected areas (PAs) is largely unknown but potential gaps could undermine biodiversity conservation at these key sites. There is also a lack of baseline information regarding local perceptions of wildlife, human, and livestock health relevance that could affect health monitoring implementation at these sites. To solve these deficiencies, we delivered a web-based survey to data managers of PAs worldwide through a specialized online forum. Specifically, we assessed perceptions regarding wildlife health (WH) and pathogen transmission between wildlife, humans, and livestock; the detection and documentation of unhealthy wildlife (injured, sick, and dead) and domestic animals in PAs; and health data management. Eighty-six out of 128 responses received were analyzed. Respondents considered WH relevant to the conservation goals of PAs, and >90% of them confirmed that unhealthy wildlife are encountered. However, >50% and >20% of respondents claimed that injured or sick and dead animals were not recorded, respectively. When these animals were documented, the recording methods and information collected differed. Although respondents considered domestic animal presence common and a conservation concern, these animals and their health status were not always recorded. Health data were often stored in a database, but paper forms and spreadsheets were also used. Responses suggested that valuable syndromic WH surveillance data from PAs are not collected or lost due to inadequate management and their value could be limited by a lack of standardized recording protocols.

Introduction

Introduction Protected areas (PAs) safeguard intact landscapes, conserving diverse wildlife and flora, and preserve essential ecosystem services while supporting local communities. However, they are increasingly threatened by anthropogenic pressures. Human encroachment and land-use change (Laurance et al. 2012; Vicente et al. 2021; Meng et al. 2023) drive resource extraction, pollution, creation of human-wildlife-livestock interfaces, and ecosystem degradation (Plowright et al. 2021; Vicente et al. 2021; Reaser et al. 2023). These processes expose wildlife to physical (e.g., snaring), chemical (e.g., toxins), and biological (e.g., pathogens) hazards and can negatively affect biodiversity conservation and global health (De Vos et al. 2016; Wolf et al. 2019; Machalaba et al. 2020; Hacon et al. 2020; Porco et al. 2023; Groenenberg et al. 2023).

Wildlife health (WH) monitoring, which involves tracking diseases, pathogens, and toxic agents in wild animal populations (World Organisation for Animal Health & International Union Conservation of Nature 2024) facilitates early detection of exposure and disease, enables rapid response to mitigate risks and adverse outcomes, and supports the evaluation of health management strategies (Woods et al. 2019; Machalaba et al. 2021; One Health High-Level Expert Panel [OHHLEP] et al. 2022; Porco et al. 2023; Elnaiem et al. 2023; Vora et al. 2023; Thompson et al. 2024). The One Health approach recognizes that the health of animals and humans and the functioning of their shared environment are deeply interconnected (Machalaba et al. 2021; OHHLEP et al. 2022; World Organization for Animal Health 2023). As a result, WH monitoring is essential for biodiversity conservation and for safeguarding human and animal health.

Ebola virus disease is an illustrative example. Outbreaks in wildlife have decimated populations of western gorillas and chimpanzees (Whitfield 2003; Leroy et al. 2004; Bermejo et al. 2006). Index cases of outbreaks of this disease in humans have involved hunters who extracted animals from the wild, including in PAs (Judson et al. 2016). Virus spread into urban areas of West Africa through human-to-human transmission in 2014 resulted in over 20,000 excess human deaths (Dudas et al. 2017; Jacob et al. 2020).

Despite its importance, WH monitoring systems remain uncommon or deficient (Machalaba et al. 2021; OHHLEP et al. 2022; World Organization for Animal Health 2023). To our knowledge, the status of WH monitoring practices in PAs is largely unknown. A lack of such monitoring or gaps could undermine biodiversity conservation and compromise One Health, highlighting the need for urgent attention. Additionally, baseline information regarding the perception of wildlife, human, and livestock health relevance for biodiversity conservation by PA personnel is also unknown. Their perceptions could impact affect WH monitoring practices and their implementation.

To address knowledge gaps associated with current WH monitoring practices in PAs and associated perceptions by personnel, we surveyed protected area data managers (PADMs) to assess their perceptions regarding WH and pathogen transmission between wildlife, humans, and livestock; the detection and documentation of injured, sick, or dead wildlife and domestic animals in PAs; and health data management in PAs.

Methods

We developed a web-based questionnaire aimed at PADMs users of the Spatial Monitoring and Reporting Tool (SMART). SMART is a suite of technology tools an online that support the administration of PAs (Cronin et al. 2021) and is used in more than 1,000 conservation sites worldwide. Thus, its user community offers the opportunity to engage a large number of PADMs. The survey was distributed to the SMART Community Forum users by the SMART Partnership (https://smartconservationtools.org) via email in October 2022. The survey remained open for three months. A reminder was sent three weeks before the closing date.

Survey questions are in Appendix S1. Because the SMART Community Forum includes many conservation actors, respondents were asked first if their job roles and responsibilities matched our definition of PADM: "a person directly responsible for managing SMART data in one or more PAs or a general manager or administrator of one or more PAs that uses SMART data." Respondents who did not identify as a PADM were excluded. The survey had five sections. Section 1 assessed the perception of PADMs on the importance of WH in achieving conservation goals, the role of human and livestock pathogens in affecting WH, and the role of wildlife pathogens in affecting public and livestock health. Section 2 asked respondents to rank the overall frequency of encounters with injured, sick, or dead wildlife in PAs and to indicate whether animals in each of these classes, along with healthy wildlife, are recorded as a specific type of individual when found during patrols. Section 3, asked about the presence of domestic animals in the PAs , the documentation of their health status, and the perceived threats of domestic animals to conservation goals. In sections 1-3 Likert scales were used for responses. Section 4 addressed health data storage practices when collected, and section 5 assessed the current state of SMART deployment in PAs.

An introductory web page explained that the survey was voluntary, anonymous, and aimed at PADMs and that clicking the "start the survey" button constituted consent. A tutorial was provided for the language-translation tool of this survey built on Google Forms (Appendix S1). No personal information was collected, so the survey was exempt from full ethics review by the Wildlife Conservation Society's IRB (REF# 22-53).

Responses by PADMs could represent either a single or multiple PAs. For our analysis, we focused on what we defined as local" responses, which included one or two PAs. "Non-local responses", which covered more than two PAs, were analyzed separately. We assumed that PADM s responsible for more than two PAs would conduct occasional site visits and that it was unlikely they would have insights into specific PA realities (e.g., patrol findings, non-recorded data, data management, etc). However, they likely had an understanding of perceptions at central offices at the decision-making level. In contrast, we assumed "local" PADMs would work on-site and understand PA realities. The two-PA cutoff was chosen to balance maximization of the local respondent sample size with accurate classification of them. We discarded responses that pertained only to marine PAs (determined based on the World Database on Protected Areas; https://www.protectedplanet.net/en/thematic-areas/wdpa?tab=WDPA) because marine PA management, species, and patrol logistics are markedly different from those in terrestrial PAs. The descriptive analysis of survey responses was conducted in R 4.3.1. The responses dataset is available from https://figshare.com/s/36513db82ac5dfa8e71d?file=49682265. Descriptive analyses can be found at https://github.com/dmontecino/SMART_survey.

Results

We received 128 responses. Forty-two were removed because either the PA name or names were not provided, the PAs were marine, or respondents did not match the target audience (8, 7, and 27, respectively). The final dataset contained 86 respondents from from 23 countries. Seventy-three were local responses, 67 surveys pertained to a single PA, and 6 pertained to 2 PAs. Local responses came from 19 countries. There were 13 non-local responses from 10 countries. The names of the countries are not provided to protect the identity of the respondents, but local responses were from North, Central, and South America (n=45); West, Central, East, and Southern Africa (n=16); Southeast and Southern Asia (n=11); and Europe (n=1). Most responses came from South America. Non-local responses were from West, Central, and East Africa (n=6), Central and South America (n=3), and Southeast and Southern Asia (n=4).

Perceptions of wildlife health importance

Most respondents either strongly agreed or agreed with the statements "Wildlife health, including infectious and non-infectious diseases, is important to achieve the conservation goals of the protected areas where I work." and "Human or livestock pathogens can affect wildlife populations inhabiting the protected area(s) I work in." (92% and 81%, respectively). Regarding the affirmation "Pathogens carried by wildlife inhabiting the protected area(s) where I work in can affect livestock health.", 48% of respondents strongly agreed or agreed and 29% neither agreed nor disagreed (e.g., were neutral). Across respondents, 63% strongly agreed or agreed that "Pathogens carried by wildlife inhabiting the protected area(s) where I work in can affect human health." Neutral responses were 19%. Detailed distributions are shown in Figure 1. Non-local responses followed similar trends; neutral responses were proportionally fewer (Appendix S2).

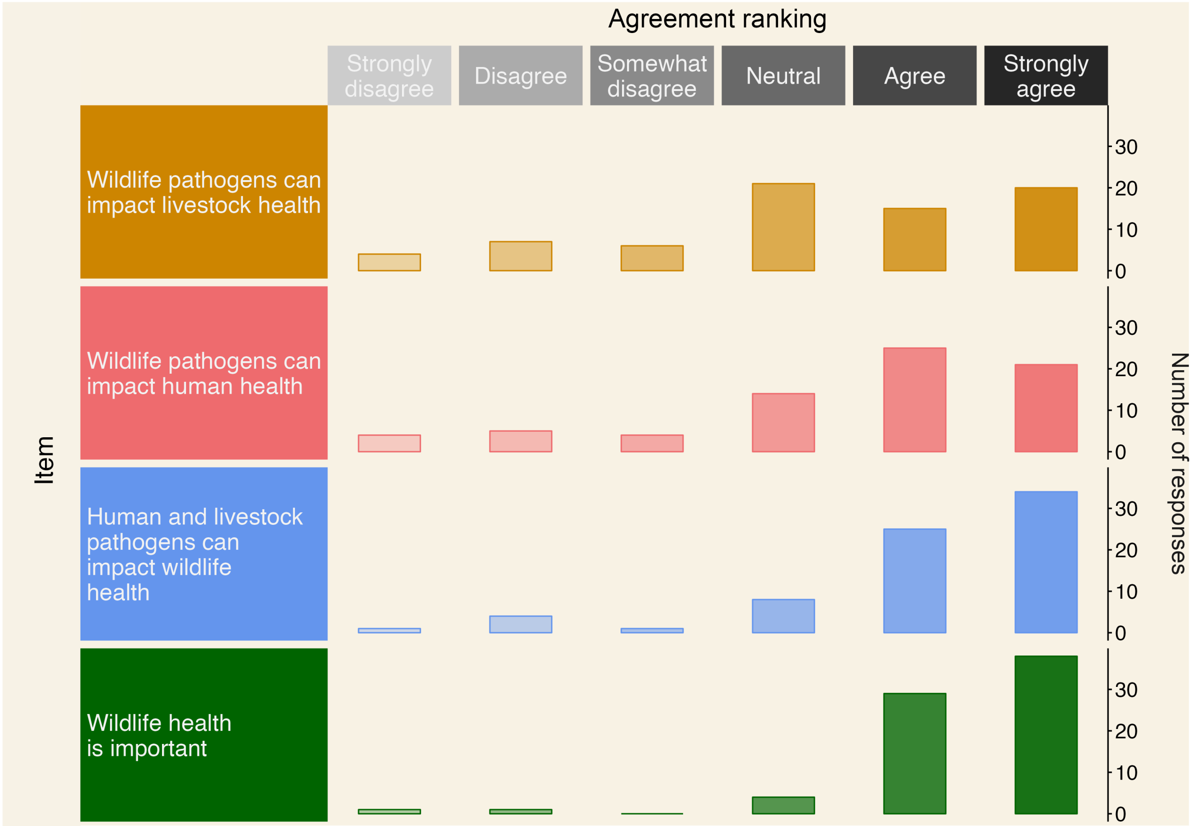

Figure 1: Level of agreement (grey scale) among local protected area data managers with the statements "Pathogens carried by wildlife inhabiting the protected area(s) where I work in can affect livestock health." (brown), "Pathogens carried by wildlife inhabiting the protected area(s) where I work in can affect human health." (red), "Human or livestock pathogens can affect wildlife populations inhabiting the protected area(s) where I work in." (blue), and "Wildlife health is important to achieve the conservation goals of the protected area(s) where I work," (green). Overall frequency of encounters with sick and injured wildlife was requested in a unique question; therefore, rows one and two show the same total number of responses per encounter category.

Encounters with injured, sick, or dead wildlife and documentation

Most local overall frequency-of-encounter responses concentrated between "very rarely" and "occasionally" (Figure 2). Seventy-six percent of local PADMs reporting the encounter of dead animals in the PAs (e.g., responded "very rarely" or more frequently) indicated that these encounters were documented. Forty-nine percent of local PADMs reporting encounters with injured or sick animals and 35% reporting encounters with sick animals in the PAs confirmed their documentation. In general, the documentation of injured, sick, or dead animals tended to be higher as the encounter frequency increased from "very rarely" to "very frequently". For example, the percentage of local responses reporting the documentation of sick animals as "very rarely" was <20% versus >50% for the encounter frequency "very frequently" (Figure 2). All non-local PADMs reported the encounter with injured or sick wildlife and dead wildlife. The percentages of non-local PADMs reporting the documentation of these animals were larger compared with local responses (85%, 62%, and 92% for injured, sick, and dead wildlife respectively; Appendix S3).

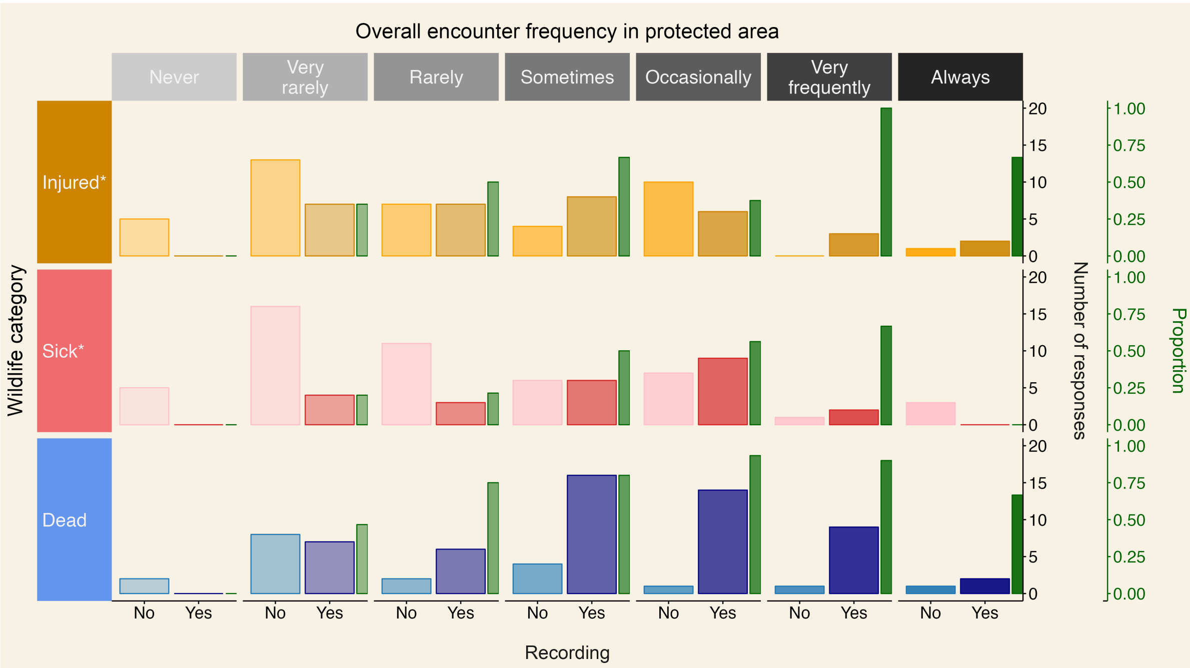

Figure 2: Number of local protected area data managers who reported that the health status of and frequency of encounters with wildlife are recorded or not recorded in the protected area they worked in. Green bars represent the proportion of respondents that reported recording of wildlife in each category.

All 17 local PADMs who indicated encountering dead wildlife "very rarely" or more frequently but answered that these animals were not documented, either agreed or strongly agreed with the importance of WH to achieve conservation goals. Similarly, 94% of local PADMs who indicated encountering injured wildlife "very rarely" or more frequently but answered that these animals were not documented, either agreed or strongly agreed with this statement. For sick wildlife, the percentage was 91%. The corresponding percentages for non-local PADMs were 50%, 80%, and 0% for injured, sick, and dead wildlife, respectively.

Documentation methods

The documentation method of injured, sick, or dead wildlife varied among the 58 local PADMs that reported the recording of one or more of these groups. Most often, each animal was documented individually ("individual observation"). The second most common method was a complete inventory of healthy, injured, sick, or dead animals for each species. Reporting their presence or absence was the third most common method (Figure 3). For non-local responses, the predominant method was "each animal is an individual observation" across health categories (Appendix S4).

The items recorded from each observation were not consistent across responses (Figure 3). Photographs and the species were the main items collected across documentation methods and health categories. Anomalies observed in unhealthy wildlife (e.g., sick or dead) and the condition of carcasses were not always recorded (Figure 3). In non-local responses the trend was relatively similar; however, items were reported as being recorded more consistently (e.g., age, anomalies, and condition in the three health categories; Appendix S4).

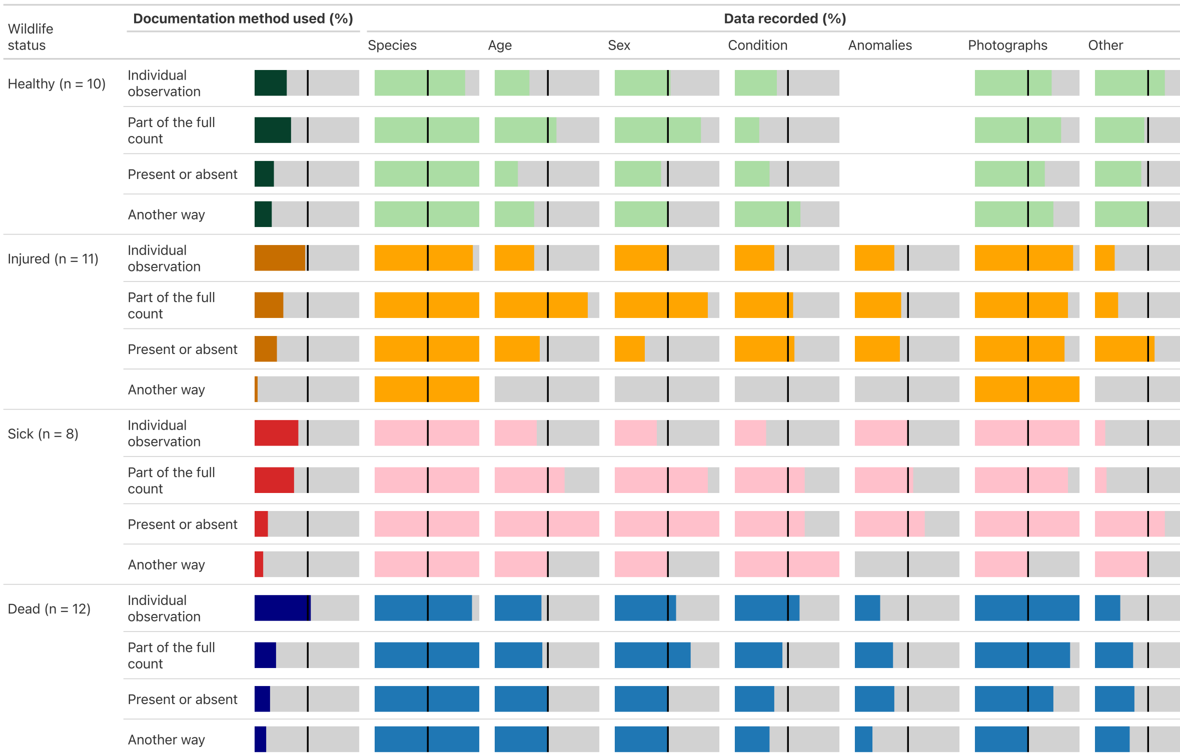

Figure 3: Distribution of the methods of documentation (second column) of healthy, sick, injured, or dead wildlife found during ranger patrols as reported by local protected area data managers and the recording of specific types of data for each wildlife health status across documentation methods (black line, 50%).

Domestic animals in protected areas

Fifty-two local PADMs (71%) responded that domestic animals were found in their PAs. Among them, 67% reported that domestic animals were documented if observed during patrols, and 26% reported recording of their health status (Figure 4). Forty-two local respondents reporting domestic animals in the PAs (81%) either agreed or strongly agreed that domestic animals are a conservation concern (Figure 4). Twenty-seven of them (64%) answered that these animals were documented. Fourteen out of 21 respondents claimed that domestic animals are not found in the corresponding PAs and either agreed or strongly agreed that they are a conservation concern (67%).

Eight non-local PADMs (62%) responded that domestic animals were found in the PAs. Among them, seven (88%) reported that domestic animals were documented if observed during patrols, of which only two (29%) reported recording their health status (Appendix S5).

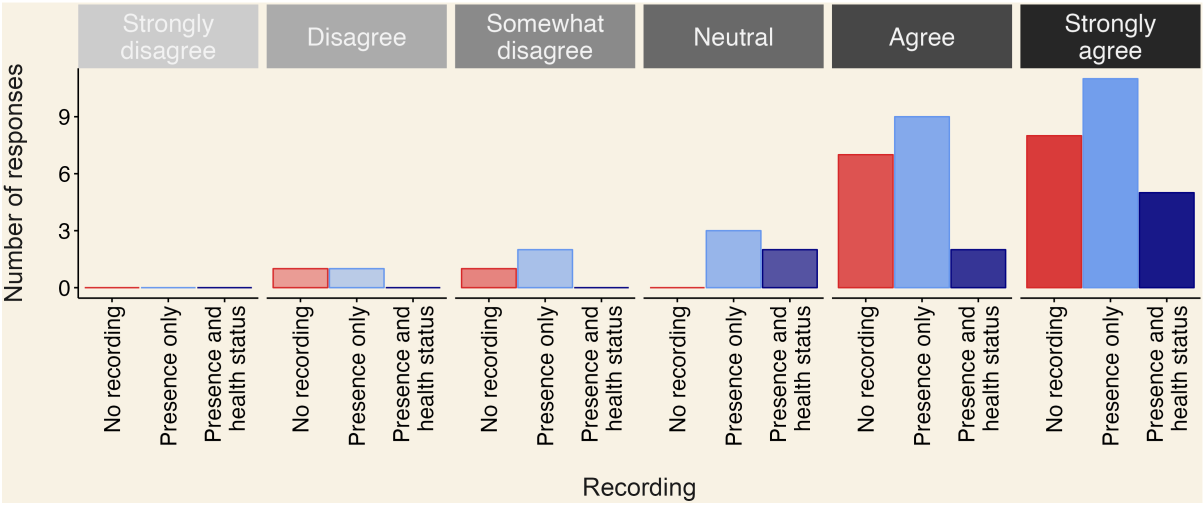

Figure 4: Responses of local protected area data manager to statements that the presence and health of domestic animals in protected areas is a conservation concern (red, no recording of domestic animals; light blue, recording of domestic animals but not their health status; dark blue, recording of domestic animals and their health status). Data are from the group of protected area data managers who reported the presence of domestic animals in the protected area.

Health data storage practices

Seventy-three percent, 54%, and 65% of local PADMs reported the documentation of injured, sick, or dead wildlife being stored in a SMART database. Paper forms, reports, and spreadsheets were employed when unhealthy wildlife were documented, but their data were not stored in a SMART database.

Thirty-one of the 35 local respondents (100%) recording domestic animals during patrols indicated that this information was stored in a SMART database. The health status of domestic animals, when documented, was also stored in a SMART database.

Discussion

Our findings suggest that syndromic WH surveillance data are not collected or lost due to inadequate management. Even when WH data are collected and properly managed, the usefulness for surveillance is likely limited by the diversity of methods employed to record them. By the time of the survey, an initiative to foster the harmonized recording of WH data in PAs (Montecino-Latorre et al. 2024 [preprint]) had been implemented in a couple of sites only in a single country, and it did not affect overall results involving multiple PAs and countries.

The PADMs largely considered WH relevant to conservation goals of PAs. However, several local PADMs expressed neutral views on the potential impact of wildlife pathogens on human and livestock health. Local PADMs and field staff could be exposed to zoonotic pathogens (Adjemian et al. 2012). It is essential to provide rangers with training in biosecurity measures to mitigate these risks.

Most PADMs confirmed that unhealthy wildlife were encountered. However, the percentage of local PADMs who agreed or strongly agreed that WH is relevant for the conservation goals of PAs was higher than the percentage of those reporting the recording of unhealthy wildlife. In other words, the perceived importance of WH did not translate into reporting. This contradiction was also observed in the responses specifically reporting the encounter of unhealthy animals but not their documentation. This discrepancy could be explained by recent global pathogen-driven crises, such as SARS-CoV-2 and H5N1 highly pathogenic avian influenza virus (Nicola et al. 2020; Leguia et al, 2023). It might also be explained by other morbidity or mortality events of different etiology that our audience was sensitized to at the time of the survey but before health-associated monitoring objectives could be planned and implemented. These findings could also suggest a lack of knowledge or resources to act on their understanding of the importance of WH for conservation goals.

More non-local respondents reported the documentation of non-healthy wildlife than local respondents. This difference could be explained by non-local and local responses coming from different PAs or it could represent differences between the expectations of managers in an administrative role (non-local PADMs) and field realities in PAs (local PADMs). For example, the mandate to record non-healthy animals may exist, but it is not pursued in practice because of limitations regarding WH training, the use of a recording tool, comprehension of the methodology to record these data, or willingness to record these data (Wilfred et al. 2019; Kavhu & Mpakairi 2021). If any of these cases exist, PA management agencies should take a more active local role in identifying and correcting weaknesses in WH data collection.

We noted a general agreement among PADMs regarding the conservation threat domestic animals (e.g., dogs, cats, cattle) present. Although we did not explicitly ask why domestic animals are a conservation concern, most PADMs also agreed with the statement "Human and wildlife pathogens can impact wildlife health." whether these animals were found in the PAs or not (Appendices S6 and S7). Pathogen transmission from domestic animals to wild animals can seriously harmimpede biodiversity conservation, including in PAs (Porco et al. 2023), and they add to the pressures on wildlife from domestic animals in- and outside PAs (e.g., predation, competition [du Toit 2011; Gompper 2013]). The observed contradiction between perceived conservation risk of domestic animals and documentation of their presence and health status could be explained by the same drivers mentioned above.

Effective management of data and harmonization are foundational pillars for WH monitoring (World Organisation for Animal Health 2010, 2015, 2018; Sleeman et al. 2012; Ryser-Degiorgis 2013; Stephen 2018; Machalaba et al. 2021; Stephen & Berezowski 2022; Giacinti et al. 2022; Hayman et al. 2023; Heiderich et al. 2023). However, we identified challenges in WH data harmonization and governance that align with historical pitfalls in WH surveillance (Carmichael

2012; Cardoso et al. 2021; World Organization for Animal Health 2023; Heiderich et al. 2023; Suwanpakdee et al. 2024). When healthy and unhealthy wildlife were have been documented, inconsistencies in data structure and attributes were present. The lack of harmonization across PAs, within and beyond country borders, diminishes the value of collected health data, making transboundary health assessments challenging. Similarly, tracking WH trends over time becomes infeasible. Additionally, records of unhealthy wildlife could be stored in paper forms or Excel sheets rather than a SMART database. Data in paper forms or Excel sheets can be uploaded to a SMART database manually by filling specific fields or through a mobile application (SMART Mobile) designed to capture data as determined in the corresponding SMART database (Cronin et al. 2021). Consequently, WH data in paper forms and spreadsheets reflect that they were not considered in the PAs' SMART databases. We did not ask about the use of SMART Mobile, but challenges in its adoption have been described (Wilfred et al. 2019; Kavhu & Mpakairi 2021; Wyatt et al. 2023).

This is the first account of WH perceptions and monitoring practices in PAs. Because survey respondents were contacted through the SMART Partnership, survey respondents may not fully represent the broader population of local and non-local PADMs. Ideally, a follow-up longitudinal study and respondents selected through random sampling from a sampling frame, including local and non-local PADMs of the same PAs, could further refine and enhance our initial insights. This approach could also identify geographic differences and associations between distance patrolled per time unit, landscape type, and fauna size in the overall encounter rates with health and unhealthy wildlife and domestic animals. Potential differences in reporting as a consequence of experience with the recording tool used (SMART Mobile or other) should also be assessed.

Leveraging existing PA human resources who can detect morbidity and mortality in animals offers a cost-effective strategy to establish minimal WH monitoring. Rangers can detect non-healthy animals in PAs, and they have provided data to assess health risks and trends or trigger responses to disease outbreaks (Wolf et al. 2019; Vila et al. 2019; Kuisma et al. 2019; Orozco et al. 2020; Montecino-Latorre et al. 2020; Porco et al. 2023).

Our recommendation is to include standardized WH monitoring in the remit of rangers following a unified methodology and standards. Currently, there are approximately 280,000 rangers worldwide, and 1.5 million will be needed to protect 30% of the planet by 2030 (Appleton et al. 2022). The present and projected number of rangers reveal their unique potential as a worldwide One Health workforce that could drastically improve WH and One Health surveillance (Machalaba et al. 2021; Hopkins et al. 2024; Montecino-Latorre et al. 2024 [preprint]; World Organisation for Animal Health & International Union Conservation of Nature 2024). However, our findings suggest that several problems must be addressed first.

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